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MAPPING INNOVATIONS IN NORTH GERMANIC WITH GIS

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ABSTRACT

The mapping of innovations, as opposed to taxonomic features, has so far been little used in historical linguistics and dialect geography. Here I show with two examples from Peninsular North Germanic how linguistic theory may cast light on complex mosaics of geographically competing features and how dialect geography can help choose between competing reconstructions. This research builds on a database of more than 50 innovations and over 1000 municipalities in the Nordic countries coupled with mapping software (ArcGIS).

[1] INTRODUCTION

Dialectology has traditionally relied on maps showing the areal distributions of features. [1]

Such maps provide a great deal of useful information for undertaking reconstructions in historical phonology. Although dialectometry makes use of state-of-the-art mapping techniques, historical linguistics has not yet attempted to use areal distribution data to support or refute reconstructions. What I hope to show here is that mapping the spatio-temporal structure of linguistic variation can provide important and, at times, crucial validation of our reconstructions.

To this end, a couple of years ago, I started compiling a database of cultural and linguistic innovations in North Germanic. The database, stored simply as an Excel spreadsheet, currently has data for over 1000 municipalities in Scandinavia and the Nordic region, and covers over 50 innovations. Each municipality is marked as either having the innovation (1) or not (0). The data can be presented visually using mapping software such as ArcGIS (http://www.esri.com/software/arcgis/index.html) in a form that can be adaptable to needs of various users.

[1] The thesis presented in this article has taken shape over several years, during which time I have had the privilege of fruitful discussions with a number of scholars on the research reported here. In particular, I would like to thank Gjert Kristoffersen, Aditi Lahiri, Ove Lorentz, Bruce Morén-Duolljá, Tomas Riad, Curt Rice, and Øystein Vangsnes.

The data has been compiled from traditional maps, such as those in Brøndum-Nielsen (1927), Christiansen (1969), Haugen (1976), Sandøy (1996). These maps are 'taxonomic' in the sense that they represent the areal distribitions of *features*; they do not assume a theory of the *innovations* that gave rise to them. It may be difficult to discern the pattern of innovations that has given rise to the feature mosaic represented on the map. In order to explain the feature mosaic we can turn to (i) linguistic theory as a rich source of hypotheses about which innovations are likely and how they might interact sequentially, and (ii) to theories dealing with the diffusion of innovations (Rogers 2003), in particular spatial diffusion (Hägerstrand 1967).

There is, to be sure, an extensive tradition in dialectology dealing with the interpretation of the geographical distribution of dialect features. From the configuration of certain isoglosses[2], for example, it is possible to see that linguistic features spread out from particular centres. An important early contribution in this vein was Kranzmayer (1956), who was able to infer that the Central Bavarian area between Munich and Vienna including the Danube valley was the centre of several phonological innovations in southern German. The spreading of innovations may leave more conservative zones, called relic areas, unaffected. Innovations may also differ in their areal extent. These differences may be explained by the chronology and changes in communication patterns in the network over time.

One important line of inquiry is the work of the Neolinguistic school (Bàrtoli 1925, 1945; Bàrtoli & Bertoni 1925; Bonfante 1947), whose contributions are also discussed by Petyt (1980) and Trudgill (1975). Matteo Bàrtoli and his colleagues attempted to define areal norms which could be used to establish the relative age of geographically competing variants. The most important such norms are listed below in (1). These formulations are adapted from Trudgill (1975, 236).

(1) Given linguistic forms A and B,
   a. If A is found in isolated areas, and B in areas more accessible for communication, then A is older than B.
   b. If A is found in peripheral areas and B in central areas, then A is older than B.
   c. If A is used over a larger area than B, then A is older than B.

In what follows, we'll apply these norms to two examples from North Germanic.

[2] In an innovation-oriented perspective, an isogloss is a line marking the maximum extent of the spread of some innovation, like the line left on the sand after the wave recedes.

[2] STRONG FEMININES IN MID AND WEST NORWEGIAN

A good example of how recoding traditional feature mosaics in terms of innovations and visually interpreting the result comes from the areal distribution of allomorphs of the definite suffix in the strong declension of feminine nouns in varieties spoken in Western and Mid-Norway. Nouns in the strong declension typically have a stem that ends in a consonant, such as *kløv* 'packsaddle', or *bygd* 'country settlement, township'; those in the weak declension end in an unstressed /e/ or /a/, e.g. *ferje* 'ferry'. For further details on this classification, see for example Beito (1986 [1970], 112ff.).

Figure 1 is an adaption of a traditional map from the collection in Christiansen (1969). As can be seen, it presents an initially bewildering mosaic of geographically competing variants, with realizations of the strong feminine definite singular suffix ranging from {-i}, through {-ei}, {-e}, {-æ}, {-ɑ}, and {-ɔ} to {-u}.

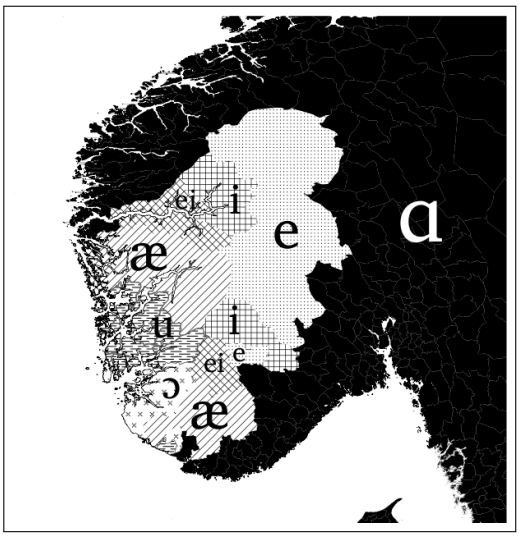


FIGURE 1: Areal distribution of strong feminine definite suffixes in Western Norway

Trying to apply Bàrtoli's norms directly to Figure 1 to determine the relative ages of the variants does not get us very far. Fortunately, in this case, we can be reasonably sure how this variation arose, thanks both to the evidence of manuscripts and phonetic theory. In Old Norse, the feminine definite suffix had the form *-in* (see e.g. Gordon 1981). In most of Scandinavia, the final *-n* was lost, but a trace of it remained as nasalization on the vowel. This has disappeared in most varieties, although nasalized suffixes still survive in some relic areas. It can still be heard in Älvdalen (Levander 1909) in Dalecarlia, and was still found in Selbu, in South Trøndelag, a century ago (Gjert Kristoffersen *voce*). Nasalization is known to affect vowel quality in various ways. Delvaux et al. (2002), for example, found that nasalized vowels in French had generally lower F2 (had a 'darker' timbre) than their oral counterparts. This qualitative difference may be enhanced by making other changes to the articulation of the vowel, including retracting the tongue body, rounding the lips, lowering (in front vowels), and raising (in back vowels). All of these strategies serve to mimic or reinforce the qualitative effects of nasalization in that they lower F2. We can note that the first eight cardinal vowels, [i e ɛ a ɑ ɔ o u], de-

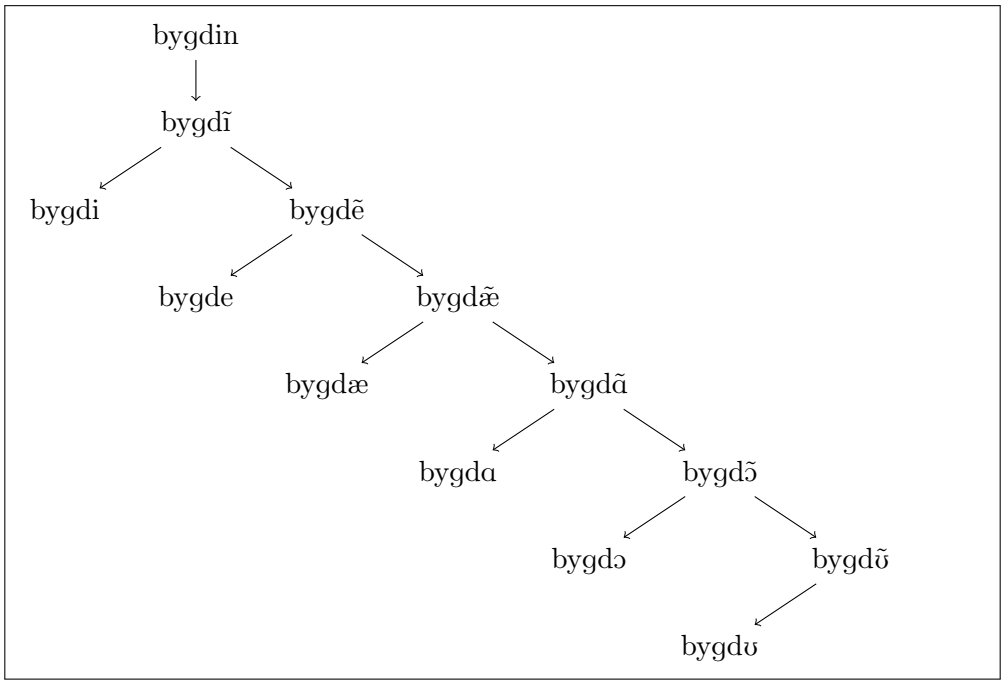


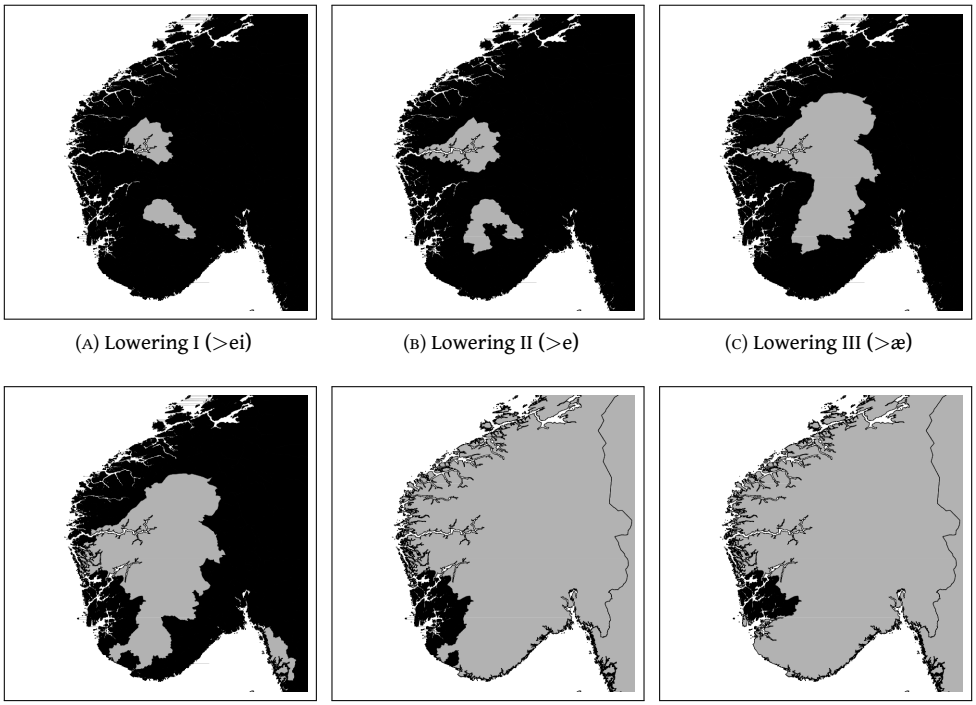
FIGURE 2: Evolutionary pathways in the development of strong feminine definite suffixes in Western Norway

scend in F2.[3] Given this, it is possible to reconstruct a series of vowel quality alterations, beginning with lowering from nasalized [ĩ] through [ẽ] to [æ̃], followed by retraction to [ɑ̃], rounding to [ɔ̃] and, finally raising to [ʊ̃]. The development is summarized in Figure 2. (We can assume the diphthongal variant {-ei} represents an intermediate stage between {-i} and {-e}, although this is not crucial for the fundamental point.) The right-branching path of the tree traces the darkening in the quality of nasalized vowels. Loss of nasalization, represented by the left-branching paths, prevents further darkening.

Something like the reconstruction of events sketched in Figure 2 is pretty much taken for granted by North Germanic dialectologists (e.g. Sandøy 1996, 133), but mapping the individual innovations lends strong support to the reconstruction as well as brings much needed clarity to the confusing geographical picture. The areal distributions of each innovation are shown in Figure 3. Areas manifesting a given innovation are shown in black. The 'greater than' symbol (>) may be read 'at least as far as'.

As Figure 3 shows, Lowering and Retraction as far as [ɑ] affected almost all va-

[3] F2 can be made audible by whispering the vowels (Catford 1988). Produced in sequence, it should be possible to hear a drop in pitch as we proceed from [i] to [u].



(A) Lowering I (>ei) (B) Lowering II (>e) (C) Lowering III (>æ)

(D) Retraction (>ɑ) (E) Rounding (>ɔ) (F) Raising (>ʊ)

FIGURE 3: Areal distribution of vowel nasalization and darkening

rieties of southern Norwegian (and, off-map, Swedish and northern Norwegian as well). However, western and mid Norway, the mountainous inland in particular, resisted these changes to various degrees. What we see is two kinds of conservatism at play. On the one hand, we see older high front vowel qualities being preserved inland. Most dialects show lowering at least as far as [ei] except two relic areas in grey in inland Agder and Telemark and Sognefjord (A), which preserve the [i] realization. Only slightly fewer dialects show lowering at least as far as [e] (B). Lowering as far as [æ] has left quite a large contiguous relic area in the mid Norwegian inland (C), and when we consider retraction as far as [ɑ], the relic area extends all the way down to the west coast (D). On the other hand, we see that darkening has proceeded further in some coastal areas. This innovation depends presumably on the nasalization of the vowel being preserved longer than elsewhere in the Scandinavian Peninsula. Thus in Rogaland and southern Hordaland, we find raising at least to [ɔ] (E), and in the northern part of Rogaland and southern part of Hordaland, the quality has been raised all the way to [u] (F).

[3] DOUBLE PEAKED ACCENT IN CENTRAL SCANDINAVIA

The previous section showed how linguistic theory may be brought to bear to clarify the geographical picture. In this section, we show how dialect geography can clarify the linguistic history.

The North Germanic varieties spoken on the Scandinavian peninsula (Norwegian and Swedish) distinguish between two so-called word accents, Accent 1 and Accent 2. The tone accent contrast is exemplified in the stylized tone curves in (3) for the citation forms /ˊlɑme/ 'the lamb' and /ˇlɑme/ 'to lamb' in one urban variety of Nordland Norwegian (Bodø).[4] The boxes represent disyllables, the vertical line in the middle the syllable boundary.

(2) *Accent 1 vs. Accent 2 in Nordland Norwegian*

The way in which these accents are realized varies geographically. A shibboleth of what many non-Scandinavians take to be prototypically Swedish or Norwegian is a 'double-peaked' realization of Accent 2, illustrated for Oslo speech in (3).

(3) *Accent 1 vs. Accent 2 in Oslo Norwegian*

In a few Norwegian dialects spoken in the area of Trøndelag, both Accent 1 and Accent 2 have a double-peaked realization, the first peak occurring earlier in Accent 1. However many varieties have a single-peaked realization. The question which of these two realizations is the oldest has occupied scholars for decades. However, reconstructing accent invites special problems because it is not represented in the manuscripts. In the literature, both points of view have been defended. Elstad (1980), Lorentz (2005), and Hognestad (2006, 2007) argue that it is the single-peaked realization that represents the original state of affairs. In a series of papers over the last fifteen years or so, however, Tomas Riad has argued that it is the double-peaked realization that is the older of the two. Riad argues that the double-peaked realization may be reconstructed as far back as what is known as the Syncope Period of Proto-Nordic (esp. Riad 1998, 2003). The

[4] The diacritics /ˊ/ and /ˇ/ mark the primary stress as being associated with Accent 1 and Accent 2 respectively.

single-peaked realization, on Riad's view, is a later innovation. It can be hard to find compelling phonological or phonetic reasons for preferring either of these competing proposals over the other. What I propose to show here, is that, Riad's proposal may be challenged on geographical grounds independent of phonetic and phonological considerations. When we compare the areal distribution of the double-peaked realization with other known, approximately datable innovations, we in fact find a striking match. The picture that emerges is one where a large contiguous area of Central Scandinavia forms a relatively innovative block, with Trondheim as the main foundry of change. This also makes sense in the light of the archaeological and historical evidence.

[3.1] *The evolution of double peak*

Dialectal variation in the realization of the Accent 1–Accent 2 distinction was first mapped in a now classic study by Meyer (1937, 1954), who elicited disyllabic simplex words with declarative intonation for 100 North Germanic dialects, 93 of which were dialects of Swedish, 5 Norwegian, and 2 Danish. This prepared the way for a rich crop of further work, although until recently work on lexical tone has tended to be pursued along national lines. Significant work on the individual languages include Gårding & Lindblad (1973), Gårding (1975, 1977), Bruce (1977, 1983), Bruce & Gårding (1978), and Gårding et al. (1978) (Swedish); Fintoft & Mjaavatn (1980) (Norwegian).

Much work on North Germanic accent to date assumes the existence of lexical tones. Our starting point, however, is recent work by Morén (2007), who argues that the accent distinction is not tonal, but involves a difference in prosodic structure. The distinguishing feature of Accent 1 is here taken to be that the prosodic word contains a nested monosyllabic prosodic word.[5] Thus the Accent 2 word *lamme* 'to lamb' contains a single prosodic word $(\,\mathrm{lam\ni})_{\omega}$, while the corresponding Accent 1 word *lammet* 'the lamb' has a minimal prosodic word $(\,\mathrm{lam}\,)_{\omega}$ contained within a higher-level (maximal) prosodic word containing both the root and the definite clitic *-et*: $(\,(\,\mathrm{lam}\,)_{\omega}\,\mathrm{\ni}\,)_{\omega}$. Recursion at the level of the prosodic

[5] Stress in Standard Swedish falls by default on the penultimate syllable. Morén (2007) addresses a neglected correlation between accent and prosodic structure and stress, showing that exceptional finally as well as antepenultimately stressed words invariably have Accent 1. The problem of how to represent Accent 1 phonologically is therefore intimately, not to say essentially, connected with prosodic structure and the representation of lexical stress. Assuming diacritic marking is undesirable, encoding lexical stress must minimally entail representing the prosodic word node and its designated head, e.g. $\overset{\omega}{|}$ /ˈduminu/ *'domino*. The basis of the North Germanic accent distinction, interpreting a suggestion by Morén-Duolljá (*voce*), is that underlyingly specified prosodic words cannot acquire additional syllable nuclei due to some faithfulness requirement. Remaining nuclei that cannot be parsed into the underlying prosodic word must therefore be parsed into a higher level constituent, identified here as a recursion of the prosodic word. The lower (underlying) prosodic word is thus forced to surface as monosyllabic, and this structure has an effect on the intonational pattern. This account also echos a recent proposal by Lahiri et al. (2005) to the effect that Accent 1 is the marked member of the opposition.

word has also been argued by Itô & Mester (2006, 2008). The tonal component of both accents is purely intonational and, underlyingly at least, phonologically invariant across both accents. For purposes of this paper, I will take the difference in pitch pattern between Accent 1 and Accent 2 in any given dialect to be a matter of phonetic interpretation only: in Accent 2, the peak is timed to occur later relative to the beginning of the (minimal) prosodic word. This understanding also meshes with the finding that the length of the word correlates positively with the degree of peak delay in several languages. Longer words evince longer peak delays in English (Steele 1986; Silverman & Pierrehumbert 1990; Bruce 1990; House & Wichmann 1996), German (Grabe 1998), and Inis Oirr Irish (Dalton & Ní Chasaide 2003, 2007).

The null hypothesis is that the prosodic structure of Accents 1 and 2 is invariant across Peninsular North Germanic dialects; it is on the level of intonation that they vary. This makes the problem of reconstruction much more tractable. Before we grapple with the details of the reconstruction, however, let us briefly review the basics of intonational phonology. For two good recent introductions to this field, see Gussenhoven (2004) and Ladd (2008).

A basic distinction is generally drawn between pitch accents, which associate to stressed syllables, and boundary tones, which align to the edges of prosodic constituents, such as the intonation phrase.

Bye (2010) argues that cross-dialect accentual variation is the result of two kinds of phonetic enhancement and subsequent phonological reinterpretation of the output by new generations of speakers. Enhancement of the first kind involves delay of a high tone peak relative to the stressed syllable that is phonologically associated to the high tone. As Farrar & Nolan (1999) and Gussenhoven (2004) argue, delaying the peak makes it sound higher. This effect is apparently due to the way in which listeners exploit phonetic knowledge. Listeners tacitly know what pitch it is possible to achieve within a given interval. When the peak is delayed, listeners subconsciously add the extra pitch that it would have been possible to achieve within the onset-to-peak interval to the objective pitch. Peak delay is one of the strategies that speakers recruit in order to convey paralinguistic meanings deriving from what Gussenhoven calls the 'Effort Code', the tacit knowledge of the positive correlation between the size of the pitch excursion and the degree of effort required to achieve it. Although this correlation is at base physiological, speakers are nevertheless able to bring it under cognitive control and exploit it for communicative purposes. Once this occurs, the relation between pitch and the meaning it conveys, albeit still a scalar one, is to some extent conventionalized. Greater pitch excursion is universally interpreted on the affective level as indicating greater surprise, helpfulness or engagement; on the informational level, it signals greater urgency, and is frequently grammaticalized as a marker of focus. What we might call the 'exchange value' of pitch, that is, what degree

of pitch excursion is necessary to signal a given level of engagement, will vary to some extent from one community to the next. In some communities, the use of a relatively wide pitch range may be semantically neutral, no more than a general characteristic of the speech of that particular community. In other speech communities where the pitch range is generally narrower, the same wide pitch span would be interpreted as semantically marked. Peak delay is a cost-effective way to signal these meanings because it results in higher perceived pitch with smaller excursions and less effort. Another strategy for making peaks sound higher without raising the objective pitch is by introducing a relatively low on-glide; valleys may similarly be enhanced by relatively high on-glides. Given the social value of signaling meanings such as engagement and helpfulness, speakers may be expected to exaggerate the apparent degree of pitch excursion beyond community expectations. After a while these expressive strategies undergo a kind of semantic bleaching and become entrenched as the neutral idiom in much the same way as happens with expressive vocabulary in general (e.g. swearwords, politeness formulae, and so on).

The phonetic enhancements just described provide the raw material for phonological reanalysis in the next generation. Figure 4 sketches the evolution of the double-peaked accent as proposed by Bye (2010). Each box shows the prosodic and tonal representations of the Accent 2 word *himmel* 'sky' and the Accent 1 word *segel* 'sail' at consecutive stages of development. The curve provides a visual representation of the phonetic realization. The left-to-right arrows mark changes in phonetic realization (the curve), i.e. peak delay and the introduction of enhancing high and low on-glides. The arrows going southwest mark phonological reanalyses, realignment of tones and the introduction of new tones. The most conservative varieties simply have a H pitch accent followed by a low boundary tone (L%) marking the right edge of the intonational phrase, giving a falling pattern over all. Once delay of the H tone peak occurs, it may be further enhanced by introducing a low on-glide, which is reanalyzed as the insertion of a phonological low tone. In Figure 4, this is shown in the change of an original H pitch accent into a bitonal $\widehat{\text{LH}}$ complex. Since the low tone is a new target, it may become the object of enhancement itself, for example through the introduction of a relatively high on-glide. This is the phonetic origin of the double-peaked realization that is so characteristic of Central Scandinavia. The on-glide may also be phonologized as a high tone in a later generation, i.e. $\widehat{\text{HLH}}$. Because the peak is timed to occur late in Accent 2 and early in Accent 1, this new initial H tone will only be audible in Accent 2. Here we set aside the question whether this entails

a phonological difference or not.[6] This gives rise to tonal crowding and what is the linearly second high tone (a reflex of the original high tone) in the tritonal cluster is no longer accommodated within the stressed syllable. This creates an ambiguity for the learner: is the second high tone aligned to the stressed syllable (part of the pitch accent), or is it associated to the edge of the intonation phrase? These situations, where the learner lacks sufficient evidence to accept or reject a hypothesis about the structure of his language, create the conditions favorable for reanalysis to take place. In many dialects with the double-peaked realization, the second high tone has accordingly been reanalyzed as a H% boundary tone, giving rise to a cluster of boundary tones on the right edge. In the most progressive dialects, the original final L% boundary tone has been truncated. Finally, in the most advanced dialects, Accent 1 has also acquired a double peak with the introduction of a high on-glide.

[3.2] *The areal distribution of double peak*

If what was outlined in the previous section is the correct understanding of the evolution of the double-peaked realization of the accent, it should be possible to correlate each hypothesized innovation with a contiguous region on the map (Bàrtoli's areal norm (1-b)). The areas associated with later innovations should be nested within the areas associated with earlier ones deriving from the same centre of innovation (Bàrtoli's areal norm (1-c)).

Applying Bàrtoli's norms to double peak

Applying Bàrtoli's norms to the areal distributions of each innovation suggests that double-peaked realization is a Central Scandinavian innovation. By hypothesis, double-peaked accent arose in those varieties which had earlier shifted from early accent to delayed accent, which are shown on map (A) in Figure 5. This area properly includes the area in which double-peaked varieties are found, which is map (B).[7] A contiguous part of the double-peaked area, that includes eastern Norway and western Sweden, evinces truncation of the final low tone (C). Finally, in Trøndelag, the realization of Accent 1 is approaching that of Accent 2 by the addition of a high on-glide (D).

The double-peaked realization is thus largely found in one contiguous area (with a few exceptions explained below), whereas the single-peaked pronuncia-

[6] This issue commonly arises in discussions of truncation in the literature. Where the domain for the realization of some tonal contour is short, a tone at the edge of the domain may fail to be realized. It is not always a simple matter to decide whether to ascribe this effect to phonetic implementation or to a phonological deletion rule.

[7] The reader will notice that there is an outlier in the north of Norway which also has the double-peaked realization. Massive flooding in the southeast Norwegian inland in 1789 lead to the migration of large numbers of farming families in Østerdalen and Gudbrandsdalen, in southeastern Norway, to Bardu and Målselv.

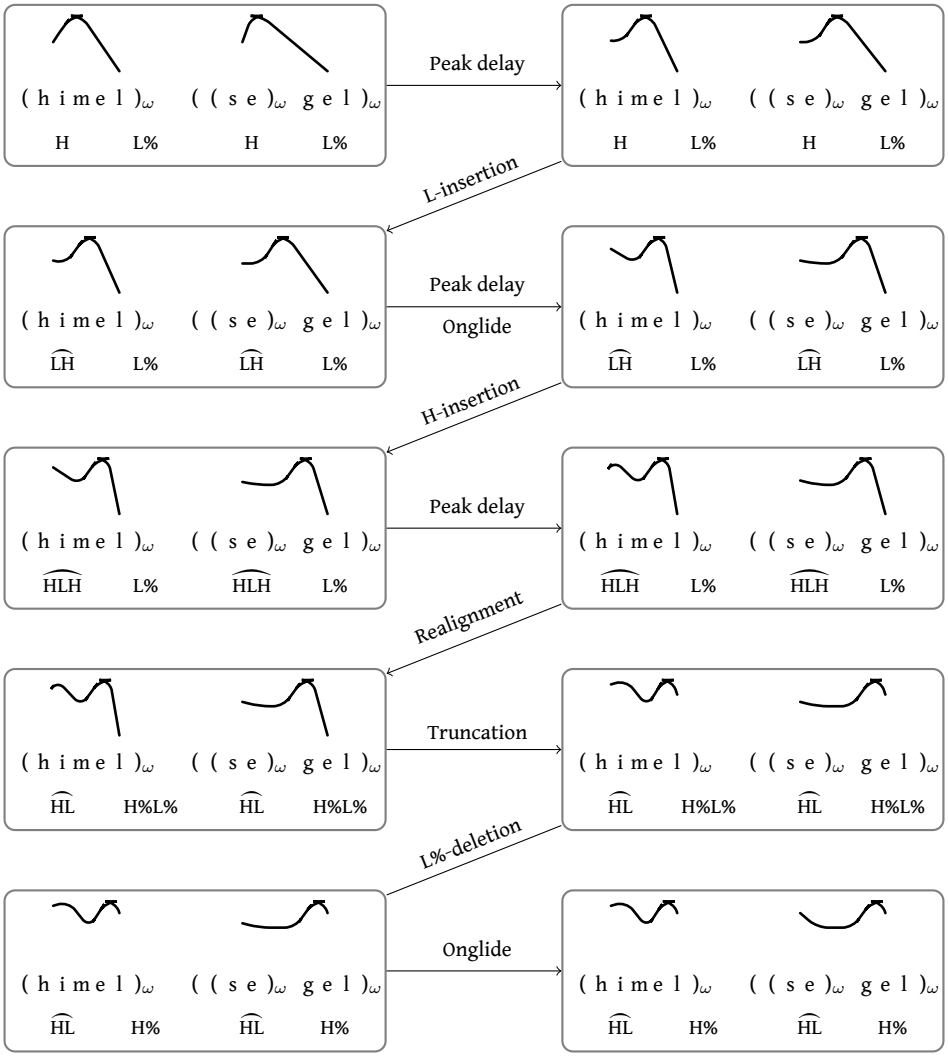
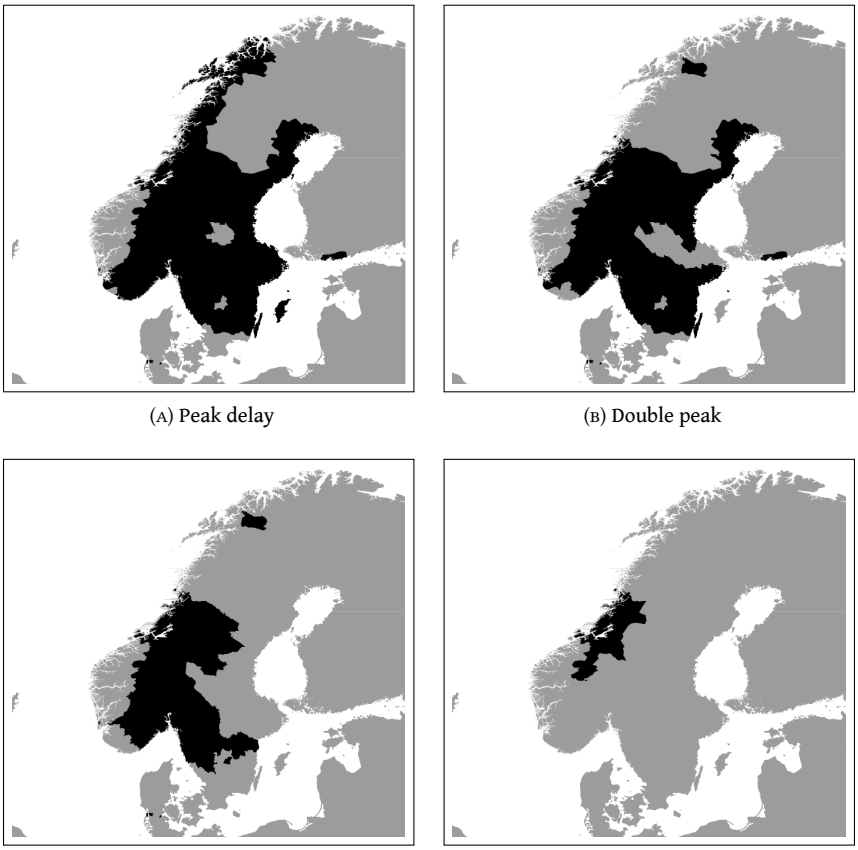


FIGURE 4: Evolution of double-peaked accent

tion is found in several separate areas. It is also found in isolated areas, such as Dalecarlia, peripheral areas such as Scania, West and North Norway, and its geographical extent is larger, reaching from Scania to Northern Norway. Given this, one can argue that it is unlikely that the single-peaked realization is the innovation, since it is unlikely that similar innovations start in separate areas. As an argument for the diachronic priority of single- over double-peaked Accent 2, it is far from watertight. For one thing, it is not unheard of for similar innovations



(A) Peak delay

(B) Double peak

(C) Truncation

(D) H on-glide in Accent 1

FIGURE 5: Central Scandinavian innovations in intonation

to arise in different places.[8] It is thus still possible that Riad's Hypothesis is correct. Indeed, Riad challenges the idea that the double-peaked realization could be the innovation on two additional grounds. First, it is possible to read the map a different way. There are several apparently outlying points on this map where double-peaked realizations of Accent 2 are found: Bardu and Målselv (northern

[8] One well-known case involves the phonemic split of Middle English /ʊ/ into /ʊ/ and /ʌ/. This occurred in two non-contiguous areas, Scotland and the Southeast of England. The split may nevertheless have been a single innovation that spread via social network connections between Glasgow, or Edinburgh, and London. The well-known glottal stop associated with vernacular forms of London English is another innovation that is reputed to have spread directly from Glasgow relatively recently (the earliest descriptions of Cockney lack glottal stop). See Andrésen (1968) and Fabricius (2000) for details.

Norway), Nyland (in Finland), and southern Denmark.[9] This may be interpreted to mean that it is the double-peaked realization that is the oldest. Second, Riad casts doubt on the notion that Central Scandinavia could have been a spreading zone, since it requires us to believe that the features were spread over putatively difficult terrain. This view is bound up with the fact that Riad places the development of accent very early — in the Proto-Nordic period, at a time when, he believes, "the land divides, the sea unites". We shall refute this view below.

Let us briefly comment on the apparent outliers. The inhabitants of Bardu and Målselv are largely the descendants of speakers of East Norwegian (which has a double-peaked realization of Accent 2) from Østerdal and Nordgudbrandsdal who migrated there in the 18th and 19th centuries. A number of varieties in southern Denmark are claimed to have double-peaked Accent 2. This claim requires much further investigation, however, since the available phonetic descriptions are sketchy and impressionistic. A historical connection between the double-peaked realizations of Accent 2 in southern Denmark and those in Central Scandinavia is in any event unlikely due to radical differences in the distributions of the accents in the two dialect groups. Kroman (1947) shows that, in South Funish, Accent 2 is restricted to disyllables whose root vowel was *short* in Common North Germanic. Disyllables whose root vowel was long have Accent 1. In Central Scandinavian on the other hand, all Common North Germanic disyllables evolved Accent 2. It is possible that the double-peaked realization of Accent 2 found in Nyland should be understood as part of a wider Central Scandinavian innovation. As we shall see below, shared innovations between East Swedish and Central Scandinavian lend some plausibility to this hypothesis. Other varieties of East Swedish (spoken in Finland and Estonia) have lost the lexical accent distinction, apparently quite recently as an effect of contact with Finnish (Ahlbäck 1971). Unfortunately, there is no data with regard to how the accents were realized in these varieties, so it is no longer possible to tell whether Nyland was part of a contiguous region of accentual innovation.

Double peak in geographical context

The relative age of features cannot be established on areal distributions alone. Where possible, they must be compared to those of known and datable innovations. This provides a fix on the time and place of origin of the putative innovation. Finally, this geographical picture must be related to the available ethnological, archaeological and historical evidence. This will be the topic of the final section.

Understood as an innovation, Single-peaked Accent fails to cluster with known

[9] Riad also mentions Stavanger as an outlier, but the maps of Fintoft & Mjaavatn (1980) show that there is a corridor from the inland to the west coast of varieties with a double-peaked realization of Accent 2. This realization is nonetheless new on the west coast. For details, see Hognestad (2006).

coastal innovations. The two most uncontroversial coastal innovations are the lenition of /p t k/ to [b̥ d̥ g̊] and the uvular realization of /r/. On the southern coast of Norway, for example, *mat* 'food' is pronounced [maːd̥] (standard: [mɑːt]). In Danish, [d̥] underwent further lenition to [ð̞]: [mɛð̞]. The uvular realization of /r/, which, as a broader European phenomenon, is found throughout much of the European continent as well. Its spread to the Danish capital in the late eighteenth century and, from there, to the southwest coast of Norway is a matter of historical record (Nielsen 1959).

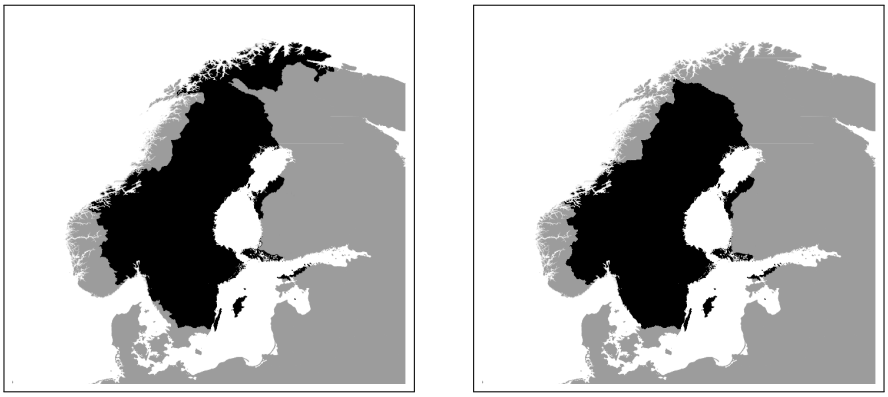
(A) Lenition (B) Uvular *r* (C) Single peak

FIGURE 6: Two coastal innovations and single peak compared

The single-peaked realization is indeed also found in most of Denmark, Skåne, and the southwest of Norway, roughly the same areas where we find lenition and uvular *r*. However, it is also found in a contiguous region of Central Sweden, and northern Norway and Sweden. If we abstract away from the accent distinction, there is no reason not to include Finnish and Estonian varieties of Swedish, Iceland and the Faeroes, or for that matter most of Europe and beyond. The geographic evidence for a connection between single-peaked accent and innovations known to centre on Skagerrak is therefore weak.

Let us now turn to the clustering of the accentual innovations described in the two preceding sections, including the emergence of the double-peaked realization itself, with Central Scandinavian distribution. Two syntactic innovations are of broad Central Scandinavian provenience, shown in Figure 7. The first is the use of the expletive *det* in presentation sentences of the type *Det er kommet en båt* 'a boat has arrived' rather than *der* 'there', as in its geographical competitor *Der er kommen en båt*. Another Central Scandinavian feature is the use of *ha* 'have' in resultatives, e.g. *Hun har kommet hjem* 'she has come home' rather than the verb to be, as in *Hun er kommen hjem*.

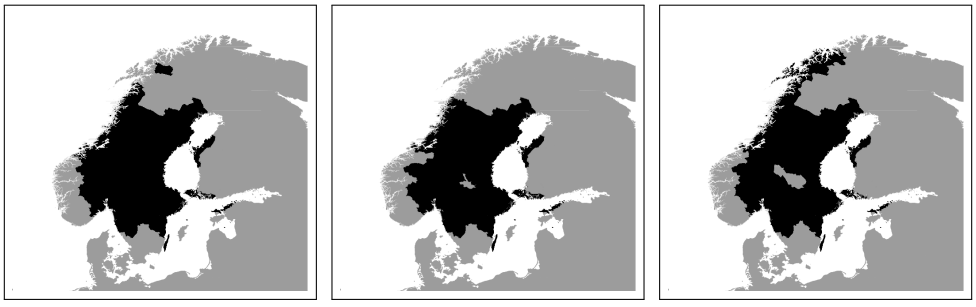
Now let us turn to phonological features. One striking feature of the phonemic inventories of most Central Scandinavian varieties of North Germanic is the presence of retroflex consonants. Old Norse *l* became a retroflex flap [ɽ] in some en-



(A) Expletive *det* (B) Resultative *ha*

FIGURE 7: Two syntactic innovations

vironments (Figure 8A). In a slightly smaller properly included area, Old Norse *rð* also became [ɽ] (Figure 8B). Another innovation was the development of retroflex consonants from clusters of /r/ followed by a coronal consonant /t d n l s/ (Figure 8C).

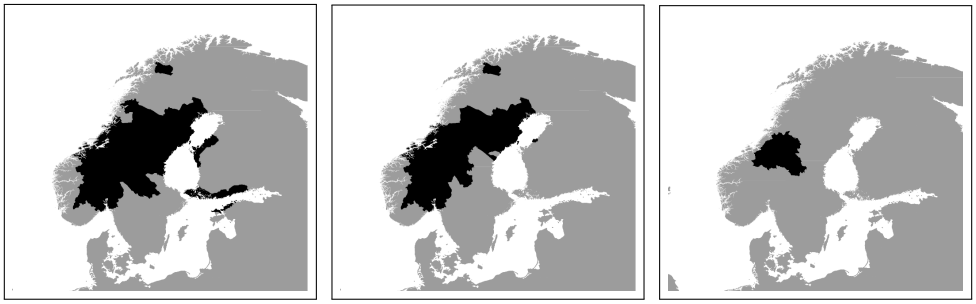


(A) Flap [ɽ] < *l* (B) Flap [ɽ] < *rð* (C) Retroflexion

FIGURE 8: Retroflexion and the retroflex flap [ɽ]

Another important set of phonological innovations concerned the vowel system shown in Figure 9. Vowel balance refers to allophony in the desinential vowel. After a heavy root syllable $\bar{\sigma}$, as in a word like Old Norse *bíta* 'bite', the quality of the desinential vowel was reduced, e.g. $\bar{\sigma}$.Ci > $\bar{\sigma}$.Ce, $\bar{\sigma}$.Ca > $\bar{\sigma}$.Cɐ, $\bar{\sigma}$.Cu > $\bar{\sigma}$.Co. Following a light root syllable $\breve{\sigma}$, however, as in Old Norse *vita* 'to know', the quality of the desinential vowel was preserved, e.g. $\breve{\sigma}$.Ci, $\breve{\sigma}$.Ca, $\breve{\sigma}$.Cu. The areal distribution of these innovations is shown in Figure 9A. Related to this development in many dialects is metaphony of the root vowel in words with a light root syllable (e.g.

Bye 2008). All dialects with this feature minimally harmonize a low root vowel with a following /ɔ/, e.g. tala > tɔʈɔ 'speak', and (vacuously) sofa > sɔvɔ 'sleep' (partial metaphony, Figure 9B). In a smaller area, metaphony has spread to all root vowels (full metaphony, Figure 9C); examples with desinential /ʉ/: ʋiku > ʋʉkʉ 'week', legu > lʉgʉ, hɔku > hʉkʉ, loku > lʉkʉ, furu > fʉrʉ 'pine'; examples with desinential /ɔ/: bita > bɔtɔ 'bite', skera > ʂɔrɔ 'cut', tala > tɔʈɔ 'speak', sofa > sɔvɔ 'sleep', bruna > brɔnɔ 'thaw'.



(A) Vowel balance (B) Partial metaphony (C) Full metaphony

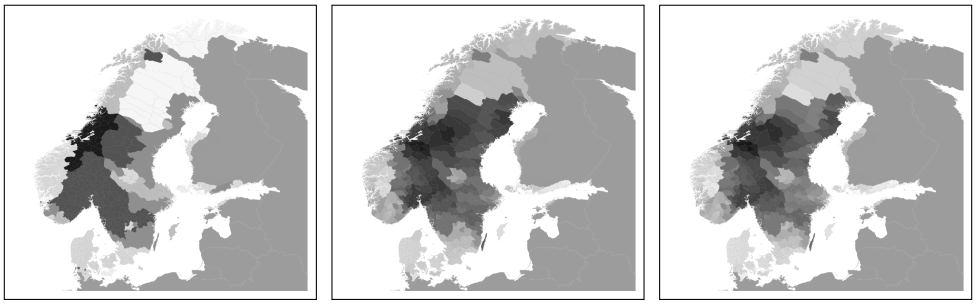
FIGURE 9: Vowel balance and metaphony

There is a good match between our hypothesized accentual innovations and other independently motivated, known and (reasonably) datable Central Scandinavian innovations. Putting all this together, it is possible to get a picture of where the geographical core of these innovations lies. In Figure 10, darker regions of the map are connected with more innovations, lighter regions with fewer. As we can see from 10A, it is Trøndelag that is the most innovative accentually, followed by southeastern Norway, and Jämtland and Götaland in Sweden. Considered against the non-accentual innovations (Figure 10B), Trøndelag is also the core. Figure 10C combines both accentual and non-accentual innovations into a single map. Southeastern Norway around Oslofjord and the Bothnian coast of Sweden are also dark. As can be seen, there is no evidence for the dictum that "the land divides, the sea unites".

Cultural, archaeological and historical context

It is fruitful to consider linguistic innovations in a broader archaeological and historical context.

Study of the maps of the previous section reveal that Trøndelag forms the hub of the Central Scandinavian 'province'. Full metaphony is associated with Trøndelag and Jämtland, and double-peaked realization of Accent 1 is associated with Trøndelag, Møre and Romsdal. Retroflexion and the flap also extends into Götaland in Sweden. It is therefore reasonable to suppose that Central Scandinavian



(A) Accentual innovations (B) Non accentual innovations (C) All innovations

FIGURE 10: Geographical core and periphery in Central Scandinavia

innovations in general can be traced back to the influence of Trøndelag. The primary axes along which these innovations spread can be ascertained by studying the maps for vowel balance (Figure 9A) and partial metaphony (Figure 9B). These maps suggest two primary axes of spread, one between Trøndelag and the Baltic coast of Central Sweden, and another between Trøndelag and Oslofjord. A secondary axis of spread may have existed between Oslofjord and Götaland. Below we shall review the archaeological and historical evidence for the importance of Trøndelag as a centre of influence and its connections with the rest of Scandinavia, and examine the nature of the contact.

It is clear that there has been a strong continuous connection between Trøndelag and the Baltic coast of Central Sweden, although the centre of influence on the Baltic coast has changed over the centuries. According to Elgvin (1961) there was an important trade route from the Møre and Trøndelag coast to the Baltic as early as the Stone Age. Archaeological evidence from the early Bronze Age (1–600 AD) also points to ancient and significant connections between Trøndelag and Middle Bothnia (Ångermanland and Medelpad) (Baudou 1986). Starting in the early Iron Age, however, Middle Bothnia was drawn into Mälardalen's sphere of influence. In the 7th and 8th centuries (the Merovingian period), there are a number of finds that attest to the presence Anglo-Saxon and Frankish influence in Trøndelag (e.g. the short sword known as the *scramasaxa*), but there are far stronger traces of influence from the Vendel culture of Uppland in Sweden (Marstrander 1956, 44) in the form of ornamented swords and spears, buckles with inlaid enamel, much of it associated with a new form of inhumed burials, generally boat graves. Taken in conjunction with what we know about the judicial organization of Trøndelag during this period and traditions about a connection found in the sagas, there is reason to believe there was a significant immigration from Svealand into Trøndelag in the Vendel era. In the Viking era, too, it is Trøndelag's *eastward* connections to the Baltic rather than its westward ties that really

stand out. The large number of Arabian coins (a third of the ca. 400 found in Norway) attest to lively trading connections between Trøndelag and Mälardalen, in particular Birka, with its connections eastwards to Russia and the Black Sea. In contrast, the volume of finds in Trøndelag from western Europe is small.[10]

A route between Trøndelag and Oslo has been known since the Bronze Age and has always been the most important route in Norway (Steen 1942, 240). It is doubtful that this route itself was used for trade to any great extent, however. Its main purpose was administrative and ecclesiastical. Both Nidaros (now Trondheim) and Oslo were trading hubs in their respective areas, though, and there were also more southerly connections eastwards from East Norway into Sweden (Elgvin 1961). Those living in the inland valleys had to make journeys to Oslofjord, and the western fjords to stock up on salt and fish (Christiansen 1946, 56f.). Erixon (1933, 254) characterizes trade across the Norwegian-Swedish border as "lively and significant" (p. 254). There was a large market at Frösön in Jämtland where Trøndelag and Svealand came together to trade (Steen 1942, 82). As Erixon makes clear, trade was very largely import into Sweden of goods from Norway. For western Sweden, the nearest markets were located in Norway. Fish was transported from markets in Trondheimsfjord to the border, where Jämtlanders received the goods. The import business gave rise to a new breed of middlemen known as *färdmän* in Jämtland, Ångermanland and Härjedalen. Jämtlanders were also central in the market at Levanger in Trondheimsfjord where they sold iron tools and imported fish and horses (Hallan 1966).[11]

Horses were also an important in trade. During the winter, farmers from Upper and West Dalecarlia would transport horses, barrels of herring and dried cod from Trondheim or Röros via Lake Femund, Särna and Idre to the parishes around lake Silja. Erixon adds that this contact even extended across the Gulf of Bothnia into Finland. From the early mediaeval period the Bothnian Gulf became important for connecting western Sweden and the coast of Finland (Baudou 1987). Another shared characteristic is ornamental saddlery, which is found in East Norway from (Vestfold to Trøndelag), Dalarna, Härjedalen, Jämtland, Medelpad, Ångermanland, parts of Västmanland and northern Bohuslän.

Now that we have established that important routes existed connecting the Trøndelag–Baltic and Trøndelag–Oslo axes, it is worthwhile to consider the nature of the contact between the players (Christiansen 1946, 56f.). Traders travelled in large convoys, with 20 to 30 loads being common. These journeys took many

[10] This excludes a number of objects brought back from raids in Ireland, in which vikings from Trøndelag played a significant part. What is important here is enduring trade relationships.

[11] Jämtland, Härjedalen and Idre & Särna were part of Denmark-Norway until 1645 when they were ceded to the Swedish Crown as part of the terms of the Treaty of Brömsebro. After this the Swedish authorities began to monitor and keep records of Jämtlander trade for customs purposes. Hallan's evidence relates to this period but he stresses that there is every reason to believe that the Jämtlanders played an important role in the relations between Trøndelag and Svealand a long time before records began.

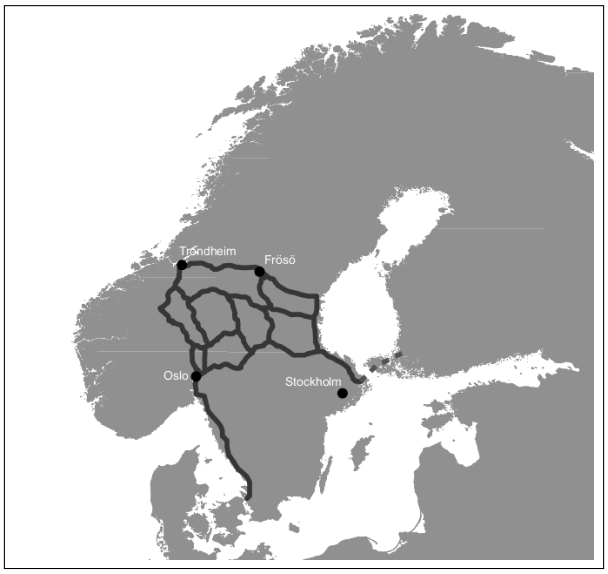


FIGURE 11: Central Scandinavian trade and pilgrimage routes

days. The journey from Gudbrandsdalen to Oslo, for example, took a fortnight with horse and packsaddle. Such journeys thus created conditions for forging lasting relationships with people outside one's local neighbourhood which would have encouraged accommodation of speech.

Also crucial for an understanding of the spreading of innovations are the routes of pilgrimage. These are shown in Figure 11 from information in Authén Blom (1961). The cult of Olav Haraldsson (St. Olav), who died at the Battle of Stiklestad in 1030 AD, was one of Europe's most important. After Rome itself, Olav's shrine in Kristkirken in Nidaros (now Trondheim) ranked in this respect alongside Santiago de Compostela and the shrine of Thomas à Beckett in Canterbury (Authén Blom 1961). Olav's Mass was celebrated every autumn. There were three main routes to Nidaros. The main route, which was used by pilgrims coming from the Continent (via Skåne and Konghelle) and from within Norway was the one through Oppland and Gudbrandsdalen described above. The route through Østerdalen was little used by Norwegians but was commonly used by Swedes (Steen 1942, 247). Interestingly, the cult of St. Olav was also widespread in Finland. Pilgrims from Finland would cross the Bothnian Gulf at Åland and proceed to Nidaros either following the more southerly route from Hälsingland to Härjedalen or the more northerly one over Jämtland and down into Verdalen. The latter, in addition to being the main arterial route between Sweden and Norway was also apparently especially popular with pilgrims because Olav Haraldsson himself took the same route on his return to Norway from exile in Novgorod. In sum, evidence from archaeol-

ogy and history testify to the existence of robust networks throughout Central Scandinavia over which linguistic and other innovations could diffuse.

[4] CONCLUSIONS

Historical linguistics and dialect geography have much to gain from the use of geographical information systems to represent areal distributions of innovations. In this paper I have tried to show this with two examples from Peninsular North Germanic. In the first example, we saw how applying results from linguistic theory could clarify the geographic picture. Mapping innovations reveal a spatio-temporal structure that simply cannot be seen from the taxonomic map, which merely represents features. The second example showed how studying the areal distribution of a feature, and comparing its distribution to known innovations, can be used to support or refute a reconstruction.

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