

NINA GRØNNUM'S MODEL OF DANISH INTONATION FROM AN AUTOSEGMENTAL-METRICAL PERSPECTIVE

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МОДЕЛЪТ ЗА ДАТСКА ИНТОНАЦИЯ НА НИНА ГРЬОНУМ ОТ АВТОСЕГМЕНТНО-МЕТРИЧНА ГЛЕДНА ТОЧКА

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Abstract: The purpose of this article is to present an overview of Nina Grønnum's model of Danish intonation and discuss its central assumptions from the perspective of the autosegmental-metrical (AM) theory of intonational phonology. An attempt is made to outline key differences between Grønnum's model and AM models, as well as summarize the findings from recent empirical investigations of intonation in Danish spontaneous speech and discuss their implications for phonological modeling. Based on that, the article argues that AM theory is not incompatible with the data for Danish intonation (as has been previously claimed by Grønnum). Rather, it is hypothesized that an AM model for Danish would be able to provide a more accurate account of melodic variation in Danish spontaneous speech.

Keywords: Danish intonation, phonological modeling, autosegmental-metrical theory, accent, stress

Резюме: Целта на статията е да се представи накратко моделът за датска интонация на Нина Грьонум и да се разгледат основните му положения от гледна точка на автосегментно-метричната (AM) теория на интонационната фонология. Прави се опит да се очертаят основни разлики между модела на Грьонум и AM моделите, както и да се обобщят резултатите от по-скорошни емпирични изследвания на интонацията в спонтанната датска реч, като се обсъди и приложението им за фонологичното моделиране. Въз основа на това в статията се застъпва схващането, че AM теорията не е несъвместима с данните за датската интонация (както се твърди от Грьонум). Вместо това се аргументира хипотезата, че AM модел за датския език би могъл да предложи по-добро описание на мелодичната вариация в спонтанната датска реч.

Ключови думи: датска интонация, фонологично моделиране, автосегментно-метрична теория, акцент, ударение

0. INTRODUCTION

Nina Grønnum (b. 1945) is a pioneer in the experimental study of Danish intonation. She carried out the first acoustic analyses of distinct read Copenhagen speech starting in the mid-1970s. The results of her analyses and the implications for a model of Danish intonation are summarized in her doctoral dissertation (Grønnum 1992). The central assumptions of Grønnum's model are firmly reiterated in her latest work on the subject (Grønnum 2022).

The specifics of Grønnum's model will be presented in more detail shortly. In doing so, I will attempt to put the model's tenets against those of AM (autosegmental-metrical) theory, one of the most influential approaches within contemporary prosodic theory and practice. The AM theory of intonational phonology has been applied to a number of typologically and prosodically varied languages and “has facilitated the discovery of important empirical insights about the cross-linguistic nature of intonation” (Dilley and Breen 2022, 182). The central assumptions of the theory stem largely from Pierrehumbert's (1980) thesis, which was crucial for distinguishing the phonological and the phonetic level within intonation and the relation between the two. An account of the history and development of AM theory is given in Ladd ([1996] 2008), who coined the term *autosegmental-metrical*. It “reflects the connection between (...) an autosegmental tier representing intonation's melodic part, and metrical structure representing prominence and phrasing” (Arvaniti 2022, 25). The main innovation and strength of the AM approach lies namely in that it “makes a principled distinction between the phonology of intonation and its phonetic realization” (ibid, 25). In other words, the proponents of AM theory support the notion that intonation is indeed *phonological* – a notion which is far from universally accepted and is therefore not reflected in all intonational models, cf. Ladd (2008, 9–12), Barnes & Shattuck-Hufnagel (2022, 3–9). As we shall see later (3.1.), whether they see a place for a phonological level in their analysis of melodic variation, appears to be a fundamental point of disagreement between Grønnum's model and AM models of intonation.

The article is structured as follows: **Section 1** offers a summary of the key elements in Grønnum's model. **Section 2** outlines the distinction between hierarchical vs. linear models of intonation, which is essential in the comparison between Grønnum's model and AM theory. In **Section 3**, I attempt to contrast Grønnum's model with AM theory by using the set of questions devised by Barnes and Shattuck-Hufnagel (2022) to elicit a more explicit account of the goals and central assumptions of any prosodic model. In **Section 4**, I present the existing attempts at modeling Danish intonation within the AM tradition and Grønnum's response to some of them, as well as a public correspondence between herself and Robert D. Ladd regarding his treatment of her model in his 1996 book. **Section 5** is an overview of some recent empirical findings

about Danish intonation and their implications for prosodic modeling. Finally, in **Section 6**, the main points of the article are summarized, and conclusions are drawn.

1. GRØNNUM'S MODEL OF DANISH INTONATION – SUPERPOSITION AND SUBORDINATION

Grønnum bases her model on a series of empirical investigations carried out by her from the mid-1970s, focusing on distinct, formal, read Copenhagen Danish speech. There are **two base components** in her model – *the prosodic stress group* (initiated by the onset of any (primarily) stressed vowel and extending over all succeeding unstressed syllables, with an associated F0 pattern), and the global *intonation contour*, which is characterized by varying degrees of declination depending on the utterance's function. The two components in Grønnum's model are hierarchically organized – the F0 stress group patterns are superposed on and subordinate to the intonation contour.

1.1. Stress groups

The F0 pattern associated with each prosodic stress group consists of a rise from the (low) stressed syllable to the first posttonic, followed by a fall whose extent is dependent on the number of posttonics after the first one (i.e. the fall is absent if there is only one posttonic) (Grønnum 2022, 89). The full pattern can only be realized if there are enough syllables to carry it; if there are no posttonics in the stress group, the pattern is truncated (rather than compressed) and there is no rise in F0 (Grønnum 1998, 135; 2022, 98, 105). The pattern is also sensitive to location; rises and falls are more extensive early in the utterance than later, and slightly more extensive on less declining contours (Grønnum 2022, 89).

In contrast to other Scandinavian language varieties such as Standard Central Swedish or (optionally) Bornholm Danish (cf. Grønnum 1990b, 188–189, 209), Copenhagen Danish lacks a default sentence accent, meaning that no one stressed syllable is more prominent than any other in utterances with neutral intonation (Grønnum 2022, 89–90). With emphasis for contrast, the prominent word may exhibit a somewhat increased F0 on the stressed syllable and a higher rise to the posttonic, but this is not obligatory; the relative prominence of the focused group is also (and sometimes – only) achieved by the reduction or deletion of F0 patterns in both preceding and succeeding stress groups, which are subject to deaccentuation (Grønnum 1998, 141; 2022, 91).

If the effects of focus or emphasis are disregarded, Grønnum writes, “we are left with F0 patterns in prosodic stress groups, whose manifestation is entirely predictable from the wider

context” (Grønnum 2022, 98). This is why she repeatedly states that, in Danish, “stress group patterns have no autonomous status other than as the manifestation of stress” (Grønnum 2022, 98) – a claim whose theoretical implications will be discussed in more detail further down (3.1.).

There is a great deal of variation across different regional variants of Standard Danish both in the shape of the F0 pattern, its range, and its alignment with the segments (cf. Grønnum 1990a; 1990b; 1998, 147–151; 2022, 104–105), and this melodic variation is “probably what contributes most to a Danish speaker/listener’s immediate recognition and localization of regional variants” (Grønnum 1998, 147). However, in all of these regional variants the manifestation of F0 patterns appears to be likewise predictable, which is why it is Grønnum’s belief that “with proper scaling, the model will cover the majority of regional variants of Standard Danish as well”. This claim is called into question by recent empirical investigations in Jutlandic Danish (see 5.4.).

1.2. Utterance intonation contours

The stressed syllables in an utterance carry the intonation contour. The stress group patterns demarcated by the stressed syllables are “superposed on and subordinate to” the intonation contour, rises being slightly higher earlier in the utterance and on less declining contours (Grønnum 2022, 98). Utterance contours are characterized by varying degrees of declination: on one end of the scale, we have terminal declarative utterances which exhibit the most steeply declining (and least pragmatically marked) contours, and on the other end lie interrogatives whose non-declarative function is not marked lexically or syntactically; they are associated with level contours. Between those two extremes we find interrogatives whose function is marked by word order inversion and/or an interrogative particle, and non-terminal clauses. Within this intermediate category a trade-off between lexical/syntactic markers and intonation contour slope can be observed: the more strongly marked the non-declarative function of the utterance, the more steeply declining its contour. Thus, *wh*-questions are accompanied by more steeply declining contours, whereas questions only marked by word order inversion (including so-called “echo questions”) are the least declining (Grønnum 2005, 348; 2022, 99). These facts lead Grønnum to the conclusion that, in Copenhagen Danish (and most regional Danish variants), “intonation cues to modality are global, not local” – according to her analyses, there is no specific F0 movement at the end of the utterance to signal its function (Grønnum 2022, 100). Rather, utterance modality is signaled by the overall, global course of the intonation contour and its degree of declination. This is part of the argumentation used by Grønnum to refute the relevance of a linear, locally determined AM model for Danish, and this brings us to

a general point of disagreement between the two models: the question of hierarchy vs. linearity when it comes to phonological representation.

2. HIERARCHY VS. LINEARITY

An overarching difference between Grønnum's model and AM theory can be summarized by a distinction Ladd (1983) proposed between *Contour Interaction* and *Tone Sequence* types of approaches to intonational modeling. Contour Interaction (CI) models assume that the intonational contour of an utterance consists of local 'bumps' that are superimposed or overlaid on global shapes or slopes (therefore, they are also referred to as *superpositional* or *overlay* models of F0, cf. Ladd 2008, 23). The components which generate these pitch configurations are hierarchically structured, interact with each other and operate within prosodic domains of various sizes (Ladd 1983, 40). The Contour Interaction approach is well exemplified by Grønnum's model of Danish.

In contrast, Tone Sequence (TS) or linear models assume "no layer or component of intonation separate from accent: intonation consists of (...) a sequence of tonal elements" (Ladd 1983, 40). AM models belong to the Tone Sequence type, as they describe intonation in terms of a linear string of discrete intonational events (pitch accents and edge tones) whose manifestation is exclusively locally determined and implemented on a left-to-right basis. Global trends in pitch contours are seen as the result of the iterative application of local downstep rules (Ladd 2008, 44).

Grønnum's (1995, 130; 2022, 106) reiterated claim is that a linear AM account of Danish intonation "in terms of (varying degrees of) local downstep or range reduction, triggered by certain pitch accent configurations", would be "perhaps a formal possibility but empty of the significance it carries in tone languages". Such accounts of Danish have already been proposed by Pierrehumbert (1980) and Gussenhoven (2004) but were met with objections by Grønnum (see 4. in this article). In the next section I will try to illustrate the differences between the two approaches to intonational modeling (and thereby, the reasons for Grønnum's reservations towards an AM model of Danish) by contrasting their "answers" to the set of six questions which Jonathan Barnes and Stefanie Shattuck-Hufnagel (2022) put forward to help explicate the central commitments of a prosodic model.

3. BARNES & SHATTUCK-HUFNAGEL'S 6 QUESTIONS

The questions by Barnes and Shattuck-Hufnagel (2022, 1–2) aim to establish the prosodic model's relation to: 1) phonology, 2) meaning, 3) phonetics, 4) typology, 5) psychological status, and 6) transcription.

3.1. Phonology

Barnes and Shattuck-Hufnagel (2022, 3) cite Ladd ([1996] 2008) on the fundamental division between models of intonation which are phonological in nature, and models which are not. The former posit a small set of abstract sound categories that serve as a bridge between meaning and the acoustic signal, where the link between a given sound category and the meaning(s) it expresses is arbitrary – much like a phoneme inventory in segmental phonology. Non-phonological models, on the other hand, posit no such inventory (or may simply remain agnostic as to its nature). Instead, they map meanings and functions directly on to the acoustic signal.

In her chapter on Danish in the volume edited by Barnes and Shattuck-Hufnagel, Grønnum writes:

“Over the last couple of decades, it has become customary to call a representation that (...) mediates between a less and a more concrete stage in the production of intonation *phonological*. (...) However, if you want to avoid the obvious – but obviously false – analogy to segmental phonology and its sequentially ordered and minimally contrastive units, then *symbolic* representation is perhaps a better concept.” (Grønnum 2022, 87)

As I understand, Grønnum tacitly classifies her model as a non-phonological (in the sense of the distinction outlined above) one; indeed, she does not see a place for a strictly “phonological level” in intonation at all. In an earlier work, Grønnum (1995, 125) elaborates on her reservations towards this term and states that she does not “think it feasible or expedient to phonologize differences in F0 or pitch contours which are merely the acoustic or perceptual correlates of a contrast in another linguistic dimension, namely stress.”

This statement is central for understanding Grønnum’s views on intonation. It is reiterated several times in her 2022 chapter, e.g. here: “...the stress group patterns have no autonomous status other than as the manifestation of stress” (Grønnum 2022, 98). It appears that for Grønnum, the F0 patterns associated with stressed syllables are only perceptually salient as the phonetic manifestation of stress. Grønnum denies accent an autonomous phonological and perceptual status in Danish; rather, she appears to conflate accent and stress entirely – in a manner that is antithetical to AM theory. When laying out the fundamental concepts of AM intonational phonology, Ladd ([1996] 2008, 44) formulates four basic tenets, one of which being the principled distinction between pitch accent and stress. Pitch accents are “phonological elements of the pitch contour that accompany *certain* stressed syllables” (ibid, 48; emphasis mine – M.B.), meaning that not all stressed syllables are also automatically accented. AM theory posits that utterances have both *a stress pattern* and *an intonation pattern*. The stress pattern “reflects a set of abstract prominence relations” and “is manifested in a variety of phonetic cues” (ibid, 54) which include F0, duration, vowel quality, and intensity, “with F0 generally the most important” (ibid, 50). In addition, there is an intonation pattern composed of

a string of pitch accents and edge tones, where the pitch accents are “lined up with the text on the basis of the prominence relations” (Pierrehumbert 1980, 102). Therefore, pitch accents serve as a cue to the location of prominence and often co-occur with prominent stressed syllables; but languages such as English or Dutch, where stressed syllables can be unaccented, show that “there is a phonetic phenomenon of stress that can usefully be distinguished from pitch accent” (Ladd 2008, 61).

With the above discussion in mind, and considering the observations which Grønnum (2022, 104) herself cites about syllables with reduced stress retaining all characteristics¹ of stressed syllables *with the exception of an autonomous pitch pattern*, it appears to me that accent and stress are indeed separate phonological and phonetic phenomena also in Danish.

Grønnum (1998) has previously touched upon the peculiar behavior of stressed syllables surrounding emphasis for contrast, stating that it “could have provoked a discussion of accented versus nonaccented”, as such syllables suffer a reduction or deletion of their F0 pattern; but she is unsure whether “this reduction is not also a true de-stressing” (Grønnum 1998, 139–140). It is interesting to see that in earlier works, Grønnum was more open to the idea that accent and stress could be two separate phenomena but has since rejected it (with insufficiently clear motivation). By examining spoken Danish data in the course of my doctoral work, I hope to be able to clarify whether unaccented stressed syllables actually exist in Danish, which, if true, would present more convincing arguments in support of the hypothesis that pitch and stress are separate phenomena in Danish as well.

Last but not least, Grønnum objects to the appropriateness of the term “pitch accent” for Danish, as “(i) there would be only one category, and it would always align in the same fashion with the segmental material; and (ii) its phonetic manifestation is predictable” (Grønnum 2022, 104). One could say that in this case, the contrast is between accent and lack thereof. For Pierrehumbert and Gussenhoven, there appears to be no problem with positing an inventory of just one pitch accent for Danish, although they disagree as to how this pitch accent should be analyzed and transcribed (see 4.).

3.2. Meaning

The next question Barnes and Shattuck-Hufnagel (2022, 1–2, 8–9) pose has to do with how a prosodic model relates to meaning: whether meaning is derived holistically or compositionally, and where, if anywhere, does the notion of the morpheme (or minimal meaning-bearing

¹ Full vowel quality, vowel length, distinct articulation (i.e. absence of reduction or lenition processes otherwise prevalent in Danish), stød (Grønnum 2022, 104).

element) reside in the model. Grønnum's answer here is rather clear: in her analysis, the prosodic stress group patterns are prominence-lending, but have no meaning in and of themselves. Therefore, she deems the intonation contour the only candidate for a direct link to meaning (Grønnum 2022, 107), but only in an intricate interplay with the larger context. She points to the correlation between intonation contour slope and sentence type outlined in 1.2. in this article, where utterance modality is signaled by the global course of the intonation contour and its degree of declination. I take this to mean that in Grønnum's model, meaning is derived holistically, by taking both the global course of F0 and the larger context into account. The unit which comes closest to fulfilling the role of a “meaning-bearing element”, is the global intonation contour; but the representation is “symbolic” (Barnes, Shattuck-Hufnagel 2022, 9) in the sense that intonation contours themselves do not bear any meaning.

In contrast, within AM tradition, meaning is derived compositionally, as the individual tones in the tonal string are associated each with their own elements of meaning, much like morphemes. Then, utterance meaning is built up compositionally from the combination of those elements, in a similar fashion to sentence meanings (Barnes and Shattuck-Hufnagel 2022, 8). On this matter, Grønnum and proponents of AM hold diametrically opposing views.

3.3. Phonetics

The third question posed by Barnes and Shattuck-Hufnagel (2022, 2, 9–14) deals with the model's relation to phonetic implementation – whether the model has “an explicit theory of phonetic implementation which could possibly serve as the basis for speech synthesis” (*ibid*, 2). Here one could say that Grønnum's model is predominantly aimed at phonetic implementation, considering that she rejects the phonological status and analysis of F0 patterns altogether. In contrast, AM models are first and foremost concerned with working out the phonological structure of intonation contours (i.e. the underlying tones which they consist of), but they also aim to account for phonetic variation by focusing on various issues of tonal alignment and scaling.

3.4. Typology

The next point of interest is the extent to which a model makes typological predictions about the kinds of prosodic systems which should or should not exist in the languages of the world.

Grønnum (2022) does not explicitly address this question, perhaps since her model pertains to (Copenhagen) Danish only. She does predict that “the model will cover the majority of regional variants of Standard Danish as well” (Grønnum 2022, 104), and elsewhere she has

stated that also certain Swedish and German varieties exhibit “interaction between events at different levels” and “subordination of lower to higher level structures”, although to varying degrees (Grønnum 1990b, 212), i.e. that the principles of superposition and subordination upon which her model is founded, can also be extended to these neighboring language varieties. And even though certain regional variants of Danish, such as Sønderborg and Bornholm, “have a specific, final boundary tone that does not interact with what precedes it” (Grønnum 2022, 106), she claims that these local features are not precluded by the global, hierarchical character of her model and can in fact be incorporated in it.

In the conclusion of an earlier article summarizing the results of her analyses of regional variants of Danish and comparing them with German and Stockholm Swedish (Grønnum 1990a), Grønnum ponders whether all of these different prosodic systems could be equally well handled within one and the same descriptive frame of reference and concludes that, rather, “some [are] better suited for one theoretical framework and others for another” (Grønnum 1990a, 143–144). This appears to convey a rather relativist view of prosodic theory, Danish and its regional (and neighboring) variants evidently being “the odd man out” (Grønnum 1998b, 112). In contrast, AM theory appeals for the study of intonational universals – it assumes that every intonational language can be analyzed in terms of a linear string of pitch accents and edge tones.

3.5. Psychological reality

The fifth question Barnes and Shattuck-Hufnagel pose concerns the model’s psychological status: whether the model aspires to have a level of psychological reality and reflect speaker-hearer cognition. Here it appears that both Grønnum’s model and AM models incorporate psychological reality as a goal, but Grønnum hypothesizes that her holistically conceived model is cognitively simpler and therefore has a higher degree of psychological reality for Danish speakers than a model of Danish in terms of local events. She claims that linguistically naïve Danes do not conceive the local humps in an utterance contour as part of its melody, but rather disregard them in favor of the overall shapes (Grønnum 2022, 110). Grønnum’s hypothesis has, to my knowledge, not been tested empirically, and, as she herself notes, it is “worth testing”. In particular, it would be illuminating to establish whether “local humps” in the pitch contour in reality have so little perceptual significance as Grønnum ascribes to them – if they, conversely, prove to be distinctive, this could be an argument in support of the adequacy of an AM model for Danish.

3.6. Transcription

The last question posed by Barnes and Shattuck-Hufnagel (2022, 2, 16–19) concerns the model’s relation to systems of prosodic transcription – whether the model could be used as a tool for prosodic transcription, or at least, what its implications for a system of prosodic transcription are.

As Grønnum (2022, 108–110) points out, the basic tenets of her model “have served well as anchor points in the transcription of spontaneous Danish speech in the DanPASS corpus”. The *Danish phonetically annotated spontaneous speech corpus* (DanPASS) (Grønnum 2009) consists of non-scripted monologues and dialogues, the former focusing on describing images and giving directions, and the latter being replicas of the HCRC map tasks – so one could say they are in reality only *half*-scripted and contain examples of *semi*-spontaneous speech. The perceived pitch level of each stressed syllable is annotated to three degrees: high (h), mid (m), and low (l), and gradual decline over several syllables is marked with arrows. These distinct levels can potentially bear resemblance to the H and L tonal targets used in ToBI transcription; however, Grønnum explicitly stresses that

“any similarity with the tones and break indices (ToBI) convention (...) is merely superficial. For the description of Danish intonation, the phonological assumptions behind ToBI are inappropriate, and as a phonetic transcription system, it is not sufficiently fine grained.” (Grønnum 2022, 110)

Once again, Grønnum rejects the appropriateness of AM theory, upon which ToBI systems of transcription are based, for Danish. The ToBI (Tones and Break Indices) convention was originally developed for the transcription of American English (see Silverman et al. 1992) but has since been used as a starting point for the development of similar systems for various other languages (Arvaniti 2022, 50–51). What distinguishes ToBI from other systems for transcribing intonation such as INTSINT or the one used in Grønnum’s corpus, is the fact that ToBI is a tool for *phonological* transcription, as Grønnum rightfully notes. It is founded on the principles of AM intonational phonology, and therefore reflects the distinction between an underlying tonal representation and its phonetic realization. It aims to transcribe the *phonological properties* of intonation by using tonal labels (H and L tones), which represent underlying tonal targets assumed to be “both meaningful to native speakers and systematic and consistent across native speakers of the language variety” (Jun 2022, 151). One of the main strengths of ToBI is that while each ToBI system is language-specific, they are all founded on the same theoretical and analytical principles, which in turn facilitates the study of intonational universals and prosodic typology (Jun 2022, 163). Developing a ToBI model for Danish would therefore not only contribute to typological insight, but also allow for a more straightforward contrastive analysis

with various other languages which have already been modeled (and transcribed) within this framework.

4. EXISTING (PARTIAL) AM MODELS OF DANISH

4.1. Pierrehumbert (1980)

Danish has not been overlooked by the AM community. In fact, we find that already Pierrehumbert (1980, 208–213) in her highly influential dissertation discusses Grønnum’s data for Danish and what she terms “the layered theory of intonation”. After having presented Grønnum’s view, Pierrehumbert proposes an alternative analysis of the Danish data in terms of pitch accents, edge tones and downstep – with only one type of pitch accent (L^*+H-) and a low $L\%$ boundary tone in questions and declarative sentences alike (which is less evident if there are one or no unstressed syllables after the last stressed one). Contrastive emphasis results in an increased $H-$ value on the emphasized stress group, while nearby H -s are lowered, but not deleted.

To account for the observed contrast in declination in declaratives vs. non-declaratives, Pierrehumbert (1980, 211–213) proposes *a downstep rule* for Danish which is operative in declaratives, but suspended in questions; in addition, “there are degrees of downstep which correspond to the degree to which the utterance is non-final”. To account for this variation, Pierrehumbert introduces a downstep coefficient k “to vary between its minimum value and l as a reflex of the relevant semantic continuum” (*ibid*, 212).

Grønnum offers her commentary on Pierrehumbert’s analysis in two consecutive articles (Thorsen 1983a, 210–216, Thorsen 1983b, 32–38) and ultimately deems it inappropriate for the Danish data.

4.2. Gussenhoven (2004)

In his chapter on the Scandinavian languages, Carlos Gussenhoven (2004, 223 – 226) offers a speculative account of the origin of Danish *stød* (as a reinterpretation of an earlier lexical tone distinction), as well as a reanalysis of Pierrehumbert’s autosegmental interpretation of Danish as having a L^*H pitch accent. Instead, he proposes an H^*L accent, “whereby the H^* is aligned late, and downstepped, and L is right-aligned” (Gussenhoven 2004, 225). When it comes to declination, he observes: “As for interrogative intonation, Standard Danish suspends or attenuates declination, leaving the phonological representation intact” (Gussenhoven 2004, 226). Gussenhoven also points out that the Scandinavian languages have considerably simpler

intonation systems than West Germanic languages (i.e. Danish only having one intonation contour/pitch accent) and hypothesizes that the fact that these languages have (had) *lexical* pitch accents could contribute to their limited inventory of intonational pitch accents.

To my knowledge, Grønnum has not responded (publicly) to Gussenhoven's analysis.

4.3. Correspondence with Ladd (1998)

One treatment of Danish intonation which Grønnum has taken an explicit, public stand on, is that contained in the first edition of Ladd's ([1996] 2008) now well-known book. She does so in an open Letter to the Editor of *Journal of Phonetics* (Grønnum 1998b). In it, she claims that “Ladd's treatment of Danish intonation is apt to give the reader a biased and rather impoverished idea of the relative merits of the superpositional model as it applies to Danish” (Grønnum 1998b, 109) and proceeds to lay out the reasons for her objections: firstly, it appears that Ladd has incorrectly interpreted her depictions of global intonation slopes of varying declination as categorical, i.e. as “an inventory of three invariant intonation slopes”, when they are in fact a gradient, non-categorical “fan of slopes between two extremes”. Further, Grønnum stresses that she has taken a clear stand in the “superposition vs. linearity” debate, and states once again that “a linear tonal sequence representation, a representation ‘only in terms of local phonological events’, of Danish intonation is descriptively inadequate” and that “‘pitch accent’ is not an appropriate concept for (...) the F0 pattern associated with the prosodic stress group in Danish” (Grønnum 1998b, 111). She objects to Ladd's treatment of global slope variation as pitch range reduction modeled with downstep – she claims that “global slope in Danish is indeed linguistic, and of course it must be included in the model — though it cannot adequately be modeled as ‘downstep’” (Grønnum 1998b, 112). Grønnum concludes her letter rather categorically: “If Danish intonation cannot be accommodated in Ladd's model, then that model needs revision. Otherwise, its proponents will have to give up on its generality and count Danish as the odd man out.” (Grønnum 1998b, 112)

In his response, Ladd (1998) apologizes for the inaccurate representation of Grønnum's global contours as categorical and distinctive; but he also notes that he does not disregard her findings about global trends and that “incorporating global shapes into the AM model would represent an ‘important theoretical concession’” (Ladd 1998, 113). Admittedly, he does not wish to make that concession: his position is that any evidence of distinct global contour shapes should be examined with an eye to reinterpreting them in terms of *local* events, in line with AM theory's tenets.

Furthermore, Ladd states that Grønnum's model "does not suffer from the problem of quantitative description", as other global models do. Rather, he believes that the main point of disagreement between Grønnum and AM lies in the concept of look-ahead: Grønnum insists on incorporating it in her model, AM does not. But Ladd states that "a model with this kind of look-ahead is still perfectly compatible with an AM conception of the general problem of modeling intonation" and goes so far as to suggest that if they focus on "empirical substance" instead of labels, "Grønnum and I will both find that we agree on rather a lot" (Ladd 1998, 114).

I take this to mean that for Ladd, Grønnum's data for Danish can be successfully incorporated into an AM model, if only she would concede that a linear, locally determined representation is adequate. In all the years following this correspondence, however, Grønnum has not agreed to such a concession; on the contrary, with each new work on the subject, she firmly reiterates her earlier objections to a linear representation, oftentimes verbatim. It would seem that this long-standing disagreement between Grønnum and AM theory can only be decided by new and convincing empirical data. In the next section, I will try to summarize some recent empirical findings for Danish intonation and their potential implications for prosodic modeling.

5. RECENT EMPIRICAL INVESTIGATIONS

5.1. Tøndering (2004)

In his master's thesis, John Tøndering (2004) investigates the direction-giving monologues in the DanPASS corpus and reports finding five different types of F0 patterns in addition to the "prototypical" rising-falling pattern described by Grønnum as invariant. These five patterns appear to be dependent on the "degree of prominence" (*prominensgrad*) of the stressed word (Tøndering 2004, 55–56), which in turn is affected by the word's information status – words containing new information exhibit a relatively high degree of prominence (Tøndering 2004, 83). Tøndering does not appear to analyze them as distinctive pitch accents – indeed, he does not attempt a phonological analysis at all. In the conclusion of his thesis, however, he expresses the view that it is "important that one in future investigations includes Danish spontaneous speech intonation in an international discussion on intonology (*Intonational Phonology*)" (Tøndering 2004, 84; translation from Danish mine – M.B.).

5.2. Grønnum and Tøndering (2007)

In an article from 2007, Grønnum and Tøndering investigate 300 utterances with question intonation, plus 51 declaratives for comparison, from the map task dialogues in the DanPASS corpus. In general, they report similar global trends as in read speech, with a few differences: questions with inversion are slightly less declining and terminate higher up than declarative (i.e. syntactically unmarked) ones (cf. 1.2), while declarative questions themselves terminate slightly lower than true declaratives (Grønnum, Tøndering 2007, 1231). The latter is curious, because “one would expect that an utterance which has no overt lexical or syntactic markers of its interrogative function would have to have a prosodic cue” (*ibid.*); but apparently this is not obligatory in certain circumstances (the authors do not ascertain what these are).

Another curious result of this study lies in the rise from the last stressed syllable to the first post-tonic: Grønnum and Tøndering (2007, 1232) report finding the highest rises in true declarative utterances, and the smallest in questions with word order inversion. In an AM framework, this could be analyzed as a local cue to modality; but the authors hasten to dismiss such an analysis and instead point out that “utterance modality is distributed across the whole utterance, by the global course of the intonation contour, not by any local, final pitch movement” (*ibid.*, 1232). In 2022, Grønnum attributes the confounding difference in the final rise magnitude to the fact that new information is typically found last in declaratives but first in questions (Grønnum 2022, 111). However, she herself admits that this difference “could have been a candidate for a separate cue to modality if it were not for the contraintuitive [*sic*] fact that these rises are more extensive in declaratives than in interrogatives” (*ibid.*, 112). My hypothesis is that an alternative AM analysis might be able to provide further insight into the observed phenomenon.

5.3. Tøndering (2008)

In his doctoral dissertation published in Danish in 2008, Tøndering investigates the monologues in DanPASS and finds no evidence of look-ahead or pre-planning, contrary to read speech. In addition, he reports substantial melodic variation in intonation contours, which he has not attempted to systematize, as his dissertation’s main focus is prosodic boundaries. However, he establishes several points which he considers should be “central elements in a prosodic model of spontaneous Danish”², among others that utterance modality is signaled locally and determines the pitch height in the last stressed syllable, and that the model is non-hierarchical,

² All translations from Danish in this subsection are mine (M.B.)

but linear: F0 events are not “subordinated to any superior prosodic structures”, but “follow each other in a linear fashion”. (Tøndering 2008, 233–234).

Tøndering also discusses the results of the 2007 study of question intonation (see 5.2.) but comes to a rather different conclusion than the one in the article: that perhaps utterance modality “can wait until the end of the utterance to present itself”, and that “signaling is local”. He bases this hypothesis on the prevalent melodic variation found in the examined data, and stresses that “one needs to take the variation seriously and investigate the individual cases” (Tøndering 2008, 230).

On the very last page of his dissertation, Tøndering (2008, 235) concludes that he has not found evidence for a non-linear, hierarchical model for Danish intonation and considers the existing model insufficient in accounting for the circumstances in spontaneous speech. Instead, he reiterates the need for the development of a linear model of spontaneous Danish.

5.4. Jespersen et al. (2021)

In a 2021 study, Anna Bothe Jespersen and her colleagues test a range of predictions stemming from Grønnum’s “a-phonological” (Jespersen et al. 2021, 2611) model by analyzing read material from the regional variant of Jutlandic Danish. They find little evidence for the model’s claim that “stress groups are identical in form throughout the utterance, differing only in height and span” (Jespersen et al. 2021, 2614). Instead, their data reveals an array of F0 shapes associated with various metrical and prosodic anchor points and differing in both range and shape. As a conclusion, the authors stress the need for further investigations into conversational speech, which would facilitate a phonological analysis and the adequate modeling of Danish intonation.

6. SUMMARY AND CONCLUSION

In conclusion, I have shown that Nina Grønnum’s model of Danish intonation, while meticulously worked out and supported by the author’s data for read material, seems to have difficulty withstanding newer investigations and data from spontaneous speech – in particular, the substantial amount of melodic variation which Grønnum’s model apparently struggles to adequately account for. In contrast, recent evidence seems to point toward the feasibility of a linear, non-hierarchical AM model of Danish in terms of pitch accents and boundary tones. A careful reanalysis of the data within the AM framework and the development of such a model would not only be beneficial to the study of Danish intonation itself, but also allow for a more straightforward contrastive analysis with other languages

already modeled within the AM framework – and thereby also facilitate typological research as well as studies of the properties of L2 intonation, which are of particular practical interest for students of Danish as a foreign language.

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