UK declarative rises and the frequency code

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1 Prosody and Universals of Language

One of the most fascinating things about prosody is something that I have referred to before (Hirst and Di Cristo, 1998b) as the *Prosody Paradox*. This is the fact that prosody is at the same time the most universal and the most language-specific (and even dialect-specific) characteristic of language.

Prosody is universal in the trivial sense that all languages possess prosody. Of course, all *utterances* have prosody because their *prosodic form* can always be characterised as a changing pattern of segmental duration, loudness and pitch. In a less trivial sense, all languages make use of *prosodic functions* to express a number of linguistic and paralinguistic functions such as chunking, highlighting, discourse and dialogue management as well as for the expression of speech acts and of speaker states like attitudes and emotions.

Prosody is language and dialect-specific in that the way in which these prosodic functions are mapped on to the prosodic forms differs from language to language and from dialect to dialect. Of course, if this was not the case, then every language and every dialect would have the same prosody.

Even the mapping between prosodic functions and prosodic forms does, however, seem to show some universal tendencies. Specifically, Bolinger (1964) pointed out that in a large majority of languages in the world there is an association between low pitch and declarative mode as opposed to high pitch associated with interrogative mode. The most common association is that of Yes-No questions with a final rising intonation pattern and of statements with a final falling intonation pattern. Bolinger (1979) reported that, of a sample of nearly 250 languages, about 70% were said to use rising final pitch to signal questions while the remaining languages used a higher over-all pitch for questions than for statements.

John Ohala (1983) suggested that the universal tendency for an association between pitch and mode might be explained by the existence of a universal biological code, which he called the *frequency code*, linking high pitch to small larynx size and hence in a progressively more abstract way, associating it with submissiveness, uncertainty and

questioning, whereas low pitch is linked to large larynx size and hence associated with dominance, finality and assertiveness.

There are, however, a number of exceptions to this near-universal. Gussenhoven (2002) called the type of intonation patterns which do not obey the generalisation "un-natural" patterns, by contrast to the "natural" association implied by the frequency code.

First of all, in quite a large number of languages, questions do not appear to have any regular association with rising final pitch. In the chapters in Hirst and Di Cristo (1998a), this is said to be the case for Danish (Grønnum, 1998), Finnish (Iivonen, 1998) and Western Arabic (Benkirane, 1998), in which Yes/No questions are only distinguished prosodically from statements (if at all) by a raising of the pitch of the whole utterance, and, in the case of Danish, by a suppression in questions of the lowering of pitch between the onsets of successive accents which is normally observed in statements..

Secondly, in a number of dialectal variants of different languages, rising final pitch can be systematically used without conveying any implication of non-finality. Chapters in Hirst and Di Cristo (1998b) mention Midland and Northern dialects of English of the British Isles (Hirst, 1998), the Extremadura dialect of Spanish (Alcoba and Murillo, 1998) and the Corfu dialect of Greek (Botinis, 1998).

Cruttenden (1994), in the light of such counter-examples, made the weaker claim that there are no cases of languages where rising pitch is associated with statements and falling pitch with questions. Even this claim (which I have myself repeated (Hirst and Di Cristo, 1998b)) is apparently not valid, though, since precisely such an association has since been described for the American Indian language Chickasaw (Gordon, 1999, 2005).

2 Declarative rises in Northern UK dialects

Cruttenden (*op. cit.)* describes two geographic areas where English is spoken with a much higher frequency of final rising pitch than is found either in the Received Pronunciation (RP) accent of British English, or in the General American accent of the USA. These are, on the one hand, the dialects of Urban Northern United Kingdom[1], and on the other hand the dialects of English in the region he calls the *Pacific Rim* (Australia, New Zealand, California and Canada).

Cruttenden suggests that in the case of the UK dialects, the difference in usage is *systemic*.

> A systemic difference would involve some of the universal semantic tendencies (…) not being applicable in one particular language or dialect.

[1]Cruttenden refers to Urban Northern *British* but Urban Northern *United Kingdom* is more accurate since it includes Northern Ireland.

Specifically, in these Northern UK dialects the use of final rising pitch does not seem to carry any association of non-finality.

In contrast, the higher frequency use of final rising pitch observed in the Pacific Rim region is attributed by Cruttenden to a *conceptual-stylistic* difference. In other words, in these dialects speakers are using a different cognitive style: the use of rising pitch continues to be associated with non-finality but the speakers choose to express non-finality more frequently than do speakers of the two standard dialects of English.

In the rest of this chapter I shall only be concerned with the rising patterns found on declarative utterances in the Northern UK, since it is these "unnatural" declarative rises which pose a particular problem for the frequency code hypothesis.

The use of rising pitch in the Northern UK without the associated implication of non-finality has long been known. One of the first systematic descriptions of this intonation pattern was in the description of Scouse by Gerry Knowles (1975). Knowles suggested that the pattern might be of Celtic origin, since the speakers of the Liverpool dialect which he studied (Scouse) were mostly of Irish origin. In the light of this, Knowles calls this use of rising pitch with declarative utterances

> *Irish Falls*, which, perversely, go up.

a name which aptly captures the systemic difference with the rising patterns of other dialects.

In a survey of the variety of intonation patterns in the British Isles, Cruttenden (1986) mentions this idea of a Celtic origin for these intonation patterns, a hypothesis which he approves as interesting, whereas in his later study, specifically devoted to rising intonation patterns in English (Cruttenden, 1994), he argues that the hypothesis cannot be valid. While it could account for most of the Northern UK cities it would not explain why the pattern is to be found in Tyneside (Pellowe and Jones, 1977). Cruttenden cites evidence that the Irish population in the region of Newcastle was almost inexistant before 1830 and that the Scots who did live there at that time originated mainly from the Eastern lowland regions where the declarative rising pattern is not observed. He gives documentary evidence, however, that the *Tyneside Tone* was well established before the nineteenth century. The *Irish Fall* hypothesis also fails to explain why the pattern is found in only some parts of the Celtic speaking areas of the British Isles (Northern Ireland, Western Scotland) but not in others (Republic of Ireland, Wales, Eastern Scotland). While rejecting the Celtic origin of this pattern, Cruttenden does not offer any alternative historical explanation for its geographical distribution.

I have suggested (Hirst, 1998) that the original distribution of these populations (before the shift from Western Scotland to Northern Ireland then to West Midland England) did have something in common: both Tyneside and Western Scotland were areas of intense raiding and settlement by Norwegian Vikings in the early 9th century, as can be seen in Figure 1[2].

[2]Figure downloaded from `http://downloads.bbc.co.uk/rmhttp/schools/primaryhistory/`

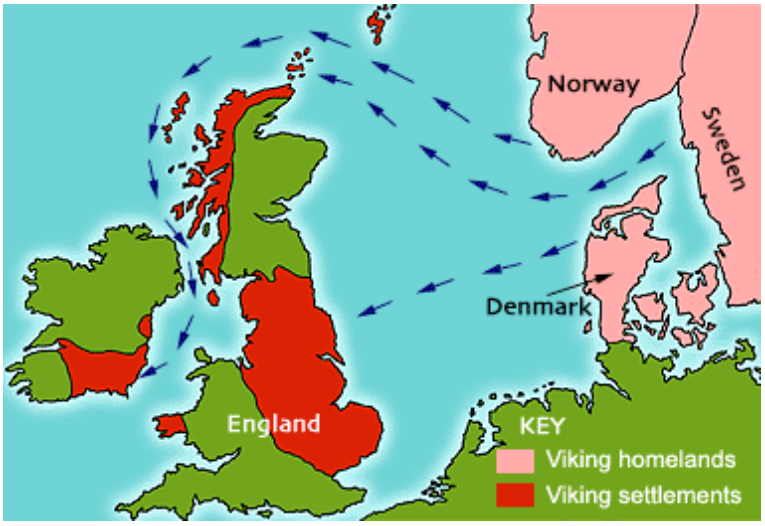


Figure 1: Map of Viking Homelands and Settlements in the UK.

Recent genetic evidence (Oppenheimer, 2006; Sykes, 2006) suggests, furthermore, that there have been strong connections between the populations of these areas of Northern UK and those of Scandinavia and that these connections largely antedate the first Viking raids when, on 8 June 793, Norsemen destroyed the abbey on the `Holy Island' of Lindisfarne in Northumbria.

The connection with Scandinavia is particularly interesting due to the fact that East Norwegian intonation has, in fact, also been described as having final rising pitch patterns in statements (Fretheim and Nilsen, 1989). This makes the hypothesis of a Nordic origin for these intonation patterns fairly attractive, so that perhaps we should call these declarative rising pitch patterns *Viking falls*, rather than Irish falls.

3 Why should Viking Falls go up?

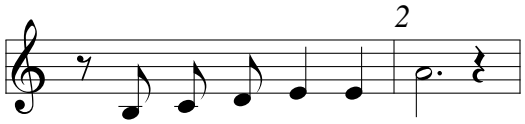
Whatever the origin of these declarative rises, there remains the essential problem of explaining why a rising intonation pattern should be used for statements which have no implication of uncertainty or questioning, instead of the apparently more natural falling pattern.

A possible analogy can be made with music. The finality of a musical phrase is often conveyed, at least partly, by a musical *cadence*. Musical cadences are, of course, typically falling, as implied by their name which derives from Latin *cadere* 'to fall'. In fact, however, a musical cadence does not necessarily fall. The essential characteristic of a cadence is the resolution of a tension caused by more dissonant chords being replaced

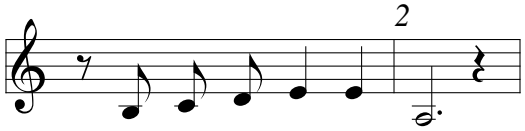
`images/vikings/who_were_the_vikings/vk_map_whowerethey.jpg`.

by the tonic chord. In European classical music, the authentic or perfect cadence usually consists of a progression from a dominant chord (V) to a tonic (I), e.g. from G to C, or from E to A for example. The tonic chord, however, may be *inverted* with the root of the chord being the highest note instead of being the lowest. The result of this is that a melody may finish with a rising pattern, despite the fact that it actually corresponds to a final cadence.

Thus, in a song such as a tango[3], the final cadence is often performed as a final rise, as in:



where the rising cadence is perceived as being every bit as conclusive as if the melody had been performed with a final fall, with the final note an octave below the actual final value.



One of the reasons for the perceptual equivalence between a normal and an inverted cadence is that a musical note is perceived as having the same identity as a note produced exactly one octave below or above it. Acoording to Braun and Chaloupka (2005):

> Two tones with fundamental frequencies (f0) at a ratio of 2/1 have a common perceptual effect. This is reflected by the octave-based circularity of tone names that occurs in all advanced music cultures. For example, tones with f0 of 110, 220, or 440 Hz are all called A. Only in technical descriptions an additional octave number is added, like A2, A3, or A4. The perceptual circularity is commonly called octave equivalence, but the underlying anatomy and physiology in the human brain is still unknown. [p85]

Thus in the preceding examples, the essential identity of the tune is given by the notes, which in both cases are B C D E E A, whether the final 'cadence' is rising or falling. See also Braun (2010) and De Looze and Hirst (2010).

A possibility, then, would be that in the case of the declarative rises we have been discussing, what counts is the final pitch of the 'boundary tone', rather than the octave at which it is actually produced.

This, however, would only explain why a rising pitch could still be interpreted as expressing finality, it does not give a reason why speakers of a particular dialect should actually choose to do make use of this possibility, despite what seems to be a flagrant

[3]Cf for example *En esta tarde gris* http://www.planet-tango.com/lyrics/tardegris.htm

transgression of the frequency code. Such a transgression of the frequency code seems even more surprising in a warrior society like that of the Vikings where the desire to give an impression of greater size was presumably of great importance.

A hint of a possible explanation may perhaps be found in another striking characteristic of speech from the Scandinavian area, that of creaky voice, or laryngealisation, found typically in the speech of many speakers of Swedish (Horne, 2009) and Finnish (Iivonen, 2004) and probably throughout Scandinavia in general[4].

Creaky voice, although it may occur at any pitch, is frequently associated with very low pitch, particularly at the end of a paratone. For some speakers, however, it can occur for a large part of their speech. It is tempting to see this as the result of a global lowering of the pitch range of the speaker's voice but this is, for the moment, pure speculation and the relevant comparisons of measurements of pitch range for speakers with and without creaky voice have yet to be made.

The relevance of creaky voice to the use of final rising pitch would come from the fact that a global lowering of pitch range might have the effect not only of increasing the likelihood creaky voice but also of making it virtually impossible to signal a prosodic boundary by a final lowering of pitch. If your mean pitch is already at the bottom of the range of your voice, then you cannot lower your voice any further. The only solution, then, is to produce a 'boundary tone' which is at the same *note* as a lowered pitch would be, but situated an octave above it. Creaky voice and octave shift, under this interpretation, might then be seen as two solutions to the same problem caused by a global lowering of pitch range or *key*.

Once again, this is still pure speculation, the relevant measurements of pitch range have yet to be made for speakers using declarative rises compared to others. Interestingly, however, the explanation I suggest here *does* provide a possible answer to the question I asked at the beginning of this paper, namely why some speakers should making an apparently 'unnatural' association between rising pitch and statements. If the octave shift of the boundary tone is the result of a global lowering of the overall pitch key, then this is the result of the speaker attempting to appear *larger* than he really is, in conformity, rather than in contradiction with, Ohala's frequency code.

Interestingly, this hypothesis would be a further argument in favour of interpreting the final boundary tone as a static, rather than as a dynamic pitch target (*i.e.* as a final fall or rise) as has been suggested by some authors (Xu and Wang, 2001; Prom-on et al., 2009).

In the final section of this paper I describe an informal experiment manipulating a recording by a Norwegian speaker, to test whether lowering the final pitch target by an octave produces a contour which sounds similar to a declarative pattern as used by

[4]In Danish (Grønnum and Basbøll, 2001), laryngealisation is used lexically to distinguish words containing *stød* and words without it. Words with stød in Danish correspond generally to those with Accent 1 in Swedish. It is tempting to speculate that the phonologisation of stød occurred at a time when the use of creaky voice was widespread thoughout this part of Scandinavia.

speakers of other dialects or languages.

4 An informal experiment

The experiment reported here is extremely simple and obviously is not intended to be a serious perceptual study of the effect of modifying a pitch accent via speech synthesis but simply to be a very straightforward graphic illustration of a technique which might, in future research, be put to more systematic application. For the experiment, I made use of a recording of one of the passages of the Eurom1 corpus for Norwegian (Chan et al., 1995). The sentence illustrated in Figure 2 is the declarative utterance "Jeg har et problem med vannfilteret mitt." As can be seen in this figure, the speaker produces this utterance with a rising final intonation pattern. In order to examine the effect of modifying simply the final target value of the intonation pattern, the f_0 pattern was modelled using the Momel algorithm (Hirst, 2007) implemented as a plugin for the Praat software (Boersma and Weenink, 1992-2011), which analyses the fundamental frequency pattern as an underlying smooth continuous curve connecting a sequence of 'target points'. In

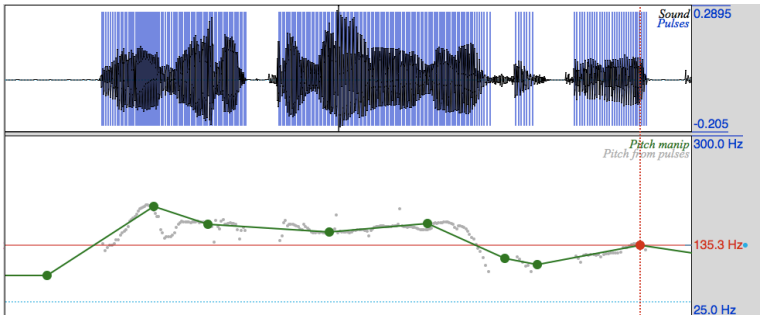


Figure 2: Norwegian sentence with modelled target points using Momel

Figure 2 the target points are shown connected by straight lines but in order to modifying the original speech the points are connected by smooth quadrating transitions (constituting what is technically called a quadratic spline function).

In line with the idea that this final rising pattern could be the result of an octave shift of a final pitch target, the final value of the last target point was simply divided by two making an octave shift down from the observed target value of 135.3 Hz down to a value of 87.7 Hz, giving the pattern which can be seen in Figure 3.

The remodelled curve was subsequently smoothed by quadratic interpolation, giving the output as can be seen in Figure 4, which was then used for the Praat *Manipulation* function which provides resynthesis of the utterance with the modelled f_0 using the overlap and add technique.

Although, as I mentioned before, this experiment is merely illustrative, the result strikes me as surprisingly convincing and does suggest that just applying an octave shift

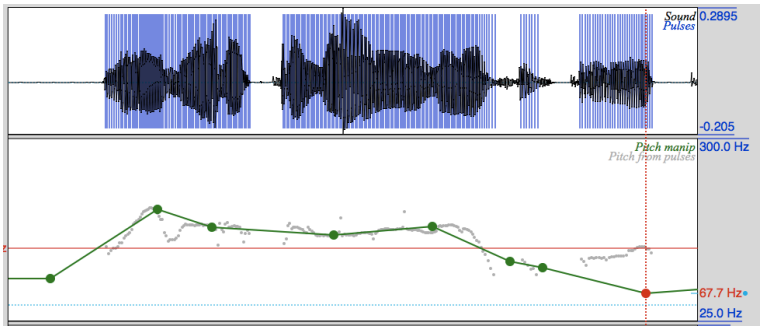


Figure 3: Norwegian sentence with modelled target points using Momel and final target lowered by one octave

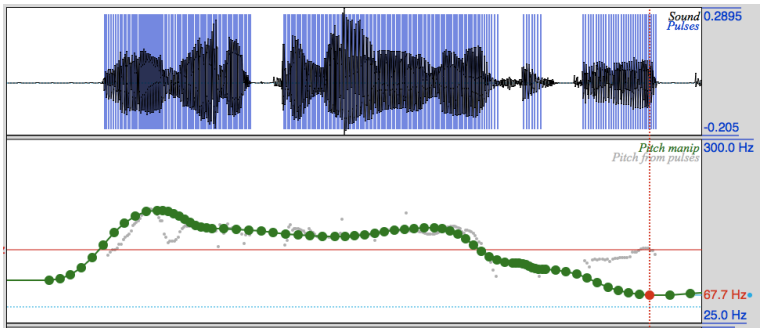


Figure 4: Norwegian sentence with smooth curved derived from target points as in Figure 3

to a single target point can produce an intonation contour which seems very similar to that observed in the majority of languages and dialects which produce declarative utterances with falling pitch.

5 Conclusions

In this exercise in historical phonetic-fiction I have made a number of rather strong claims any one of which I may easily expect the reader to have some difficulty accepting.

My first suggestion, that the UK declarative rises are of Viking origin, is an idea which originally occurred to me many years ago after a visit to the Newcastle area. I believe the idea does give a coherent explanation for an areal feature of prosodic phonology for which I have never seen any more convincing explanation.

The idea that an octave shift might act like an inverted cadence in music is obviously one which could suggest a number of far more sophisticated experiments than the simple illustration which I have given here. In particular it does seem likely that our ideas of

how pitch patterns are perceived requires more study in the light of recent work on the topic of the circularity of perception of pitch at different octaves.

The final idea is that the octave shift is actually a way of respecting the frequency code by lowering the overall frequency of the utterance, leaving little other means for marking a pitch boundary than by a final rise. This again is an idea which could suggest a number of practical experiments looking for example at possible differences in pitch distributions for speakers using declarative rises compared to those using the more widespread falling patterns.

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