

Phonetic naturalness in Norwegian retroflexion

1. Outline

Norwegian has a phonological process in which morpheme initial /t̪ d̪ n̪ s̪/ become retroflexes. The specific details of this process differ depending on the dialect. I will show here that a diachronic perspective on phonology is able to predict how this process manifests itself in the different dialects, whereas a synchronic approach centered on the phonetic naturalness of phonology does less well. I argue that phonetic naturalness plays no role in phonology, and that the ‘natural’ aspect of phonology is the result of more basic properties of language acquisition.

2. Introduction

2.1 Phonetic naturalness accounts for typology

In the early days of generative phonology, it was seen that the formal simplicity of a rule was not enough to be able to derive its cross-linguistic plausibility. To account for typology, universal markedness conventions were therefore incorporated into the phonological grammar, with the specifications of these conventions determined by articulatory and perceptual properties (Chomsky & Halle 1968, Postal 1968, Cairns 1969). Subsequent models of generative phonology emphasize even more strongly that phonology is informed by phonetic naturalness (Hooper 1976, Stampe 1979, Clements 1985, Archangeli & Pulleyblank 1994, Boersma 1997).

2.2 Phonetics naturalness in phonology is redundant

The incorporation of phonetic naturalness into phonology in order to account for typology was in the early days criticized by Bach & Harms (1972). Two of the points they make are:

- (1) It is descriptively inadequate: Phonetically ‘implausible’ interactions are in fact common.
- (2) It is redundant: Phonetically motivated processes are common due to limitations on what can emerge diachronically. These diachronic aspects do not need to be stated again in the synchronic grammar.

2.3 Phonetics in phonology today

In Optimality Theory (OT), phonetically defined markedness constraints play a crucial role in the derivation of the output (Prince & Smolensky 2004). The idea that these constraints are phonetically motivated was pushed especially by linguists at UCLA (Kaun 1995, Jun 1996, Steriade 1999, Hayes 1999, Kirchner 2001, Flemming 2002, Gordon 2002). Known as ‘Phonetically Based Phonology’ (PBP), it provides an OT formalization of the idea that the phonological output is the result of conflicting constraints on articulatory ease and perceptual salience (cf. e.g. Martinet 1968).

Much as a reaction to this move, a number of linguists have reiterated Bach & Harms' (1972) objections that the phonetic naturalness of phonology is taken care of by diachrony, and that it would be redundant to restate these facts in the synchronic grammar (Dolbey & Hansson 1999, Buckley 2000, Hale & Reiss 2000, Hyman 2001, Blevins 2004, Blevins & Garrett 2004, Yu 2004, Barnes 2006, Mielke 2008). This line of approach is commonly referred to as 'Evolutionary Phonology' (EP).

2.4 Parsimony in phonological theory

Given the existence of phonetically arbitrary rules in languages, any phonological theory must allow for them to be learned, stated, and derived. Theories that are primarily built around phonetic naturalness tend therefore to be dichotomic, as they claim that phonetically natural rules are learned/stated/derived in a different way than phonetically arbitrary rules (Stampe 1979, Clements 1985, McCarthy 1993, Hayes 1999). According to Hale & Reiss (2000), this approach violates the principle of theoretical simplicity, which makes them less preferable than theories where the link between phonology and phonetics is arbitrary at the outset.

3. Norwegian retroflexion

3.1 Norwegian retroflexion – a phonetically natural process?

In Norwegian, morpheme initial laminal alveolars / $\underset{\cdot}{t}$ $\underset{\cdot}{d}$ $\underset{\cdot}{n}$ $\underset{\cdot}{s}$ / become apical postalveolars (=‘retroflex’) [$\underset{\cdot}{t}$ $\underset{\cdot}{d}$ $\underset{\cdot}{n}$ $\underset{\cdot}{s}$] when directly preceded by the apical alveolar /r/, which itself deletes:

/ba:r/ ‘bare-ADJ’	+	/- $\underset{\cdot}{t}$ / ‘ADJ-N’	>	[ba: $\underset{\cdot}{t}$]
/ $\underset{\cdot}{t}$ a:r/ ‘take-PRES’	+	/- $\underset{\cdot}{d}$ ə/ ‘it’	>	[$\underset{\cdot}{t}$ a: $\underset{\cdot}{d}$ ə]
/ $\underset{\cdot}{t}$ a:r/ ‘take-PRES’	+	/- $\underset{\cdot}{n}$ / ‘he’	>	[$\underset{\cdot}{t}$ a: $\underset{\cdot}{n}$]
/ $\underset{\cdot}{t}$ a:r/ ‘take-PRES’	+	/- $\underset{\cdot}{s}$ æ/ ‘REFL’	>	[$\underset{\cdot}{t}$ a: $\underset{\cdot}{s}$ æ]

In most theoretical descriptions of this process, it is described as an articulatory assimilation or articulatory merger (Hovdhaugen 1969, Kristoffersen 1980, Eliasson 1986, Bradley 2007), as exemplified below.

The ‘retroflex rule’ (Hovdhaugen 1969):

$$\left[\begin{array}{c} -\text{syllabic} \\ +\text{sonorant} \\ -\text{nasal} \\ -\text{anterior} \end{array} \right] + \left[\begin{array}{c} -\text{syllabic} \\ +\text{anterior} \\ +\text{coronal} \end{array} \right] \rightarrow \emptyset + [-\text{anterior}]$$

$$\text{e.g.} \quad /r/ \quad + \quad /t/ \quad \rightarrow \emptyset + [t]$$

Endresen (1974) points out that these ‘pure assimilation/merger’ solutions are not descriptively correct, since the trigger /r/ and the targets / $\underset{\cdot}{t}$ $\underset{\cdot}{d}$ $\underset{\cdot}{n}$ $\underset{\cdot}{s}$ / are [+anterior] (alveolars), whereas the output

is [–anterior] (postalveolar). The question is, “[how can] two [+anterior] segments give one [–anterior] segment?”.

3.2 Why is the output postalveolar? A synchronic account

Endresen (1974) and Kristoffersen (2000) view Norwegian retroflexion as an apical assimilation.

The ‘retroflex rule’ (Endresen 1974):

$$\left[\begin{array}{c} +\text{coronal} \\ -\text{distributed} \end{array} \right] + \left[\begin{array}{c} +\text{coronal} \\ +\text{distributed} \end{array} \right] \rightarrow \emptyset + [-\text{distributed}]$$

A markedness convention subsequently fills in [–anterior] for [–distributed] coronals, although no phonetic motivation is provided for why an apical postalveolar [ɹ̥] should be less marked than an apical alveolar [t̥].

Under the current PBP approach, there is a clear perceptual motivation behind the postalveolar output [ɹ̥] – it is perceptually more distinct from the laminal alveolar [ɹ̥̥] than the apical alveolar [t̥] is:

$$\begin{array}{ccccc} & & \textit{Perceptual distance} & & \\ & & [ɹ̥̥] \leftarrow & \rightarrow & [t̥] \\ [t̥] \leftarrow & & & & \rightarrow [ɹ̥] \end{array}$$

3.3 Why is the output postalveolar? A diachronic account

The apical alveolar /r/ is not the only trigger of retroflexion in Norwegian. The apical postalveolar /ɹ/ triggers the same process (cf. Endresen 1974, Kristoffersen 2000):

/gʷɹ̥/ ‘yellow-ADJ’	+	/-t̥/ ‘ADJ-N’	>	[gʷɹ̥]
/st̥æ:ɹ̥/ ‘steal-IMP’	+	/d̥iŋ/ ‘your’	>	[st̥æ:d̥iŋ]
/st̥æ:ɹ̥/ ‘steal-IMP’	+	/-ŋ/ ‘it’	>	[st̥æ:n]
/st̥œ:ɹ̥/ ‘sore-ADJ’	+	/s̥ɔm/ ‘as’	>	[st̥œ:s̥ɔm]

In the dialects of Sør-Trøndelag, Møre og Romsdal, and Nordland, these two processes are distinct (Riksheim 1921, Mo 1922, Rypdal 1929, Skånlund 1933, Olssen 1958, Holten 1974, Haugen 1982, Jenstad 1985, Brekke 2000). In the 19th century, the same distinction was found in the oldest generation in rural dialects in the southeast of Norway (Larsen 1894):

Apical alveolar /r/	+	laminal alveolar /t̥ d̥ n̥ s̥/	>	apical alveolar [t̥ d̥ n̥ s̥]
Apical postalveolar /ɹ/	+	laminal alveolar /t̥ d̥ n̥ s̥/	>	apical postalveolar [ɹ̥ d̥ n̥ s̥]

The current state in Urban East Norwegian, where /r/ and /ɹ/ both trigger postalveolarization, is the result of a diachronic merger (Storm 1884, Hoff 1949, Torp & Vikør 1993). Due to the small perceptual distance between apical alveolars and apical postalveolars (cf. Storm 1884), they

could easily be confused in perception, and as a consequence merge into a single category (Ohala 1993). As already mentioned above, the merger could still be observed in this region in the 19th century (Larsen 1894), and it is currently taking place in the dialects where they have traditionally been kept distinct (Haugen 1982, Jenstad 1985, Sandøy 1990).

The ‘unnatural’ aspect of Norwegian retroflexion is therefore the result of rule telescoping, where a diachronic process $A > B > C$ is synchronically represented as $A > C$ (Wang 1968):

History:	UR /r-t/	Assimilation / /	Merger /t/
Synchrony:	UR /r-t/		Retroflexion /t/

Map of Norway



3.4 Synchrony vs. diachrony

The postalveolar output in Norwegian retroflexion receives relatively straightforward accounts in both PBP and EP. In PBP, the output needs to be sufficiently distinct from other segments, and this consideration weighs heavier than the need to retain the alveolar articulation of the trigger /r/ (M >> F). In EP, the output is the result of a diachronic merger through misperception of acoustically similar sounds.

Yet these two accounts make different predictions for how retroflexion works in dialects with a different inventory of rhotics – the potential triggers of retroflexion.

4. Norwegian dialects without retroflex triggers /ɽ/ or /r/

4.1 Dialects without /ɽ/

In Northern Norway (Skjekkeland 1997), Risør on the southern coast (Hødnebø 2005), and in the traditional Dano-Norwegian speech in Oslo (Western 1889), there is an /r/ but no /ɽ/. Diachronically, these dialects therefore never had a stage where a postalveolar /ɽ/ caused postalveolarization to [t̪ d̪ ɲ s̪]. Under the EP approach, this also means that the apicalized [t̪ d̪ ɲ s̪] could not merge with them through misperception. Since there would be no diachronic source of postalveolarization, it therefore predicts that these dialects have a process where /r/ triggers apicalization of following /t̪ d̪ ɲ s̪/ to apical alveolars [t̪ d̪ ɲ s̪].

With PBP, the postalveolars [t̪ d̪ ɲ s̪] are perceptually optimal irrespective of the presence or absence of /ɽ/ in the inventory. PBP therefore predicts the same output forms in these dialects as in the dialects with /ɽ/. Alternatively, PBP makes no prediction, since the absence of /ɽ/ is not synchronically related to what process /r/ might trigger.

All the dialects in question have a process where /r/ triggers apicalization to alveolar [t̪ d̪ ɲ s̪], as expected under the diachronic view (Brekke 1881, Storm 1884, Western 1889, Larsen 1907, Iversen 1913, Alnæs 1925, Christiansen 1933, 1976, Hødnebø 2005). Under a PBP analysis, the output with apical alveolars [t̪ d̪ ɲ s̪] shows that the need to retain the alveolar articulation of the trigger /r/ must weigh heavier than the need to create coronals that are sufficiently distinct from other coronals (F >> M). Yet it does not follow that the ranking M >> F in a dialect with /r/ and /ɽ/ should switch to F >> M when the dialect lacks /ɽ/. If anything, we would expect that the need to retain the alveolar/postalveolar articulation of rhotics to be more, and not less, important in dialects where alveolar and postalveolar rhotics contrast.

4.2 Dialects without /r/

4.2.1 Oslo

In the early 19th century, an innovation occurred in an upper-class Dano-Norwegian sociolect in Western Oslo, whereby /r/ was replaced by the dorsal uvular /ʁ/ (Larsen 1907, Torp 1997). Since retroflexion long predates this innovation (14th century, Seip 1955), a diachronic EP approach

predicts that retroflexion would remain, but as a result of rule telescoping become phonetically unmotivated:

History:	/gɔ:r/	/gɔ:r də/	Older Norwegian
		/gɔ: ɖə/	Retroflexion
	/gɔ:ɣ/		Uvularization
Synchrony:	/gɔ:ɣ/	/gɔ: ɖə/	Phonetically unmotivated alternation

4.2.2 Arendal

Along the southern coast of Norway, all dialects have a dorsal uvular /ɣ/ instead of /r/ (Foldvik 1988), an innovation that probably dates to the early 19th century (Torp 1997). Going up east along the coast, the use of /ɣ/ comes to a sudden halt after Tvedestrand, a town situated right in between Risør to the east (/r/) and Arendal to the west (/ɣ/) – ca. 25 km away from both. This /ɣ/-/r/ border has not moved since the earliest recordings (Larsen 1907, Foldvik 1988, Torp 1997, Hødnebo 2005). At the same time, retroflexion has slowly moved west down the coast, and it reached Risør in the late 19th century (Torp 1997, Hødnebo 2005).



Under a diachronic EP framework where the probability of an innovation spreading is determined by social and cultural factors, and not by phonetic motivation (Hale 2007), retroflexion is predicted to spread into the /ɣ/-dialects of Tvedestrand and Arendal, since retroflexion is a characteristic property of the prestige dialect: Urban East Norwegian.

Under the PBP approach, the assumption is that phonetically unmotivated processes are harder to learn, and thus less easily transmitted (Wilson 2006). Since the general view is that the synchronic retroflexion in /r/-dialects is articulatorily motivated, many claim that it cannot exist

in an /ɤ/-dialect, since it would be ‘unnatural’ for /ɤ/ to trigger such a process (Eliasson 1986, Sandøy 1993, Torp 1997).

4.3.1 Data – Oslo

Although it is known that speakers of the /ɤ/-sociolect in Oslo have retroflexes in their phonemic inventory (Larsen 1907, Torp 1997), it has previously not been addressed whether these speakers derive retroflexes across morpheme boundaries.

The most well-known speaker of this sociolect is the late philosopher Arne Næss (1912-2009), born and raised in the upper class in Western Oslo (Bostad 2010). Examples from a 1964 interview with Arne Næss:¹

/gɔ:ɤ/ ‘go-PRES’	+	/ʌ:t/ ‘out’	>	[gɔ:ɤʌ:t]
/gɔ:ɤ/ ‘go-PRES’	+	/dɔ:/ ‘it’	>	[gɔ:dɔ]

A session with a speaker (a retired classics scholar, born in the 1930s) from Oslo shows how this process is productively applied to nonce formations:

/bɛmɔɤ/ ‘nonce’	+	/dɑ:g/ ‘day’	>	[bɛmɔdɑ:g]
/bɛmɔɤ/ ‘nonce’	+	/ʂɑ:k/ ‘case’	>	[bɛmɔʂɑ:k]
/bɛmɔɤ/ ‘nonce’	+	/ʂtɛ:n/ ‘stone’	>	[bɛmɔʂtɛ:n]
/sɔmɔɤ/ ‘summer’	+	/ʂko:/ ‘nonce’	>	[sɔmɔʂko:]

As predicted under the EP approach, rule telescoping has led to a phonetically unmotivated retroflexion process.

4.3.2 Data – Arendal

Neither retroflex segments nor retroflexion as a process existed in the /ɤ/-dialects of Tvedestrand and Arendal before WWII (Voss 1940, Hødnebø 2005). These communities have incorporated retroflex segments since (Kristoffersen 1980, Torp 1997). At the end of the 1970s, Kristoffersen (1980) found in recorded speech of school children in Arendal that there was a 5% retroflexion rate across morpheme boundaries within words. There is a high possibility, though, that these represent lexical borrowings of morphologically complex forms, and not active retroflexion. To address this issue, I conducted a session with a speaker from Arendal (27 y.o.). The session shows that the retroflexion process applies to real and nonce words alike, with an application rate of well above 50%:

¹ <http://www.youtube.com/watch?v=5m5tTwg2-IM>, accessed October 28, 2010.

/hø:ɤ-/ ‘hear-STEM’	+	/-tə/ ‘PRET’	>	[høtə]
/tɑ:ɤ-/ ‘nonce-STEM’	+	/-tə/ ‘PRET’	>	[tɑ:tə]
/ʃtu:ɤ-/ ‘big-ADJ’	+	/-t/ ‘ADJ-N’	>	[ʃtu:t]
/ʃkɑ:ɤ-/ ‘nonce-ADJ’	+	/-t/ ‘ADJ-N’	>	[ʃkɑ:t]
/fɑ:ɤ/ ‘father’	+	/-ʃ/ ‘POSS’	>	[fɑ:ʃ]
/pɥ:ɤ/ ‘nonce’	+	/-ʃ/ ‘POSS’	>	[pɥ:ʃ]

In result, these dialects have acquired “an outmost unnatural rule” (Kristoffersen 1980):

$$\begin{bmatrix} +\text{sonorant} \\ +\text{back} \\ +\text{high} \\ -\text{nasal} \end{bmatrix} + \begin{bmatrix} +\text{anterior} \\ +\text{coronal} \\ -\text{back} \end{bmatrix} \rightarrow \emptyset + [-\text{anterior}]$$

As Kristoffersen points out (1980), the rule “can only be explained by knowing the social and cultural context”. As expected under the diachronic framework, the lack of phonetic motivation does not prevent retroflexion from being incorporated into the grammar, since it has a clear sociolinguistic basis.

5. The role of phonetic naturalness in typology – reevaluated

According to Hayes (1999), children are less likely to innovate phonetically unmotivated processes, since they are not available in children’s phonological knowledge. As a result, such processes should be less common cross-linguistically. In EP, however, language learners are not believed to spontaneously innovate changes. Rather, innovations are due to errors in perception and articulation. As a result, EP also predicts that phonetically motivated processes should prevail.

Since errors in perception and articulation exist independently of the grammar, supporters of EP have argued that it is not necessary for the grammar to incorporate phonetic naturalness in order to account for typology. This also means that the commonality of phonetically motivated processes across languages is not an argument in favor of PBP. In recent years, phonologists have instead turned to learning experiments in order to test whether phonetically motivated rules are in fact learned differently from unmotivated ones.

5.1 Unnaturalness and learnability

Some claim that phonetically motivated processes come for free, in that they are innate or universal, whereas unmotivated processes must be learned from the data (Schane 1974-5, Donegan & Stampe 1979, Hayes 1999). From this it could follow that phonetically motivated processes are more common in languages because they are more easily transmitted in the learning process (Wilson 2006).

Several experiments now exist where the learnability of phonetically motivated vs. phonetically unmotivated interactions has been tested. They all speak against the idea that unmotivated

processes are harder to learn (Jusczyk et al. 2003, Saffran & Thiessen 2003, Pycha et al. 2003, 2006, Seidl & Buckley 2005, Kuo 2009, Skoruppa & Peperkamp in press).

5.2 Complexity and learnability

Others claim that complex processes are harder to learn than simple processes, where ‘complex’ is to be understood as a process referring to several phonetic features or as a process that cannot be captured with reference to a natural class of segments (Chomsky & Halle 1968, Moreton 2008a). Under this view, ‘simple’ phonological processes are more common across languages because they are more easily transmitted (Bach & Harms 1972).

Learning experiments generally support the claim that complex processes are harder to learn (Saffran & Thiessen 2003, Wilson 2003, Pycha et al. 2003, 2006, Peperkamp et al. 2006, Moreton 2008b, Cristià & Seidl 2008, Kuo 2009). In this case, the abundance of phonetically motivated processes could be seen as an epiphenomenon, since such processes tend to be simpler in their phonological representation than phonetically unmotivated processes.

5.3 Phonetic distance and learnability

Wilson (2006) and Skoruppa et al. (to appear) find that people are less successful in learning a phonological process when the phonetic distance between the alternating elements is large (similar findings in a priming experiment in Marslen-Wilson et al. 1996). However, Wilson’s experiment is confounded with phonetic naturalness, and Skoruppa et al.’s experiment is confounded with complexity. In Stausland Johnsen (to appear), it is found that speakers are less likely to adopt an alternation when the phonetic distance between the elements increases, even though the alternations tested are all phonetically motivated and equally complex. This study is not a learning experiment, on the other hand.

These studies suggest that phonetic complexity also plays a role in the learnability of phonology. Since phonetically motivated processes tend to be phonetically simple (Skoruppa et al. (to appear)), there is yet another reason to suspect that phonetic naturalness is in reality an epiphenomenon of a complexity issue in pattern recognition.

5.4 Complexity and typology

We have identified three areas of complexity that plausibly play a role in the learnability of phonological processes: 1) The number of features involved, 2) Natural classes, 3) Phonetic distance.

Mielke (2008) presents a typological survey of one of these areas – *natural classes*. In the 6000 processes investigated, Mielke finds that 29% of them do not refer to natural classes, and must therefore be regarded as complex (or ‘unnatural’). Since there are three areas of complexity, it is not unreasonable to suspect that complex interactions are at least as common as simple interactions in phonology.

This discrepancy between natural language typology and artificial language learning questions whether it is justifiable to extrapolate from the lab to the world at all. It might indicate that the difficulty of acquiring ‘unnatural’ or ‘complex’ interactions is so easily overcome (cf. Schane et al. 1974/75) that it has no practical consequences for natural language acquisition.

It seems certain that there are innate biases in learning that can be traced in learning experiments. It is not clear, however, that these are *grammar* biases, and it is questionable what role they play for real language acquisition. As a result, we might find better explanations for both language typology and isolated facts from research on the constraints and factors in innovation and diffusion more than from language learning experiments with extremely brief exposure to phonological patterns.

6. Conclusion

In Norwegian, a phonological process takes laminal alveolars /t̪ d̪ n̪ s̪/ to retroflexes in morpheme initial position. The details of this process, however, differ depending on the dialect. A diachronic perspective, with no special role granted to phonetic naturalness, does well in predicting what those details might be. A synchronic perspective centered on phonetic naturalness does not make accurate predictions, to the extent any predictions are made at all.

As there is no convincing support from language typology, language specific facts, or phonological experiments that phonetic naturalness has a place in the phonological grammar, I suggest that its *apparent* role is an epiphenomenon of errors in perception, articulation, and pattern recognition.

A question for further research is to investigate whether the phonological module is entirely void of phonetic content, an idea that plays a central role in Chomsky & Halle (1968), and which has seen increasing popularity in recent years (Hale & Reiss 2000, Ohala 2005, Barnes 2006, Coetzee & Pretorius 2010).

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