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Bei Erweiterung des Wissens macht sich von Zeit zu Zeit eine Umordnung nötig, sie geschieht meist nach neueren Maximen, bleibt aber immer provisorisch.
Johann W. von Goethe

Form follows function, but not very far.
Zwicky and Zwicky (1980)

Kas, menninkäinen ennen päivänlaskua ei voi, milloinkaan elää päällä maan.[1]
From ‘Päivensäde ja Menninkäinen’; Text: Reino Helismaa, Interpretation: Tapio Rautavaara

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This work is dedicated to the beauty of language.

[1] A troll cannot stay above ground before sundown.
Der Menninkäinen kann vor Sonnenuntergang niemals draußen, auf der Erde, sein.

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List of Abbreviations

ET	Element Theory
GP	Government Phonology
OT	Optimality Theory
PBOT	Phonetically Based Optimality Theory
SPE	Chomsky and Halle (1968)
BG	Boundary gemination
FEN	Final empty nucleus
FNA	Finnish nasal place assimiliation
IEC	Initial Empty Consonant
ME	Melodic expression
SF	Standard Finnish
gov	government
lic	licensing
m-licensing	melodic licensing
Pl	plural
Px	possessive suffixe
Sg1	First person singular
ACC	genitive marked direct objects
ADJ	genitive marked adjectives
GEN.ATTR	attributival genitives
ill	illative case
ine	inessive case
nom	nominative
pass	passive/impersonal

Outline

This thesis is composed of four chapters taking four perspectives on the phenomenon of Finnish nasal place assimilation (FNA). These four chapters give a broad perspective on nasal place assimilation in Finnish and discusses generative formalisation of typological patterns. Particular focus is dedicated to place assimilation in Government Phonology (Kaye et al., 1990), which, aside from a few notes in Backley (2011), still lacks a substantial treatment of place assimilation.
The study of segmental durations in Finnish genitives in Chapter 4 examines the role of sentential stress and syntactic configurations in relation to speaker and speech rate specific patterns in the reduction of the nasal.

Chapter 1 gives an overview of the typological claims and both their generative and phonetic explanation. In light of this overview, the role of phonological formalism is reevaluated. It will be argued that formalisation remains a valuable source of hypotheses on potential explanations in phonology, if they are used not as a substitute but as an abstraction and extension of these insights.

While more and more insight is gained on the phonetic precursors of patterns in place assimilation, it still is an open question why assimilation occurs at all. Commonly a conflict is assumend between with the wish to be understood and the wish to reduce articulatory effort. However, also non-teleological models have been developed, for example in (Ohala, 1990). Moreover, how articulatory ease is processed, when speakers decide to simplify their task of articulation, is still a very open debate that is only touched upon in this thesis.

Chapter 2 introduces the Finnish data and discusses dialectal variation and potential influences on assimilation rates in production. Further, a brief introductory overview on Finnish dialects is given. It shall be highlighted that the generalisations made on influences in place assimilation in work as old as Ikola (1925) for Finnish are by and large confirmed by present day research on languages such as German (Bergmann, 2012).

Chapter 3 gives an analysis of Finnish nasal place assimilation in the framework of Government Phonology, and discusses the problems encountered trying to capture the phenomenon. Formal devices are developed, which seem to be extendable to represent typological pattering while providing phonetic grounding as discussed in chapter 1.

Chapter 4 provides a detailed phonetic description of FNA as well as a study of the influences of syntactic position and thus sentential stress on durational reduction in Finnish nasals. It will be shown that both speaker and speech rate specific factors seem to interplay in shaping reduction patterns in place assimilation. Also, an outlook is provided on necessary refinements of the study to provide a better understanding of the phenomenon.

Chapter 1

Theoretical considerations regarding place assimilation

The study of place assimilation phenomena has led to the consensus that cross- linguistically frequent patterns are shaped by requirements and properties of human perception. Kohler (1990) promotes the view that place assimilation is best understood as a perceptually tolerated articulatory simplification. The production hypothesis stated in Jun (1995) claims that weaker acoustic cues are more likely to be reduced articulatorily. Steriade (2001) proposes a P-map storing information on which segments are similar and how context influences these similarities.

It is argued that irrespective of the type of formalism that is used, more theoretic analyses of place assimilation (and probably assimilation in general) differ more importantly in the question about phonetic grounding, i.e. if and how phonetic knowledge and observation is, can and should be incorporated into the formalisms. It will be shown that plain formalist accounts prove insufficient to capture typological patterns satisfactorily.

Jun (1995) argues for an approach using Optimality Theory (OT) that seeks to explain typological generalisations on place assimilation (see below in 1) by representing the perceptual salience of articulatory features as universal constraint rankings. This differs from the perspective taken in Padgett (1994), who prefers a purely formal approach using a modified feature geometry in a rule based system to capture the fact that fricatives do not trigger nasal place assimilation as widely as stops or nasals do.

Baković (2007) considers a similar set of typological generalizations, and devises a ranking of formal constraints that replicate them. Yet, both Padgett and Baković also turn to phonetic explanation to explain residual data.

The insight that emerges from comparing these approaches is that purely formal theories have to assume a clear cut separation between phonetics and phonology, which may be hard to maintain given recent results on simulation of emergent systems (De Boer, 2000). Moreover, when trying to account for typologies using abstract formalisms, redundancies are introduced into linguistic theory, as both phonological theory as well as phonetic observation offer answers as to why certain patterns of sound systems are abundant, while other similarly conceivable patterns are not.

This chapter will proceed to present the well known typological generalisations on place assimilation asymmetries (Mohanan, 1993). This will be followed by a review on their potential phonetic explanations based largely on the review given already in Jun (1995) and a comparison of the approaches mentioned above in more detail.

1.1 Typology of variation

Place assimilation phenomena in the world's languages are subject to hierarchical asymmetries concerning phonological properties of the target and the trigger as well as the direction in which place assimilation occurs. For example, nasals and stops are more likely to be targets of place assimilation than fricatives or non-nasal sonorants. Similarly, stops and nasals are more often found to trigger place assimilation than fricatives. These asymmetries are not restricted to manner of articulation, but also place of articulation is influential on the likelihood of assimilation. Velars or labials are typically more likely triggers of place assimilation than coronals, whereas coronals are more likely to undergo place assimilation as compared to velars or labials.

Mohanan (1993) compiles these typological observations into implicational statements. Here, I will reproduce the roughly equivalent rearrangement of the formulations proposed in Jun (1995, p.78ff), where Jun also takes into account additional data of his own survey.

(1) Asymmetries in Place Assimilation (Jun, 1995, p. 78f)

- a. Target Place
  - i. If velars are targets of place assimilation, so are labials.
  - ii. If labials are targets of place assimilation, so are coronals.
- b. Target Manner
  - i. If fricatives or nonnasal sonorants are targets of place assimilation, so are stops.
  - ii. If stops are targets of place assimilation, so are nasals.
- c. Trigger Manner
  - i. If nonnasal sonorants trigger place assimilation, so do nasals and fricatives.
  - ii. If nasals or fricatives trigger place assimilation, so do stops.
- d. Trigger Place
  - i. If coronals are triggers, so are velars.
- e. Syllable position
  - i. If the onset is a target of place assimilation so is the coda.

Such regularities are not restricted to alternations alone, they can be observed already in the organization of the lexicon before any alternation takes place. They shape sets of consonant clusters and consonant inventories. It is, for example, a well documented observation that for each language, the set of coronal consonants is larger than the set of consonants of any other place of articulation.

Nasal-obstruent clusters are mostly homorganic, but also more complex restrictions are reported. In English (Mohanan, 1993), coronal nasals must not precede a non-coronal obstruent. Cross word-boundary assimilation patterns also reveal that a similar restriction does not hold for a word-final velar nasal, which does not assimilate facing a word initial non-velar stop as for example in *kiŋpaul* (*ki[mp]aul; *'king Paul'*).

Similar asymmetries can be found in German were heterorganic nasal-obstruent clusters are mostly disallowed. Only a bilabial nasal can occur lexically in such clusters, cf. *He*[*m*]*d* ('shirt') or *I*[*mk*]*er* ('Beekeeper'). A further restriction seems to be that only labial-coronal nasal-obstruent clusters seem to be allowed without an intervening syllable boundary (cf. *[mk#]). A final velar nasal of a first member of a compound never assimilates when followed by a non-velar stop, *Langbank* [laŋbaŋk] *[lambaŋk] ('gymnastics bench'). Even though the final segment of 'lang' is a velar nasal, there is some debate as to whether this nasal is in fact phonologically best represented as a nasal-obstruent cluster (von Isacenko, 1970), which could naturally block assimilation. Irrespective of this debate, however, such clusters can in fact undergo place assimilation if they are both coronals. In very casual speech a similar final coronal nasal-obstruent cluster can undergo assimilation as in *Handball* [hambal] (with possible gemination of the labial plosive) ('team handball') (cf. [hant] 'hand' in isolation).

The same pattern (expectedly) prevails across morpheme boundaries. In the verbal prefixes *um-*, *herum-* the final labial nasal never assimilates to the following verb, whereas in prefixes with a final coronal nasal *an-*, *heran-*, *ein-* place assimilation will occur irrespective of whether the following consonant is a stop or a fricative. On the level of the lexicon, nasal-fricative clusters do not show restrictions regarding place of articulation. Coronal nasals may be substituted with a place assimilated alternant when followed by a fricative, as can be seen in (2), whereas labial nasals do not change.

(2) German nasal-fricative clusters

manch	[manç] / [maɲç]	*'some'*
Senf	[zɛnf] / [zɛɱf]	*'mustard'*
Amsel	[amzəl] / *[anzəl]	*'turdus merula'*

The German pattern is by no means unique. As the English evidence shows, parallel cases can be found in language after language, providing further instantiation of asymmetries in place of articulation.

The next section will present the most prominent hypotheses regarding the connection of perceptual knowledge and place assimilation typologies. It will also try to shed light on how these hypotheses shape the theories built upon them and illustrate the type of data each of these phonological theories use as their basic evidence.

1.2 Functional hypotheses on assimilation

1.2.1 Ease of articulation

In the view articulated in Zipf (1935), the connection between assimilation and ease of articulation is twofold. On the one hand, there is a direct relationship in cases like nasal place assimilation, where, for example, in the sequence [mb] much of the articulatory configuration needed for the pronunciation of [b] is already anticipated in the pronunciation of the nasal. Another, more indirect relationship between ease of articulation and assimilation is implied on page 109, where assimilation is described as a weakening or instability of the target. This weakening is caused by the target's relative frequency. Relative frequency - in turn - is an effect of ease of articulation, as smaller gestural *magnitude* (complexity) correlates with a higher relative frequency of a sound.

1.2.2 The role of perception

However, ease of articulation alone is at least insufficient to explain patterns in place assimilation, maybe (Ohala, 1990) even unnecessary. For example, it fails to explain that while nasal-stop clusters are mostly homorganic, fricative-stop clusters do not share this tendency, in other words, it fails to explain the asymmetry of target manner. Also, as Ohala (1990) argues, ease of articulation is insufficient to explain the directional pattern, i.e. why, given a cluster C1C2, it is C1 which adapts the place of articulation of C2, but not vice versa? Ohala (1990) reviews perceptual studies using splicing experiments and concludes that more than one factor may be responsible for the overwhelmingly retrograde nature of place assimilation:

First, place of articulation of C2 may be more dominant than cues of C1, because the acoustic of C1 information is more recent and thus more prominent in memory. This seems to be corroborated by the findings in Fujimura et al. (1978), where it was shown that even in C1C2 clusters with the burst excised from the stimulus, the formant transitions into the following vowel dominate the perception of place of articulation. On the other hand, there could be an intrinsic difference in the quality of VC vs. CV transitions, as the latter usually contain place cues of the burst. Unreleased stops - as they typically occur in C1 of a C1C2 cluster, are frequently misidentified, as they lack the salient place cues contained in the burst (Malécot, 1958). Third, linguistic experience influences the cues listeners pay most attention to. This is at play, Ohala argues, in the case of the experiment in (Fujimura et al., 1978) where reverse playback stimuli provoke different reactions from Japanese and English native speakers respectively. However, see Mitterer et al. (2006) for a different claim regarding assimilation patterns of sonorants in Hungarian and Dutch. Also, Steriade (2001) argues similarly that speakers weigh CV transitions more strongly than VC formant transitions, since CV transitions usually contain the most reliable place cues - namely the burst.

In the construction of phonological theories, however, debate is focused on a more basic aspect of explanation. The narratives of how speakers store, use and gain knowledge about perceptual prominence of segments differ quite considerably from theory to theory. Moreover, it is debated whether such knowledge is necessary at all (Ohala, 1990).

Honest misperception Ohala (1990) proposes that all sound change and alternation is due to honest mistakes on behalf of the listener. In C1C2 clusters the place cues of C2 dominate the perception of place of articulation of both consonants. This explicitly goes against a teleological view that speakers strive to simplify their task of articulation, or enhance ease of perception for the listener. Instead, misperception which are shaped by perceptual factors, cause sound change to proceed in cross-linguistically similar directions.

A view closely related to the ideas in Ohala (1990) is examined amongst others in De Boer (2000). He examines the potential of self-organization in computer simulations to account for the emergence of human-like vowel systems without the need to store knowledge about perceptual similarity. Crucially, the model assumes a non-verbal feedback process informing the agents whether a vowel was correctly understood by the other agent. The nature and prevalence of such feedback processes in humans is, to my knowledge, an open debate.

A similar view also underlies the framework of Evolutionary Phonology (Blevins, 2004, 2006), where properties of human perception are (among other factors) responsible for cross-linguistic similarities and variation. However, core phonological knowledge is only invoked in the theory if other explanations cannot be found.

Knowledge based accounts A hypothesis, which focuses on general auditory constraints and processes, is the production hypothesis put forth in Jun (1995, p.42). It implicitly harbors the claim that speakers can access knowledge about the perceptual salience of cues. However, it does not qualify that knowledge more precisely.

(3) Production Hypothesis
Speakers make more effort to preserve the articulation of speech sounds with powerful acoustic cues, whereas they relax in the articulation of sounds with weak cues.

Thus, speakers, when spending an average amount of effort on every segment of a sequence, are bound to produce, as Jun explains in a footnote, a sequence where strength of place cues varies from segment to segment, since speech sounds inherently differ in perceptual salience. When a speaker reduces articulatory effort, these reductions will target segments which are already less prominent perceptually.

However, it is unclear, why the production hypothesis is a hypothesis after all. Given that place assimilation patterns and their explication in terms of perception are already known, the hypothesis adds little new territory. One may argue that the hypothesis allows widening of the empirical focus in the sense that it could potentially explain all asymmetries found in place assimilation patterns, however it leaves open the question of how and whether the speaker uses and stores the knowledge of perceptual salience.

Also, the only alternative to the production hypothesis, exemplified in (4), where speakers compensate for weaker cues by exerting more effort on their articulatory correspondent gesture, is empirically wrong. So the production hypothesis much more appears to be a conclusion.

(4) Alternative (implausible) production hypothesis
Speakers relax to preserve the articulation of speech sounds with powerful acoustic cues, whereas they make more effort in the articulation of sounds with weak cues.

It thus seems that there are not many alternatives to a claim in the flavor of (3) given the data and the idea that speakers store knowledge about perceptual similarities.
Lindblom et al. (1995), in line with Kohler (1990) argues for the view that speakers adapt their speech to requirements of the listener. Alternations in assimilation produce outputs that are minimally distinct from the input, since speakers choose a pronunciation that enhances ease of perception. Alternations in place assimilation are maximally simplified articulations that are still perceptually tolerable.

In Steriade (2001), it is argued that perceived similarity between the input and output of assimilation rules increases the likelihood of the rule to apply, as speakers intend to simplify their articulation only in such a way that they do not get caught in doing so by the listener. In an additional step she posits the so-called P-map. The P-map is conceived of as a model of the knowledge the speaker uses to simplify his task of articulation, such that perceptual cues are only minimally changed. The p-map is a set of statements describing similarities of contrasts, i.e. in which contexts which contrasts are stronger (more distinctive) or weaker. This explicitly endows the speaker with the possibility of deliberation. Speakers may choose to simplify their clusters along the lines of their knowledge about the listener's needs.

Steriade (2001) bases the claim of the use of knowledge on results from a splicing experiment in Hura et al. (1992). In a perception task, speakers had to identify the final segment of the first word of two-word stimuli. Their findings indicate that misperception does not correlate with the place of articulation of the following consonant. Instead, they conclude, results seem more consistent with the assumption that speakers tend to misperceive in the direction of a default place of articulation. If assimilation should be explained to be exclusively due to misperception, without an underlying teleological aim for optimisation, one would expect misperception to tend to be of assimilatory nature, Steriade argues.

However, already Hura et al. (1992) explicitly call for caution in interpreting their results in terms of a refutation of the hypothesis in Ohala (1990), since their stimuli seem to produce a context where assimilation should not be expected, due to the too large overall length of the examined cluster.

To conclude, in most such views ease of articulation is the driving force for assimilation, whereas perceptual factors such as the dominance of place cues are responsible for the details of the asymmetries observed.

The following section briefly reviews the most widely accepted perceptual explanations for patterns relevant in place assimilation patterns of nasals, as well as point to those areas where perceptual explanation seems to be second best to explanations based on articulatory constraints.

1.3 Phonetic evidence

1.3.1 Directional asymmetry

Place cues of stops are found across three parts, only one of which being actually part of the stop itself: The formant transitions of the preceding vowel (VC transition), the burst of the stop and the formant transitions of the following vowel (CV transition). In C_1C_2 clusters where both consonants are stops, the burst of C_1 can be very short and low in amplitude or not occur at all. Further, as C_1 is followed by a consonant, there are no vowel transitions to provide information on place of articulation. Bereft of two out of three possible cues, the articulatory gesture for place of articulation of C1 carries only one perceptual cue for its place of articulation.

Phonetic precursors regarding the direction of place assimilation have been discussed, for example, in Ohala (1990). Splicing experiments in (amongst others) Fujimura et al. (1978) and Streeter and Nigro (1979) show that stops with conflicting VC and CV formant transitions are overwhelmingly identified according to place of articulation of the CV transition, even if place cues from the burst are missing. They were able to show that CV transitions dominate the perception of place of articulation for stops. Also, in reverse playback of the same stimuli, CV cues (from the originally VC transition) dominated the perception, as to exclude different intrinsic qualities of cues in VC vs CV transitions. Malécot (1958) produces support for the crucial role of the burst in identifying place of articulation in stops. Together with the weakened burst of C1, this leads to the perception of only one consonant instead of the cluster.

Another effect of relative salience of place cues, which is pointed out in Steriade (2001), is that debuccalization of stops in final position is caused by lack of the salient CV cues in the absence of a vowel following the stop.

Interpretation of this result still leaves open the question as to what makes CV cues more salient in perception. Prominence in memory or, as proposed by Steriade (2001), linguistic experience and knowledge? More precisely, she argues that people are trained to focus on CV cues since this is the region where listeners find the most reliable cue, namely the burst. Accordingly, she argues, based on phonetic evidence given in Dave (1977), that the predominantly progressive assimilatory interaction of retroflex stops with other apicals in languages, which have such contrasts, is due to place cues being more dominant in the VC transition for such consonants.

1.3.2 Target manner asymmetry

Nasal consonants are very distinct from all other consonants with the possible exception of laterals (Ohala, 1975). Amongst themselves, however, the different nasals are similar, as formant frequencies cuing place of articulation are obscured by antiresonances of the closed oral cavity as well as the softer tissues and larger surface areas in the nasal cavities. Thus, in the case of nasals, the output of place assimilation is a phone, which is acoustically similar to the input. It is this acoustic and perceptual similarity that makes such assimilation processes likely to target nasals.

In C_1 position an unreleased stop and a nasal consonant share that their place cues stem almost exclusively from the formant transition of the preceding vowel. Hura et al. (1992) showed that fricatives followed by a word initial stop are less confusable than nasals and stops, which is held to explain their unassimilability. Fricatives contain sufficient place cues in the energy distribution of the frication noise to reliably identify their place of articulation. Perception of place is not solely bound to formant transitions of the neighboring vowels. For that reason place information is more salient in continuants than in stops and nasals.
These two phonetic properties are held to provide the basis for the target manner assymetry (see also (1b)).

1.3.3 Trigger manner asymmetry - [+cont] triggers in place assimilation

Also the manner of articulation of the trigger partakes in asymmetries in place assimilation.

(5) Trigger Manner (Jun, 1995)

a. If nonnasal sonorants trigger place assimilation, so do stops and fricatives.

b. If nasals or fricatives trigger place assimilation, so do stops.

Following a perceptual hypothesis (irrespective of their detailed formulation), place of articulation of, say, nasals must be more distinguishable, i.e. cues for place of articulation more salient, before non-nasal sonorants than before fricatives and stops. However, place assimilation is but one of many alternative outcomes, if a nasal becomes adjacent to a sonorant. (6) illustrates a variety of strategies that languages use to avoid nasal-liquid clusters. The discussion here will be restricted to this type of cluster as its behavior with respect to assimilation seems clearly distinct to the behavior of nasals in nasal-glide clusters, where place assimilation seems more pervasive, or plosive-sonorant clusters.

(6) Nasals before Sonorants

a. Deletion

Malay	Onn (1978)	gloss
n+l	/pəŋ + layan/ → pəlayan	*'waitress'*
n+r	/pəŋ + rompak/ → pərompaʔ	*'robber'*
Lithuanian	Jun (1995)	
n+l	san + lyti → [sa:lytis]	*'clash, contact'*
Brussels Flemish	Jun (1995)	
n+l	een ladder → [ə̃liːʀ]	*'a ladder'*

b. Total assimilation

Finnish vernacular	Suomi et al. (2008)	gloss
/n#l/	järve[ll]aita	*'a lake's shoreline'*
/n#r/	järve[rr]anta	*'a lake's shore'*
Italian	*some dialects*	
n+l	con + la → co[ll]a	*'with the (fem.)'*

c. Post-nasal hardening

Nchufie	Jun (1995)	gloss
n+l	/a/ + /N[1]/ + /liɛ/ → [a:ndiɛ]	*'he slept'*
Shupamem	Nchare (2007)	
n+l	/in/ + /loʔ/ → in[d]oʔ	*'to leave'*
n+r	/in/ + /raane/ → in[z]aane	*'to be careful'*
Tswana	Coetzee et al. (2007)	
n+l	go + N + loma → gontoma	*'to bite me'*
n+r	n + r → [nt^h]	*no example available*

d. Place assimilation

Hindi	Jun (1995)	gloss
m+l	/sam/ + /$leek^h$/ → $sanleek^h$	*'protocol'*
m+r	/sam/ + /$reek^haa$/ → $sanreek^haa$	*'alignment'*
Inuit[2]	Bobaljik (1996)	
n+ʀ	*upənʀɑʀ → upi[ɴɴ]ɑɑq	*'spring'*

The examples in (6) largely stem from the survey in Jun (1995), who shows that non-nasal sonorants are unlikely triggers of place assimilation, which he only found in Hindi. Diachronic evidence for a similar place assimilation is construed in Bobaljik (1996), however, his conjectures are based on, as he admits, non-standard assumptions about the interpretation of the data in the Inuit dialect continuum.

[1]Capital N is used for phonologically placeless nasals.

[2]This phenomenon is not a synchronic alternation but a diachronic development development having occured in the development from Proto-Eskimo to the modern dialect groups 5-9 according to Bobaljik (1996)

Another fairly typical effect is, what Jun labeled 'post-nasal hardening', which is illustrated in (6c). In post-nasal hardening the liquid hardens typically to a voiced stop upon contact with the nasal, however postnasal devoicing is also attested for Tswana. Another diachronic example is Greek 'andros' (nom. aneēr), where the plosive arose by syncope of the vowel separating the nasal and the final r.

When a nasal is deleted before a sonorant, as in (6a), there is - again - variation in detail. In Brussels Flemish one finds nasalization of the preceding vowel, in Lithuanian compensatory lengthening, and in Malay no compensation at all. The case of Malay offers the additional facet that voiceless obstruents are deleted after causing place assimilation of the nasal.

The Finnish example can also be viewed as deletion with subsequent compensatory cross-boundary lengthening. This view will be explored in Chapter 3, where an analysis of the phenomenon in Government Phonology is sketched.

In the survey given by Jun (1995), the most common pattern of alternation in nasal-liquid clusters is that nothing happens at all. This is readily explained by the fact that the most common nasal is the coronal nasal. Thus, in most cases nasal-liquid cluster are already homorganic. Moreover, nasals are subject to the place asymmetry stating that labials and velars do not as readily undergo place assimilation as coronals do.

Possible phonetic explanations

The three distinguishable general patterns of nasal deletion, hardening of the lateral and place assimilation, however, must be derivable from more basic properties of articulation and perception.

'Post-nasal hardening' or intrusive stops typically occur before fricatives (cf. English 'warmth' [wɔɹmpθ]), and results from a lack of synchronization of velar closure and the oral gesture following the oral occlusion of the nasal (Ohala and Ohala, 1993). This type of stop epenthesis is commonly described as a phonetic, articulatory process. Similarly, in nasal sonorant clusters, depending on the timing of the velar closure, i.e. raising of the velum to shut off the nasal cavity, a burst sound may occur. If this burst is sufficiently audible, it can enforce the perception of a - typically voiced - stop intervening between the nasal and the sonorant. Also, Jun (1995) argues, this possible nasal burst may contain sufficient information to cue place of articulation and reduce the likelihood of place assimilation.

Thus, the behavior of a nasal-liquid cluster is crucially dependent on the timing of the velar closure relative to the oral articulatory gestures. If the closure of the nasal port occurs before the change in the oral articulation, epenthetic stops can occur. If the oral gesture of C2 precedes the change in nasality, either place assimilation or nasalisation of the following consonant occurs, as for example in Korean (Iverson and Sohn, 1994). Cases of total assimilation, like the Finnish case, occur when nasality is present, but the oral occlusion never occurs. Such a case will be demonstrated in 4.2, where it is shown that in Finnish nasal-fricative clusters, oral occlusion is often insufficient to allow segmentation of the nasal from the preceding vowel, while at the same time a minor amount of frication is present already before the fricative. In nasal-liquid sequences, articulation of [l] is similarly anticipated yielding a nasalised liquid, which may or may not subsequently lose its nasality.

The most likely explanation for the asymmetry is not based in perception but in articulation. Byrd (1996) showed that clusters containing fricatives show less articulatory overlap than clusters containing plosives. This goes against Jun (1995) who argues that all asymmetries are based on perceptual factors. The lesser overlap may well be due to the fact that fricatives lack a holding phase, during which movement of the articulators remains largely without accoustic consequences, and can thus proceed more slowly. Thus imprecision in gestural timing for nasal-stop clusters only varies the time when place of articulation changes, which may or may not influence the nasal. For nasal-fricative clusters the changes due to imprecision range from a nasalised fricative to intrusive stops. Thus the amount of *chaos* that threatens nasal-continuant clusters may also be the cause for speakers to try to reduce articulatory overlap.

To summarise this section, it is worth pointing out that, while directional asymmetries and target manner asymmetries have been well explained by phonetic perceptual evidence, asymmetries in trigger manner arise mainly because of articulatory factors.

However, the typological situation is much less clear, as nasal-continuant clusters show a wide variety of different assimilatory patterns, where place assimilation may well be the minority. This variation is due to the relatively large effects of imprecision in gestural timing. Thus, perceptual and articulatory factors interact in such a way that salience of place features of nasals followed by [+cont] segments cannot be assessed reliably by examining typological patterning.

1.3.4 Target Place

(7) Target Place (Jun, 1995)

a. If velars are targets of place assimilation, so are labials.

b. If labials are targets of place assimilation, so are coronals.

Asymmetries in place of articulation can readily be observed with data from German prefixes in (8). But also in Finnish, the occasional loanword with a final labial (e.g. helium) will keep its final consonant's place of articulation intact (Suomi et al., 2008).

(8) Labials don't assimilate (German)

ein + kaufen	ei[ŋk]aufen	*'to shop'*
um + kommen	*u[ŋk]ommen	*'to be killed'*

Results from various studies are cited in Jun (1995) to evidence a perceptual basis of the target place asymmetry. These leave aside the differences in the burst and consider only consonant transitions. Central to the argument is the observation that **dg** clusters are more overlapped than **gd** cluster (Byrd, 1994). If this increase in overlap is due to a reduction of the coronal gesture, then such a finding is consistent with the hypothesis that unreleased coronal stops are perceptually less salient than a labial or a dorsal, and thus more likely to be. Similarly, Ladefoged (1975) notes that formant excursions of coronals are smaller. In addition, the higher velocity of the gesture contributes to a shorter, and thus less perceptible pattern in formant transitions. A summary is given in table (9).

(9) Some facts regarding target place

Coronal vs. labial/dorsal	**Labial vs. dorsal**
Coronal gestures are rapid → Fast formant transitions (Kuehn and Moll, 1976);	F2-F3 convergence; typical velar formant pattern (Jakobson et al., 1952)
Comparatively small formant excursion (Ladefoged, 1975)	
More overlap in **dg** than **gd** (Byrd, 1994)	

On the other hand, results from Hura et al. (1992) indicate a more complex picture. They found out that confusion rates in nasals are largest for velar consonants compared to labials and coronals which fare roughly the same. This sheds some doubt on arguments relating confusion rates with assimilation patterns.

1.3.5 Trigger place

Regarding asymmetries of **trigger place**, most arguments are related to similar facts. The longer and more extensive the place gestures of C2 are, the larger is also the gestural overlap. Jun speculates that C2 with slower gestures exert more influence on the formant transitions of the vowel preceding C1 than gestures with shorter movements.

Also, the empirical situation is not very clear. The only example for such an asymmetry presented in Jun (1995) is Korean, the relevant data reproduced in (10).

(10) Trigger place asymmetry in Korean

Korean	Jun (1995)	
lab+vel	/ip + ko/ → [ikko]	*'wear and'*
lab+vel	/nam + kɨk/ → [naŋkɨk]	*'the south pole'*
lab+cor	/ip + ta/ → [ipta]	*'wear+Sentence Ender'*
lab+cor	/sum + ta/ → [sumta]	*'hide+SE'*

1.4 A typology of formalisation

1.4.1 Formalism and explanation

Patterning across languages has shown that there are not only impossible and possible patterns, such as stress on all prime-numbered syllables, but there are also likely and unlikely patterns and languages. However, generative analysts were often very keen on developing formalisms that rule out certain configurations and allow others. For example, the revised feature geometry in Padgett (1994) - as discussed in (1.4.4) - eventually excludes languages where nasals assimilate to fricatives, even though it initially set out to capture a cross-linguistic typological fact that is best characterised as a tendency.

In a way, it seems that linguistic formalisms were, for a long time, caught between two poles of usage. On the one hand, they were used to formulate grammars of single languages, as for example in Wheeler (1975) and to some extent also in Karlsson (1983) or Schane (1970). Such work can be viewed to continue the tradition of grammarians such as Pāṇini. This task called for an expressive and flexible formal toolkit.

Yet, SPE (Chomsky and Halle, 1968) also had the goal to restrict its descriptive power such as to exclude impossible and unattested grammars. It was readily acknowledged that this required major additions to the basic rule notation system by the formulation of marking conventions. This addition to the theory brought about a shift of empirical focus away from phonologies towards phonology, i.e. from single languages towards the formalisation typological patterning. In underspecification theory, discussion in phonology was not about adapting the tools for the narrative, for example to make possible a description of a new breed of phenomena previously flying under the radar of linguistic scrutiny, but about finding explanations with respect to why a certain language exhibits a certain pattern. In the introduction to his Radical Underspecification analysis of Korean assimilation Cho (1988, p. 41) notes, that

> not enough attention as been paid to the task of explaining why only certain types of assimilation are found in the language, and under what conditions such assimilation takes place. This paper is an attempt to answer these questions by showing how various seemingly unrelated rules can be collapsed into one single rule of spreading specified - consequently marked - features to an adjacent unspecified segment.

This quote revealingly illustrates the role of the formalism. Such an explanatory role for the formalism has been criticised by Foley (1977, p. 4) who notes that

> whenever transformationists could ask a significant question about language, as 'Why does the laxing rule fail before dentals?' (SPE: 172), they characteristically do not ask the question but instead invent another notational device.

In his view such formalist methodology creates a lack of 'linguistic significance'. This notion shall be explicated here as the idea that explanation of phonological phenomena can not and should not be extracted from the formalisms. This is particularly true if the formalism cannot be made to match a crucial property of its correspondent dataset - the gradient and non-absolute nature of generalisations that can be drawn from the dataset. In the view pursued here, this argument extends straightforwardly to Standard Optimality Theory (see chapter 1.4.5), where this criticism would translate to the invention of new constraints.

Following such a view, formal generative analyses only mimic or illustrate phonological behavior, but fail to explain it. Kohler (1990, p. 83) notes in a similar vein:

> In spite of the usefulness phonological observations and generative rules can be put to in, e.g., text-to-speech systems, they do not explain the occurrence of reduction phenomena because they do not refer them to general principles of speech behavior that determine certain processes and rule out others. To gain these insights into the ways speech functions phonetically, and thus to achieve explanatory adequacy we have to turn to the physiological, articulatory and perceptual constraints of speech and to the social conditions that impose selection and codification on biological potentials.

1.4.2 Phonology without phonetics - 'Phonological grounding'

Foley (1977) criticised Chomsky and Halle (1968) for being 'unduly optimistic' that their theory can be saved by introducing markedness theory. He believes that concepts like natural class and natural rules are just more mythical terms for statistical frequency of patterns, and are therefore not to be part of an abstract system of phonology. Notational conventions that were intended to represent such patterns in markedness theory, he argues, should be viewed as what they are - notational conventions, and not the cause of the existence of these concepts. Strategies like correlating the number of features necessary to represent a natural class to the naturalness of this natural class are bound to be fruitless, since, as Foley (1977, p.13) argues, simplicity and economy of description is not to be confused with linguistic truth. Instead, he proposes a purely phonological theory based entirely on phonological entities which

> must be established without reduction to the phonetic characteristics of the superficial elements. Though in practice the phonological elements manifest themselves phonetically, it is quite possible to conceive of other manifestations of an abstract linguistic system. A phonological theory based on the phonetic composition of the manifest elements would exhibit the reductionist fallacy and fail to yield insight into the nature of language. (Foley, 1977, p.25)

In this view, phonology is exclusively about relations between phonetic entities.

Most commonly, the work in Foley (1977) is referred to as an example of removing phonological entities further from their phonetic realisation. This is true, yet, it merits more than mere renaming of features into Greek symbols and numbers. Aside from the criticism of the formalist methodology as illustrated above, it further provides a theory of universal phonological patterning, which draws evidence from what he calls (Foley, 1977, p. 32) *thoughtful observation of phonological phenomena*. Allowing for some liberty of translation, this is tantamount to a formal theory of typology.

The formalism in Foley (1977) is based the notion of strength and weakness, and on the inertial development principle in (11)

(11) Strong elements strengthen first and most extensively and preferentially in strong environments, and weak elements weaken first and most extensively and preferentially in weak environments.

Weakness and strength are established according to phonological behavior comparing patterns in languages, i.e. typology. Consider the lenition patterns in (12) as presented in Foley (1977, 25). Gray cells highlight places of articulation which do not lenite in the respective languages.

(12) Place asymmetries in lenition

North German		Danish		Spanish	
sagen → sa[ɣ]en	'say'	kage → ka[ɣ]e	'cake'	amigo → ami[ɣ]o	'friend'
baden → *ba[ð]en	'bathe'	bide → bi[ð]e	'bite'	vida → vi[ð]a	'life'
beben → *be[β]en	'tremble'	købe → *kø[β]e	'buy'	haber → ha[β]er	'have'

Given the data above, Foley hypothesises that the segments g, d, b are ordered in such a hierarchy that no language should be found that where for example *d* lenites but *g* does not. The weakest segment is g as it most readily is lenited, whereas d does not lenite that willingly, while b offers the greatest resilience to lenition phenomena.

The dimension of place of articulation thus projects a hierarchy labeled α and its elements receive numbers that increment with their strength. The velar is labeled $\alpha 1$, the coronal $\alpha 2$ and the labial $\alpha 3$.

Universal rules are stated as rule schemes, lenition, being one such universal rule, can then be specified as [+voice, α_n] → [+cont] / V _ V. The 'n' in α_n represents the cutoff point in the hierarchy. Languages specify the strongest segment that undergoes lenition as a value for n. The idea of universal rule types specified language specifically for their cutoff points has been taken up later also in Mohanan (1993).

However, strength and weakness are vulnerable theoretical entities, as they provide great *ease of explanation* to the lazy linguist, i.e. these notions can readily be applied to any phenomenon a linguist sees fit, since they are not grounded phonetically. Moreover, also their typological grounding is dubious, as no explicit methodology is proposed that provides a guideline of how to arrive at such hierarchies. At least none that goes beyond *careful phonological observation*[4]

[4]This conception is similar to the *phonological epistemological principle*Kaye (2005, p. 283) that lies at the foundations of Government Phonology and states that the "'only source of phonological knowledge is phonological behavior'".

While such an approach, as also Durand and Laks (2002) conclude, is not without appeal, the rejection of evidence beyond phonological patterning, deprives the theory (a) of a source of corroborative evidence for the respective hierarchies and (b) of a source of explanation.

1.4.3 Phonetics as part of phonology

The P-Map as proposed in in Steriade (2000) is a tool conceived of as a representation of a cognitive capacity that stores information on perceptual similarity in the respective contexts. The speaker is aware of this information and uses it in the formation of constraint rankings.

For example, following a vowel, the perceptual contrast between an input /b/ and an (implausible) output [m] in a putative process of final nasalisation is larger than the contrast between /b/ and [p] in a fairly standard process of final devoicing. Given that there is a phonotactic constraint banning voiced obstruents from word final positions, grammar has to direct the speaker to the phonological choice that minimally changes the input. Since both the realistic final devoicing and the implausible final nasalisation process only involve changing of one feature value[5], the speaker must consult the P-map about perceptual similarity and rank the correspondence constraint[6] accordingly. For the given case, the contrast between [b] and [m] is greater than the contrast between [b] and [p]. Thus, the correspondence constraint, which assures that the feature value [± nas] does not change in the derivation dominates the constraint, which penalises changes in [± voice].

This model, as Steriade (2000) notes, is at odds with a the hypothesis underlying the work in Blevins (2006) and Ohala (1990), where misperception, which again is naturally driven by perceptual similarity, trigger phonological change, especially diachronic change. However, it seems important to be aware that a good explanation of natural sound patterns and frequent types of sound change does not necessarily provide a good explanation for a particular sound pattern, a particular sound change, or a phonological rule.

Even though both approaches use the same phonetic evidence, their core datasets differ. While already Ohala (1990) was aiming to interpret the result with respect to its implications for diachrony, and, similarly, Blevins (2006) seeks to explain frequent patterns of sound change as a product of (amongst other factors) perceptual considerations, the framework of Phonetically Based Optimality Theory (PBOT) (Jun, 2008; Steriade, 2001) focuses more narrowly on specific patterns in languages. Still, both theories should be subject to comparison as both seek to explain typological patterning.

[5]Note that even here, residuals of the assumption that formal simplicity is in any way related to linguistic truth timidly surfaces. It warrants constant reiteration that too many hypotheses relating the nature of a formalism to linguistic patterning have been shown insufficient, and that better explanations are available. Also note that this is not an argument to abandon formalism, it merely emphasises the usage of formalism as a restrictive descriptive tool that visualises pattern otherwise unseen, and thus to generate new hypotheses on phenomena previously thought unrelated.

[6]=Faithfulness constraint

The following analyses exemplify how various traditions, irrespective of their theoretical orientation, fall back on phonetic explanation for at least some parts of the paradigm that is under analysis. Further, they show that a completely phonetically based analysis can help to visualise the forces behind the observed patterns and allow for more precision and accuracy in giving explanations why such patterns exist. Moreover, especially the work of Jun (1995) and subsequent work of Kirchner (2004); Jun (2008); Steriade (2001) provides a formalism that serves to point to where phonetic research may still be trailing, as for many of the observed asymmetries (e.g. trigger manner) there is only a limited amount of phonetic evidence, compared to other asymmetries (e.g. direction, target manner) where the phonetic research is utterly unanimous.

1.4.4 Trigger manner in Feature geometry - Padgett (1994)

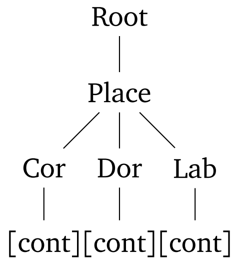
While the framework of feature geometry (Clements, 1985) has significantly improved ease of representation of phenomena of place assimilation, attempts at capturing typological generalisations are scarce. Most prominently, Padgett (1994) attempted to formalise the typological observation that nasal place assimilation to fricatives is comparatively rare. Instead, nasals, when followed by a fricative, are frequently deleted, undergo assimilation but simultaneously cause preocclusion of the fricative, or remain unchanged. This is illustrated for English by the data in (13).

(13) No place assimilation to fricatives in English Padgett (1994, p. 471)

a.		b.	
confess	*coɱfess	complacent	*conplacent
confederacy	*coɱfederacy	composite	*conposite
confirm	*coɱfirm	compassion	*conpassion
convert	*coɱvert	combust	*conbust
convoke	*coɱvoke	combine	*conbine

Padgett proposes a revised feature geometry (see 14) where stricture is dependent on place of articulation. In particular he argues that[± cont] must be dominated by the place feature. For nasals [± cont] will always be specified as [- cont] by virtue of the marking convention in (15).

(14) Stricture as a daughter of the place node (Padgett, 1994)



(15) Marking Convention
If [+nas, +cons], then [-cont]

This marking convention is designed to rule out spreading of the place feature of a fricative to a nasal, since this, given the proposed geometry, would yield a [+nas, +cont] specification. However, it is conceded that English place assimilation to fricatives does occasionally occur, as (16) serves to show.

(16) Labiodental nasal before [f,v] in English casual speech.
a. i[ɱ]famous b. i[ɱ]variable

Padgett explains these as phonetic processes, which underlie gradient mechanisms as opposed to the strict absolute formalisms, which determine phonological patterning. Thus, in his view these cases are not explained by feature spreading but by gestural overlap. This creates an additional set of explanations for a phenomenon whose articulatory grounding should only require one such set.

This analysis incorporates a typological observation deeply into the core of phonological theory, the geometrical organisation of features. At the same time it fails to account for the gradual nature of these observations. Jun's (1995) survey shows three languages where fricatives serve as the trigger for nasal assimilation: German, Nchufie and English. This serves but to show that an absolute ban on fricatives as triggers of place assimilation is to coarse a formalisation that cannot possibly account for the restricted variability of assimilation patterns. Further, the behavior of fricatives is but the tip of the iceberg of a battery of generalizations that Padgett does not cater to. Interestingly, he still needs to include phonetics in his set of explanatory tools. This will be discussed also in 1.4.5.
Further, it also will fail to make any claim as to why for example German does allow the coronal nasal to assimilate to the labiodental fricative in *a[ɱ]fangen* ('begin'), while a bilabial nasal must not change as in *u*[*m*]*sichtig* ('cautious, considerate').

1.4.5 Trigger manner in Standard OT - Baković (2007)

The approach taken in Baković (2007) shall be discussed, because it attempts to capture similar patterns of local assimilation as Padgett (1994). At the core of his analysis are six possible patterns of assimilation that occur in nasal-fricative clusters (17).

(17) Patterns of place assimilation in Baković (2007)

a. Place assimilation of nasals to following stops

b. Blocking of place assimilation before fricatives

c. Spanish nasalised fricatives which occur in assimilated nasal fricative clusters

d. Place assimilation before fricatives

e. Deletion of nasals before fricatives

f. Voicing assimilation with a possible vowel epenthesis between stops

Here, focus will be on the treatment of blocking of assimilation before fricatives, as well as his solutions regarding epenthesis of consonants between nasals and fricatives.

The engine of the analysis is devised around the interaction of faithfulness constraints preserving the structure of the input and markedness constraints which seek to eliminate unwanted segments, sequences or configurations from the output. It is the relative ranking of sometimes very specific constraints that generate the optimal output.

(18) introduces the constraint set used in Baković (2007). The constraints will be subject to discussion, after some of their most crucial properties have been exemplified. It will become clear what type of assumptions about the separation between phonetics and phonology underlie his approach.

(18) Constraint set in Baković (2007, p.340)

a. AGREE(place), penalizing adjacent output segments with different place values;

b. IDENT(place), penalizing changes in place values from input to output;

c. NONASFRIC, penalizing nasal fricatives in the output;

d. STR/PL, penalizing output segments with the same place but different [±cont] values;

e. DENT(cont), penalizing changes in [± cont] values from input to output.

AGREE(place) is a markedness constraints that penalises outputs which contain heterorganic clusters by evaluating whether place features of a cluster agree in the output, while IDENT(place) penalises changes in place values from the input to output, and is thus a faithfulness constraint.

The relative ranking of these two constraints is crucially responsible for whether place assimilation occurs at all. If the markedness constraint dominates the faithfulness constraint a coronal nasal before a labial consonant will surface as a labial, as the candidate more faithful to the input ([np])will be ruled out by the higher ranked markedness constraint.

Blocking of place assimilation

Blocking of place assimilation before fricatives is a feature any analysis of nasal place assimilation seeking typological adequacy must capture in order to comply with the asymmetry of trigger manner. The constraint ranking in (19) demonstrates the crucial nature of the constraint STR/PLACE in generating this implicational pattern. This ranking uses the constraints in Baković (2007) and was generated with the help of OTSoft.

(19) Blocking of assimilation to fricatives

/nf/	NoNas Fric	StrPl	MAX	Ident (cont)	Agree (Place)	Agree (cont)	ident (place)
☞ nf					*	*	
f			*!				
ɱf		*!				*	*
f̃f	*!			*			*

/np/	NoNas Fric	StrPl	MAX	Ident (cont)	Agree (Place)	Agree (cont)	ident (place)
☞ mp							*
np					*!		
p			*!				

Before the analysis is discussed in more detail, a brief explanation of the notational conventions of standard OT (Prince and Smolensky, 1993) is given.
If a candidate violates a constraint it is assigned an asterisk as a violation mark. It is not the total number of violations that determines the winner. Instead, the candidates which violate highly ranked constraints are successively ruled out. Those *fatal* violations are indicated by an exclamation mark. The winning candidate is the candidate whose highest ranked violation mark is ranked below the highest violation marks of all other candidates. If two candidates have the highest ranked constraint violation of the same constraint, then the number of violations can be decisive. The optimal candidate is marked by convention by a pointy finger to its left.

(19) shows that the ranking of STR/PLACE above AGREE(PLACE) is crucial to generate a pattern where nasals assimilate to stops but not to fricatives: STR/PLACE is violated by the assimilation candidate [ɱf] in case of a nasal-continuant cluster, not, however, by [mp] in a nasal-stop cluster. The deletion candidates are ruled out by MAX, and NONASFRIC excludes nasalised frictatives from surfacing. Aside from violating STR/PLACE, the assimilation candidate [ɱf] incurs two more constraint violations which could serve to rule out this candidate, namely AGREE(cont) and IDENT(place). IDENT(cont) is also violated by the non-assimilation candidate [nf] and thus cannot serve to decide between these two candidates. The ordering of IDENT(place) below AGREE (place) is, as discussed above, crucial to ensure that the assimilation candidate emerges before stops.

Thus, the same effect that is achieved by Jun (1995) by positing a perceptually grounded universal constraint ranking, as will be discussed in (1.4.7), is done in Baković (2007) by the constraint STR/PLACE. This constraint, as stated in (18) bans clusters whose segments have different values for [± cont] but identical ones for [± place]. As constraints in OT are conceived of as reflections of 'principles of markedness' (Hayes, 1999) such a constraint is tantamount to claiming that nasal fricative clusters are more natural if they are heterorganic. However, place assimilation does occur also in nasal-continuant clusters in a variety of languages[7]. Typological reviews on such clusters are not known to the author, but it seems that a tendency preferring heterorganic nasal-continuant clusters, if it is there, is not very clear. [8] However, even if typology were to show that nasal fricative clusters contrary to the constraint tend to be homorganic (as it seems to be the case), in an OT framework this would be due to a low ranking of the constraint STR/PLACE. Another perspective on the constraint STR/PLACE is the following: The empirical problem that the constraint is designed to solve, is the question of why place assimilation of nasals occurs rather before stops than before fricatives. The explanatory value of such a move depends on a central debate in phonology: The question of phonetic grounding.

Assuming the constraint is a formal device without phonetic grounding, i.e. features are labels for phonological entities who seem to behave alike, then the explanatory value of the constraint is void. If a pure formalism is used to explain typological generalizations, it cannot yield any insight as to why a specific behavior occurs, unless one assumes this constraint reflects a mental capacity - a claim that in recent years significantly lost support (Durand and Laks, 2002).

On the other hand, if there is *some* phonetics in phonological theory, which seems utterly inevitable to the author, the explanatory substance given the definition of the constraint is that place of articulation is dependent on the [± cont] values of the adjacent segments. As nasals and stops are both [-cont] and fricatives are [+cont] the constraint penalises the output if both segments share the same place of articulation. Now, what does this mean in terms of explanation? The definition[10] of the feature [± cont] given in Halle and Clements (1983) is as follows:

> Continuants are formed with a vocal tract configuration allowing the airstream to flow through the midsaggital region of the oral tract; stops are produced with a sustained occlusion in this region. (Vowels; glides, r-sounds, fricatives vs. nasal and oral stops, laterals.)

[7] In the view sketched here, such a pattern would of course be due to a lower ranking of STR/PLACE.

[8] Finnish would be a classical example of a language where also nasal-fricative clusters must, except for a couple of exceptions which are noted in section 2.1.1, be homorganic. Also in German, though it allows heterorganic nasal fricative clusters also without an intervening morpheme boundary[9], such clusters are still the minority compared to the rather abundant /ns/. Yet, this could easily be due to the generally lower frequency of non-coronals, as the cluster /ns/ is also much more frequent than, say, /mf/, which seems to be even rarer than /ms/.

[10] Technically, this definition is not seen as a definition, but as a collection of articulatory correlates of the feature. It is taken here as a definition, since these correlates are the main and only evidence such features are based on.

Given this definition, one must conclude that continuous flow of airstream is the cause for the asymmetry in place assimilation patterns. Thus, some phonetic grounding seems inevitable, and it seems doubtful, given the insight already brought forth about the perceptual factors in such asymmetries that this is the best approximation to a complete explanation of the phenomenon.

Another problem of the analysis concerns factorial typology. A factorial typology is the sum of the patterns a given set of constraints can generate under all possible permutations of their ranking. Implicational patterns that arise in such factorial typologies are the so-called t-orders. Factorial typologies and t-orders can be calculated fairly simply using OT-Soft. It can be shown that t-orders of a factorial typology of the constraint set used in Baković (2007) yield (among others) the implication that all languages, where nasals undergo place assimilation to fricatives (/nf/ → [ɱf]), nasals should also undergo place assimilation before sonorants. However, granted the utter difficulty of adducing empirical evidence to place assimilation before sonorants as discussed in section1.3.3, this seems not to be the case (cf. the hierarchies established in Mohanan (1993) and Jun (1995)), as the implication is exactly the other way round: If place assimilation occurs before sonorants it also occurs before fricatives.

Phonetic substance

Moreover, Baković already uses phonetic explanation to complete his analysis. It serves well to explain insertion of epenthetic consonants between nasals and fricatives.

A pattern where nasals do assimilate to fricatives is analysed by ranking NoNasFric and Agree(place) above Str/Place. As an example Baković uses data from Venda which is given here in (20).

(20) Assimilation in Venda

a.	/n + vulɛdza/	→	[mbvulɛdzɔ]	'finishing'
b.	/n + bvuda/	→	[mbvudɔ]	'a leak'

The interesting part here is the example in (20a) where the nasal assimilates in place to a voiced fricative. Additionally an intrusive stop is inserted between the nasal and the fricative. Note that this epenthetic stop remains untreated by phonology and is, as Baković argues, due to properties of articulatory phonetics and questions of gestural timing.

Thus, patterns in place assimilation in this view are explained by two independent systems. The question of whether there is assimilation or not is one of phonology, a formal system that uses constraints, which refer to formal characteristics of representations, while stop-epenthesis is explained in one short sentence, as a matter of gestural timing.

The view iterated here, is that such an approach is problematic. Typological observation has overwhelmingly been shown to be explicable by articulatory and perceptual conditions, which seem more plausible an explanation compared to the interaction of abstract constraints. Of course, it should be acknowledged that some aspects of assimilation phenomena may have a different status compared to others within the system of a language, yet this does not require their explanatory toolkit to differ this vastly.

Second, it should be asked why the mechanisms held to account for gradient phenomena, which fall under the realm of phonetics should be so fundamentally different from the mechanisms that play a role in categorical patterns in phonology.[11]. Thus, while the tongue and the ears are indeed shaping patterns of cross-linguistic variation, explanation in phonological theory is either a compromise, paying tribute to such patterns by labeling the formal entities (contraints, elements, features, etc.) in such a way that they necessarily reflect such typologies to some extent, or in the ideal of a substance free view (Hale and Reiss, 2000) a mere mechanism, whose explanatory realm is severely restricted.

1.4.6 Towards an integrated perspective - Mohanan (1993)

Mohanan (1993) condenses the theoretic development from SPE via something quite similar to natural phonology towards an integrated perspective on phonetics and phonology into one paper. In aiming for a *substantial* way to capture typological patterning in a formal framework, he acknowledges that ultimately all universals should be substantially explained by requirements of articulation, perception and of the communicative function of language. These universals, however, must first be developed by abstraction from recurrent typological patterns.

These abstractions have the form of preference statements in the spirit of marking conventions. Compliance with such statements is a measurement of comparison of the naturalness of a linguistic unit or process. More natural segments can be characterised by compliance with statements such as (21). These statements are - in essence - marking conventions and rooted in the approach of radical underspecification.

(21) [+nasal] → [+voice] (unmarked)

In his view, however, not all such SPE-type markedness principles are of the same strength. Even the almost universally observed principle like the one in (21) finds itself disproved by languages which have contrasting voiceless nasals, for example Washo (Jacobsen, 1964), whereas (24) is just the reflection of the fact that coronals are more natural than other segments, despite the fact that most, if not all, languages also have non-coronal segments. For the case of place assimilation he assumes the universal principles in (22) and (23).

[11] One attempt to shed light on such a question is made in Moreton (2008), who provides evidence that (articulatory) *phonetic precursors* alone are insufficient to explain typological patterns. He argues for distinguishing typological patterns that arise through *channel bias* - factors of articulation and perception - from *analytic bias* - innate cognitive capacities that direct and enable children to learn certain patterns more easily than others. However, his experimental evidence is based on articulatory evidence alone, and the differences found in learnability of vowel height harmony compared to a grammar where consonant voicing occurs after high vowels (height-voice harmony) may well be due to perceptual factors, and other language specific biases.

(22) In the sequence [+stop] [+cons] the two consonants must share a single place node.

(23) The following segment is the trigger.

(24) If a segment is [+cons], than it is [+cor].

In what he calls phonological assemblies these universal principles are supplemented by language particular statements specifying which segments are triggers and which segments may be targets. The concept of a phonological assembly was by no means a new idea. It goes back at least to Foley (1977) who similarly states universal rule schemata (generalised rules like lenition assimilation) that are adapted language specifically as briefly illustrated in (1.4.2). Thus, a complete assembly for a place assimilation pattern of a particular language will consist of the universal principles (22), (23) and the restricting statements. These statements restrict domain, and specify the trigger and undergoer segments if necessary. For English these are the statements in (25).

(25) a. DOMAIN: syllable

b. TRIGGER: [-cor]

The universal patterns in place assimilation listed in (1) raise the question, how the content of these statements can be further restricted, since languages in which only a [+cor] segment triggers assimilation are unattested. Mere parametrisation of these options - as achieved by phonological assemblies - Mohanan (1993) argues, is insufficient since these choices "appear from nowhere", since they are not grounded in the actual phonetic properties of the features, but are just a choice the linguist is forced to make based on the data.

As a solution to this arbitrariness, two new notions are introduced. The notion of fields of attraction serves to characterise the non-exceptionlessness of linguistic phenomena in an analogy to magnetic fields. These fields of attraction represent states to which linguistic systems are attracted. If a certain distributional requirement is in the center of one such field of attraction, it is quite possible that not all languages succumb to the adhesive force of this field. Thus, typological observations and their exceptions and deviations are to be viewed as the result of a pattern of constraint random variation around a certain field of gravity.

Secondly, the notion of *dominance* is useful in explaining trigger and target place asymmetries (Mohanan, 1993), as it helps to generate the hierarchical patterns of these asymmetries.

Place asymmetries

The formalism uses underspecification of place features. It is assumed that the specifications [+cor], [+anterior], and [-back] are underlyingly unspecified for consonants. A further assumption is that underlyingly unspecified feature values are less dominant. Given these assumptions, it follows that a coronal is least dominant, as its specification involves only unspecified feature values as illustrated in (26) where dominant feature values are marked in boldface.

(26) Dominance of places of articulation

Dominance	Place	Features
⇓	Velar	[−**ant**], [−**cor**], [+**back**]
	Palatal	[−**ant**], [+cor], [−back]
	Labial	[+ant], [−**cor**], [−back]
	Alveolar	[+ant], [+cor], [−back]

Dominance is not only relevant regarding place asymmetries. Also the directional asymmetry is explained this way.

(27) In place specification, the second segment in a sequence is dominant (with respect to the first).

The statement in (27) ensures that the place of articulation of the second segment of a sequence survives. Given a principle like (22), a conflict may arise between the assimilatory force to share a single place specification, and the relative dominance of the two place specifications, as the first consonant in the sequence may be more dominant. This type of conflict is resolved in such a way that a dominant place specification of the target is more likely to survive. Thus, in the situation of a cluster /ŋt/, the dominance of the velar in C1 can block (27) from applying, whereas in an opposite situation /nk/ the place specification of the second segment overrides the place of the first segment.

Languages may differ regarding their sensitivity towards dominance hierarchies of place of articulation. While English coronals do not trigger place assimilation, they very well do so in Malayalam, where no effects of dominance of place of articulation are observed.

The reason why place assimilation patterns (and other patterns of neutralization) occur at all, formalised as principle (22), is a reflection of ease of articulation, which is counteracted by a requirement of contrast maintenance. A speaker constantly has to resolve the conflict of reduction of articulatory effort and contrast maintenance. However, while the articulatory aspect can be (at least in theory) quantified as the number of gestures and their respective complexity involved in pronouncing a segment, nothing is said about how the antagonist force of contrast figures in the theory. This is remedied in Jun (1995) where a theory of the preservation of perceptual cues is developed that is largely based on phonetic evidence.

Dominance, on the other hand, merely shapes the details of the patterns in a given language, and is left as a theoretical formalism still waiting for a substantial explanation.

1.4.7 A phonetic formalism - Jun (1995)

The OT based formalisation proposed in Jun (1995) sets out to capture Kohler (1990)'s idea that phonological processes are shaped by perceptual factors. Its empirical domain are the slightly adapted cross-linguistic generalisations on place assimilation Mohanan (1993) in (1).

These modifications of Mohanan's generalisations are based on a survey of assimilation patterns of a broad variety of languages. One very crucial modification involves the tearing apart of the two classes of sonorants into nasals and non-nasal sonorants. Very often the status of non-nasal sonorants, i.e. liquids, is not easy to determine, since the most common sonorants, [r] and [l], are both coronal. Thus the nasal most likely to show place assimilation - the coronal nasal - will not change under assimilation[12].

Moreover, as was shown above, while nasal-stop clusters have a restricted set of possible outcomes, i.e. either there is place assimilation or not[13], nasal-continuant clusters have a much wider variety of possible outcomes, and place assimilation is but one of them.
These hierarchies are translated into OT constraint rankings. The aim is a to give a functional perspective on speech economy, where aspiring ease of articulation is counterbalanced by constraints determining what is important and has to be preserved, based on perceptual conditions. Two conflicting types of constraints are introduced that are functional in nature, as they serve to regulate articulatory reduction based on principles of articulation and perception.

(28) Weakening Constraint

Conserve articulatory effort

One of these two types is the weakening constraint which applies to gestures and reduces their magnitude. Evaluation of the constraint is based on articulation. Some significant reduction in gestural magnitude must occur, lest the candidate incurs a violation mark.

The second type of constraints can be viewed as following the famous *rich get richer* observation about language, which goes as a shorthand for stating that more prominent properties are enhanced during production, while less salient features are further backgrounded. This is formalised in the constraint family of the so-called preservation constraints. These preservation constraints assign violation marks to candidates, which have undergone *perceptual* reduction of some kind, and are formalised as in (29).

(29) PRES (X(Y)): Preserve perceptual cues for X (place or manner of articulation) of Y (a segmental class).

A preservation constraint assigns a violation mark, if a perceptual cue is not present in

[12] In fact, only languages with assimilation of underlying /ŋ/ or /m/ offer potential for determining the actual status of non-nasal sonorants in this hierarchy.

[13] I leave aside the possibility of changes in voicing in whichever direction.

the actual articulation of a segment. For example PRES(pl(_fric)) assigns a violation mark to a segment, if its following segment is a fricative and its perceptual cues for place of articulation are not preserved. Note that in this view assimilation is not a mere *change* in place of articulation, instead it is the consequence of reduction. When a place gesture is reduced the neighboring place gesture takes its place.

Two preservation constraints PRES(M(N)) and PRES(M(P)) are universally ranked PRES (M(N)) >> PRES (M(P)) if the acoustic cues of M are stronger for N than for P. This universal ranking constitutes the link of perceptual factors with the phonological formalisation. Four general types of hierarchies are assumed to interact in the typological patterning of place assimilation:

(30) Hierarchies

a. Target manner
b. Trigger manner
c. Target place
d. Trigger place

The hierarchy involving Target manner shall now be illustrated in more detail.

(31) Target Manner

a. If fricatives or nonnasal sonorants are targets of place assimilation, so are stops.
b. If stops are targets of place assimilation, so are nasals.

Thus, if only one natural class of manner undergoes place assimilation in a certain language then this class will be nasals. The next larger group will be nasals and stops, and eventually also fricatives. This can be translated in terms of universally ranked preservation constraints.

(32) PRES(pl($\underline{[+\text{cont}]}$ C)>>PRES(pl($\underline{[+\text{stop}]}$ C)>> PRES($\underline{[+\text{nas}]}$ C)

The underlined features followed by 'C' shall indicate that they are the features that belong to the segment preceding the consonant, thus - as most cases of place assimilation are retrograde processes - the target consonant.

This universal constraint ranking ensures that place assimilation of [+cont] segments are more severely sanctioned than place assimilation of a stop which in turn is more sanctioned than place assimilation of nasals. The position of the weakening constraint within this hierarchy determines which type of consonants surface faithfully and will assimilate. As discussed above at length, this hierarchy is motivated by both the typological observation and its perceptual phonetic explanation, namely the relative prominence of perceptual cues in fricatives and non-nasal sonorants.

Since he submits to the hypothesis that the universal (grammatical) constraint ranking is determined by phonetic prominence of the respective features, it is necessary to show that place cues of a pre-consonantal nasal are weaker, and the gestures which produce them thus more omissible - than place cues of a stop, and their place cues are in turn weaker then those of a fricative.

(33) Malayalam nasal place assimilation Jun (1995, p.139)

/sam+giitam/	PRES (MNR (NAS))	PRES (MNR (-CONT))	PRES (PL (ONSET))	WEAK	PRES (PL([NAS]C))	PRES (PL (CODA))
☞ saŋ giitam				*	*	*
sam giitam				**!		
sam piitam			*!	*		
sa giitam	*!	*		*	*	*
saggiitam	*!			*		

This ranking tableau shows how the most optimal candidate is selected by the constraint ranking. (33) shows that the relative ordering between the constraints WEAK (the weakening constraint) and the preservation constraint PRES(PL([NAS]C)) is crucial to distinguish between the first two candidates, i.e. place assimilation vs. no place assimilation. The two violation marks assigned by WEAK to the non-assimilation candidate stem from the fact that neither segment of the cluster undergoes any reduction. Recall that evaluation of the weakening constraint is based on articulatory reduction. The assimilation candidate reduces the labial gesture while at the same time extending the duration of the velar gesture such that it overlaps with nasality. As the velar stop is not weakened also the assimilation candidate incurs a violation mark for WEAK, yet still surfaces as the optimal candidate. Note that the higher ranked constraints of the universal constraint ranking in (32) are not immediately relevant to the data set here. The other two preservation constraints aside from PRESpl([+nas]C), which preserve place articulation of stops and [+cont] segments, must crucially be ranked above WEAK for Malayalam as such segments are indeed not subject to place assimilation.

What is clearly achieved by Jun in his dissertation is the integration of perceptual conditions into phonological theory. To that end, *universal* constraint rankings of preservation constraints and their perceptually based evaluation are employed to supplement the articulatory feature system.

Further, he shows how the hierarchical nature of the typological implications can find analogous representation in the OT system. Yet, the empirical domain still shows substantial gray areas. For example, the less well-established hierarchy concerning trigger manner is neither typologically nor phonetically soundly corroborated. Neither are articulatory biases incorporated into the formalism. Especially, patterns of errors of perception, which are overlaid by patterns of imprecision of articulation, may well prove to challenge this theoretical frame, or - more positively - provide fruitful testing ground for hypotheses on the interaction of articulation and perception in the diachronic emergence of (phonological) assimilation patterns.

Summary

This chapter introduced and contrasted several formal approaches to place assimilation. It was shown that typological patterns can successfully be explained by factors of perception and articulation. This sheds doubt on approaches seeking to capture typological phenomena based on formalism. If, however formalism includes to model perception and articulation new ground is created to further clarify the roles and the interaction of these two factors.

Chapter 2

Basics of Finnish nasal place assimilation

2.1 Finnish Nasal Place Assimilation

2.1.1 Distribution of Finnish nasals

The distribution of the Finnish nasals in clusters is rather simple. There are no hetero-organic nasal-obstruent clusters (Karlsson, 1983). However, this is only true without exception for nasal-stop clusters. There are a couple of exceptions where a labial nasal is followed by /s/ in word-internal clusters. One such exception is the place name of the central Finnish town of 'Jämsä'. Further, there are onomatopoetic and rather meaningless verbs like 'humsuttaa' ('go around') or loans like 'hamstrata' ('to hoard'). Also in the more Swedish influenced south-western Dialects, [ms] clusters may occur through syncope in unstressed syllables of pronouns like 'semmosia' [semsii] ('such' prt.pl.) or other frequent items e.g.: 'ihmiset' [iɦmset] ('man' nom.pl.).

Word-finally, only a coronal nasal occurs[1]. Historical alternations still exist in instrumental or abessive/karitive nominals exemplified in (34). In light of the fact that all word-final consonants are coronal, one may speculate that the alternation at hand arose simultaneously with a change in phonotactics, which gave rise to the ban of non-coronals in final position.

(34)

nom.	**gen.**	**gloss**
puheli**n**	puheli**m**en	'telephone'
avai**n**	avai**m**en	'key'
pakasti**n**	pakasti**m**en	'freezer'
työtö**n**	työttö**m**än	'unemployed'

[1]In the closely related language of Estonian, the comparative morpheme -mpi corresponds in Estonian to a reduced form ending in -m. According to reports of native speakers, these labials do not undergo place assimilation.

A further restriction is a ban on clusters of nasals followed by non-nasal sonorants. The only exception is the proper name 'Venla'.

Nasal final morphemes

Morphemes showing a final nasal are abundant in Finnish. Aside from the abessive/caritive and the instrumentals noted above, one finds a large variety of derivational suffixes of the type *-inen* which form nouns, where nominative case also shows a final nasal.
In noun inflection, final nasals occur in the illative *-Vn* or its allomorphs *-hVn* and *-seen*, the genitive/accusative *-n*, the less frequent comitative and instructive. Historically, also the allative may have had a final nasal (Karlsson and Lehtonen, 1977). Finnish traditional grammarians classify adjectives and nouns together as 'nominit' (Hakulinen et al., 2004). Thus, the suffix *-in* of the superlative and of the comparative of adverbs is to be mentioned here as well.

In verbal morphology final -n occurs in the 1ST SG and the passive as well as 3RD SG of the imperative. Note that the syncretic genitive/accusative case is used both for case-marking of objects as well as for genitival attributes. I will sometimes refer to occurrences of a genitive in object position 'accusative morpheme', and to proper genitives as genitives, knowing that there is no difference between those two morphological categories. If an adjective modifies an object it is also 'accusative'-marked, thus these cases will be referred by their syntactic role.

2.1.2 Alternation

Finnish nasal place assimilation (FNA) can predominantly be observed in external sandhi. Aside from frozen items in the vernacular spoken in the urban and suburban areas in and around Helsinki, it is claimed to be a productive and automatic process that applies to word-final nasal morphemes when they are followed by obstruents (Suomi et al., 2008).
Nasal assimilation also occurs as a lexicalised syntactic item in cases such as: [emmä tiedä] which is a reduced form of /en mä tiedä/ which in turn corresponds to *en minä tiedä* in the written standard language, where it means 'I don't know'. Similar cases were noted by Karlsson (1983) for words such as *samanlainen* (← sama[ll]ainen) ('same') or *sellainen* ('such') where the first part of the geminate 'll' goes back to /n/ historically.
Nasals also underwent progressive assimilation in participles like *tullut, ollut, kuullut, kuollut, etc.* where the nasal of the participle formative -nut/-nyt became totally assimilated.

Nasal Assimilation - different authors, different observations

Karlsson (1983) In the following section I will first introduce the basic pattern of FNA, to illustrate the role of liquids and semivowels in the assimilation pattern. Before, a few statements need to be made regarding the empirical status of the phenomenon. Two sources indicate quite some variation in the pattern. (35) represents the view laid out in Karlsson (1983) for the basic pattern of NA.

(35) Finnish Nasal Assimilation I

a.	menen tänne	mene[nt]änne	*'I go there'*
	menen Poriin	mene[mp]oriin	*'I go to Pori'*
	menen kotiin	mene[ŋk]otiin	*'I go home'*
b.	pojan lähellä	poja[nl]ähellä	*'close to the boy'*
	tytön viula	tytö[ɱʋ]iula	*'the girl's violin'*
	pojan jalka	poja[ɲj]alka	*'the boy's leg'*
	pojan ranta	poja[nr]anta	*'the boy's beach'*
c.	pojan sauna	poja[ns]auna	*'the boy's sauna'*
	eilinen filmi	eiline[ɱf]ilmi	*'yesterday's movie'*
	kovin hieno	kovi[nh]hieno	*'very nice'*
d.	pojan mökki	poja[mm]ökki	*'the boy's cottage'*
	pojan näkö	poja[nn]äkö	*'the boy's eyesight'*

Karlsson formalises Finnish Nasal assimilation as a case of place assimilation by the following rule (Karlsson, 1983, p. 144):

(36) $$\begin{bmatrix} +\text{nas} \end{bmatrix} \rightarrow \begin{bmatrix} \alpha\text{front} \end{bmatrix} / \_\_ \begin{bmatrix} +\text{cons} \\ \alpha\text{front} \end{bmatrix}$$

Thus, Finnish underlying /n/ may become [m] or [ŋ], according to the place feature of the following consonant. The fate of the nasal is slightly less clear when followed by a fricative, of which /s/ is the only native member in the Finnish consonant inventory. /f/ and /ʃ/ only occur in loans. /ʃ/ is particularly rare, and very often just pronounced as alveolar [s], especially by monolingual Finnish speakers (Suomi et al., 2008). When followed by /s/, the final nasal remains unchanged, but assimilates to [ɱ] when followed by /f/. However, this view is not shared by Suomi et al. as will be shown below.

The behavior of the nasal followed by the sonorants /r/ and /l/ is not explicitly discussed by Karlsson, which probably indicates that, being [+front], /r/ and /l/ are not supposed to trigger any change in the nasal.

Before /h/, the nasal also remains unchanged. This is explained by the lack of a place feature in /h/, which, moreover, as a laryngeal, is not a real consonant.

Suomi et al. (2008)

A slightly different picture emerges from Suomi et al. (2008). In their detailed work on Finnish phonology, variability is considered to a far deeper extent than in Karlsson (1983). Their findings on FNA can be summarised as in the following examples[2].

(37) Finnish Nasal Assimilation II

a.	tytön takki	tytö[nt]akki	*'a girl's coat'*
	tytön pää	tytö[mp]ää	*'a girl's head'*
	tytön kello	tytö[ŋk]ello	*'a girl's clock'*
b.	järven laita	järve[ll]aita	*'the edge of the lake'*
	järven vesi	järve[ʋʋ]esi	*'lakewater'*
	järven jää	järve[jj]ää	*'ice on a frozen lake'*
	järven ranta	järve[rr]anta	*'lakefront'*
c.	järven selkä	järve[s]elkä	*'a lake's span'*
	pojan farkut	poja[f]arkut	*'the boy's trousers'*
	järven hiekka	järve[h]iekka	*'the lake's sand'*
d.	järven muta	järven[mm]uta	*'the boy's cottage'*
	pojan näkö	poja[nn]äkö	*'the boy's eyesight'*
	järven yllä	järv[ẽ]yllä	*'above the lake'*

The most significant difference between the two datasets can be found in example (35b): If the nasal is followed by one of the four sonorants of Finnish /l,j,r,ʋ/, Suomi et al. (2008) observe that usually total assimilation of the nasal to the following sonorant occurs, resulting in a geminate sonorant. Only in very slow and formal speech the nasal remains unchanged before sonorants.

Phonetically, /h/ in syllable initial position is a laryngeal fricative. In intervocalic position, voicing may occur. However, due its rich allophony ([ç], [x], [ɦ]) it can be phonologically analyzed as a placeless fricative Karlsson (1983). In his view, this is the reason for the lack of assimilation of the nasal to /h/[3]. Considering the data of Suomi et al. (2008), a different picture emerges, as /h/ patterns with the other fricatives, which all cause omission of a preceding nasal.
The divergences in the two datasets are summarised below in (38).

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[2]While the examples are taken from Suomi et al. (2008), they have been simplified by reducing the phonetic detail of the transcription.

[3]In fact, of course, a nasal glottal stop is articulatorily impossible, hence a nasal could not possibly undergo place assimilation to laryngeal. Hence, no statement about placelessness would be required in Karlsson's analysis.

(38) Data divergences

Final nasal followed by..	Suomi et al. (2008)	Karlsson (1983)
fricative	deletion	place assimilation
sonorant	total assimilation	place assimilation

As Suomi et al. (2008) point out, place assimilation may occur also to fricatives and sonorants in highly formal speech. In more casual speech, however, the nasal is either dropped before fricatives or undergoes total assimilation before non-nasal sonorants. It is not unexpected that the prevalence of the nasal is stronger in more formal situations, but it is quite intriguing that nasals appear to be more stable when they precede a plosive. The analysis proposed in chapter 3 will assume that a final nasal is lexically defective, and needs the type of strengthening provided by plosives. Given that /h/, which causes the nasal either to be unchanged or deleted, but doesn't geminate or causes assimilation of the nasal[4], seems to have a phonological status somewhere between sonorant and fricative[5] various explanations seem plausible for its behavior. The simplest one is that only a single Finnish word is known that features a geminate /h/. The word *hihhuli* ('holy roler') is of onomatopoetic origin. In a traditional view, it could be stated that, if /h/ behaves like a sonorant (except for its inability to geminate), as it causes deletion just like /r,l,j,ʋ/, but if it is interpreted as an obstruent it does not cause assimilation. Note that word-internally, the cluster [nh] is all but infrequent.

Another major question concerns the total assimilation cases of (37b). The absence of word internal nasal-sonorant clusters in Finnish[6] is not just a peculiarity of the Finnish language. To the contrary: Numerous languages avoid or break such clusters. For example, the diminutive suffix /ɐrl/ of Austrian German dialects causes the post-occlusion of a final nasal it is attached to. The diminutive form of [mɔ̃] ('man') is pronounced as [mandl] or [mandɐl]. Further, Onn (1978) reports that in Malay a final nasal of a prefix, undergoes assimilation before obstruents, but is deleted when preceding [r,y,l,w]. English is not as strict in this respect since it generally allows such clusters under prefixation, consider the form 'u[nl]awful', but in the heritage of the latinate vocabulary such effects are still visible (cf. 'i[l]egal'). While Finnish and Malay are generally rather strict, when it comes to consonant clusters, German and English usually allow nasal-sonorant sequences at morpheme boundaries, but they are hardly found in monomorphemic forms. Aside from a few exceptions, such clusters do not occur in Finnish.

[4]Sometimes spreading of breathy voice phonation may occur to the nasal (see section 4.2.3)

[5]There have been various attempts to group [ʔ,h] and the semivowels [j,w, etc.] together as glides, some of which are discussed in Durand (1987)

[6]There are a few counterexamples: The name *Venla* is perhaps a borrowing from Swedish Vendla or Vendula. Some dialects show rare cases of syncope: kainalo ('armpit' nom) → kainlos ('armpit' ine).

2.2 Dialectal variation in nasal place assimilation

2.2.1 Finnish dialects in a nutshell

Finnish dialects can be separated in two major groups, according to their geographical distribution named western and eastern dialects. The distinction is based on a potpourri of criteria. Rapola (1969) names seventeen distinguishing properties, which together draw the dialectal boundary. However, the exact areal boundaries for each property vary considerably.

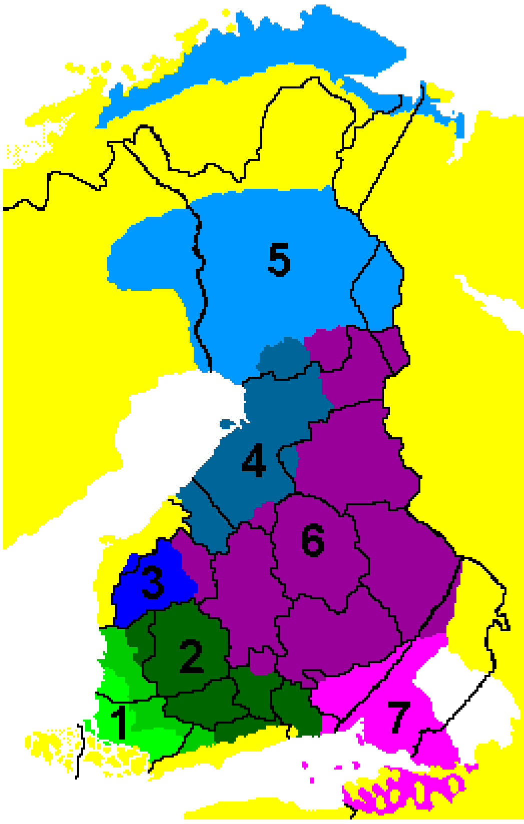


Figure. 2.1: Finnish dialects groups. 1. Tavastian dialects. 2. South-western dialects. 3. Southern Ostrobothnian dialects. 4. Central and northern Ostrobothnian dialects. 5. Dialects of southern Lapland. 6. Savonian dialects. 7. South-eastern dialects. The unnumbered shadowed green area in the west marks the Transitional dialects. Western dialects are areas 1-5 , 6 and 7 are the eastern dialects. Source: `http://upload.wikimedia.org/wikipedia/commons/e/e9/Suomen_murteet.png`

Both dialect groups are further subclassified. Western dialects comprise the Tavastian dialect group (Hämälaismurteet), the South-Western dialect and the Transitional dialects ('Välimurteet'), situated between these two. Further, the Ostrobothnian dialects are split into southern, central and northern Ostrobothnian dialects. Additionally there is the dialect of southern Lapland, which also belongs to the Ostrobothnian dialect group.

Eastern dialects are classified into the Savonian dialects ('Savolaismurteet') and the South-Eastern dialects.

In the following, some criteria for the distinction between western and eastern dialects will be exemplified, with particular focus on properties regarding final consonant assimilation.

Eastern and western dialects

The reconstructed dental spirant ð[7], which corresponds to <*d*> in the written standard of Finnish, was still to be found in a few perishes of the western dialect region (Leskinen, 1981). More typical, however, are its western dialect correspondents, which are the sounds [r,l], (the marginal) [ɾ] or [d]. The latter is mostly found in regions which were under particularly strong Swedish influence. Variants of the eastern dialects are [v,j,h] as well as deletion[8]. Some of the typical examples found in the abundant literature[9] are given in (39).

(39) Weak grade alternant of t in western and eastern Finnish dialects

Standard Finnish	western dialects	eastern dialects	gloss
pata : padan	: pa ð/*l*/*r*/*d* an	: paan	*'pot, cauldron'*
lehti : lehden	: leh ð/*l*/*r*/*d* en	: leh(j)en	*'leaf'*
rauta : raudan	: rau ð/*r*/*l* an	: rauvan	*'iron'*

As can be seen, not all variants are available for all lexemes, as the weak grade alternant is partly determined by the quality of the surrounding vowels (Rapola, 1969), especially in the eastern dialects. Generally, the difference between the dialect groups seems to be one of lenition to a liquid as opposed to lenition to a glide. Other criteria comprise, for example, further differences in consonant gradation, the realisation of the affricate *ts* of the standard language, contextual vowel lengthening, changes in vowel quality or diphtongisation.

More relevant to the topic of this thesis is the observation of Rapola (1969) that for western dialects, a morpheme-final *t* will undergo place assimilation to a following plosive, which is not the case in the eastern dialects. This is true across morpheme and word boundaries as shown in the examples in (40).

(40) Assimilation of final *t*

Standard Finnish	western dialects	eastern dialects	gloss
luvatkoon	luvatkoon	luvakkoon	*'promise.3Sg.imperative'*
maatkoon	maatkoon	maakkoon	*'rest.3Sg.imperative'*
laiskat poijat	laiskap pojat	laiskat pojat	*'lazy boys'*

Additionally, there is the complication that not every type of final -t behaves alike. Mielikäinen (1981) notes that final -t in nom. sg. forms as for example in SF *lyhyt* ('short'), *ohut* ('thin'), *kytkyt* ('tether'), *kätkyt* ('bassinet') behave the same way as the historical final *-k* (see 2.2.2) and thus undergo total assimilation to a following consonant in the eastern

[7]Standard IPA transcription is used, instead of the FUT transcription used in the literature on this topic, to remain consistent within this thesis.

[8]This is not true for all orthographic occurrences of *d*, but only for those, which represent a weak grade alternant of /t/. Of course, this comprises not only the still visible gradation of roots but also the predominantly diachronic suffixal gradation that is found in partitive and infinitival morphology.

[9]Leskinen (1979, 1980, 1981); Rapola (1969); Mielikäinen (1981); Kettunen (1940).

Savonian dialects as well as in eastern parts of southern Savonia.

2.2.2 Related word-boundary phenomena - Boundary Gemination ('Rajageminaatio')

In modern Finnish, there is a group of vowel ending morphemes that trigger gemination of the initial consonant of word following. This phenomenon is due to the loss of a final consonant, predominantly /-k/, which may have occurred rather recently. Itkonen (1964a) for example reports of some rare occurrences of such final consonants being pronounced in prevocalic or domain final contexts which were reported by dialect researchers during the end of the 19th century.
A parallel phenomenon can be witnessed with regard to final -*t*. Especially final -t of the nut/nyt participle is lost in a wide range of dialects (Rapola, 1969).

BG is well known under the term *rajageminaatio*[10] ('boundary gemination'; BG; Hakulinen et al. (2004)), and received extensive treatment especially from Finnish scholars, but also in generative frameworks, for example in Kiparsky (1973). BG is illustrated in (41).

(41) Finnish Boundary Gemination

a.	mene[**k k**]otiin!	'go home!'
	mene[**p p**]ois!	'go away!'
	mene[ʔ ʔ]alas!	'go down!'
	mene[**ss**]inne	'go there!'
	mene!	'go!'
b.	hän menee[**k**]otiin	'he goes home'
	hän menee[**p**]ois	'he goes away'
	hän menee[]alas	'he goes down'

According to Itkonen (1964a), the roots of this process lie in an assimilation process across word boundaries, where final consonants underwent place assimilation. In a second step, the assimilated consonant was lost also in intervocalic position. If the following word begins with a vowel, opinions diverge with respect to whether the glottal stop is long or short. This is particularly interesting, since the initial glottal stop does not always occur. Its occurrence is governed by social factors and factors of style and tempo (Suomi et al., 2008).

According to Karlsson and Lehtonen (1977, p.10), the following words and word forms participate in BG: (I) A group of words like *vene* ('boat')[11], *kone* ('machine') or *perhe* ('family'), whose nominative end in -*e* , (II) the allative case marker -*lle*, (III) the most frequent

[10] Other terms referring to the same phenomenon are: *alkukahdennus* ('initial doubling'; Karlsson and Lehtonen (1977) or *loppukahdennus* ('final doubling'; Itkonen (1969)) and *loppuhenkonen* 'final break', which - to be precise - does not refer to the phonological phenomenon, but the assumed final phoneme that triggers BG.
[11] For this Baltic loanword, loss of a final ʃ is more likely, nonetheless its behavior in BG is identical to forms having lost a final k.

particles, (IV) adverbs derived by the ending *-sti* as in *kauniisti* ('beautifully') - cf. *kaunis* ('beautiful') , (V) the first infinitive, (VI) 2nd person imperative singular, (VII) negated imperative, (IIX) conditional negative, (IX) negative imperative forms ending in -ko/ö, (X) secondary phenomena of the type *kai, yhä* and (XII) the passive perfect participle. Two further groups have to be added: Suomi et al. (2008) note that the 3rd person possessive suffix *-nsa* and the negated indicative also trigger BG.

Not all occurrences of BG are due to a lost *-k*. For example Itkonen (1964, p. 19) himself is uncertain as to the historic nature of the allative case marker (SF *-lle*), claiming that dialectal evidence points provides support to both final *-k* and final *-n*. The same candidates are in the race for final consonant of the third person possessive suffix (SF *-nsa*). Some of the words of group (I) words have lost a final [ʃ] that most likey changed to [h] before loss occurred.

(41a) exemplifies BG after imperative verb forms, where a *-k* suffix was lost.

2.2.3 Nasal place assimilation

The picture given here on the final nasal remains does not cover all dialectal regions in equal depth but is based on reports of Leskinen (1979, 1963) and Mielikäinen (1981); Ikola (1925); Virtaranta (1946); Rapola (1969).

In*utterance final position* nasals are generally either omitted, reduced to a voiceless nasal, or reduced to a nasal vowel. Only a handful of by now extinct dialects (e.g.: The Savonian dialect of Swedish Värmlandt) have retained a full nasal in final position.

In *prevocalic position*, the picture is somewhat different. Here a clear distinction between Western and Eastern dialects is observed, whereby the western dialects retain the full nasal with the exception of the south-western dialect group. The only dialects which lose a prevocalic final nasal are the South-Eastern dialects and the (neighboring) southern variants of Savonian. Additionally, most Ostrobothnian dialects exhibit vowel lengthening with concomitant nasalisation.

However, omission and reduction are not the only reported strategies. For the northern Savonian dialects, Leskinen reports a glottal stop that replaces the nasal in prevocalic position. This glottal stop can occur both as a singleton or as a geminate. This relates to the phenomenon of Boundary Gemination, as discussed above.

Common to most dialects, besides those which are most notorious for losing the final nasal, is that the final nasal undergoes place assimilation to *plosives* and total assimilation to *sonorants*. This total assimilation results in a shortened geminate (Ikola, 1925). Before *fricatives*, Leskinen notes that the alveolar occlusion is somewhat loosened, which also conforms to gestural assimilation of the tongue movement. Thus, mainly the articulatory gesture of the tongue is the target for reduction, while the nasal quality prevails in most contexts, be it as a nasal quality of a lengthened vowel, or as a devoiced final nasal. Nasality is only lost in a total assimilation configuration when followed by a non-nasal sonorant. However, some dialects (e.g.: the South-Savonian and the South-Eastern dialect) are known for the loss of a final nasal before *s* and *h*. Also Ikola (1925)and Virtaranta (1946) note that *ns* behaves the same way across word-boundaries as word-internally, as its realisation is particularly sensitive to (sentential) stress. For a more complete overview the reader is referred to the dialect atlas of Kettunen (1940).

2.2.4 Factors in dialectal variation

According to the observations noted in the detailed description of the South-Savonian dialect (Mielikäinen, 1981) the loss or prevalence of the final nasal is subject to syntactic, morphological and phonological conditions.

A word final nasal in an initial and thus main stressed syllable is most likely to remain as is, while in longer words and thus in unstressed syllables the nasal is more likely lost. This can be observed in words like *on* ('is'), the conjunction *kun* 'when', or the negative verb of the 1Sg. *en*.

After long vowels, the nasal is more likely lost compared to short vowels, as for example in words like *niin*, which more often than not is pronounced as [nĩĩ].

Ikola (1925) suggests that also the nativity of a phoneme interacts with assimilation. The non-native (but reasonably familiar and rarely substituted) /f/ clearly differs in behavior from /s/ in the dialect of the lower Satakunta, a sub-dialect of the south-western dialect group. Nasals, but also the final 'ghost' consonants in BG are predominantly deleted, if they are followed by /f/, while they are unchanged (or assimilated in BG) before the /s/. However, it is unclear whether this is an effect of the lower frequency of /f/ or of its status of not being a member of the native phoneme inventory. Also, deletion of final consonants before /f/ may well be due to the lack of both /nf/[12] or geminate /f/ (aside from proper names).

The class of the following consonant influences the likelihood of omission. Virtaranta (1946) reports that the variation of n is particularly rich before *s* in the described local variant of the south western dialect.

Morphologically, -n is more likely to be retained if the morpheme consists exclusively of -n. This would be, for example, the 1sg or the genitive -n, whereas the illative -Vn or the passive -VVn, where -n is just part of a larger morpheme, is lost more frequently. Functionally, this corresponds to a preservation of salient information. More baroque morphemes can afford to lose the final nasal, since their underlying form can be retrieved from the remaining parts of the morpheme or the context. This can also be observed in forms without a long vowel before the final nasal. Most typically, nominative forms ending in *-nen*, which are frequent in derivational morphology, are pronounced without the final nasal.

On a syntactic level, loss occurs more frequently in utterance final position than in other

[12] Typically, /nf/ sequences, for example in Swedish proper names, are modified such that the labial fricative is voiced (cf. *raanveltti* for 'Granfelt').

contexts, while sentential stress contributes to the stability of the nasal.

It is very difficult to quantify the weight of all those factors, since most of them depend on each other. It is conceivable for example that some morphological forms are more likely to occur utterance finally than others. Also, morphological and phonological conditions overlap as larger morphemes frequently also involve long vowels before the final *-n*.

Chapter 3

Government Phonology and nasal place assimilation

In light of the theoretical discussion in chapter 1, the role of the formalism of Government Phonology (Kaye et al., 1985, 1990; Kaye, 1989; Pöchtrager, 2006; Scheer, 2004) needs to be clarified. To this end, it must be noted that Government Phonology (GP) is a cover term for vastly heterogenous conceptions of the role of phonology within grammar. The core of GP, though, can be summarised as the idea that representations are governed by principled restrictions, which may be parameterised but are neither gradeable nor violable.

The lack of a derivational component in GP has been acknowledged also amongst researchers within GP, most notably Scheer. Formal aspects of the nature of melodic representation have been addressed in Pöchtrager (2006). The analysis presented here, has two major goals. The first is to provide a restrictive formal analysis of Finnish nasal place assimilation that compensates this lack of derivation by formulating representations as explicitly as possible, the second goal is to indicate that such restrictions leave potential for capturing gradient and variable phenomena and typological asymmetries in place assimilation.

In the account presented here, this results in a reduction of intuitive simplicity of the representations, which has often been noted as one of the major benefits of the autosegmental representations used in GP. Yet, the view is maintained that such a visualisation based formalism is a helpful tool for an intuitive understanding of the processes and the underlying phonetic conditions that govern them. It is this insight that leads to the conclusion that adapting GP to the needs of flexible representation of cross-linguistic fact in the empirical domain of place assimilation is both a realistic and fruitful enterprise.

3.1 Some preliminary notes on the Finnish consonants

Before the details of an analysis are laid out, a few notes regarding the consonant inventory are at hand. The Finnish consonant system is very limited. There are three voiceless stops /p,t,k/, but only one voiced stop, namely /d/, which only occurs as an alternant of /t/ in consonant gradation (cf. katu *'street' nom.* vs. kadun *'street' gen.*), and a small range of loanwords that are specific to dialects of urban regions ('duuni' *job*). Other voiced plosives are only found in loanwords (banaani *'banana'*). Of the fricatives only /s/ and /h/ are native members of the inventory, additionally a labiodental fricative /f/ can frequently be found in loanwords. Other fricatives like /ʃ/ can occasionally be found, but do not seem to play a systematic role in the language, and are therefore ignored. The classification of /h/ as a fricative is taken from Karlsson (1983), but will be reconsidered in the course of the analysis.

The sonorants are classified into the groups of semivowels /ʋ,j/, the liquids /l,r/ and the nasals /m,n,ŋ/, the last one being defectively distributed, since it occurs either in assimilation contexts followed by /k/, or on its own as a result of consonant gradation.

3.2 Finnish Nasal Place Assimilation - a first approximation

In autosegmental terms, assimilation processes are best analyzed as feature spreading. In Government Phonology GP binary features are replaced by privative units of melodic representation, the so-called *elements*.

If sandhi is understood in the sense of the term connected speech, thus neglecting its much broader use as a term for anything phonological that happens as a consequence of morphological or syntactic concatenation, the trigger for phonological changes in the first place is a change in the status of boundaries.

What is found in Finnish, is that word internal clusters are very similar to clusters that occur across word boundaries, or put differently, internal and external consonant clusters are subject to the same wellformedness conditions. In a formal approach in GP, ideally, three facts about the distribution of Finnish consonants will automatically be explained, once an analysis of FNA in external sandhi is given.

(42) Three restrictions on Finnish nC-clusters

a. No heteroorganic Nasal-Obstruent Clusters.

b. No Nasal-Sonorant Clusters, with the exception of geminates.

c. Word final consonants are coronal.

Note that, according to Karlsson (1983), the cluster *nh* constitutes an exception to (42a). In GP, the effects of assimilation should follow from the representation and independent principles. These principles are absolute and cause changes in the representation when violated. The following is an attempt to analyze FNA with the givens of ET.

3.2.1 Data

As discussed in section 2.1.2, FNA is a variable phenomenon. For the purposes of this analysis the pattern is simplified to place assimilation before obstruents and total assimilation before sonorants. Optional deletion of the nasal is incorporated with respect to /h/ which will be discussed in detail in section 3.6.

3.3 Representations

3.3.1 Word Final Nasal

At first, the nature of the final nasal must be determined. Therefore, consider the alternation of the nasal in (34) repeated here for convenience in (43) below.

(43)

nom.	**gen.**	**gloss**
puheli**n**	puheli**m**en	'telephone'
avai**n**	avai**m**en	'key'
pakasti**n**	pakasti**m**en	'freezer'

The alternation in (43) is an artifact of a diachronic change, during which every word final *m* became *n*. Synchronically, this alternation shows that word final nasal must be coronals, and that the language will repair violating segments. At this point two approaches seem feasible to describe this repair strategy.

The historic nature of this alternation suggests that an A element was inserted independently of the originally present melody, simultaneously melodic primes, presumably an U element, were removed from the segment. In such a view, the representation of the -n of the gen case would be {L̲,ʔ} - a default unspecified Nasal. The realisation as [n] would be due to a *principle* restricting final consonants to coronals. However, this is not always true, since in connected speech they[1] will undergo place assimilation, i.e. the ME is filled with the place element from the following segment. Thus, there would have to be another surface *constraint* penalizing heteroorganic nasal-obstruent clusters to cause this feature spreading. These two principles, the ban of word final non-coronals and the ban on heterorganic nasal-obstruent clusters, would be in a conflict.

To avoid interacting constraints, it seems to be the only possiblity to assume a *floating* A element that can be linked to the melodic expression (ME) depending on the makeup of the following segments and the structural configuration, as will be shown.

The stop element ʔ is present, because, following Anderson (1976, p. 329), Finnish nasals pattern with stops.[2]

[1]Both nasal and non-nasal stops (see section 2.2.2).

[2]They both trigger a diachronic dissimilation process involving a change from /k/ to /h/.

(44) The structure of the word final nasal

a. {L,ʔ} A̲
\
x

Note that so far, the segment cannot be realised. It will be necessary that linking of the place element A only occurs as a last resort strategy. In fact, the floating A element will only be linked when followed by a vowel. The idea of a floating A element is nothing new. It has been proposed among others in Rennison and Neubarth (2003), as will be discussed below in more detail. The present approach, however, differs in that it assumes that such a defective ME is only assumed for final codas. Also outside of a GP framework such ideas are abundant. As discussed in section 1.4.6, the spiritually similar idea that coronals are underspecified for place has been used also in Mohanan (1993)[3]. Note that lexically the floating A is designated to become a head, but cannot be realised in the absence of *melodic licensing*, as will be explained below.

3.3.2 Stops

The representations of the plosives are not unproblematic. Especially /k/ offers potential for a headache: Since ET lacks a prime referring solely to the velar place of articulation, it is not immediately obvious how /k/ should be distinguished from other plosives, and it is even less obvious, how place assimilation to velar place could be represented. Scheer (2004) argues strongly for such a prime. This view, though, seems to be aside the mainstream view, so other options will be considered. One road that is taken for example by Backley (2011), and also followed here, is to invoke the notion of headedness. For /k/, it has been noted that velars frequently pattern with labials, while coronals and palatals on the other hand have been found to co-occur in contexts of phonological processes. Thus, for labial and velar plosives, the following representations are given by Backley.

(45) The representations of /p/ and /k/

a. {U̲,ʔ}
|
x
/p/

b. {U,ʔ}
|
x
/k/

In this view, an unheaded U element is responsible for the velar place of articulation. Backley (2011) proposes that unheadedness corresponds to weakness of place cues of place elements. In languages where coronals and palatals pattern together, he claims, and both places of articulation are represented by an I element, palatals are headed since their F2

[3] The articulatory basis of this behavior has been investigated in work by Byrd (1996); Barry (1992) and Browman and Goldstein (1992)

is higher than F2 of coronals. For the distinction of velars and labials by the same formal means no such correlation to a phonetic property is provided in Backley (2011), however he argues that in some languages - similarly to coronals - also velars show show inherent weakness, which is symptomatic of unheadedness, in that they occur in weak positions and are targets of assimilation. Considering the fact that velars in a large number of languages the velar nasal does not occur word initially thus in a strong position the unheadedness of velars as opposed to labials gains further plausibility.

Another view that will be referred to as the default view, puts even more emphasis on the property of inherent weakness by representing velar as the default place of articulation that lacks a place element altogether.

(46) The default view representations of velar stops and nasals.

	a.		b.
	{ʔ}		{L}
	|		|
	x		x
	/k/		**/ŋ/**

This type of approach is taken for example in Rennison and Neubarth (2003). In this view, all cases of assimilation to ŋ are in fact seen as the lack of assimilation, while /n/ and /m/ are the result of spreading of the respective element A and U.

The major problem that follows from this setting, is that all alternating nasals must be underlyingly velar, even those that surface as coronals, when they are word final or followed by vowels. In these cases, according to Rennison and Neubarth (2003), an ambient R element (corresponding to A in the present theory) causes this effect. It is remarkable that these ambient A elements occur only in the context of Nasal assimilation, moreover, they do so independently of the quality of the surrounding vowels. Thus, in a word like *initial*, with an underlyingly unspecified and thus velar nasal, this initially floating ambient element needs to attach to the nasal.

However,it is not entirely clear how this *need* can be specified. In fact, it seems necessary to make a statement that the default nasal must not occur on its own due to its melodic weakness[4], and must somehow be helped by a surrounding default stop - a velar stop. However, since melodic representation of the nasal does not change in such configurations - there is simply no transmission of elements - some structural relation between the two consonants would be needed to sufficiently strengthen the melodic expression to allow it to surface.

Thus, it cannot be melody alone that is responsible for the strange behavior of velar consonants, and further structural conditions are necessary.

The Coda Mirror (Ségéral and Scheer, 2008) provides a formalisation of lateral rela-

[4]Note that in the view presented here, such a move becomes obsolete, since a ME containing L as its only element will always fail to be realised since phonetics simply doesn't know what to do with it. This is not a matter of weakness, this ME is just not part of the inventory of the language. This is what causes the floating A eement to be linked to the nasal.

tions. In this view, the coda position has been identified as a weak position that is neither governed nor licensed by the following nucleus. This accounts for the tendency of coda consonants to lenite and/or vocalise. Applying this view to the default nasal view leads to a crucial complication: While a weak position can legitimately contain a weak nasal, it remains unclear why the default nasal of a coda position can be an assimilation target, if the assimilation is considered to be an addition of further elements to a melodic expression, and therefore as a type of fortition, as the default nasal does not have any place specification. Thus, /m/ and /n/ being stronger (melodically more complex) counterparts of a weak default nasal /ŋ/ ultimately leads to predictions regarding fortition and lenition that cannot be met. Regarding this it must be stressed that spreading of the stop's place element is not a matter of copying it into a target ME but of an additional linking of the same element corresponding to the same articulatory activity.

Aside from this theoretical argument against the default view, the data on different patterns in English nasal place assimilation presented in (10) of Rennison and Neubarth (2003, p.114) show that the prefix /un-/, as oppossed to the latinate prefixes /in-/ or /con-/, allows the nasal to remain unassimilated. In such cases of optionality, it will always be a coronal nasal that may surface, whereas a velar nasal is restricted to the neighborhood of a velar stop. Even though this does not contradict an analysis involving an ambient A element, it seems to suggest an analysis that emphasises the underlying status of the coronal nasal more strongly.

Thus, the following representations of the set of Finnish plosives will be used here for the analysis of FNA:

(47) Representation of the stops /p,t,k/.

a.	b.	c.
{$\underline{\text{U}}$,ʔ}	{$\underline{\text{A}}$,ʔ}	{ʔ,U}
|	|	|
x	x	x
/p/	**/t/**	**/k/**

3.3.3 Sonorants

In Government Phonology and Element Theory, there is no particular manner feature for sonorants or any subclass of sonorants, except for nasals. Semivowels are viewed as the consonantal counterpart to vowels. MEs of vowels and semivowels are identical and consist solely of a headed {$\underline{\text{U}}$} element. What differentiates them is their position.

The liquids l and r are more controversial. Even though they are generally believed to pattern together (Backley, 2011), r is represented as a simplex {A} expression whereas l-type sounds involve a complex expression like {$\underline{\text{U}}$,I} (Rennison and Neubarth, 2003) or {UA} or {AI} (Backley, 2011). Here, however, I will follow Pöchtrager (2001), who assumes $\{\underline{A},I\}$ as the representation of [r], in order to account for differences in the behavior of glides versus liquids. Only a subset of the sonorants can be subsumed under consonantal melodic expressions that lack manner elements. This subgroup will exclude nasals and /h/. The representations for the Finnish sonorants are given in (48).

(48) Finnish sonorants

a.	b.	c.	d.
$\{\underline{U}\}$	$\{\underline{I}\}$	$\{\underline{A},I\}$	$\{\underline{U},I\}$
|	|	|	|
x	x	x	x
/ʋ/	**/j/**	**/r/**	**/l/**

Semivowels and L can be straightforwardly distinguished by complexity that is, the number of elements contained in the representation.

3.3.4 Fricatives

The representation of the fricatives /s,f/ is straightforward. Element Theory proposes the element H that is responsible for high frequency noise. Accordingly, the representations of the place of articulation are parallel to those of the plosives.

(49) Representation of the fricatives /s,f/.

a.	b.
$\{\underline{U},H\}$	$\{\underline{A},H\}$
|	|
x	x
/f/	**/s/**

While /h/ will be analysed as a fricative, the discussion of its representation is delayed to the end of this section.

3.4 Derivations

3.4.1 M-licensing

Government Phonology operates without the use of rules. Instead, principles and well-formedness conditions govern changes in the lexical representations.

In order to derive spreading of elements in place assimilation by means of principles alone, an additional formal tool is needed. *Melodic licensing* (m-licensing) can be dispensed by H and ʔ in order to accommodate place elements in a ME. M-licensing is a tool in the spirit of the licensing constraints for MEs of vowels (Kaye, 2000; Charette and Göksel, 1998), in the sense that it potentially can be parametrised and used to account for the makeup consonant inventories[5]. For now, m-licensing shall be used to model the phenomenon of

[5]For example Finnish the ʔ and H elements can only m-license one place element in a melodic expression. Following the version of element theory proposed in Backley (2011) this bans labiodentals $\{ʔ\ \underline{U}\ A\}$, palatalovelars $\{ʔ\ \underline{I}\ U\}$, and uvulars $\{ʔ\ U\ \underline{A}\}$ from the consonant inventory, since they all involve complex resonance, which is represented by combining place elements. However, such a restriction falls still short of eliminating

Finnish nasal place assimilation. Additionally, the proposed formalisation shows potential to capture place and manner asymmetries in the typology of assimilation phenomena.

The definition of m-licensing is given below in (50). Note, however, that headedness does not seem to play a role for m-licensing. In the present view this fact disqualifies m-licensing as a type of licensing constraint. M-licensing will always obtain irrespective of which element is the head of the ME, or whether the ME is headed at all.

(50) M-licensing
ʔ and H can m-licese U,I,A in a ME.

M-licensing is a relationship between manner and place elements. Since each place and manner of articulation has different properties compared to other places and manners of articulation, the strength of this relationship is a function of these properties. These differences are phonetic in nature and are discussed at length in section 1.3. Here, the assumption is made that these properties, are encoded in the place and manner elements. For place elements they encode the temporal extension of the articulatory gesture, as well as their tendency to overlap when in coda position, which is higher for coronals than for labials Byrd (1994, 1996). It is well known that tongue body gestures require movement of a more massive structure of the tongue than gestures of the tongue tip. Further, velars are produced with larger contact area of the tongue and the palate than apicals. The view pursued here, is that m-licensing represents acoustic salience of place cues of a certain configuration of place and manner elements. Thus, the claim is made that the m-licensing relation is strongest for unheaded U and weakest for MEs containing A.
For manner of articulation the perceptual dimension is the foundation of the strength of m-licensing. Since place of articulation is most clearly perceptible in fricatives (Hura et al., 1992), this is also where m-licensing is strongest. It is weakest in MEs with ʔ[6], and even weaker in MEs containing both ʔ and L. Further arguments for stronger m-licensing in fricatives also come from articulatory evidence. Clusters containing a fricative are generally shown to be less overlapped than clusters containing plosives (Byrd, 1996, p.233).

A thusly developed gradient notion of m-licensing will be necessary to capture a larger variety of nasal assimilation patterns with a simple adjustment in the interaction of m-licensing with the likelihood of a place element to spread. The general idea, which is inspired by Mohanan (1993), is that in place assimilation the strength of m-licensing is compared. The higher the difference between the strength of the m-licensing relation of the trigger is compared to the target's m-licensing, the higher is the likelihood for assimilation to occur. The claim is made that an additional formal module is necessary for GP in order

palatals {ʔ̲ I} and pharyngeals {ʔ A̲}, the former being the (unheaded) I element alone, and the second one involving a headed A element from the consonant inventory.

[6]Note that this yields the prediction that nasals and plosives expose the same tendency to undergo assimilation and to lenite. This is obviously not in compliance with linguistic fact. The L element in MEs of nasal must be assigned a crucial role in modifying the m-licensing strength, too.

to allow for a representation of cross-linguistic observation in place assimilation.

For the analysis of the Finnish pattern an absolute notion of m-licensing is sufficient[7].

(51) Finnish m-licensing
ʔ and H can m-license *either* U or A in a ME.

In Finnish, the ʔ and H elements must use their m-licensing capacity exactly once per ME. This is formalised in (51) Thus, a melodic expression like {ʔ̲,U,I} is ungrammatical since only one place element can be m-licesed by the ʔ element, while {ʔ̲, A} is ruled out, since I is never m-licensed under any condition. Unlike other licensing conditions m-licensing is not restricted to L-Structure, but also obtains during a derivation. Consider, for example, defective lexical entries like the one proposed for word final nasals, where a floating A element is lexically present. Such a strange defect can now be stipulated as the failure of m-licensing to apply lexically[8] A derivation needs to specify how such a failure is compensated for. This happens either by relinking, which becomes synonymous with post-lexical m-licensing, or by other means which will be inspected below in more detail. Henceforth, m-licensing will be represented by a subscript '+' to the right of the m-licensed element.

Having the representations set up this way, enables us to accommodate the assimilation pattern in an analysis. The vocalic place elements U,I,A are bound to spread.
This is taken care of by a principle that forces spreading of U,I,A[9]. Three conditions have to be met in order to allow spreading of U,I,A. Superficially, it seems that the target consonant must not contain a place element in its ME. This may be subject to parametrisation, and in languages, where labials do assimilate to the following plosive, the trigger's m-licensing relation is able to break the m-licensing of the target. More precisely, a spreading place element must be licensed within the ME of the trigger consonant. Also, the spreading element must find m-licensing within the trigger consonant. Thirdly, spreading only occurs to a weak position in terms of the coda mirror.

3.4.2 Place-Spreading

In Finnish, spreading to and from a consonantal position underlies different locality constraints than spreading to and from vowel positions, where we find non-local vowel harmony. While no analysis of vowel harmony will be attempted, two distinct types of spread-

[7] Yet, interestingly, the only heteroorganic nasal-obstruent cluster of Finnish that occurs exceptionally - /ms/ - is a case where a - by virtue of headed U̲ - strongly m-licensed ME meets another - by virtue of the H element strongly m-licensed ME, and yet no assimilation occurs. In fact, assimilation to fricatives is cross-linguistically rare. This seems to be due to the influence of governing relations on the strength of the contribution of the H element to the m-licensing relation. As discussed in 1.3.3, several factors seem to interact here. For example, it was noted that preocclusion of post-nasal fricatives provides a place cue for the nasal that does not occur before plosives. Moreover, gestural overlap in clusters with fricatives is lower. It is unclear how to translate this information to m-licensing.

[8] Again, in terms of a model phonetics this corresponds to the fact that frequent assimilation of a final consonant is likely to reduce the specificity of the mental representation of such final element.

[9] Note that since the I element is never m-licensed it will de facto never spread.

ing are introduced to distinguish these two types of spreading. P-spreading will be responsible for all consonantal assimilation processes in Finnish as it is restricted to consonantal positions, while V-spreading occurs only in vocalic position. While this view is certainly to restrictive, since it does not allow for melodic interaction between consonants and vowels, for Finnish it offers a descriptively adequate tool, as no assimilation processes between vowels and consonants are reported.

P-Spreading allows parametrisation of what spreading can do in a language. These specifications involve locality and directionality. That is, how far and in which direction spreading is possible.

(52) Finnish p-Spreading

a. Spreading is leftwards.

b. Spreading must cross a word boundary.

(52b) is a necessary condition, since word-boundaries in Finnish clearly impose stronger restrictions on consonant-clusters than normal Finnish coda-onset clusters. Word internally, non-homorganic clusters like [tk, sp, sk,sm,tv] can be found that do not arise or undergo assimilation across word boundaries.

This notion has to be further supplemented with the specification of what is allowed to spread and which melodic conditions have to be met.

(53) Finnish p-spreaders

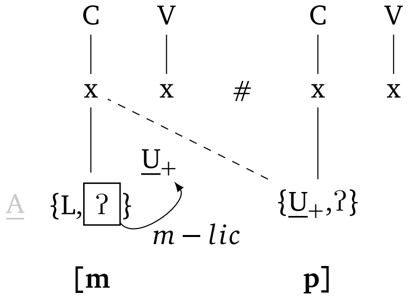
a. The place elements U, I, A spread leftwards, iff they are within a m-licensing domain in both the target and the trigger.

3.4.3 Assimilation to plosives

The principles above provide the tools for the analysis of the Finnish data. Firstly, assimilation to plosives and fricatives will be considered. The following sections will treat the behavior of nasals when followed by sonorants and vowels respectively. Recall that the main problem with element theory and assimilation is the lack of a velar place feature to treat place assimilation. A solution has been proposed, under which velars are represented by an unheaded U in a headless melodic expression, whereas labials are represented as headed U elements.

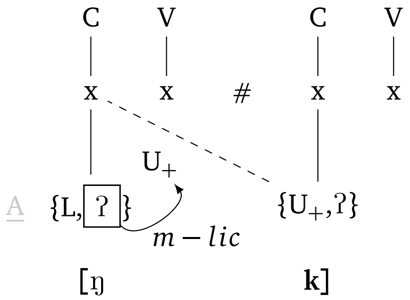
(54) shows assimilation of /n p/ to [m p] in a phrase like *pöydä*[mp]*äällä* ('on the table'). Note that the only respect in which this representation differs from [nt] like in the phrase *poja*[nt]*yyli* ('the boy's style') is that the latter one would involve an A element instead of an U element. It will become clear later why this is also a case of assimilation.

(54) Assimilation to [mp]



Above, the U element is m-licensed in the trigger consonant by the stop element, as indicated by the subscript '+'. (55) below illustrates assimilation to k, as for example in the phrase *poja*[ŋk]*anssa* ('with the boy'). The only difference between (54) and (55) is the headedness of the U element.

(55) Assimilation to [ŋk]

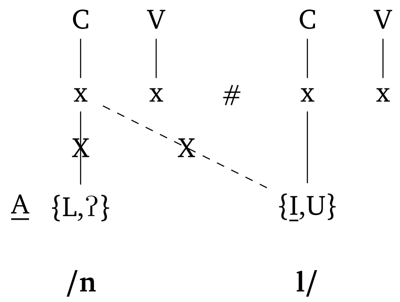


3.4.4 'Total assimilation' by sonorants

In analyses of nasal assimilation in the framework of Feature Geometry (Padgett, 1994), nasals that undergo total assimilation in the vicinity of sonorants, are explained by spreading of the entire root node. Sonorants, which are traditionally viewed as weaker than obstruents, seem to have the power to annihilate the entire ME expression of Nasal, and substitute it with their own. There are a couple of reasons to doubt such a view. It is completely arbitrary why a nasal should behave differently in the vicinity of stops and fricatives as opposed to when followed by a sonorant. This has to be specified by rule. The view taken here is that in fact, in Finnish, m-licensing is indirectly responsible for the patterns we find, since the place elements in MEs of sonorants are not m-licensed.

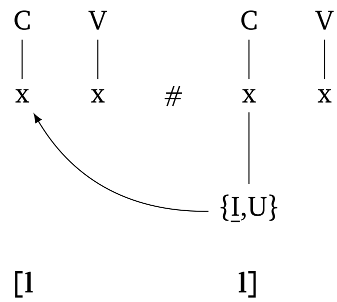
In (56) the sonorant /l/ fails in the absence of m-licensing to spread a place element to the nasal, which in turn cannot be realised itself. Recall that (44) showed that the word final nasal is defective and cannot be realised, when left on its own. The reasons for this behavior will be further clarified in (3.5.2).

(56) Failure of assimilation to liquids and glides



As a consequence of this failure, the now vacated position of the nasal will be identified by the *entire* ME of the sonorant. This identification process is typical for Finnish. Recall the Boundary Gemination phenomenon discussed in section 2.2.2. There, it was demonstrated that a historically vacated position in Finnish is always occupied via gemination of the first consonant of the following word, even to the extent of creating limital geminates (Itkonen, 1964b) that only occur across word boundaries, but not word-internally. These geminates are [jj] and [ʋʋ].

(57) Gemination of liquids and glides



However, an obvious question still needs to be addressed. Why is the nasal deleted in the first place? It was shown in (44) that the final nasal is defective and cannot be realised. The ʔ element is unable to dispense its m-licensing capacity. The only option that is left would be relinking (m-licensing) of the floating A element. Now, the behavior of this nasal in (57) shows that a preconsonantal position is not the environment where relinking occurs.[10]

What has been shown thus far is that the so-called total assimilation is a result of the lexical status of the final nasal, and the lack of support it gets from a sonorant. While this view is able to account for the avoidance of nasal-sonorant clusters across word boundaries, it fails to relate this fact that nasal-sononrant clusters do not exist word-internally. Unless the assumption is made that all nasal-initial coda-onset clusters of Finnish do lexically lack a place element.

In order to support such a view, it would be desirable to find diachronic evidence. Such evidence could stem from loanword phonology. However, to my knowledge there is no example of a purely word internal nasal-sonorant cluster that underwent a diachronic

[10]See section (3.5) below for problems with the formalization of this fact in a CVCV framework.

change after being borrowed into the Finnish language. What can be found though, are examples where derivational morphology triggers exactly the same change in such clusters. For example the word *saman+lainen* ('same') is consistantly pronounced as *sama[ll]ainen*. This, to the very least, shows that the type of boundary does not play a relevant role in this type of alternation. This further supports a view that accounts for defectiveness of final nasals by structural conditions, namely domain finality. This domain has to be defined in terms of syllable structure. Thus, Nasals in Coda positions are not lexically defective, but are tampered with by means of syllable structure, which seems to have the power to reduce the melodic complexity of a nasal by removing its place element. In such a view the defectiveness of the assimilated nasal does not stem from a failure of lexical m-licensing, but from conditions on syllable structure[11]. Given the strictly initial word stress and the fact that final syllables are mostly unstressed a stronger dominance of initial syllables over final ones seems a logical consequence. This dominance triggers the effects under consideration. The hypothesis is that this stronger dominance will restrict the set of consonants which are able to survive in this hostile environment of a final coda and further promote their weakening. In the following, a proposal is sketched that attempts to formalise this hypothesis based upon the coda mirror theory of lenition (Scheer, 2004; Ségéral and Scheer, 2008, 2001; Ziková and Scheer, 2010).

3.5 Vowel-initial words

This section will deal with how the word final nasal surfaces as alveolar when the following word is vowel initial. Recall that this is in fact the only context in which the word final nasal will be forced to m-license the floating A element, and thus be realised as [n]. This fact is due to the position of the nasal in syllable structure, when followed by a vowel, namely in an intervocalic onset position. However, this statement is based on the observation that in connected speech phenomena, such as FNA, linguistic boundaries become obsolete and the string is treated by phonology like a single word.

3.5.1 The principles of the coda mirror

In the CVCV model of Government Phonology (Scheer, 2004) syllable constituent structure is reduced to a succesion of consonantal and vocalic positions. Generalizations involving syllable structure have to be expressed in terms of lateral relations. Further, the strict CVCV framework requires that there always be an empty nucleus word-finally and an onset word-initially, even in vowel-initial words.

[11]Conceptually, a static, lexical view, and a dynamic, structural view are not mutually exclusive, but rather find independent motivation, that both are required. Syllable structure and linear order shape place assimilation patterns, as well as place assimilation patterns shape the way lexical items are stored in memory.

These lateral relations are formalised in the coda mirror[12] . It uses two lateral relations, namely government (gov) and licensing (lic) to represent weakening (gov) and strengthening (lic) of segmental content. Both relations are initiated in the vowel and apply leftwards. Per default, government and licensing target the C position preceding the vowel. If this C position is preceded by an empty V position goverment is diverted to silence it. Empty nuclei can neither govern nor license. By definition, a C position that is only licensed is a strong position and occurs in word initially and following coda consonants. Weak positions are either the intervocalic position, which is both governed and licensed, as well as word and syllable final codas, which are neither governed nor licensed, because the V position following them is empty and thus laterally inert.

3.5.2 The problem of vowel initial Words and CVCV

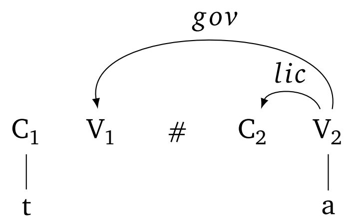
It has been shown for many languages that external sandhi is sensitive to the quality of the initial sound of a word. For example, in some dialects of English, final stops lenite or remain unchanged depending on whether the following word begins with a consonant or a vowel (Harris, 1994), consider the examples in (58).

(58)

a.	/get#a/	[gɛtə]
b.	/get#by/	[gɛʔbaɪ]

With the givens of CVCV theory and the Coda Mirror, an analysis of the English examples above becomes impossible. There is no way to differentiate the status of the final consonant in (58a) and (58b). This is illustrated in (59).

(59) The status of word-final codas I



Irrespective of whether C_2 contains overt material or not, it will always be licensed by the nucleus following it. Even empty C positions incur this fate, since, quoting (Scheer, 2004, p.141),

If an Onset is not licensed its Nucleus must be empty.

The Nucleus V_2, however, is filled and will license its Onset. C_1 is left unlicensed and ungoverned - the configuration of the coda position - irrespective of the beginning of the following word.

[12]Here, version 1 is used as laid out by Ségéral and Scheer (2001)

Note that, even though the present analysis of FNA relies on a solution for this problem, there is independent need to relate the status of a final consonant to the beginning of the following word. Harris (1994) avoids this problem by representing vowel initial words without an initial C position. This move has the consequence that the FEN of the word preceding the vowel initial word in sandhi configuration is deleted as well. This can be seen as a violation of the Structure Preservation Principle, which forbids manipulation of syllable structure during the derivation. However, it yields the correct licensing relation for his analysis, as the final consonant becomes truly intervocalic. Most of the accounts of such phenomena outside of government phonology involve resyllabification.

While the analysis at hand does not use this terminology, the effect of resyllabification must somehow be achieved. Around word boundaries, syllable constituency is reorganised. In CVCV models the behavior corresponding to syllable-constituents is derived from lateral relations, so it is clearly necessary that a word boundary situation tampers with the standard behavior of these relations. If it is possible to find a way to make these lateral relations work in the desired way, such an analysis is preferable to resyllabification, because it provides a complementary theoretical concept to the FEN, and simultaneously uses the existing governing relations to generate the effects of resyllabification. Such a move, of course, is nothing new (cf. Harris, 1994) . What is new, however, is that the solution here will not derive resyllabification without deleting the vowel initial onset position. However, structures, which are not strictly CVCV, go against the universal assumption of CV as the only syllable type.

The proposal that will be made here, in order to derive word boundary effects in Finnish, is an empty category principle for consonants.

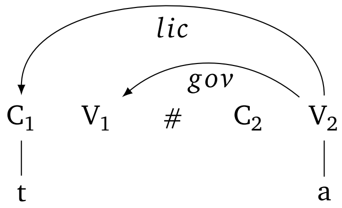
3.5.3 The IEC [jɛts] - The initial empty consonant

Consonants are the mirror image of vowels in a variety of ways. The least sonorous consonants are those that are predominantly found in strong positions. FEN - final empty nuclei are known for being laterally inactive. They may or may not be able to govern or license. A property that is set by a parameter. I will propose that the IEC - the initial empty consonant - is inactive in exactly the opposite way. It may or may not accept licensing and government. As far as phonetic realisation is concerned, some languages seem to enforce that an IEC be filled phonetically. German is such a language, where IECs are automatically filled by a glottal stop. Other languages, amongst which Finnish can be found, do not enforce realisation of the IEC in any way, while Estonian strictly forbids it. Thus, for German it can be assumed that a IEC is susceptible to licensing, which, as a direct consequence, causes the glottal stop to emerge.

3.5.4 Consequences of the IEC for Finnish Sandhi

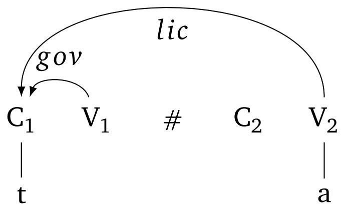
Now reconsider (59) with the implementation of the IEC.

(60) The status of word-final codas II



You will notice that the IEC has as a consequence that the final coda consonant is licensed, which corresponds to a strong position. This is an unwanted result, as well, since it in fact behaves like an intervocalic consonant. However, a minor modification suffices to achieve the right result. The data coerces the assumption that in Finnish FEN are able to govern. Given this slight modification, the representation is as follows[13].

(61) The status of word-final codas III (final)

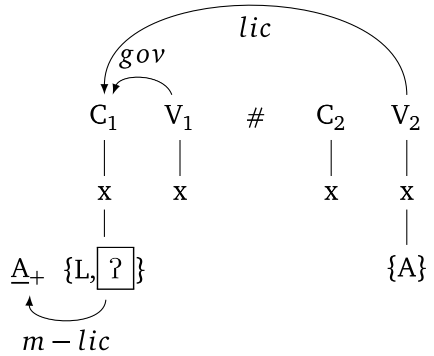


The modifications so far have brought about, what could prima facie be seen as collateral damage. Namely, since the FEN have been enabled to govern, pre-consonantal word-final codas find themselves in the nightmare position, i.e. a governed position where segmental content is inhibited to the most severe extent. However, is this as unwanted, as it seems? The claim here of course will be that a negative answer can be given. The reason for this lies in the fact that in the course of the development of the Finnish language final consonants have been subject to deletion upon a regular basis (see section 2.2.2), whereas other coda consonants have not incurred this fate in a similarly dramatic way.

Turning back to the Finnish data, we have the tools to explain, why intervocalically the final nasal is realised.

[13] For expository reasons the representation of the government relation of V_2 to V_1 has been omitted.

(62) The intervocalic situation of FNA



As a consequence of being both governed and licensed, the stop element of the final nasal can m-license the floating A element, and thus incorporate it into its melodic expression, which then will be pronounced as [n]. So far, it was shown, how the beginning of a word interacts with the final consonants of a preceding word. It was shown that a final consonant finds itself in different structural configurations, whether it is followed by a vowel or by a consonant. In the latter case segmental expression is inhibited in the so-called nightmare position (Ségéral and Scheer, 2008). There is no way for the lexically floating A element to be m-licensed, however, m-licensing may occur if it is sponsored by the initial consonant. If this is not the case, for example in the case of liquids and glides, the final nasal is unpronounceable and deleted.

If the final nasal is followed by a vowel initial word, there will not be any sponsoring of m-licensing, however, there will be a different structural configuration, which allows the nasal to m-license the floating A element.

3.6 The residual case of /h/

Examination of the transcription of various dialects in the Lauseopin Arkisto of the University of Turku revealed that it is very well possible that a word final nasal remains unaffected by /h/ and will be normally pronounced. The data of phonetic survey in section 4.2.3, however, suggests that the basic pattern with /h/ is that a preceding word final nasal will not be deleted, but either reduced in intensity or pronounced as a breathy voiced nasal. For the Helsinki dialect examined in Chapter 4, /n/ before /h/ was pronounced predominantly as a breathy voiced nasal.

There has been a reasonable amount of debate about whether /h/ is best described as a sonorant or a fricative, or even as a semivowel. The proposal here is that /h/ is represented, following Finnish traditional approaches, as a fricative: {H}. This accounts for its allophony since, lacking place elements that generate formant resonances it is easily assimilated. Also, this representation correctly predicts that there will be no assimilation, since it contains no place element that could spread.

However, there are a few options about what could happen in this configuration. The most straightforward option is that the final nasal is deleted, and the H element identifies the vacated position. However, this is not what happens. What can be observed is that [h] never geminates in Finnish. So something must block {H̲} from geminating in the same way that sonorants do. The descriptive generalisation would be that this is impossible, because of the lack of a geminate /h:/ also word-internally. However, standard Finnish also lacks geminate [j] and [ʋ] word-internally, but in sandhi environment their gemination becomes possible. Formally, this difference in behavior is attributable to the lack of place elements, which in Finnish seem to have to be present, so that the ME can identify a position.

A second theoretical option is that {H̲} must dispense of its m-licensing capacity since it is in a strong, word-initial, position. Since, in the absence of place elements, it cannot m-license anything by itself, all that is left to do is to help the preceding final nasal to m-license its floating A element. This will lead to the final nasal being pronounced as [n]. This partly is in compliance with the data, since there is a lot of variation with respect to the behavior of the final nasal when preceding a [h]-initial word.

What can be observed here is an instance of optionality. This optionality is rooted in the fact that there is more than one option to repair an unwellformed representation. Two conditions interact: M-licensing is strictly local. The m-licensee must occupy the same position as the m-licensor. The other condition is that m-licensing must be dispensed. In the case of /h/ we thus find instances of constraint interaction, a state which here is believed to bring about optionality.

3.7 Conclusion

It was shown that with some theoretical modification, namely the entity under the name of m-licensing, a long needed formalisation of the initial empty consonant (IEC) and lexical stipulation, namely the final nasal, the melodic and structural effects of FNA can be integrated into Government Phonology. Some of these modifications can easily be motivated independently. The IEC has been shown to be a long time necessity for GP, further this notion can be extended to hiatus avoidance and initial glottal stop epenthesis. The discussion of [h] and its dubious status within the phonology of Finnish has shown that optionality can be, even if somewhat clumsily, implemented into goverment phonology. Similarly, the notion of m-licensing has been introduced as a tool to regulate spreading of place features. The potential of m-licensing cannot be fully evaluated here, yet it provides a tentative sketch of how m-licensing may be extendable to derive typological patterning in GP. Further potential for theoretical and empirical discussion are provided by the implications of the adopted conditions on the FEN and the IEC for interface issues. Can these theoretical tools provide a formalism that banishes boundary symbols from representations - a goal long fought for by Scheer (2009)? Can the analysis be extended straightforwardly to the phenomenon of boundary gemination? Can the stipulated lexical representation of the final nasal be further justified, by analysing historic processes of consonant deletion in Finnish? What is the relation of FNA to phonotactic constraints of Finnish, and how, if at all, can GP account for this type of restrictions? For now, these question must be left unanswered.

Chapter 4

The phonetics of Finnish nasal place assimilation

4.1 Overview

This chapter presents the results of a reading task designed to provide a detailed acoustic description of assimilated nasals in all phonetic contexts, as well as a study on the influence of syntactic position on nasal reduction in section 4.4.

The first study gives a detailed phonetic description of the acoustic properties of N#C clusters, an exposition on the segmentation criteria used for duration measurements, and a comparison of assimilation behavior of the two participant speakers in section 4.2.3. Its aim is to examine speaker specific variation in patterns of nasal reduction in word-boundary configuration by giving a detailed descriptive account of the acoustic properties of the final nasal. It is shown that speaker assimilation frequency and nasal reduction are speaker specific. Moreover, it is shown that nasal 'deletion' before fricatives results predominantly in a nasalised vowel.

The second study examines durations of the nasal in dependence on the syntactic environment. The central question of this study is, whether the genitive marker *-n* shows different behavior in different syntactic configuration. To that end the duration of final *-n* of genitival attributes (GEN.ATTR) is contrasted with final *-n* in object position (ACC) and adjectives with genitive marker ADJ . As genitival attributes historically provide a context that promotes the genesis of compounds[1] , it is fairly safe to assume a close connection between the two members of such a DP. Adjectival modifiers also form compounds, however, they lack genitive morphology, as they in Finnish bear the same case as their head

[1]However, many comounds which could be traced back to juxtaposition in genitival attributes seem to be loan translations most prominently from German, cf. *lasten+tarha* vs. *elain+tarha*; 'kindergarten' vs. 'zoo'; where the first member is in gen.Pl. in the former, but plain nominative in the latter which is exactly parallel to German *Kinder+garten* and *Tier+garten*, thus making the development of compounding significantly more complex. Compounds with adjectival first members do exist, but they typically are built directly from the stem, cf. *pienoisgolf* 'minigolf' or *suur+sanakirja* 'large dictionary'. However, also this type of compound may originate from German loan translations, cf. *Großwörterbuch* 'large dictionary'

noun. Opposed to the two DP-internal types of modification, direct objects and a following adjunct are never subject to forming compounds. Instead, they may straddle the boundary of an intonational phrase, manifesting itself through pauses and a different intonational pattern.

4.2 Methods and Design

4.2.1 The dataset I

The corpus consisted of altogether 93 sentences that were constructed to feature final nasals of genitives as objects, adjectives and genitival attributes. A typical sentence consisted of a nominative case subject, which was optionally preceded by an attributival genitive or an adjective, a transitive verb in third person, a direct object modified by either attr. gen. or adj. and, finally, a local or manner adjunct to have the direct object followed by further phonetic material. In the example sentence in (63) only the durations of the italicized segments were measured. Nasals following phonologically long vowels were ignored for the purpose of this study. Durations were measured of the vowel, the nasal and the following consonant.

(63) Kirk*on p*appi veti nar*un p*ohjaan soittaakseen kelloa.
'The priest of the church pulled the rope down to ring the bell'

Further properties of these sentences are discussed in section 4.4.1.

4.2.2 Participants and setting

The recordings were made during a stay in Helsinki in the summer of 2012. The volunteering subjects were native speakers of Finnish and were born in and raised in the Helsinki metropolitan area ('Pääkaupunkiseutu'). The subjects - one female speaker (Speaker B) and one male speaker (Speaker A) - both in their mid-twenties - were instructed to read sentences in a casual speaking tempo after approximately twenty minutes of semi-structured interview to warm up. The recordings were made using an AKG-C214 large membrane microphone. For digital conversion an USB audio-interface was used with sample rate of 44,1khz and a 24bit resolution. As the recordings were not made in a studio, reverb could not completely be avoided. Some attenuation, however, was achieved by placing the microphone and the subjects in a half-circle shaped booth formed by a foam mattress. Due to the relatively close placement of the speakers to the microphone in order to further attenuate reverb, bass frequencies were emphasized by the proximity effect.
Analyses and measurements were made using the software STX, developed at the Acoustics Research Institute of the Austrian Academy of Sciences, and is available for download

under ‘http://www.kfs.oeaw.ac.at/’.

4.2.3 Segmentation criteria and descriptive discussion

The realisation of the nasal underlies considerable inter- and intra-speaker variability. While in many cases segmentation could proceed along general segmentation criteria, especially segmentation of nasals was not always straightforward. Before plosives, two types of duration of the nasal were measured for the female speaker, as glottal activity continued sometimes far into the closure phase of the plosive. For the male speaker a similar bipartition was observed, however, instead of voicing, a more irregular voicing and frication pattern extended considerably into the closure phase.

Nasals before plosives

There were 157 tokens of nasals before plosives. Most of the tokens (60) stem from attributes, further 25 from adjectives, 19 from direct objects. Remaining nasals stem from compounds, a few verbs in 1st Sg and other contexts which did not provide significant amounts of tokens. Also, adjectives, direct objects and genitival attributes are the only categories, in which it was possible to control for the syntactic context. Segmentation of nasals before plosives posed the challenge of determining the end of the nasal and the beginning of the occlusion of the plosive. Here, the fact that the speakers were not recorded in a reverb-neutral studio increased the difficulty of segmentation to some extent.

The realisations of *Speaker B* vary considerably. A fully-fleshed nasal consonant, with complete formant structure and periodicity above the mid-range frequencies is an elusive creature. Especially word-internally, as in words like *tuotanto* (‘production’) or *ravintola* (‘restaurant’), where the nasal precedes a secondary stressed syllable, stops are frequently, though not always, lenited to a voiced stop or a tap. On the other extreme not many completely voiceless nasals were observed. Most of speaker B’s realisations can be classified into two different groups.

The core property of the first group is the observation that the post-vocalic voicing has two different phases. The first phase being the nasal proper, where there is more than one spectral prominence in the lower frequency range. A spectrogram of this type of nasal is shown in figure 4.1. The formant line refers to the spectral prominence which is highest with respect to frequency. The spectrum in figure 4.2 shows a spectral prominence (F1) at approximatly 500Hz which disappears in the second phase in figure 4.3, while F0 remains constant. For these cases two types of durations were measured: Firstly, from the onset of the nasal, which mostly coincides with the occlusion of the oral cavity, until the offset of F1. Secondly, from the onset of the nasal until the offset of glottal activity. This voicing period after the decay of the resonance can be due to decoupling of the resonance bodies of the nasal cavity through velar raising. Its variability is a matter of variation in the amount

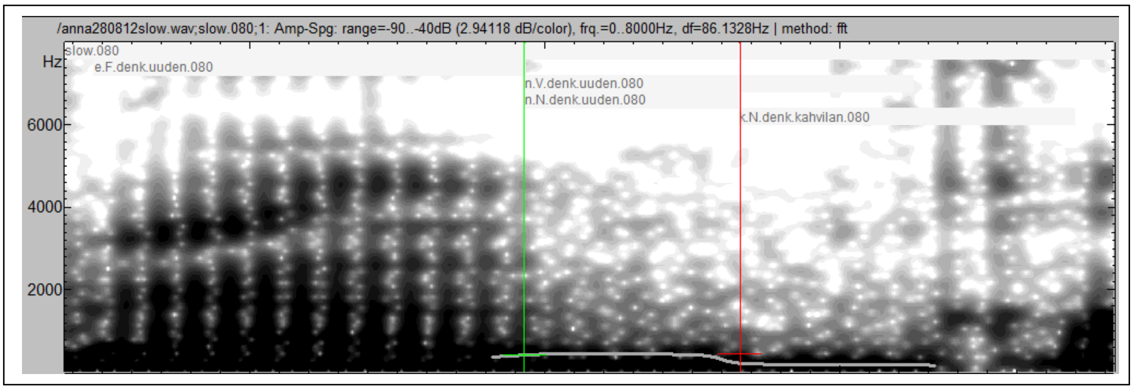


Figure. 4.1: A rather untypically long bipartite nasal. Voicing continues way beyond the decline in amplitude of F1, which is indicated by the formant marker, which for the second half follows the F0 contour. Cursor positions indicate the proper nasal. Periodicity for the nasal is detectable up to 3kHz for the nasal.

of nasal leakage (Hayes and Stivers, 1996) which allows voicing to continue longer as air pressure drop can be maintained around the glottis. For the actual duration of the nasal the shorter durations were used. Figure 4.1 provides an example of extensive postnasal voicing that continues right until the release of the plosive.

Nasals of the second group were strongly reduced. More specifically, there was no spectral peak other than F0, and if others were detectable, then, most likely, there was little or no periodicity in these higher frequencies. Due to the reduced formant structure, perception of place of articulation was unclear. Lack in formant structure and periodicity may be due to the low amount of airflow resulting in a lack of acoustic coupling of the oral cavity.

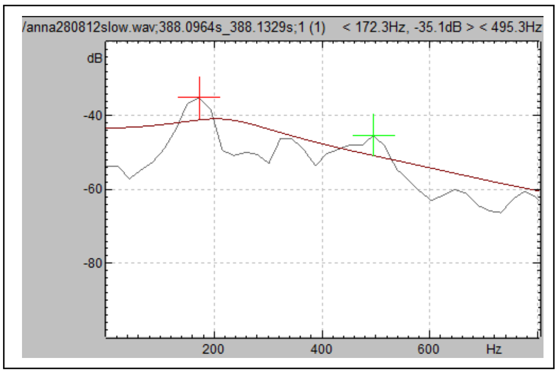


Figure. 4.2: Averaged spectrum of the first part of the nasal. Red cursor marking the F0 peak, while the green cursor marks the Nasal resonance.

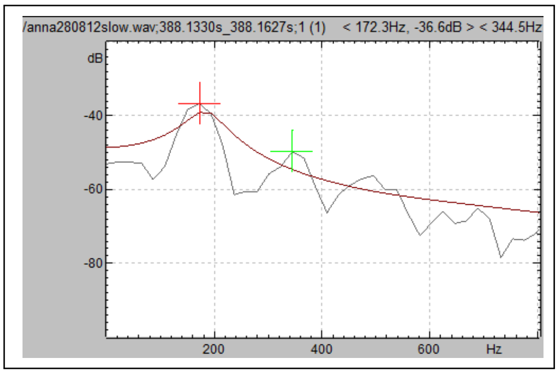


Figure. 4.3: Averaged spectrum of the second part of the nasal, i.e. the voiced part of the closure phase of the stop. There is no significant resonance. The red cursor position coincides with the F0 peak. The green cursor marks the first harmonic.

The realisations of speaker A underlie less variation. Voicing into the closure phase of the plosive did occur, though not as frequently. The male speaker's phase of velo-pharyngeal frication was interpreted as analogous to the second part of the bipartite nasals of the female speaker. They differ only in his lack of voicing which may be due to smaller amount

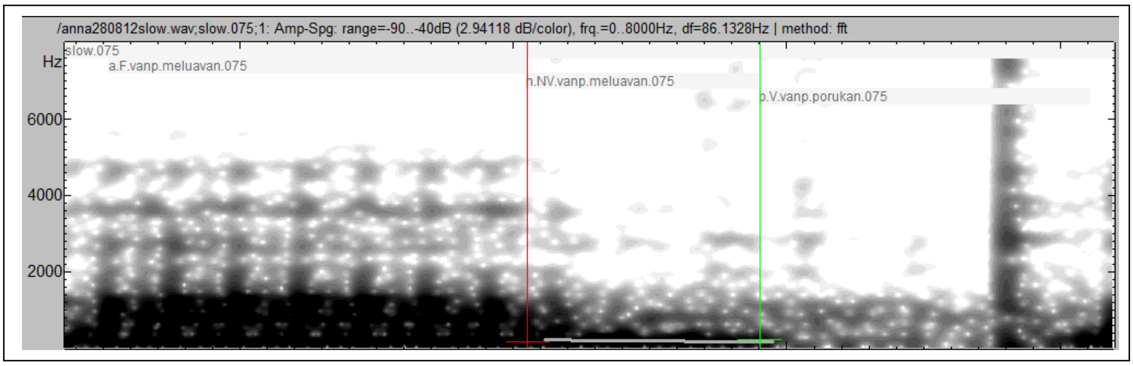


Figure. 4.4: Spectrogram of a *type 2* nasal. Glottal activity ends abruptly, no significant resonance frequencies.

of nasal leakage for the male speaker. This lack of periodicity may also be due to a minor cold, which speaker A reported to suffer from during the time the recordings were made, allowing for lesser nasal leakage and thus lesser voicing.

For segmentation purposes only periodic glottal activity was used as a criterion, because it was best suited to yield comparable durations to the female speaker.

Labeling reflected these observations. The bipartite nasal was considered to be the default realisation whereas the second group as described above was named a reduced variant. For the latter group duration measurements of the two speakers are incompatible due the difference in periodicity, which led to very short segments for the male speakers and rather normally long segments for the female speaker.

Nasals before Fricatives

Tokens of nasals before [s] were rare. Altogether there were 24 such clusters distributed slightly unevenly across speakers (A 11, B 13) and also across syntactic contexts (acc 14, adj 3, gen.attr 5). For each speaker the data contained one production of a voiced fricative, while all the others were voiceless.

Problems concerning segmentation arose through the strong tendency of the nasal, especially with speaker A, to coalesce with the preceding vowel (see figure 4.5), rendering independent segmentation difficult or impossible. This problem was fuelled further by the fact that there were hardly any full nasals in that position. What occurred most, was a nasal vowel with a generally reduced intensity.

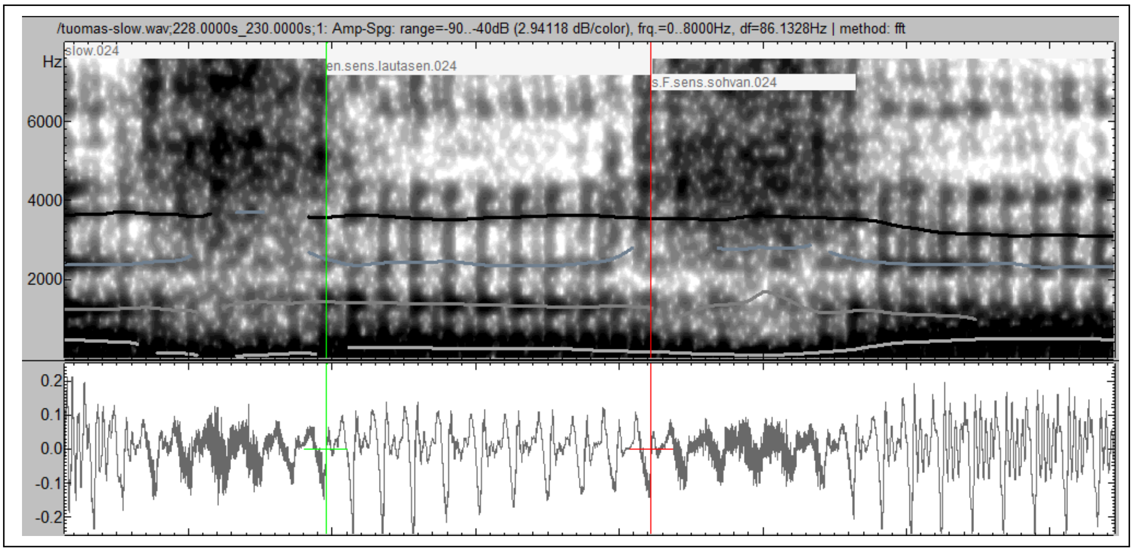


Figure. 4.5: Spectrogram of the VNS sequence of the sentence "*Jannen vauva kaatoi lautas**en** **s**ohvan päälle.*" ('Janne's baby spilled the plate over the couch.') pronounced by speaker A. Frication is observed on the nasalised vowel shortly before the onset of the fricative. Note the lack of formant transition and the moderate and gradual reduction in amplitude. The fricatives (both) are voiced, which is unusual.

In the cases where separation was deemed impossible, vowel and nasal duration were measured as one unit, making comparison only possible to combined durations of nasal and vowel of the less reduced segments. The onset of frication [s] - was used as a devision criterion, together with a decrease in amplitude and voicing. Crucially, the onset of frication was only then taken to be the starting point of the fricative, if it continued. Frequently, frication would be partly present in the waveform, but only at certain (downward) slopes of the waveform, indicating that possibly a crucial airflow speed or pressure is necessary to maintain frication during voicing, if the opening of the oral cavity is not small enough.

This leads to the trivial point that whenever such frication was present, oral occlusion was not complete and the nasal was pronounced as what is best described as a nasal vowel with some frication. However, durations of such segments were still measured, if they were sufficiently distinct from the preceding vowel. An example of one such vowel-nasal combination is shown in 4.6. In such cases criterion for the beginning of the nasal was lowering of F1, especially in low and mid vowels where F1 is normally high, and F2, as well as a reduction of amplitude.

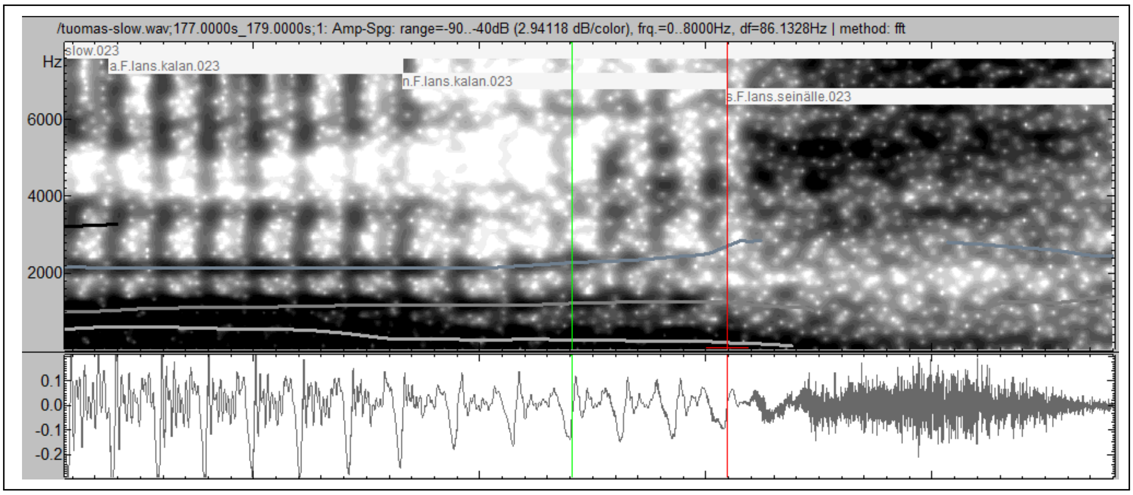


Figure. 4.6: Spectrogram of the VNS sequence of the sentence "*Arton vaimo malasi kal**an** **s**einälle*"' ('Arto's wife painted a fish on the wall') pronounced by speaker A. The cursors bracket the part of the nasal, which showed frication at downward slopes of the waveform. Note the steep fall of F1 at the beginning of the nasal, which is due to the rise in amplitude of the nasal resonance, interpreted as a fall in frequency by the formant tracking algorithm.

The productions of the nasal by the female speaker vary greatly. Generally, a coronal gesture rarely occurred between the vowel and the fricative, and, if it occurred, occlusion was never complete, instead frication of the following fricative occurred already during the nasal vowel that replaced the proper nasal. Also it seems that the absence of a coronal gesture is sometimes compensated for by a reduction in voicing and amplitude, and possibly a slight presence of breathy voice. Generally, consistent segmentation of segments of this type was not possible, and they are best described as nasal vowels. The two examples below in figure 4.7 and figure 4.8 indicate the bandwidth of variation in the realizations of the nasal.

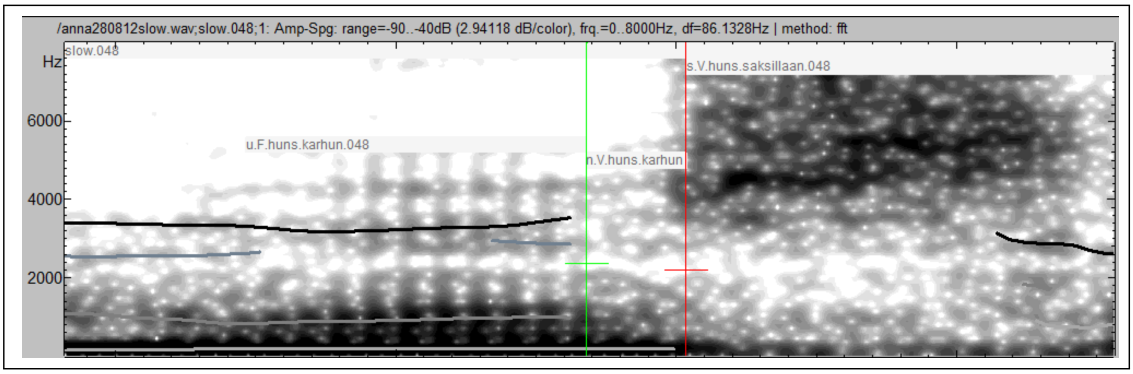


Figure. 4.7: Spectrogram of the VNS sequence of the sentence "*Saksikäsi Edvard tappoi vihaisen karh**un** **s**aksillaan.*" ('Edward Scissorhands killed the angry bear with his scissors.') pronounced by speaker B. The vowel and the fricative are separated by a period of reduced voicing. No oral occlusion occurs.

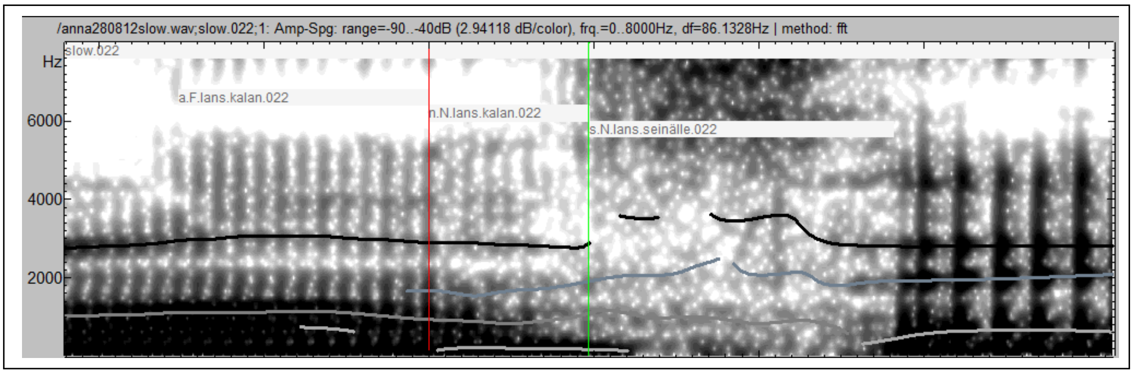


Figure. 4.8: Spectrogram of the VNS sequence of the sentence "*Arton vaimo malasi kal**an** **s**einälle*" ('Arto's wife painted a fish on the wall') pronounced by speaker B. Frication extends into the nasal vowel. No occlusion occurs.

Before [h], segmentation was based on the presence of frication noise and on changes in amplitude. In utterance-initial position in Finnish, /h/ will mostly be realized with weaker voicing than word-internally. More periodicity was also observed on the nasal in the syntactic context of GEN.ATTR where the cluster seemed shorter. After nasals, in type-wise rare but token-wise frequent word-internal *nh* clusters, /h/ was generally pronounced as breathy voice spread across the surrounding segments as is exemplified in figure 4.9. Across word-boundaries, segments were more distinct, though not always (see figure 4.10). The onset of (ever so light) frication, or, as illustrated in figure 4.10, the presence of a higher frequency resonance, was taken to be the begin of [h].

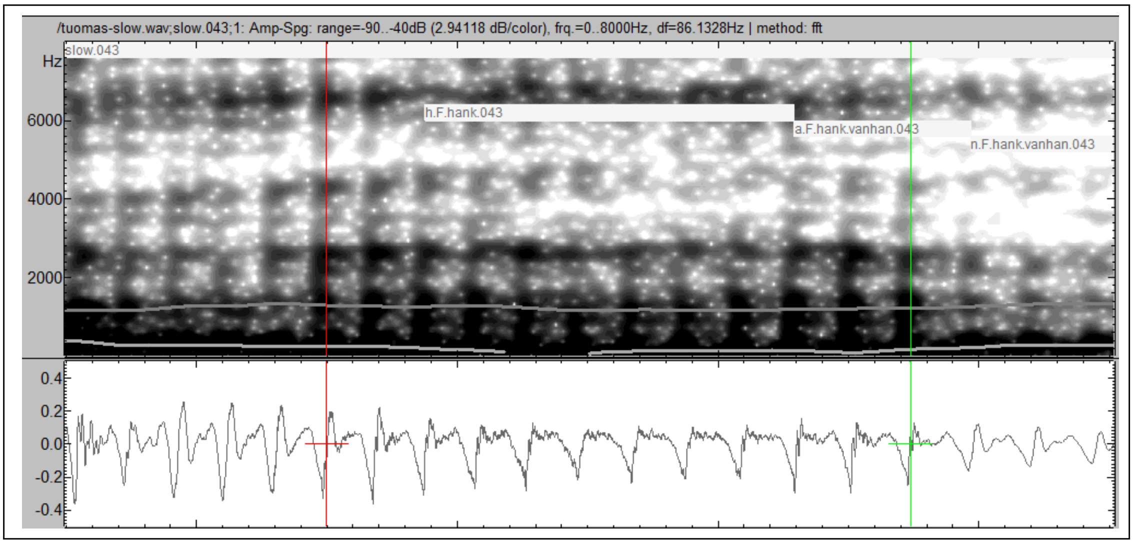


Figure. 4.9: Spectrogram of the word-internal VNH cluster of the word "*vanhan*"' ('old.gen') pronounced by speaker A. The duration of frication is indicated by the cursors while the segmentation indicated in the spectrogram (gray bar named 'h.F.hank') is based on amplitude and acoustic impression.

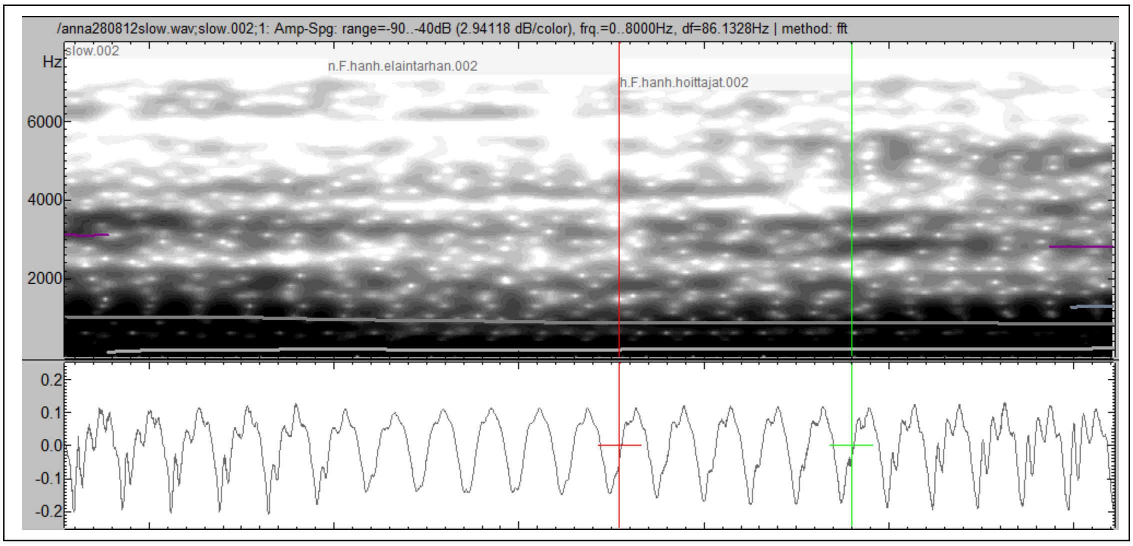


Figure. 4.10: Spectrogram of the VNS sequence of the phrase "*eläintarhan hoittajat*"' ('zookeepers') pronounced by speaker B. Segmentation based on amplitude and high frequency resonances.

Nasals before sonorants and glides

Nasals were most difficult to separate from other non-nasal sonorants, especially from [l] due to its similarity to nasals. Altogether, there where 67 such clusters (A 28, B39; ACC 27, ADJ 13, GEN.ATTR 22) in the dataset.

Whenever there was total assimilation of the nasal, the segmentation problem solved itself. Regarding [l], however, it sometimes was difficult to determine whether total assimilation occurred at all. The problem was propelled further by the possibility of an intermediate articulation, i.e., slight nasalisation on the first part of the otherwise totally assimilated (laterally opened) /nl/ sequence. The only criterion that could be used for determining this was the auditory impression and the frequency of F1 which is slightly higher for [l]. One such articulation is shown in figure 4.11.

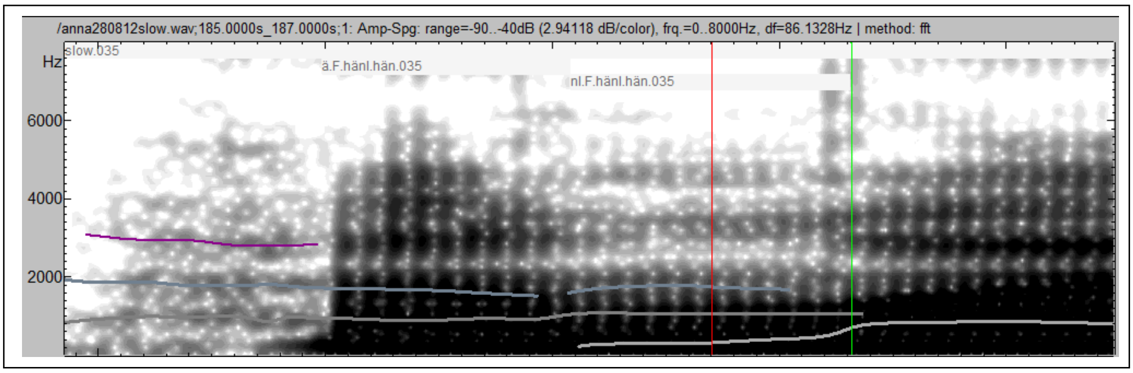


Figure. 4.11: Spectrogram of the VNR sequence of the phrase "*Hä**n** **l**aittoi äidin pienen pöydän autoon.*" ('He put mother's small table into the car.') Note the significant raise of F1 in the second half of the assimilated /nl/ sequence indicating partial nasalisation on the first part of the cluster. The acoustic impression for the overall sequence is rather l-ish.

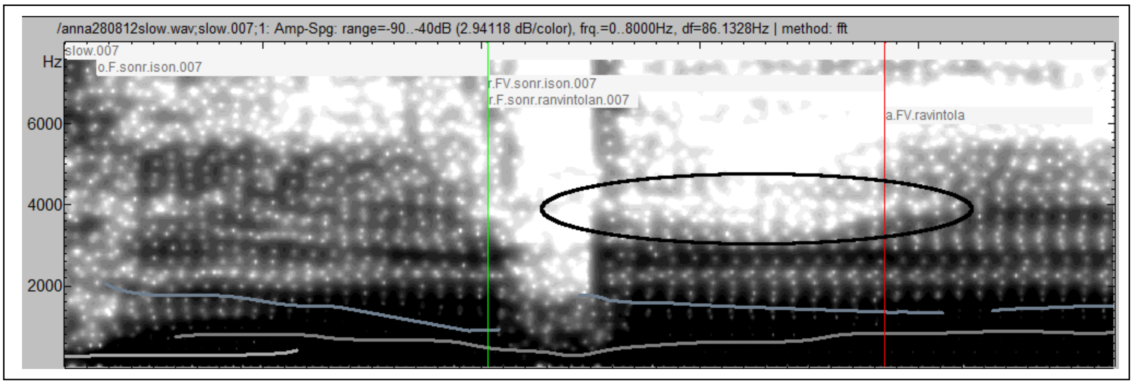


Figure. 4.12: Spectrogram of the VNR sequence of the phrase "*I**son r**avintolan pääkokki*" ('The chef of the large restaurant.') pronounced by speaker B. The cursors bracket the tap [ɾ] plus the additional phase of retroflexion following it. The typical lowering of the third formant is indicated by the black ellipse.Together with the preceding vowel the duration of these three 'segments' corresponds to the overall average duration of VN-plosive clusters.

Coarticulatory effects caused further difficulty for the segmentation of [r]. The beginning of [r] was taken to be the last period *before* the drop in amplitude corresponding to the first occlusion of the trill (if it was indeed realised as such). For both speakers, total assimilation of a nasal before /r/ to [rr] was a rare exception. Instead, when /n/ was deleted, r was realized typically as a tap. However, the timing slot was still present, and additional length was given to the following vowel, which was than realized as a rhotacized vowel with a typically lowered 3rd formant. This is shown in figure 4.12.
Before the glides /j/ and /v/, formant transitions were used as criteria.

4.2.4 Discarding tokens

Segmentation was not always possible, and not all segmented examples could were included in the statistic analysis. This has several reasons. A few nasal-consonant clusters were preceded by a long vowel. In such cases the entire cluster was discarded, for the reason that, as noted above, vowel length may play a role in nasal assimilation. In cases where the vowel was phonologically short, but, because of a preceding sonorant, coalesced with other vocalic segments, measurements were often impossible, and such clusters had to be discarded.

4.3 Results I - Assimilation patterns in read Finnish

4.3.1 Nasals before Plosives

Before plosives, the nasal was typically reduced in intensity, but most commonly assimilated in place to the following plosive. Two occurrences of complete loss were observed. Rather typical, especially for the male speaker, was the occurrence of a short period of velopharyngeal frication in the moment of velar raising during the transition from the nasal to the plosive. Absolute total numbers of tokens in the statistics may vary from speaker to speaker, as some productions had to be discarded for various reasons. Nasals followed by /t/ were not considered.

The results in table 4.1 summarise the behavior of the nasal before plosives. Except for one production of speaker B only the unassimilated nasals were only produced by the male speaker. These occurred, given the small overall proportion of the ADJ context compared to other context, overwhelmingly in ADJ . Of the 7 unassimilated nasals 4 where ADJ . That amounts to 40% of all productions in this contexts. The category '*reduced N*' refers to the nasals of type two as described above. The label 'deletion' was used for cases, where the nasals are reduced to a non-nasal weakly voiced vocalic segment or to silence. There where no cases of complete deletion including skipping of a timing slot.

Table 4.1: Nasals followed by plosives.

	place assim.	deletion	reduced N	no assim.
Speaker A	31	0	3	7
%	75,6%	0%	7,3%	17,1%
Speaker B	36	2	8	1
%	76,6%	4,3%	17%	2,1%
Total	67	2	11	8
%	76,1%	2,3%	12,5%	9,1%

4.3.2 Fricatives

Since the only fricative native to the Finnish language is a dental /s/, fricatives are irrelevant to patterns of place assimilation. Nonetheless, the behavior of the nasal showed considerable variation before /s/. Next to a full nasal, one could observe a heavily nasalised vowel for a brief period of time before the onset of frication. In a few cases this nasal vowel was additionally accompanied by a substantial amount of frication. However, there was no occurrence of complete loss of nasality. Table 4.2 summarises the types occurrences of types of realisation. The preceding vowels of nasal-fricative clusters were always nasalised. For the female speaker, there is no full nasal with oral occlusion among the data. However, the nasal was always separable from the preceding vowel due to a slight frication stemming from reduced voicing and the subsequent reduction in amplitude as well as a decrease in F1 frequency due to an increase in nasality. Further, the disappearance of the formant structure above F1 was an indicator for the end of the vowel.

The status of /h/

With one exception, post-nasal /h/ was exclusively realised as voiced ɦ in a way similar to what can be observed in word internal clusters. For the male speaker the preceding nasals were predominantly realised as full [n]. The productions of the female speaker varied

Table 4.2: Nasal consonants before word initial /s/.

	full nasal	nasal vowel
Speaker A	4	7
%	36,4%	63,6%
Speaker B	0	11
%	0%	100%
Total	4	18
%	18,3%	81,7%

considerably. When assimilation occurred, /n/ was realised roughly as [ɦ̃]. However, such realisations show little to no periodicity in frequencies higher than 500-1000Hz. Further, the F4 region above 3kHz is typically weak. With the offset of nasalisation both formant patterns and the F4 region become more intense.

Table 4.3 shows that - again - the realisations of the female speaker were more strongly inclined towards assimilation, whereas the productions of the male speaker were faithful to the alveolar place of articulation. Thus, while the assimilatory patterns, i.e. the type

Table 4.3: Nasal consonants before /h/. Speaker A does not show reduction of the nasal, as opposed to Speaker B, whose nasal consonants are mostly placeless and breathy voiced.

	full nasal	nasalised h
Speaker A	14	0
%	100%	0%
Speaker B	5	9
%	35,7%	64,3%
Total	19	9
%	67,9%	32,1%

of change /s/ and /h/ cause seems quite similar, the assimilatory force exerted by the former is stronger. This is suggested by the higher frequency of nasal reduction before /s/ compared to /h/ (see tables 4.3 and 4.2). Vowel nasalisation is particularly abundant in nasal-fricative clusters, as only one single occurrence has been classified as partly nasalised before /s/. The situation in /nh/ clusters is illustrated in table 4.4.

Table 4.4: Nasality in Vowels preceding /nh/ clusters.

	nasal vowel	partly nasal vowel	non-nasal vowel
Speaker A	8	1	2
%	72,7%	9,1%	18,2%
Speaker B	4	4	1
%	44,45%	44,45%	11,1%
Total	12	5	3
%	60%	25%	15%

4.3.3 Sonorants

Before the sonorants r,j,l,v final nasals predominantly undergo total assimilation. For the glides /j/ and /v/ partial place assimilation did occur, as the nasal was realised with palatal or labiodental place respectively. Token of clusters with /j/ and /v/, however, were elusive. Moreover, the similarity of ɱ and ʋ and the glide nature of [j] added further complication to segmentation. Deletion refers to cases where the nasal was omitted entirely by shortening the temporal extension of the cluster. Table 4.6 shows how many of the total

Table 4.5: Nasals followed by Sonorants.

	Total Assim.	No Assim.	Deletion
Speaker A	26	15	0
%	63,6%	36,4%	0%
Speaker B	31	11	4
%	67,4%	23,9%	8,7%
Total	57	26	4
%	65,5%	29,9%	4,6%

assimilation cases from above actually show some residue of nasality. The criterion of full vs partial nasalisation was mainly time. If more than a quarter of the vowel showed nasal characteristics in the spectrogram they were annotated as partly nasalised. Full nasality was awarded if the nasal quality stretched for more than half of the vowel. Vowels that were preceded by a nasal consonant were not considered, hence the difference in totals of vowels vs. nasals. Table 4.7 shows that nasalisation is abundant, if the nasal is not

Table 4.6: Traces of Nasalisation on Vowels before *fully* assimilated nasals.

	nasal vowel	partly nasalised V	no nasality
Speaker A	1	3	14
%	5,5%	16,7%	77,8%
Speaker B	6	5	18
%	20,9%	17,8%	62,1 %
Total	7	8	32
%	14,9%	17,0%	68,1%

lost under total assimilation. All but one partly nasalised vowels were produced by the male speaker (A). This is consistent with the higher tendency towards assimilation for the female speaker (B).

Table 4.7: Vowel nasality before unassimilated nasal-nonnasal sonorant clusters.

	nasal vowel	partly nasalised vowel	no nasality
Total	6	11	0
%	35,3%	64,7%	0%

4.3.4 Pauses and the intervocalic position

Intervocalically, the final nasal is uniformly realised as [n]. The only variation is due to whether or not the nasal is separated from the following word by glottal stop, or vocal fry phonation on the word-initial vowel. Such pauses occur across all syntactic configurations considered. Table 4.8 gives an overview of the distribution of pauses across syntactic boundaries. Quite surprisingly, these glottal stops were slightly more frequent in genitival attributes as opposed to objects, though again numbers are few and not very representative.

Table 4.8 also shows that similar pauses occurred between nasals and their following consonants. All of them occurred after direct objects.

Table 4.8: Occurrence of a glottal stop in prevocalic position, and of pauses in preconsonantal position.

	Object	Gen.Attr	total
NʔV	2/6	5/11	7/17
%	33,3%	45,5%	41,2%
NʔC	9/97	0	9/97
%	9%	0 %	9%

4.3.5 Summary

So far, it was illustrated that nasal place assimilation in read Finnish is subject to inter-speaker variation, as only the male speaker produced non-assimilated nasals. Further, it was shown that nasal before fricatives are mostly reduced to nasalised vowels. To some extent, this is also true for nasals before /h/ though not as significantly. Nasals before plosives are not only assimilated in place but also reduced in voicing. However, stops may be voiced, too, when followed by a nasal, especially for the female speaker. Before sonorants, the pattern is most difficult to access. It seems as though nasalisation prevails to some extent, while simultaneously total assimilation is frequent.

4.4 Context and speaker specific timing strategies in Finnish nasal place assimilation

This section is concerned with the influence of syntactic environment on speaker specific strategies on timing and on nasal assimilation. This assimilation process is viewed in light of parallel processes of Finnish, where final consonants are deleted (see section 2.2.2) . Both processes instantiate cases of final reduction. Based on reports about Finnish dialects which relate assimilation patterns to sentential stress, the hypothesis is made that syntactic position influences the way speakers reduce word final segments. Since the placement of prosodic boundaries is dependent on syntactic structure, and prosodic boundaries delimit domains for the placement of prominences within a sentence Selkirk (1984); Ladd (2008), the effects of syntactic structure will necessarily be mediated by sentential stress. Iivonen (1998) reports on juncture effects that, amongst others, comprise occasional segmental lengthening before morpheme boundaries in compounds. Of the three syntactic contexts, to be further illustrated below, ADJ and GEN.ATTR are within a DP, while in the context of ACC the two words straddle a DP boundary.

Duration measurements are used as an approximation to consonantal reduction for a variety of reasons. Nasal durations for Dutch were shown to be shorter for spontaneous speech as compared to read speech (van Son and Pols, 1996). As spontaneous speech is generally reduced compared to read speech, durations were used to provide indication regarding reduction of the nasal.

However, durational reduction is not the only dimension of reduction, and RMS-value, differences in F2 slope and center of gravity provide further indication of articulatory reduction. For the purposes here, duration measurements alone were used to determine whether reduction of the nasal is depending on the syntactic context.

4.4.1 Structure of the dataset II

This section will illustrate the restrictions that were applied to the data set to reduce variation, and eliminate potential distorting factors. Each of the contexts ACC , ADJ and GEN.ATTR came with special restrictions on which data can be allowed for a comparison of these context. Additionally, global phonetic/phonological factors had to be eliminated. These are discussed as well.

Specifying the context

ACC The sentences in the dataset were structured such that most of them contained a direct object followed by an adjunct. Most of these adjuncts were local, directional or temporal adverbials (LOC/TEMP). The remaining were proper adverbs (ADV). Due to the size of the data set these differences could not be controlled for. Another potential source of variation was introduced through variation in length of these adjuncts (*adjunct length*) in number of words, longer chunks after the VP may influence the setting of prosodic boundaries. Most of the adjuncts consisted of only one or two words. Thus, the ACC context was restricted to adjuncts with at most two words.

A third potential syntactic source of variance was the question whether the object itself was further *modified* by an adjective. This may be influential since adjectives tend to fiddle with information structure, since speakers, depending on their creativity may imagine adjectives to contain contrastive or otherwise salient information that influences placement of sentential stress or other intonational patterns. Thus, only non-modified objects were considered.

Since Finnish lacks determiners which could provide means to resolve the ambiguity of the newness or givenness of a discourse element, two options are obvious. Since also languages like German, where determiners are obligatory, show prosodic reflections of givenness (Baumann, 2006), it is highly likely that Finnish will too. Especially if speakers are creative and picture a context where these utterances may occur, and phrase the utterances accordingly. It may become difficult to control for effects of these imaginations. After the reading task the male speaker reported insecurities regarding which words to emphasize.

Though according to Suomi et al. (2008) only contrastive stress influences segmental length, it is very likely that also other types of prosodic information are encoded in durations especially across ACC boundaries, where variation in nasal duration may well be the result of the presence or absence of an intermediate phrase boundary.
The variation in type of adjunct (temporal adverbial vs. adverb) could also influence ACC clusters, since their adverbs may be syntactically more closely attached to the VP as opposed to sentential adverbials. (64) illustrates the two types of adjuncts used in the dataset and the possibility of an adjective preceding the object.

(64) Loci of variation in the dataset[2]

a. Pekan pomo kuori **perunan** *hitaasti*. 'Pekka's boss peeled the/a potato slowly.'

b. Elaintarhan hoittajat veivät *paeneen* **hyeenan** *Rovaniemen eläintarhaan*. 'Zookeepers brought the/a escaped hyena back to the Zoo of Rovaniemi'

Due to the size of the dataset it was impossible to reliably examine the effects of all these factors, where possible, though they were eliminated.

ADJ The category of ADJ is interesting for a couple of reasons. As the plots will show, the many outliers somewhat distort the average. Moreover, ADJ is the context in which the occurrence of unassimilated nasals for the male speaker is most frequent, as four out of seven unassimilated nasals where observed in ADJ contexts. Since they appear to be the result of his aforementioned insecurity regarding placement of sentential stress, and they moreover sound somewhat artificial, they all have been discarded. This unfortunately reduced the data within this category to such an extent that its status cannot be easily assessed. Moreover, the group of adjectives suffered various heterogeneities. First, most but crucially not all of the adjectives were placed modifying the direct object, while others were used to further modify genitival attributes. In the latter case the nasals seemed to be distinctly shorter, yet, they were too few in number to allow for more than a mere impressionistic description of the differences. Items were also too few to control for this factor. Second, a similar effect was observed if the adjective was morphologically a participle, and

[2] Objects are marked in boldface, while adjectives and adjuncts are italicized.

thus in most cases a novel word. Again, the data set is too small for a proper analysis, yet relative durations of nasals were higher if they were part of a participle as opposed to a lexical adjective. Thus, participles were excluded from the dataset.

GEN.ATTR Genitival attributes were filtered such that they were only used if they were in subject position and thus in the beginning of the sentence.

Reducing phonological factors

Because of variation of intrinsic consonant duration, only VN#P clusters were considered in the analysis of syntactic conditions on nasal duration. However, vowel quality varied quite freely in the dataset. Further, the consonant preceding the cluster was not controlled. This was probably rather detrimental to the distributions of vowel durations.

It is also reported in Suomi et al. (2008) that phonological length of the first vowel in a word positively correlates with the duration of the initial consonant. This was controlled for by allowing only phonologically short vowels after the consonant cluster. While mean durations of the initial consonants are indeed observed to be higher in this dataset if they are followed by a long vowel or a diphthong, this effect was only significant in the ACC environment. Since items for this group were too few and were almost exclusively pronunciations of the word *kiinni*, no further speculation is attempted here.

Variation regarding word prosody was minimized by allowing only genitives of words with two or three syllables to figure in the study below, since for these groups no significant differences were observed.

The Finnish quantity system features a phonemically short 'half-long' vowel (Wiik and Lehiste, 1965), which occurs in the second syllable of CV_1CV_2(CV) words. In most dialects these half-long vowels are considerably longer than their preceding stressed vowel, not so however in the variant spoken in Helsinki, which was in the focus of this study. In all dialects, however, they are shorter than their phonemically long counterparts, and longer as their phonemically short counterparts which are preceded by a CVX (or larger) syllable.

Further, Iivonen (1998) reports that F0 peaks in word stress depend on the length of the first vowel. If the first vowel of the word is short, the F0 peak will be on the vowel of the second syllable. While the placement of F0 peaks should not influence total durations of the cluster, their absence and presence may well influence other dimensions of reduction. It is conceivable that the presence of the F0 peak on the second syllable leads to enhancement of the voicing quality of the nasal and thus via an increase in nasal leakage to slightly longer duration measurements.

As phonemic vowel length is reported to influence reduction of the nasal (Ikola, 1925), an effect of the half long vowel is a possibility, yet the data set showed no systematic difference in vowel durations corresponding to the short/half-long distinction. Thus, it was concluded that, for the purposes here, this category can safely be ignored.

Further potential factors

A palatographic study in Bergmann (2012) reports for German that nasal reduction in assimilation contexts is, among other factors, dependent on the frequency of the word. Here, word frequency was not examined systematically, but it seems noteworthy that the cluster in *punaisen risti* ('red cross') was exceptionlessly pronounced by all speakers with total assimilation and very little if any nasalisation on the vowel. Further research might find fertile grounds trying to determine whether only frequency of the entire collocation or also of each single word within it is influential on assimilation frequency.

Also, no attempt has been made here to evaluate the relation between morphological category and phonological vowel length[3] in the interplay in assimilation. It is striking that mostly those suffixed nasals are reported to be lost (Mielikäinen, 1981) and the references in 2.2.4, which follow a long vowel, such as the illative or the passive. Two considerations seem to play a role in this pattern. First, phonological vowel length has been found to be a factor in nasal reduction (Bergmann, 2012) for German prefixes, and may well be a driving force in nasal deletion and reduction in Finnish, too. Second functional systemic considerations seem to be at play here, as in morphemes which lose the final nasal more frequently, the final nasal is not the only phone in the morpheme, and its meaning can already be understood by the remaining phonetic material.

With respect to this, it may prove fruitful to try to tease apart deletion in such morphemes versus assimilation in others.

Types of duration

Both relative and absolute durations were considered in examining the patterns. Relative durations were calculations of the percentage of each segment in the VN#C cluster on its total duration. Further, the nasal's relative duration within VN and NC were calculated.

Summary

To summarise, the following restrictions were applied to the dataset, yielding the distribution of items in (66).

(65) Data filtering. Removal of

a. clusters with unassimilated nasals,
b. ACC followed by adjuncts longer than two words,
c. ADJ that are morphologically participles,
d. GEN.ATTR that are not modifying the subject of a sentence,
e. clusters with pauses,
f. clusters that were at the end of a compound,
g. clusters at the end of words with less than two and more than three syllables.

[3] Nasals were exclusively preceded by short vowels.

(66) Items per speaker and context

Speaker	ACC	ADJ	GEN.ATTR
B	9	7	12
A	7	4	12

The number of items for the ADJ category is rather low. However, patterns were consistent enough to justify not to eliminate the category. The low number of ADJ for the male speaker is due to the fact that most of his unassimilated productions were from this category.

4.4.2 Results II

Vowel Durations

The plots in figure 4.13 - 4.16 show no obvious differences between the contexts. This is confirmed by ANOVAs of both relative and absolute vowel durations, which showed no significant differences, except for relative durations of Speaker B (figure 4.16) where ANOVA showed a significant effect of context (F=4.95; P=0.02=), which was due to the differences between ACC and GEN.ATTR .

However, the general patterns vary between speakers. In ACC the male's (Speaker A) vowels are longer, while they seem to be shortest for the female speaker.

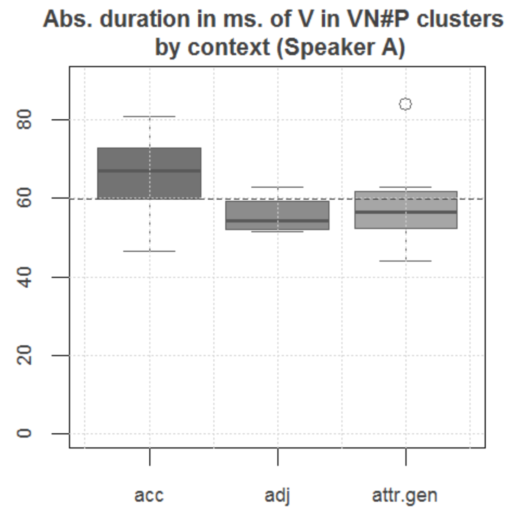


Figure. 4.13: Plot of absolute durations of Vowels by context. Productions of the male speaker. Mean durations are 65,76 (standard deviation 11,68) for **acc** , 55,68 (sd 5,04) for **adj** and 57,83 (sd 10,05) for **gen.attr**.

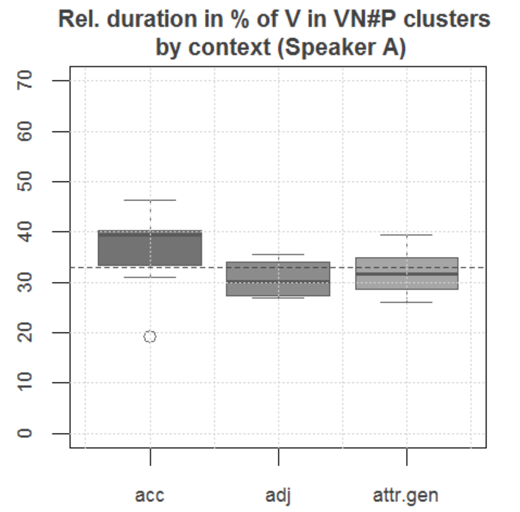


Figure. 4.14: Plot of relative durations of vowels by context. Means % are 38,83 (sd 5,16) for **acc** , 30,71 (sd 4,10) for **adj** and 31,86 (sd 4,39) for **gen.attr**.

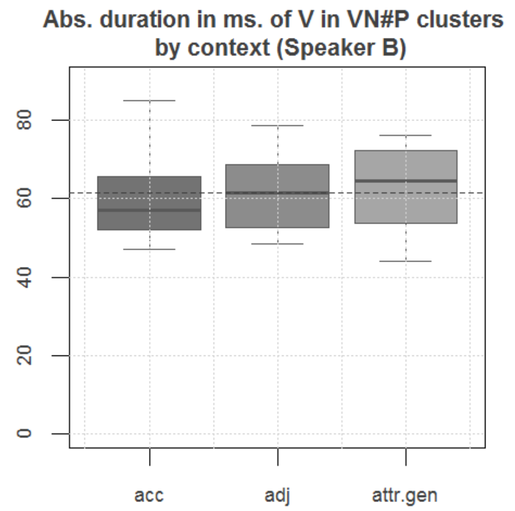


Figure. 4.15: Plot of absolute durations of Vowels by context. Mean durations are 60,13 (sd 11,71) for **acc** , 61,61 (sd 11,34) for **adj** and 62,25 (sd 10,94) for **gen.attr**.

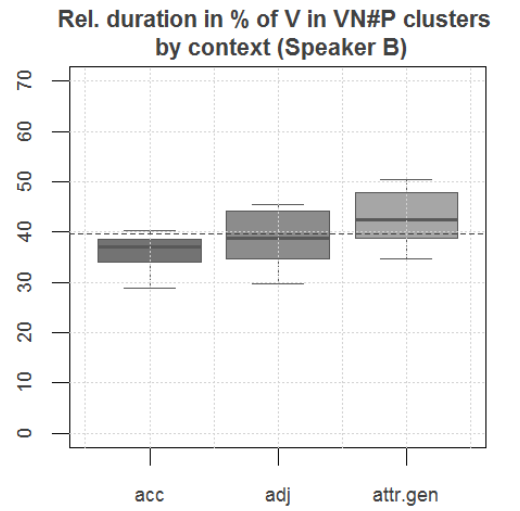


Figure. 4.16: Plot of relative durations of vowels by context. Means % are 35,82 (sd 3,71) for **acc** , 38,77 (sd 6,11) for **adj** and 42,94 (sd 5,57) for **gen.attr**.

Nasal durations

For both speakers, durations of the nasal were shorter for both ADJ and GEN.ATTR compared to ACC . The ANOVAs showed significant effects of context only for both relative and absolute durations of speaker B. They were most significant for the absolute durations of speaker B (Speaker A, F = 2,25; P=0,13 ; Speaker B, F= 8.10, P= 0.0019). Also relative durations of speaker B showed a significant effect of context (Speaker A, F = 3,36 P =

0,06; Speaker B, F = 3,95, P=0,03). Observed differences where always between ACC and either ADJ or GEN.ATTR or both. The lack of a significant result for speaker A may in this case well be due to his generally lower number of items (see 66.) The boxplots in figure 4.17 - 4.20 intuitively confirm these results showing that nasals are longer in ACC environment.

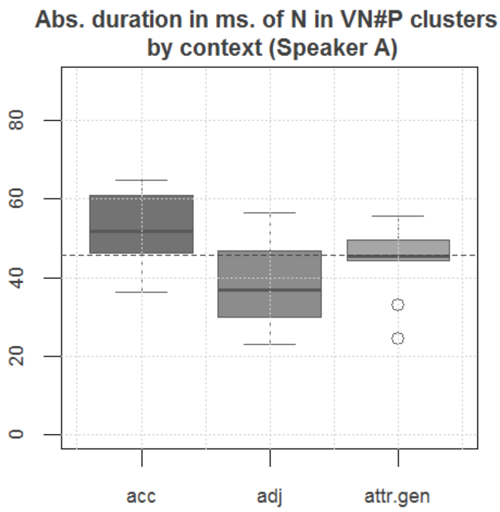


Figure. 4.17: Plot of absolute durations of final nasals by context. Mean durations in ms are 51,92 for (sd 10,21) **acc** , 38,30 (sd 13,73) for **adj** and 44,86 (sd 8,78) for **gen.attr**.

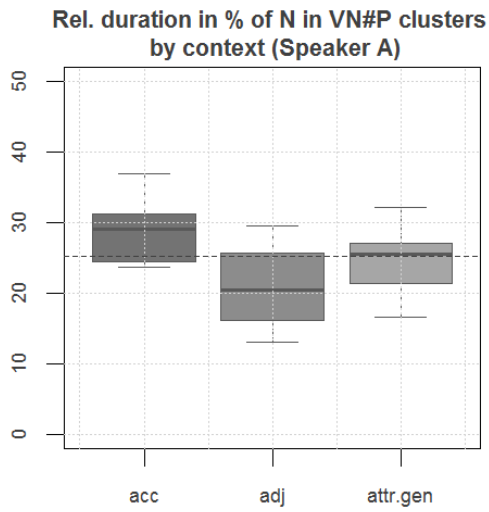


Figure. 4.18: Plot of relative durations of final nasals by context. Means % are 29,04 for (sd 4,96) **acc** , 20,89 (sd 6,82) for **adj** and 24,64 (sd 4,34).

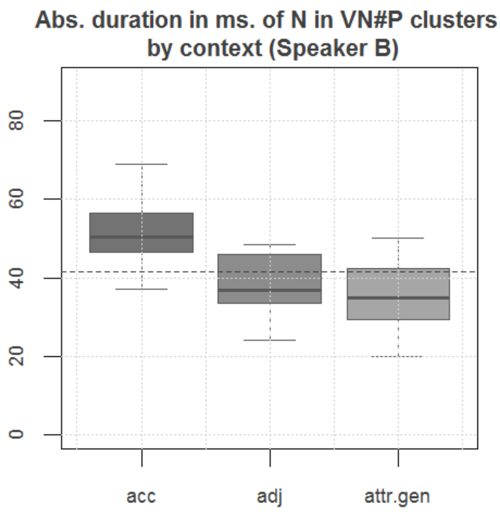


Figure. 4.19: Plot of absolute durations of final nasals by context. Mean durations in ms are 52,59 for (sd 9,97) **acc** , 48,25 (sd 13,68) for **adj** and 39,75 (sd 9,73) for **gen.attr**.

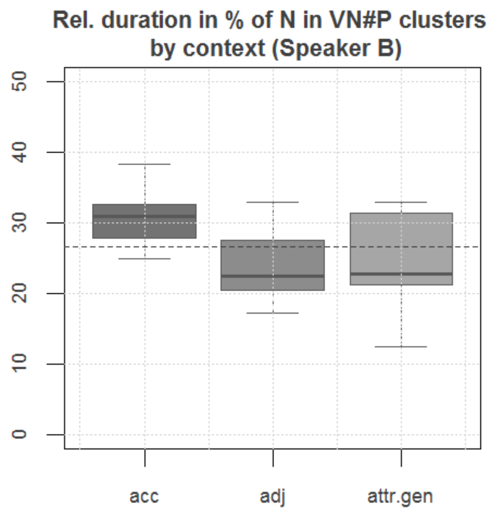


Figure. 4.20: Plot of relative durations of final nasals by context. Mean % are 30,87 for (sd 5,08) **acc** , 27,23 (sd 6,15) for **adj** and 24,48 (sd 5,02) for **gen.attr**.

Plosives

Most interesting regarding inter-speaker variation is the final member of the cluster, the plosive. While for the male speaker durations of the plosives are highest in the ADJ and

GEN.ATTR environment, they are significantly lower for the ACC context. ANOVA showed the effect to be highly significant for both relative (F=9,4082, P= 0,001) and absolute durations (F=7,14, P=0,004). No difference was found between ADJ and GEN.ATTR contexts. For the female speaker (B) no effects were found (rel, F=1,06, P=0,3; abs, F=2,92, P=0,07).

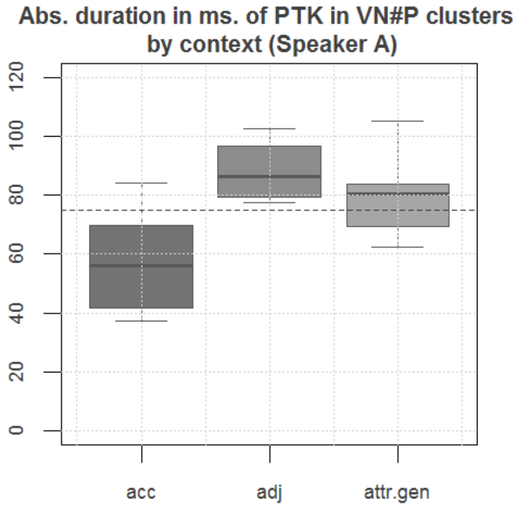


Figure. 4.21: Plot of absolute durations of word initial plosives plosives by context. Mean durations are 57,58 (sd 17,4) for **acc** , 88,20 (sd 11,22) for **adj** and 78,98 (sd 12,40) for **gen.attr**.

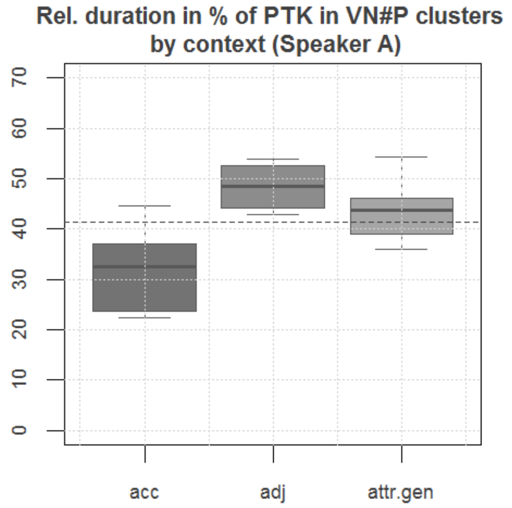


Figure. 4.22: Plot of relative durations of plosives by context. Means percentages are 32.13% (sd 8,66) for **acc**, 48.39% (sd 5,12) for **adj** and 43.50% (sd 5,38) for **gen.attr**.

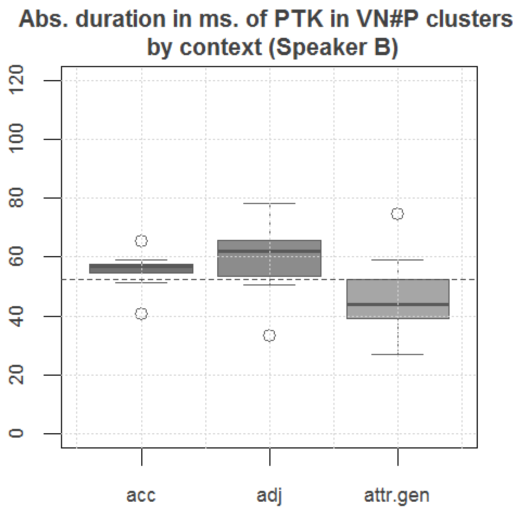


Figure. 4.23: Plot of absolute durations of word initial plosives plosives by context. Mean durations are 55,29 (sd 6,75) for **acc** , 58,90 (sd 14,26) for **adj** and 46,62 (sd 12,5) for **gen.attr**.

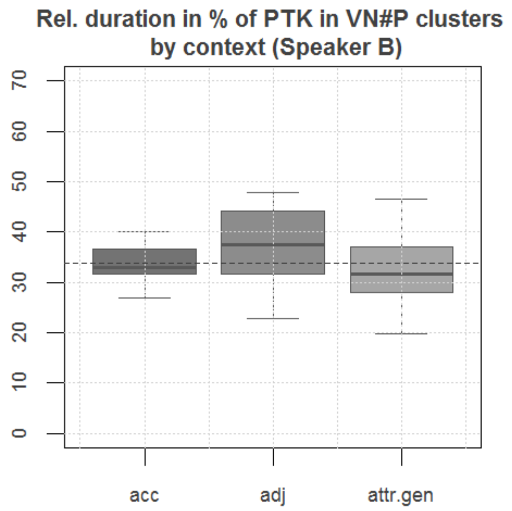


Figure. 4.24: Plot of relative durations of plosives by context. Means are 33,30% (sd 4,43) for acc, 37.14% (sd 9,15) for adj and 32.21% (sd 7,69) for **gen.attr**.

Total durations

Inter speaker differences were also observed for total durations of the cluster. While for speaker A total durations were roughly the same in all environments, this pattern shifted slightly in total durations of speaker B. This is shown in the plots figure 4.25 and 4.26. In the latter, **acc** and **adj** show similar overall durations, while total durations in **gen.attr** are shortest. This difference is also statistically significant as shown by an ANOVA (F=4,9214; P<0,01).

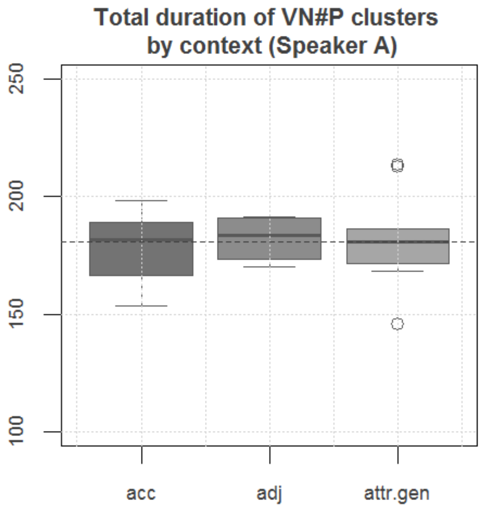


Figure. 4.25: Plot of total durations of VN#C clusters by context. Mean durations are 178,5 (sd 16,72) for **acc** , 182,2 (sd 10,60) for **adj** and 181,7 (sd 18,45) for **gen.attr**.

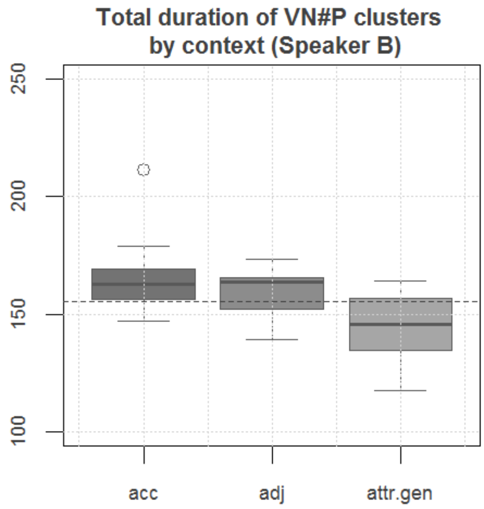


Figure. 4.26: Plot of total durations of VN#C clusters by context. Mean durations are 165,44 (sd 14,57) for **acc** , 158,11 (sd 12,18) for **adj** and 144,6 (sd 14,47) for **gen.attr**.

Summary I

Up to this point, it was shown that the syntactic environment produces significant effects on both relative and absolute durations. For the male speaker, this effect is most significant for the plosive and for the vowels, while for the female speaker nasals and total durations are influenced strongest by context. These differences always involved the ACC environment, thus significant differences were never found between GEN.ATTR and ADJ alone. This sets direct objects apart from the other two contexts, while a differentiation between GEN.ATTR and ADJ is inconclusive at best.

Relative durations II

To further examine how the proportions are effected by the context, two further variables were examined. First, the relative duration in percent of the VN sequence in the entire VN#C sequence (VN/VN#C). Second, the relative duration of the nasal compared to the vowel, in other words the percentage of the nasal in the duration within the VN sequence

(N/VN). These plots are shown for both speakers in figure 4.27 and4.28, as well as figure 4.29 and 4.30.

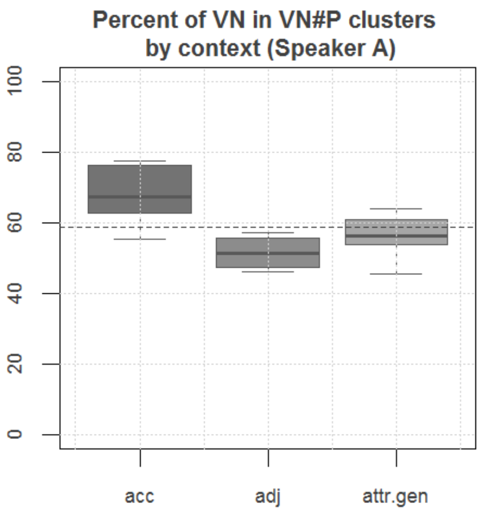


Figure. 4.27: Speaker A. Boxplot of relative durations of VN in VN#P. Mean percentages are 67,87 (sd 8,66) for **acc**, 51,61 (sd 5,11) for **adj** and 56,50 (sd 5,38) for **gen.attr**.

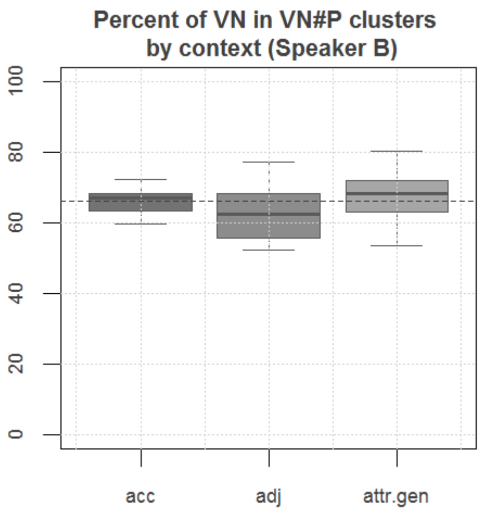


Figure. 4.28: Speaker B. Boxplot of relative durations of VN in VN#P. Mean percentages are 66,43 (sd 4,06) for **acc**, 62,86 (sd 9,15) for **adj** and 67,79 (sd 7,69) for **gen.attr**.

Regarding VN, it can be observed that for the male speaker, context has the effect that the relative durations of VN are higher in ACC . ANOVA confirms a significant effect of context for the male speaker A (F=9,40, P=0,0014), which is due to ACC vs ADJ and ACC vs GEN.ATTR . No effects for speaker B (F=1,06, P=0,3612) were observed.[4]

In figures 4.29 and 4.30 the inverted pattern is observed. Here only the female speaker shows an effect of context (F=7,29, P=0,003), while no differences are found for the male speaker (F=0,6399, P=0,64).

[4]The plots in figure 4.27 and 4.28 are the inverted versions of the plots in figure 4.22 and 4.24. The effect, however also persists with respect to absolute durations. For reasons of space the durational covaration within the cluster cannot be evaluated.

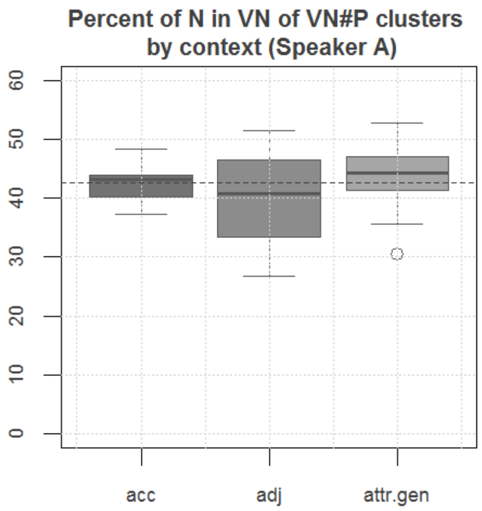


Figure. 4.29: Speaker A. Plot of proportion of N in VN of VN#P by context. Mean percentages are 42,72 (sd 3,76) for **acc** , 40,02 (sd 10,17) for **adj** and 43,57 (sd 6,06) for **gen.attr**.

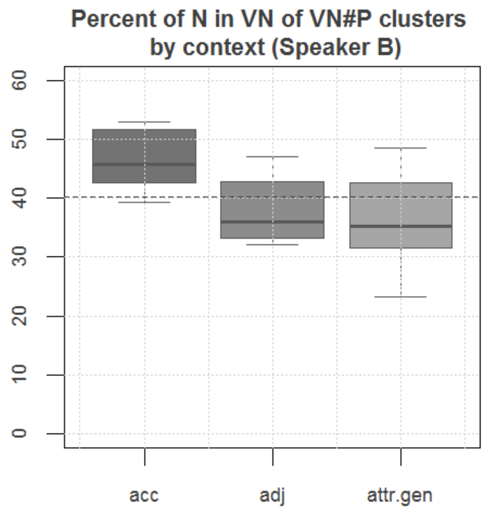


Figure. 4.30: Speaker B. Plot of proportion of N in VN of VN#P by context. Mean percentages are 46,87 (sd 5,22) for **acc** , 38,20 (sd 6,01) for **adj** and 36,37 (sd 7,39) for **gen.attr**.

4.4.3 Summary II

The male speaker's total durations remain constant across syntactic contexts, which precludes the presence of pauses that have falsely been allowed in the data. The effect of context for the male speaker is strongest for relative duration of VN, while effects for relative durations of the vowel or the nasal alone were only partly significant. This indicates that different syntactic boundaries are not necessarily realised as additional duration. For the context of ACC , instead a trade off can be observed lengthening both the vowel and the nasal while maintaining total duration isochrony by shortening the plosive.

For the female speaker, context was realised differently. In ACC context - thus across a DP boundary - the nasal was lengthened at the expense of the vowel. Additionally, for the context of GEN.ATTR reduction of total duration was observed. This sets GEN.ATTR apart from ADJ for speaker B and indicates that the functional load of differentiation of boundaries is not concentrated on one context, but has several slightly weaker effects as opposed to the male speaker. On the one hand, the ACC correlates with lengthening of the nasal, while the reduction in total durations sets GEN.ATTR apart from other contexts.

With respect to place assimilation the observations reveal that especially for the female speaker, assimilation should be least expected for the ACC environment, as nasal duration is longest there. The reduction in total duration may be due to 'skipping a beat' of certain productions, thus deleting a timing slot. This idea finds fuel in the rather lengthy voicing times into the plosives that were observed for the female speaker. Also, the two peaks of the histogram of total durations in GEN.ATTR (see figure 4.31) provide another indication for the idea that the reduction of total durations may be categorical.

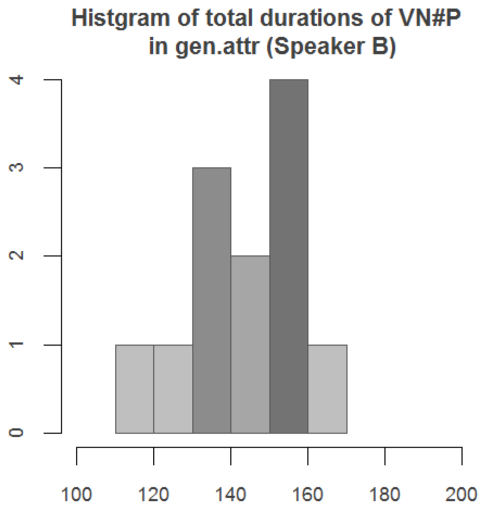


Figure. 4.31: Speaker B. Histogram of total durations in **gen.attr**.

Interpretation and discussion

These findings illustrate the presence of individual strategies of durational reduction of the nasal depending on the syntactic environment. While both speakers show effects of the context, the incarnation of these effects varies considerably. The differences in the absolute values of total duration between speakers also point to variation of speaking tempo, which may be due to a different interpretation of the reading task. This is consistent with the competitive nature of speaker A, who seemed to try to produce correct pronunciations in the reading task. It may be possible that the difference in reduction strategies is dependent on speech rate. This is in compliance with Dani Byrd (1996), who found that coarticulation in C#C clusters is dependent on speech rate.

With respect to the male speaker it is difficult to relate the observations to frequency in place assimilation. The longer durations of VN, which come at the expense of the plosive and were found for the ACC environment would lead one to expect to yield higher assimilation frequencies for both ADJ and GEN.ATTR . However, to the contrary, a particularly low rate of place assimilation was found for the ADJ environment, as already discussed in 4.3.1.

This suggests two possible interpretations of the data. One that has been implicitly assumed, but shall be reflected upon in some more depth here, is that syntactic boundaries are directly responsible for the durational pattern. They can serve to predict the occurrence of pauses and determine intonational phrasing. Since the durational changes are by and large of relative nature, a second possibility seems equally plausible.
The effects on duration are mediated by sentential stress.

In the case of GEN.ATTR, as shown in section 4.4.1, items were restricted to subject po-

sition, thus to sentence initial position[5]. In this position, they were under the influence of the strong sentence initial high pitch, which was a typical property of the reading intonation of this corpus. The exact locus of the peak varied. Mostly it was aligned with the subject noun, but depending on meaning, and probably also word-frequency this pattern was sometimes less clear. But given the general intuition that the subject nouns are pronounced somewhat more prominently, greater durations of the plosive are a plausible consequence. Since voicing modalities play a significant role in Finnish prosody[6], it must be conceded that duration measurements fail to capture all prosodic dimensions of reduction. Many of the nasals where quite lengthy, yet showed significant reduction in intensity and periodicity, while others were rather short yet no different from full intervocalic nasals. It may well be that speakers will show effects of context also for this variable. Such effects may be to some extent independent of durational effects.
For the ACC context, especially with the female speaker, the adjunct following the object was frequently produced with creaky or breathy voice phonation, indicating that the object, often carrying sentential main stress, would be more prominent, explaining durational changes. Sometimes, every syllable after the initial syllable of the object already underwent this type of reduction. This is consistent with the shortened durations of the plosives in this context for the male speaker.

As already discussed, the pattern of adjectives is the least clear of the three contexts. The dataset did not allow for a complete control of the possible interpretation of the adjectives in the sentences. It is also likely that the difficulties in how to read the sentences reported by the male speaker are related to the semantics of the adjectives, and may explain the high occurrence rate of non-assimilated nasals in this context. For the female speaker, adjectives patterned somewhere in between ACC and GEN.ATTR as they neither showed the higher nasal duration, nor the lower total duration of ACC and GEN.ATTR respectively. Yet, in order to shed more light on this issue, a more thoroughly controlled dataset is required. The discussion so far also timidly points into the direction of isochrony, as the overall cluster duration did not change for speaker A. A probable interpretation relates this fact to his slower speech rate. Here, the claim is made that the durational effects of context covary consistently with general speech rate. An alternative interpretation would see these observations on reduction patterns as a speaker specific property of Finnish prosody. A further alternative interpretation establishes a link to regional dialectal variants occurring within the Helsinki metropolitan area. Further study of these issues requires control of speech rate.

[5] Not all items were actually sentence initial, since some were still modified by an adjective.

[6] For example, speakers use pulmonic ingressive speech for short utterances consisting preferentially of particles like *juu,* nii͠. Vowels are typically devoiced utterance finally, where creaky voice is the rule rather than the exception for female speakers.

4.4.4 Concluding remarks and future perspective

The purpose of this study was to examine the influence of syntactic boundaries and their related prosodic properties on the final nasal. The syntactic contexts of ACC, GEN.ATTR, and ADJ differ primarily on whether the two words are within the same DP, which is the case for ADJ and GEN.ATTR as opposed to ACC . The effect of a stronger boundary after the direct object, which is also corroborated by the occurrence of pre-consonantal pauses exclusively in this position, manifests itself in a trade-off relationship between the nasal and the following plosive.

Further, relative stress between the words seems crucial in explaining parts of the durational variation, since partly differences between ADJ and GEN.ATTR could be observed, where, in essence, the prosodic boundary between them is the same. However, a clearer perspective differentiating the effect of intonational phrase boundaries as opposed to the placement of sentential stress is indicated, yet it was shown that syntactic boundaries effect durational patterns also in other ways aside of simple pauses.

Regarding this, further research may be required to examine patterning of sonorants, since speakers seem to be more aware of the total assimilation cases, and use them sometimes for particular emphasis. This was observed for example in a production of the female speaker of the sentence '*Manun kaveri heittää pallo[r r]aunolle.*' (Manu's friend throws the/a ball to Rauno), which was read with strong emphasis on *Raunolle*.

Further research also is required to control for effects of information structure more efficiently, by embedding the sentences in short stories, to make speaker intuitions on givenness more accessible. Also, the instruction to read the sentences like the first sentence of a book, may yield more homogeneous patterns. Type and length of adjuncts will influence prosodic properties and may change stress relations between the object and the adjunct thus influencing duration measurements.

Most importantly, though, seems the control of phonetic and phonological variables like syllabic length, the intervocalic consonantal material, and the length of the first vowel of both the genitive marked word as well as the word following it, due to their influence on durations of V and C in the VCN#C cluster. Especially the consonant preceding the VN#C sequence and the vowel following the VN#C sequence will exert influence on durations.

Chapter 5

Summary and Conclusion

In the history of generative phonology, typologically recurring patterns in (nasal) place assimilation have been analysed using a wide variety of formal ideas and assumptions. Teasing apart the underlying assumptions of the set of possible explanations and the actual implementation into a formalism are the focus of chapter 1. It was shown that the usage of formalism in the description of place assimilation in most cases is essentialist in nature (Scholz et al., 2011), in the sense that efficient formal description is ascribed an explanatory role in itself. Such practice has been subject to fierce criticism for example in (Foley, 1977).

The role of formalism in Phonetically Based Optimality Theory differs from the generative tradition. While internalist remnants are still present in the formalism, for example the p-map (Steriade, 2001, 2000), it is based on an explicit hypothesis of how speakers store perceptual information of segments that helps the speaker to arrive at an *optimally* reduced realisation of the utterance. Further, the optimality theoretic formalism allows for a flexible and encompassing formal description of gradient phenomena of reduction. However, it must be stressed that the empirical basis of claims on the storage of knowledge need to be better supported by psycholinguistic experimentation.

Chapter 1 concludes that typological observation finds better explanations in the physics and physiology of the articulatory apparatus and properties of human perception compared to simplicity of formal description. The role of formalism in such a view is to provide a concise toolkit for description of this knowledge. This goal is claimed to be suitably achieved by the derivational formalism of OT.

Chapter 2 introduced the patterns in Finnish nasal place assimilation and its dialectal variation, as well as a short introduction into the descriptive tradition of Finnish dialects.

For the analysis in Chapter 3 a formal perspective in the framework of Government phonology was chosen. The analysis provides an exhibition of the problems that are inherent to treatments of place assimilation in the framework of Government Phonology. Parts of these problems arise due to the representational and graphic formalism, while other obstacles lie in the very abstract conception of melodic representation. It is concluded that headway has to be made to provide a fitting formalisation of place assimilation patterns and their typological asymmetries in GP, but that, given such progress, a GP formalisation would benefit from its visual nature and provide an intuitive elegant representation. Failure to achieve such progress would, however, cast serious doubt on the validity of the approach, since capturing the basics of a phonological phenomenon as abundant and pervasive as place assimilation must be an indispensable goal for every theory of phonology.

Chapter 4 examines the realisations of the nasal in more detail and presents a study on the influence of syntactic boundaries and sentential stress on the timing of word-boundary VN#C sequences. It was shown that the syntactic environment influences durational proportions of the final nasal. Despite inter-speaker variation, it is concluded that sentential stress and speech rate are influential on relative segmental durations, while the entire sequence's total duration does not change to the same extent.

It is a central challenge to phonological theory to provide a formalisation of all layers of speech behavior. While the language internal description is provided in frameworks such as Government phonology, typological generalisations are successfully formalised in PBOT. However, there is no formal framework that unifies prosodic factors, language internal factors and typological factors. Such a formal theory is necessary to provide an encompassing model of speech.

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Appendix

English Abstract

Typological regularities in sound patterns have conclusively been shown to have a basis in restrictions imposed by the articulatory aparatus and factors of perception. This thesis aims to provide an overview of whether and how such phonetic precursors are implemented in formal phonological frameworks. This overview follows the evolution of generative analyses of place assimilation phenomena. Particulary, approaches of Perceptually Based Optimality Theory (PBOT) and Government Phonology as well as other rule and constraint based approaches are contrasted and evaluated.

Chapter 1 discusses the phonetic basis of recurrent patterns in place assimilation and examines phonological analyses proposed to account for those patterns. It will be shown that the incorporation of phonetic precursors into formal phonological theory allows to formulate hypotheses and evaluate their extendability based on formal criteria.

In Finnish, nasal place assimilation occurs across word-boundaries with various morphemes ending in *-n*. Chapter 2 introduces this pattern and its dialectal variation in more detail, and gives a brief introduction to the descriptive tradition of Finnish dialects.

Chapter 3 analyzes nasal place assimilation in Standard Finnish using the framework of Government Phonology (GP). The analysis proposes the notion of m-licensing. The purpose of m-licensing is the representation of the salience of place cues, and thus to provide the phonetic grounding necessary to account for the typology of place assimilation, while simultaneously accounting for the different behaviour nasals before obstruents and sonorants, which poses a challenge to Element theory.

Chapter 4 discusses the phonetic realisation of the final nasal in more detail. It is shown that its syntactic position influences its duration significantly. Based on inter-speaker variation, it is concluded that also speech rate is influential on relative segmental durations.

A central challenge to phonological theory is to provide a formalisation of all aspects of speech behavior. GP provides simple and elegant linguistic description, while PBOT provides a sound account of typological generalisations. An encompassing model of speech behaviour additionally requires inter alia treatment of prosodic factors or factors of word-frequencies. This thesis argues for the use of phonetic explanation in GP and indicates potential for development in the analysis of place assimilation.

Deutsche Zusammenfassung

Typologische Regelmäßigkeiten in Lautmustern von Sprachen werden zunehmend durch phonetische Faktoren der Artikulation und Perzeption erklärt. Es ist ein zentrales Anliegen der hier vorliegenden Arbeit einen Überblick darüber zu geben, ob und wie diese phonetischen Details im Rahmen eines formalen Modells der Phonologie berücksichtigt werden. Dieser Überblick beschreibt die Entwicklungen der formalen Beschreibung von Ortsassimilationsphenomänen. Besondere Aufmerksamkeit kommt dabei der phonetisch basierten Optimalitätstheorie (PBOT) sowie der Rektionsphonologie (GP) zu.

Das erste Kapitel bespricht den Einfluß phonetischer Faktoren auf typologische Asymmetrien in Ortsassimiliationsphenomänen, sowie generative Formalismen die alternative Erklärungen anbieten. Es wird gezeigt, dass die Bezugnahme auf phonetisches Detail generativen Theorien ermöglicht Hypothesen präziser zu formulieren und so den Rahmen für weitere empirische Forschung zu definieren.

Kapitel 2 bespricht Assimilation wortfinaler Nasale im Finnischen sowie finnischen Dialekten und bietet eine kursorische Einführung zur deskriptiven Tradition finnischer Dialekte.

Kapitel 3 beinhaltet eine Analyse der standardfinnischen Daten im Rahmen der Rektionsphonologie. Im Zuge dieser Analyse wird mit M-lizensierung ein theoretisches Konzept eingeführt. M-lizensierung repräsentiert die Stärke akkustischer Indikatoren für Artikulationsort. Die so definierte M-lizensierung verbindet so den theoretischen Formalismus mit phonetischer Evidenz. Zugleich erklärt M-lizensierung das Unterschiedliche verhalten von Sonoranten und Obstruenten in Ortsassimilation und bietet so eine nützliche Ergänzung zur Theorie der Elemente.

Weitere empirische Herausforderungen werden in Kapitel 4 präsentiert. Es wird gezeigt, dass die phonetische Realiserung der finalen Nasale starker Variation unterliegt. Weiters wird gezeigt dass die syntaktische Position einfluss auf die Dauer des Nasals hat. Aufgrund von Variation zwischen Sprechern, zeigt sich das auch das Sprechtempo Einfluss auf die relativen Segmentdauern und deren Verteilung innerhalb Wortgrenzenübergreifender VN#C Verbindungen nimmt.

Eine zentrale Herausforderung für phonologische Theorien ist die Formalisierung aller lautlichen Aspekte von Sprache. Die Rektionsphonologie stellt ein einfaches und elegantes Werkzeug zur Beschreibung einzelner Sprachen, während typologische Generalisierungen erfolgreich im Rahmen von PBOT formalisiert wurden. Ein umfassendes Model erfordert jedoch unter anderem auch die Bezugnahme auf prosodische Details wie Satzbetonung oder Häufigkeiten von Lexemen.

Curriculum Vitae

Personal Information

Name	David Djabbari
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Education

1995-2003	Grammar School: GRG 3 Hagenmüllergasse, Vienna
Jun 2003	School leaving examination, *cum laude*
Oct 2004	Enrollment in the Diploma program of general linguistics at the University of Vienna
Oct 2005	Enrollment in the Bachelor program of Finnish studies at the University of Vienna (unfinished)
Oct 2007 - May 2008	Education in Audio Engineering at Tone Art Academy, Vienna
Sept 2010 - Mar 2011	Erasmus exchange at the university of Helsinki, Finland

Summer Schools

2006	Eastern Generative Grammar (EGG) summer school, Olomouc, Czech Republic
2009	EGG summer school, Poznań, Poland
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2011	EGG summer school, české Budejoviče
2013	Finnish Literature (FILI) and CIMO, Course on literary translation, Helsinki

Conference contributions

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Experience

Mar - Jun 2012	Project aide at IAFPA project '*Vowels in Mande languages*' at the Austrian Academy of Sciences
Nov - Dec 2012	Project aide at Project on Phonotactics of Austrian dialects at the Austrian Academy of Sciences
Fall term 2011	Teaching assistant for Introduction to Phonetics and Phonology at University of Vienna
2007	Project aide at Yukuben Project, Annotation of Yukuben language recordings.

Languages

Native	German
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