Is Danish an intrinsically more difficult language to understand than Swedish?

Charlotte Gooskens[1], Vincent J. van Heuven[2] Renée van Bezooijen[1] & Jos Pacilly[2]

[1]*University of Groningen, The Netherlands;* [2]*Leiden University, The Netherlands*

1. Introduction

Danish has the reputation of being hard to understand. This is the case not only for speakers of the closely related Scandinavian languages, Swedish and Norwegian, but there are also indications that Danes have difficulties understanding their own language themselves. Many Danes, both laymen and linguists, regard Danish as a non-distinctly articulated language, which sometimes causes communication problems among its users. On the other hand there are also linguists who believe that one language cannot be intrinsically more difficult to understand than another language. However, we think there is no principled reason why there could not be some variation in the intelligibility threshold of different languages. Danish might be an example of a language with properties that make it difficult to understand, even for natives.

Results of linguistic research seem to support the impression that Danish is indeed a difficult language. Bleses & colleagues (Bleses & Basbøll 2004, Bleses et al. 2008) have shown that the early language development of Danish children is somewhat slower than that of children with other mother tongues, such as English and Swedish. A comparison with 15 different languages revealed that Danish children score lowest on vocabulary comprehension as reported by the parents. Bleses et al. attribute this result to the poor segmentability of Danish, which is caused by prosodic phenomena such as lack of specific juncture cues, of compulsory sentence accents and of local signals to utterance function. At the segmental level, lenition of consonants and other reduction phenomena, in particular schwa-assimilation and schwa deletion, would result in poor segmentability.

Other evidence for the fact that Danish is an intrinsically difficult language is that Danish-Swedish mutual intelligibility is asymmetric. Danes understand Swedish better than Swedes understand Danish. Various investigations on inter-Scandinavian intelligibility have shown that Danish is the most difficult neighbouring language in Scandinavia (e.g. Maurud 1976, Bø 1978, Börestam 1987, Delsing & Lundin Åkesson 2005). Also immigrants of various origins have more difficulties understanding Danish than immigrants in Norway and

Sweden have understanding Norwegian and Swedish, respectively (Delsing & Lundin Åkesson 2005).

The asymmetrical intelligibility scores are sometimes explained by a negative attitude of Swedes towards Denmark and Danish whilst Danes are more positive towards Sweden and Swedish. Also, contact with the language in its written or spoken form is likely to improve the performance on a language test. Danes often live close to Sweden which makes it possible to watch Swedish television and visit the country while many Swedish subjects live further away because of the large size of the country and the geographical position of the capital at the east coast. However, correlations between intelligibility scores and these two factors are low; a direct relationship is difficult to prove (Gooskens 2007). For a further discussion of the role of extra-linguistic factors in the mutual intelligibility between Swedes and Danes see Schüppert & Gooskens (this volume).

In the present paper, we assume that linguistic factors are likely to play a role. Specifically we will test the hypothesis that Danish in intrinsically more difficut to understand than Swedish. If Danish is indeed difficult for the Danes themselves, it can be expected to be difficult for non-natives as well. Grønnum (2003) attributes the difficulty that Swedes have understanding Danish to the same factors as mentioned by Bleses et al. In addition, she mentions the large number of phonologically distinct vowels. Danish has more than forty vowel sounds (including long vowels with a *stød,* a kind of creaky voice) and a large number of diphthongs.

Surprisingly, the idea that Danish would be difficult to understand even for native speakers has never been addressed experimentally. The first aim of our study was to compare the intelligibility of Danish for Danes with the intelligibility of Swedish for Swedes. An intelligibility test was developed both with sentences and isolated words read out in the mother tongue of the listeners. The test sentences and words were presented in a series of descending noise levels, from difficult to easy. If Danish is indeed an intrinsically more difficult language, the intelligibility threshold should be higher for Danish native listeners than for Swedish native listeners.

The second aim was to investigate the role of prosodic phenomena and reduction phenomena across word boundaries. As mentioned above, according to Bleses et al. and Grønnum such phenomena would degrade the segmentability of Danish. Poor segmentability is known to inhibit intelligibility. By comparing the intelligibility results for isolated words with those for sentences, conclusions can be drawn about the influence of these factors on intelligibility. If the isolated words are easier to understand (suffer less from noise) than read sentences in comparison to Swedish, this supports the hypothesis by Bleses e.a. that Danish is difficult to understand due to the low segmentability caused by prosodic phenomena and reduction phenomena across word boundaries.

2. Experiment

2.1 Stimulus material

Two kinds of stimulus material were included in the test: semantically unpredictable read sentences and isolated cognate words. The use of read speech makes it possible to test the same types of sentences in both languages and for all speakers. Moreover, it is possible to completely control the input. For example, the influence of semantic context can be minimalized and the words can be selected on the basis of certain characteristics, such as token frequency, lexical category and word length. Below we will provide more details about the stimulus material.

Semantically unpredictable read sentences (SUS)

To construct sentences to be read aloud by the speakers, the so-called SUS-generator was used that was developed by Benoît, Grice & Hazan (1996). The SUS-generator produces semantically unpredictable sentences that can be used to measure overall intelligibility. The generator was originally developed for the assessment of text-to-speech systems, but it is also a useful method for testing the intelligibility of natural language. The sentences are syntactically acceptable but semantically anomalous. For example, in a semantically anomalous sentence such as *He drank the wall* the syntactic structure is correct. The listener receives cues as to syntactic category only and will be able to make no further predictions about word identity. The advantage of using semantically unpredictable sentences is that they provide no semantic contextual cues to the intelligibility of the individual content words.

The SUS-sentences can be automatically generated using five basic syntactic structures and a number of lexicons containing the most frequently occurring words in each language. The syntactic structures are simple and the sentence length does not exceed seven words, in order to avoid saturation of the listeners' short-term memory. The following lexical categories are used to construct the sentences:

- nouns
- transitive verbs (trans. verb)
- intransitive verbs (intrans. verb)
- adjectives (adj)
- relative pronouns (rel. pron)
- prepositions (prep)
- conjunctions (conj)
- question adverbials (quest)
- determiners (det).

For our experiment we used these word classes to produce the following four syntactic structures:

- transitive: det + adj + noun + trans. verb + det + noun
- imperative: trans. verb + det + noun + conj + det + noun
- interrogative: quest + trans. verb + det + noun + det + adj + noun
- relative: det + noun + trans. verb + det + noun + rel. pron + intr. verb

All words were selected from the most frequent words in their lexical category using published databases of word token frequency in written texts or spoken recordings. Those words containing the smallest number of syllables within a lexical category were used. This means that all words are monosyllabic except for a number of verbs and question words, which generally comprise more than one syllable in the Scandinavian languages. All words are unambiguous in terms of their phonological shape and lexical category, which means that no homophones are included and no words which can belong to more than one lexical category. Furthermore, for each lexical category, there are special restrictions. For the Scandinavian languages the most important restrictions are the following:

- verbs: no auxiliaries and reflexives, only present tense
- nouns: only singular forms
- adjectives: no comparative and superlative forms
- prepositions: only single-word prepositions
- determiners: only indefinite forms

The Swedish SUS-lexicon consists of words taken from a Swedish word frequency list based on 1,000,669 words in running texts from five Swedish newspapers from 1965 (Allén 1970).

No Danish SUS-generator was available, so we had to compile one ourselves. For this purpose we used the frequency list that has been compiled by Bergenholtz (1992) between 1987 and 1990. For the sake of comparability with the Swedish material, we used only the part of the list that is based on newspapers (750.000 words). For the Danish SUS-generator we included the same number of words per lexical category as for the Swedish generator following the general principles for the SUS-generator as sketched above.

In the intelligibility test twelve different read sentences were used. They consisted of three sentences from each of the four syntactic structures (see above). Half of the twelve read sentences originated from the Swedish SUS-generator and the other half from the Danish SUS-generator in order to exclude language-specific influences such as differences in word frequency. The

Swedish sentences were then translated into Danish and the Danish sentences into Swedish so that in total we had the same twelve sentences in Swedish and in Danish. The syntax of Swedish is so similar to the Danish syntax and the four syntactic structures are so simple and general that translating the Swedish sentences word for word into Danish or visa versa was unproblematic.

When generating the sentences in the two languages, two points were taken into consideration. First, words which have different gender in the two languages were not included since it may confuse the listener if a word is preceded by a determiner with a 'misleading' gender. Words which occurred more than once were replaced by other words. Exceptions are Danish *en* (indefinite article common gender), *et* (indefinite article neuter gender), *og* 'and' and *som* (relative pronoun) and their counterparts in Swedish (*en, ett, och* and *som)*.

Words that could not be translated with a cognate were excluded. In this way we made sure that all errors made by the listeners when listening to the neighboring language could be attributed to phonological differences between the two languages. In order to make sure that word frequency played no role for the intelligibility results, we decided to use only words that were among the 5000 most frequent words in both languages according to the frequency dictionaries from which the words were taken (see above). The mean relative frequencies of all the content words (types) were almost the same in the two languages: 0.019 (between 0.002 and 0.243) for Danish and 0.018 (between 0.002 and 0.211) for Swedish. The correlation between the Swedish word frequencies and the Danish word frequencies is high ($r = 0.97$). This means that the Swedish and the Danish words are very similar as far as frequency is concerned and therefore there is no reason to expect word frequencies to have an influence on the results.

In the sentences which were generated for the experiment, 10 of the 15 Danish and 11 of the 15 Swedish verbs were bisyllabic. Also, two of the three Danish question words were bisyllabic. All other words were monosyllabic.

Isolated cognate words
Ideally, the same words that were included in the read sentences should be tested in isolation. This would provide the best basis for a comparison of the intelligibility results for these to kinds of stimulus material. However, in order to avoid priming effects, the listeners should not be confronted with the same words twice. We could have opted for a crossed design, but this would have demanded the testing of too many groups of subjects or in too long test sessions. For this reason we used different words but took care to select the isolated words on the basis of the same criteria as the words in the read sentences. This still makes it possible to compare the results. We decided to include only nouns. This means that the subjects knew the lexical category of the target words, as in the

case of the read sentences. The 24 words were selected in the same way as the words in the SUS-generator. This means that the words meet the following criteria:

- monosyllabic
- cognate
- among the 5000 most frequent words
- singular
- unambiguous in terms of phonological shape and lexical category

The mean relative frequencies of the words were almost the same in the two languages: 0.013 (between 0.002 and 0.042) for Danish and 0.010 (between 0.003 and 0.030) for Swedish. The correlation between the Swedish word frequencies and the Danish word frequencies is high ($r = 0.89$).

2.2 Speakers

Three Danish and three Swedish speakers were digitally recorded. They were young male speakers from the Swedish and the Danish capitals, respectively. Here the standard languages of the countries are spoken. The Danish speakers were (former) students from the Department of General and Applied Linguistics at the University of Copenhagen. They originated from the greater Copenhagen area and were born in 1976 or 1977. The Swedish speakers were matched with the Danish speakers as well as possible. They had the same age, originated from Stockholm and were (former) students of Linguistics from the University of Stockholm.

2.3 Speech manipulation

All sentences and words were downsampled to 16 KHz. Increasing levels of babble noise were added to yield five versions. Babble noise consists of the mixed recordings of a large number of speakers. By adding babble noise to the recording we imitate a situation where the speaker is in the middle of a crowd of people. Babble noise is held to be the most effective and least obnoxious masker of speech. As explained above, if it is true that Danish is less clearly articulated, one may expect Danes to have more problems understanding Danish in noisy surroundings than Swedes. The noise was amplitude modulated in such a way that its intensity rose and fell proportionally to that of the speech wave. This was done to ensure that each sound was made unintelligible to the same extent. We added four descending noise levels (from difficult to easy), in steps of 3 dB from 0 to -9 dB noise to the original recording. This resulted in five different versions. Version 1 is the downsampled copy of the original recording, version 2 was mixed with 0 dB noise (noise has the same level as the original recording), version 3 with –3 dB (i.e. noise is 3 dB stronger than target speech), version 4 with –6 dB and version 5 with –9 dB.

2.4 Design

Twelve read sentences and 24 isolated cognate words were tested. For each sentence or word, the five versions were presented in succession from most difficult to easiest. The listeners listened to the five versions in their own language. The read sentences and the isolated cognate words were tested in a crossed design, so that all sentences or words by each of the six speakers were tested. This means that each listener listened to six sentences and twelve words in each of the five versions in their own language.

2.3 Listeners

A total of 42 listeners participated in the experiment, 24 Swedes and 18 Danes. The Swedes were between 19 and 29 years old (mean age 22.6 years) and the Danes between 20 and 29 year old (mean 24.2). All Swedes spoke Swedish and all Danes spoke Danish with both parents. The Swedish listeners hailed from the Stockholm area and the Danish listeners from the Copenhagen area so that they were all very familiar with the variety of the speakers. None of them reported hearing problems.

2.4 Procedure

The test was carried out over the internet under computer control. All subjects listened to the stimuli through head phones. First, listeners were asked to answer questions about their personal background (age, place of living, hearing problems, etc). Next, the experiment started. Before the block of isolated words, the listeners practised with five words not included in the experiment proper. Before the blocks of SUS-sentences, listeners were given two practice sentences. For each of the five versions the listeners were asked to type out on the computer keyboard what they heard.

3. Results

3.1 Isolated cognate words

Figure 1 presents the percentage of correctly recognized words per version (1 to 5, see Section 2.5) and per group of listeners (Swedes or Danes). The versions with the highest amount of noise were always presented first followed by versions with a decreasing amount of noise. This means that an increasing percentage of correct answers can be expected. If it is true that the Danes have more difficulties understanding their own language, we expect the Danish responses to be lower than the Swedish responses. However, this did not turn out to be the case. The Swedish responses were even poorer than the Danish responses in the two first versions. However, the differences are not significant for any of the versions. The results of paired t-tests showed p-values

between .11 ($t = -1,608$, $df = 142$) for version 1 and .99 for version 5 ($t = -,011$, $df = 142$).
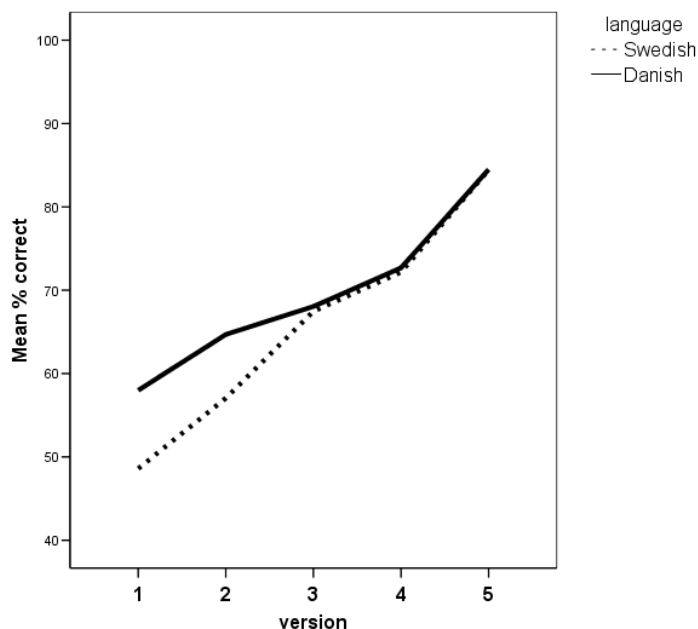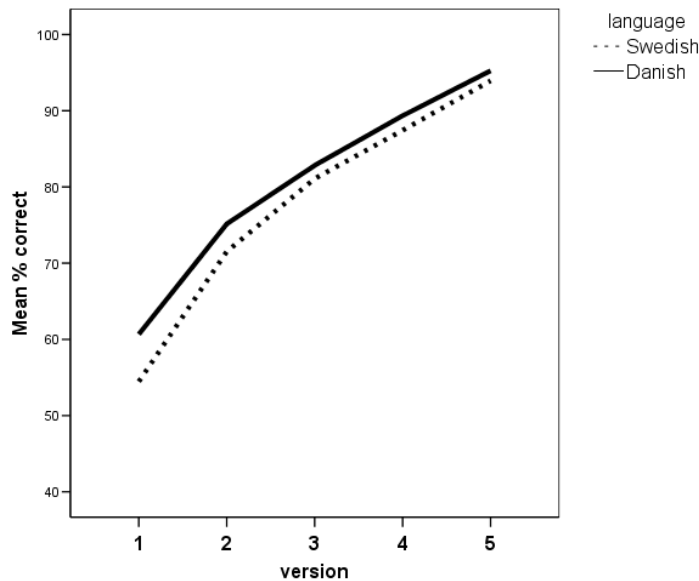

Figure 1. Mean percentages of correct recognition of cognate words in five decreasing signal-to-noise ratios broken down by speaker/listener language (Swedish, Danish).

3.2 SUS-sentences

As explained in the introduction, the effect of noise may not be as large in isolated words as in sentences, since especially assimilation and prosodic phenomena across words boundaries may be responsible for the poor segmentability of the Danish language. We therefore also included sentences in our experiment. In Figure 2 we present the percentages of correctly recognized target nouns in the read sentences. Overall, the isolated words are recognized significantly more poorly than the target words in the sentences, both by the Swedes ($p = .000$, $t = 4,303$, $df = 538$) and by the Danes ($p = .000$, $t = 4,074$, $df = 538$). However, Danes have no more problems recognizing the target nouns in the five versions than the Swedes. The differences are non-significant for all five versions (values between $p = .20$, $t = -1,282$, $df = 70$ and $p = .59$, $t = -,546$, $df = 70$). This shows that also in the case of sentences we must reject our hypothesis that the intelligibility threshold is higher for Danes than for Swedes.

Figure 2. Mean percentages of correct recognition of target nouns in SUS-sentences in five decreasing signal-to-noise ratios broken down by speaker/listener language (Swedish, Danish).

4. Conclusions and discussion

We found no evidence to support our hypothesis that Danish is an intrinsically more difficult language than Swedish. Danish listeners had no more problems understanding speech presented in descending levels of noise than Swedes. We expected a larger effect for sentences than for words, since more assimilation and reduction phenomena are reported across word boundaries than word internally. However, no differences were found between the Danish and the Swedish results neither in isolated words nor in short read sentences. It is possible that an effect would have been found if spontaneous sentences had been used as stimulus material, since read speech is likely to be pronounced more carefully than spontaneous speech. We therefore intend to repeat our experiment with spontaneous speech.

We only included three speakers from each country in our investigation. Since we do not know how much variation is found between speakers in terms of assimilation and reduction phenomena it is possible that our speakers are not representative of the two languages. It would therefore be desirable to repeat the investigation with more speakers.

A factor that should be mentioned as an explanation for the assumed difficulty of Danish is the fact that the Danish pronunciation has undergone an exceptionally fast development during the last century (Brink and Lund 1975, Grønnum 1998). This may explain the fact that in Denmark especially elderly people complain having difficulties understanding people from the younger generation and it could also be part of the explanation for the asymmetry

between Danish and Swedish. In order to test this hypothesis we will repeat our investigation with listeners between 60 and 70 years. If the elderly Danish subjects have more difficulties understanding the young speakers from their own countries than elderly Swedish subjects we may conclude that there is a larger generation gap in Denmark than in Sweden.

References

Allén, S. 1970. *Nusvensk frekvensordbok, baserad på tidningstext.* Stockholm: Almqvist & Wiksell.

Bergenholtz, H. 1992. *Dansk frekvensordbog: baseret på danske romaner, ugeblade og aviser 1987-1990.* Copenhagen: Gad.

Benoît, C., M. Grice, & V. Hazan. 1996. The SUS test: A method for the assessment of text-to-speech synthesis intelligibility using Semantically Unpredictable Sentences. *Speech Communication* 18, 381-392.

Bleses, D. & H. Basbøll. 2004. The Danish sound structure - Implications for language acquisition in normal and hearing impaired populations. In E. Schmidt, U. Mikkelsens, I. Post, J. B. Simonsen & K. Fruensgaard (eds.) *Brain, Hearing and Learning. 20th Danavox Symposium 2003*. Copenhagen: Holmen Center Tryk, 165-190.

Bleses, D., W. Vach, M. Slott, S. Wehberg, P. Thomsen, T. Madsen, & H. Basbøll. 2008. Early vocabulary development in Danish and other languages: A CDI-based comparison. *Journal of child language* 35, 619-650.

Bø, I. 1978. *Ungdom og naboland. En undersøkelse av skolens og fjernsynets betydning for nabospråksförståelsen* (Rogalandsforskning 4). Stavanger: Rogalandsforskning.

Börestam Uhlmann, U. 1991. *Språkmöten och mötesspråk i Norden*. Oslo: Nordisk språksekretariat.

Brink, L. & J. Lund. 1975. *Dansk rigsmål: lydudviklingen siden 1840 med særligt henblik på sociolekterne i København*. Copenhagen: Gyldendal.

Delsing, L.-O. & K. Lundin Åkesson. 2005. *Håller språket ihop Norden? En forskningsrapport om ungdomars förståelse av danska, svenska och norska* (TemaNord 573). Copenhagen: Nordisk ministerråd.

Gooskens, C. 2007. Contact, attitude and phonetic distance as predictors of inter-Scandinavian communication. In J.-M. Eloy & T. ÓhLfearnáin (eds.) *Near languages - Collateral languages. Actes du colloque international réuni à Limerick, du 16 au 18 juin 2005*, 99-109.

Grønnum, N. 1998. *Fonetik og fonologi. Almen og dansk*. Copenhagen: Akademisk forlag.

Grønnum, N. 2003. Why are the Danes so hard to understand? In H. Galberg Jacobsen et al. (eds.) *Take Danish - for instance: linguistic studies in honour*

of Hans Basbøll presented on the occasion of his 60th birthday, 12 July 2003. Odense: University Press of Southern Denmark, 119-130.

Maurud, Ø. 1976. Reciprocal comprehension of neighbour languages in Scandinavia. An investigation of how well people in Denmark, Norway and Sweden understand each other's written and spoken languages. *Scandinavian journal of educational research* 20, 49-72.