

Is spoken Danish less intelligible than Swedish?

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Abstract

The most straightforward way to explain why Danes understand spoken Swedish relatively better than Swedes understand spoken Danish would be that spoken Danish is intrinsically a more difficult language to understand than spoken Swedish. We discuss circumstantial evidence suggesting that Danish is intrinsically poorly intelligible. We then report on a formal experiment in which we tested the intelligibility of Danish and Swedish materials spoken by three representative male speakers per language (isolated cognate and non-cognate words, words in semantically unpredictable sentences, words in spontaneous interaction in map tasks) presented in descending levels of noise to native listeners of Danish ($N = 18$) and Swedish ($N = 24$), respectively. The results show that Danish is as intelligible to Danish listeners as Swedish is to Swedish listeners. In a separate task, the same listeners recognized the same materials (presented without noise) in the neighboring language. The asymmetry that has traditionally been claimed was indeed found, even when differences in familiarity with the non-native language were controlled for. Possible reasons for the asymmetry are discussed.

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Keywords: Mutual intelligibility; Danish; Swedish; Babble noise; Semantically unpredictable sentences; Map tasks; Cognates

1. Introduction

In this study we define speech intelligibility as the ensemble of properties that allow a native listener of the language to correctly recognize the linguistic units (such as phonemes, syllables, morphemes and words) in the order they were produced by the speaker of the utterance. Better intelligibility results in better and more efficient speech recognition. The more intelligible a speaker or a spoken utterance, the higher the percentage of units (words) that are correctly recognized, the smaller the number of transpositions in the reported serial order among the units, and the faster the native listener performs the recognition task. Intelligibility is often distinguished from the comprehensibility, which determines the comprehension of the spoken message. Listeners comprehend a spoken utterance if they get the mean-

ing (or gist) of the spoken utterance; it is the result of the process that is also termed ‘speech understanding’ (see e.g. van Bezooijen and van Heuven, 1997; van Heuven, 2008).¹

Normally, when we listen to a speaker of a different language than our own, we cannot understand the other, unless we have learnt the other language – either by explicit instruction (in a school setting) or by natural exposure to the other language (as when we immigrate to a foreign country). Sometimes, however, we may understand a foreign language, either fully or partly, even if we are not familiar with it. This may happen when the speaker talks to us in a language that is closely related to our own. In such cases speaker and listener may engage in what has been called semi-communication (e.g. Braunmüller, 2002). Both interactants continue to speak their own language, and yet understand each other. The degree to which the interactants are intelligible to one another is called mutual intelligibility.

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¹ Some authors use the term comprehension to refer to the impression of intelligibility of a speaker or utterance as measured by a subjective estimation task (e.g. Derwing and Munro, 1997).

Mutual intelligibility between related languages varieties, i.e. dialects of the same language or sibling languages within the same language family, is not always reciprocal. For instance, Portuguese (Brazilian) listeners have significantly fewer problems understanding spoken Spanish than (Latin-American) Spanish listeners have understanding Portuguese (Jensen, 1989). Similarly, listeners whose native language is a Southern Chinese ‘dialect’ understand Mandarin (Northern Chinese) varieties much better than the other way around (Tang and van Heuven, 2009).

An intriguing case of non-reciprocal intelligibility is found in Northern Europe. Here Danish has the reputation of being poorly intelligible to other Scandinavian listeners, while the other Scandinavian languages, i.e. Swedish and Norwegian, are more readily understood by Danish listeners. On the anecdotal level we find comments such as ‘Danish is not so much a language as a throat disease.’² In a recent spoof (the comedy programme *Uti Vår Hage*) on Norwegian television, the (Norwegian-accented) English commentary begins with a supposed Dane complaining: ‘I know, the Danish language has always been impossible to understand for most Scandinavians, but in recent years, it has become impossible to understand for us in Denmark too.’³

Beyond the anecdotal, it has been recognized in both first and second-language acquisition studies that spoken Danish is an extraordinarily challenging language. Bleses and Basbøll (2004), and more recently Bleses et al. (2008), have shown that the early language development of Danish children is slower than that of children with other mother tongues, such as Dutch, French and Swedish. A comparison with 15 different languages revealed that Danish children score lowest on vocabulary comprehension (as reported by the parents) during the entire period they were followed, i.e. between 0;8 and 1;3 years. At the beginning of the period, the size of the passive vocabulary of the Swedish toddlers was about twice that of their Danish counterparts, at the end of the period the Swedish toddlers’ vocabulary was still 38 percentage points larger.

Bleses et al. hypothesized that the Danish sound structure represents a difficult segmentation task not only for non-native speakers and second-language learners of Danish, but also for Danish language-acquiring children, rendering some steps in early language acquisition so difficult – due to the scarceness of phonetic and prosodic cues – that it results in a delay in acquiring receptive abilities compared to children from other countries. Bleses et al. attribute the difficulty to the poor segmentability of Danish, which is caused by prosodic phenomena such as lack of specific juncture cues, absence 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, contribute to poor segmentability.

In the context of second-language learning, Grønnum (2003) lists a number of characteristics of the phonology of Danish, which would make it difficult for foreign learners to understand. She writes: ‘An abundance of vowels, weak syllable codas, unstressed syllables without any vowel sound, and fairly inexpressive prosody makes Danish a harder nut to crack perceptually than most languages which it otherwise is reasonable to compare it to.’

Modern Danish (Grønnum, 1998b; Basbøll, 2005) has a large phoneme inventory, with 20 vowels and 18 consonants (although different phonological analyses diverge on the exact number of contrasts). Central Standard Swedish (Engstrand, 1990) has a similarly complex phoneme system, with 18 vowels (including schwa) and 18 consonants, although the number of vowels is larger if systematic allophones are included (e.g. Malmberg, 1968; Elert, 1970; Garlén, 1984). Danish has a special prosodic feature called *stød*, or laryngealization, where other Scandinavian languages have word tone 1. The most noticeable characteristic of Danish, however, would seem to be the massive reduction and assimilation of both vowels and consonants, which is absent from other Scandinavian languages, including Swedish.

Various investigations on inter-Scandinavian intelligibility have shown that Danish is the most difficult neighboring language in Scandinavia. For instance, Maurud (1976) reports that Danes are reasonably adept at understanding Swedish (a comprehension score of 43% correct content questions), while Swedes perform more poorly when having to understand Danish (23% on the listening comprehension test). Interestingly, reading comprehension scores were perfectly symmetrical (mean scores of 69%) in the same study by Maurud (1976). The same tendency towards asymmetrical speech understanding between Swedes and Danes was reported by Bø (1978), Börestam (1987), and by Delsing and Lundin Åkesson (2005).

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, 1998a). According to Telemann (1987, p. 76), changes in the Danish pronunciation may have made it more difficult for a Swede to ‘find the letters behind the sounds’ than vice versa. Indeed, the last century has seen a large number of changes (lenition processes) in the phonology of Danish. The letter-to-sound correspondences were rather straightforward around a century ago but have become more opaque in the course of the twentieth century. This would also be the reason why there is no asymmetry in mutual understanding between written Danish and written Swedish and only non-reciprocity in mutual understanding of spoken language.

The asymmetry in intelligibility between Swedish and Danish has often been explained as the result of a difference in attitudes. Danes would hold Sweden and its language,

² <http://www.studyabroad.com/lom/danish.html> (last accessed 19 January 2010).

³ <http://www.youtube.com/watch?v=s-mOy8VUEBkn> (last accessed 19 January 2010).

Swedish, in high esteem while Swedes tend to take a low view of Denmark and Danish. A second, related, account of the asymmetry rests on a difference in language contact. Denmark is a geographically small country so that most Danes live close to Sweden, which makes it possible to watch Swedish television and visit the country. The great majority of Swedes, however, live far away from the Danish border and get little exposure to Danish. Maurud (1976) collected self-estimations of contact with the neighboring language from his subjects by asking them to answer the following questions:

- how many times had they visited their neighbor countries (never, once, a few times, many times, has lived there),
- how often they listened to radio from neighbor countries (never, seldom, sometimes, often),
- how often had they watched television from neighbor countries (never, seldom, sometimes, often).

Although the Danes reported much more contact with Swedish than Swedes with Danish, correlations between individual intelligibility scores and attitudes, and between intelligibility and geographic remoteness, were found to be low; a direct relationship is difficult to prove (Gooskens, 2007). Moreover, if the asymmetry were the consequence of a difference in attitude, it is hard to see why mutual intelligibility is asymmetrical for spoken but not for written language.

The mainstream view on speech communication holds that every language is an optimal solution to the problem of finding a workable compromise between speaker needs and hearer needs. On the one hand, the speaker should be allowed to talk quickly and with minimal effort. On the other hand, the speaker's sounds must remain distinct enough to allow the listener to recognize words and reconstruct the message without having to ask the speaker to repeat himself. The evidence presented above seems to bear out that in Danish the speaker–hearer balance is unduly tipped in favor of the speaker.

In the present paper, then, we test the hypothesis that linguistic factors play a decisive role. Specifically, we will test the hypothesis that Danish is intrinsically more difficult to understand than Swedish. If Danish is indeed difficult for the Danes themselves, it will be difficult for non-natives as well. The idea that Danish would be difficult to understand even for native speakers has never been addressed experimentally. In the studies cited above, it was taken for granted that listeners would obtain perfect comprehension scores when exposed to speech samples of their own language variety. The first aim of our study was to compare the intelligibility of Danish for Danes with the intelligibility of Swedish for Swedes.

Several formal intelligibility tests have been developed for Scandinavian languages (e.g. Lidén and Fant, 1954 for Swedish; Elberling et al., 1989; Hagerman, 1984; Wagener et al., 2003 for Danish). However, none of these

tests has been developed with the specific goal of making a cross-linguistic comparison of the (intrinsic and mutual) intelligibility of neighboring languages. In order to make the materials in Danish and Swedish optimally comparable, the parallel tests have to contain the same (cognate) words in the same frequency bracket, the same sentence types and the same communicative situations. To comply with these requirements we decided to develop a dedicated comparative test.

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, i.e. from difficult to easy. If Danish is indeed an intrinsically more difficult language, the intelligibility threshold should be higher for Danish than for Swedish native listeners. A similar methodology was applied successfully earlier to examine possible subtle differences in intelligibility of native and Dutch-accented English and between native and English-accented Dutch (van Wijngaarden, 2001).

Of course, we also needed to ascertain that the mutual intelligibility between Swedish and Danish is asymmetrical, as has traditionally been claimed (see above). Therefore, we also administered the test cross-linguistically, by having Swedes respond to the Danish version of the materials and Danes to the Swedish version. We had established in pilot experiments that no added noise was required to obtain sufficient discrimination between native and non-native listeners.

We point out here that our test is the first full-fledged functional test on the mutual intelligibility of Swedish and Danish. The test did not rely on opinion scores (judgments), nor on self reports, nor did it test overall comprehension ('the gist') of the message.

An additional aim was to investigate the role of prosodic phenomena and reduction phenomena across word boundaries. As mentioned above, according to Bleses et al. (2008) and Grønnum (2003) such phenomena would degrade the segmentability of Danish. Poor segmentability is claimed to compromise 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 would support the hypothesis by Bleses et al. and Grønnum that Danish is difficult to understand due to the low segmentability caused by prosodic phenomena and reduction phenomena across word boundaries.

2. Method

2.1. Stimulus materials

Three kinds of stimulus material were included in the test: read sentences, spontaneous sentences, and isolated cognate words. The use of read sentences allows us to test

the same types of sentences with the same cognate words in both languages and for all speakers. The influence of semantic context can be minimalized and the words can be selected on the basis of characteristics such as frequency, lexical category and length.

The speaking style and the variation in spontaneous speech are quite different from constructed read sentences. It is uncertain to what degree this will influence intelligibility scores. On the one hand, spontaneous speech might be less carefully pronounced than read speech, which might result in more assimilation. On the other hand, the listeners might be helped by the contextual cues when interpreting the spontaneous sentences (see, e.g., Kennedy and Trofimovich, 2008 and references therein). Also, spontaneous speech is likely to be more varied as far as prosody is concerned.

In contrast with read sentences, reduction phenomena are less frequent in isolated words since they only occur within the words and not across word boundaries. Also, the prosodic features which are found at sentence level are absent. In the next sections we will go into detail about the different kinds of stimulus material.

2.1.1.1. *Semantically unpredictable sentences (SUS)*

To construct sentences to be read aloud by the speakers, the so-called SUS-generator was used that was developed by Benoit et al. (1996). The SUS-generator produces semantically unpredictable sentences, which can be used to measure overall intelligibility. The generator was originally developed for the evaluation of the intelligibility of text-to-speech systems at the sentence level, but it is also a useful method for testing the intelligibility of natural language. The sentences are syntactically correct but semantically anomalous. For example, in a semantically anomalous sentence such as *He drank the wall* the syntactic structure is correct. Listeners receive cues as to syntactic category only but other than that they will not be able to make any further predictions about word identity by means of semantic or syntactic contextual cues.

The SUS-items can be automatically generated using five basic sentence types and a number of lexicons containing the most frequently occurring short words in each language. The sentence types are simple and the sentence length does not exceed seven words (eight for English because of the auxiliary in questions) 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 words (quest).
- Determiners (det).

These word classes are used to implement the following sentence types:

- S1 Intransitive structure: det + noun + intrans verb + prep + det + adj + noun.
- S2 Transitive structure: det + adj + noun + trans verb + det + noun.
- S3 Imperative structure: trans verb + det + noun + conj + det + noun.
- S4 Interrogative structure: quest + trans verb + det + noun + det + adj + noun.
- S5 Relative structure: det + noun + trans verb + det + noun + rel pron + intrans verb.

All words are selected from the most frequent words in their syntactic category using published databases which list words in terms of their token frequency in written texts or spoken recordings. Only those words containing the smallest number of syllables within a word class are used. This means that most words are monosyllabic. All words are unambiguous in terms of their phonological shape and syntactic category, so that homophones are included and no words which can belong to more than one syntactic category. Furthermore for each syntactic category, there are special restrictions. For the Scandinavian languages the most important restrictions are the following:

- Verbs: no auxiliaries and reflexives, only present tense is used (including the imperative in S3).
- Nouns: only singular forms.
- Adjectives: only forms which can be used attributively, no comparative and superlative forms.
- Prepositions: only single-word prepositions.
- Determiners: only indefinite forms.

2.1.1.1. *Swedish SUS sentences.* The Swedish SUS-generator consists of words taken from a Swedish word frequency list based on 1000669 running words from five Swedish newspapers from 1965 (Allén, 1970). For each word category the following numbers of most frequent words from the frequency list were included:

- nouns 120
- adjectives 36
- transitive verbs 48
- intransitive verbs 24
- question words 3
- prepositions 11
- conjunctions 3
- relative pronouns 1
- determiners 2

All included words are monosyllabic, except for the present tense verbs, which are disyllabic in 80% of the cases. Also half of the imperative verb forms in the word lists are disyllabic.

2.1.1.2. Danish SUS sentences. No Danish SUS-generator was available, so we had to program one ourselves. For this purpose we used the frequency list that has been compiled by [Bergenholtz \(1992\)](#) between 1987 and 1990. This list differs from the Swedish list in that it is based on newspapers (25% of the words) as well as novels (50%) and magazines (25%) and on a larger number of words (4 million). For the sake of comparability with the Swedish materials, we used only the part of the list that is based on newspapers (750000 words). The texts are more recent than the Swedish texts (a difference of 22–25 years). We do not expect these differences to be of great importance for our purpose. The words chosen for the SUS-generators are commonly used words in both languages (see comparisons of frequencies on the next page). For the Danish SUS-generator we included the same number of words per word category as for the Swedish generator following the general principles for the SUS-generator as sketched above. The verbs in the present tense are disyllabic in 80% of the cases. Furthermore, two question words are disyllabic in Danish. Unlike Swedish, also the all imperative forms in the Danish SUS sentences are monosyllabic.

2.1.1.3. Generation of SUS sentences for the intelligibility experiment. In the intelligibility test 12 different SUS sentences were used. They consisted of three sentences from each of the four sentence types S2–S5 (see above). No sentence from S1 was included since this structure is rather similar to S2 and since we wanted to be able to distribute the twelve sentences equally over the structures. In order to counterbalance possible language-specific influences such as differences in word frequency, half of the 12 SUS sentences originated from the Swedish SUS-generator and the other half from the Danish SUS-generator. The Swedish sentences were then translated into Danish and the Danish sentences into Swedish so that in total we had the same 12 sentences in Swedish and in Danish. The syntax of Swedish is so similar to the Danish syntax and the four sentence types are so simple and general that it provided no problems to translate the Swedish sentences word for word into Danish or visa versa.

When generating the sentences in the two languages, the following precautions were observed:

- Words with different genders in the two languages were excluded. Listeners may get confused if a word is preceded by a determiner with a ‘misleading’ gender, and this is an effect that we are not interested in the present investigation.
- Words that occurred more than once were substituted by other words. Exceptions are *en* (indefinite article common gender), *et* (indefinite article neuter gender), *og* ‘and’ and *som* (relative pronoun).
- Words for which no cognate (i.e. historically related word) exists in the other language were excluded. By excluding non-cognates we make sure that all errors made by the listeners when listening to the neighboring

language could be attributed to phonetic differences between the two languages. However, since cognates can have different frequencies in the two languages, they might not always be equally easy to understand. In order to make sure that word frequency played no role in the intelligibility results, we decided to use only words that were among the 5000 most frequent words in both languages, according to the frequency counts by [Allén \(1970\)](#) for Swedish and [Bergenholtz \(1992\)](#) for Danish. For each word in the two languages, the relative frequency of the word form as used in the sentences was looked up. Only in the case of the imperative, was the frequency of the present tense looked up because the imperative form itself had mostly a rather low frequency. The Danish words had a mean relative frequency of 0.19 (0.03 when including only content words) with values between 0.008 and 0.037 and the mean relative frequency of the Swedish words was 0.17 (0.012 with only content words) with values between 0.002 and 0.031. The correlation between the Swedish word frequencies and the Danish word frequencies is $r = 0.97$ (0.50 when including only content words). This means that the Swedish and the Danish words are rather similar as far as frequency is concerned and therefore there is no reason to expect word frequencies to influence the results.

When generating a sentence, first ten sentences of a particular type (S2–S5) in the relevant language (Danish or Swedish) were generated. The first sentence was chosen if it fulfilled the conditions specified above. If this was not the case, the part of the sentence which did not satisfy the conditions was substituted by the same part in the next sentence which fulfilled the condition. These steps were repeated until all twelve sentences had been generated. The total number of words (tokens) is 106 per language (73 types). As mentioned above, a number of words in the Swedish and the Danish generator were disyllabic. In the sentences which were generated for the experiment, 10 of the 15 Danish verbs and 11 of the Swedish verbs were disyllabic. Furthermore, two of the three Danish question words were disyllabic. The rest of the words were monosyllabic. (1) and (2) are examples of SUS sentences used in the experiment. The full set of SUS-items in Danish and Swedish can be found in [Appendix A](#).

- (1) Structure S2:
En rød nat tager et navn (Danish)
En röd natt tar ett namn (Swedish)
 ‘A red night takes a name’
- (2) Structure S3
Vis en sol og en bog (Danish)
Visa en sol och en bok (Swedish)
 ‘Show a sun and a book’

2.1.2. Spontaneous sentences

We used two kinds of spontaneous sentences. Half of the sentences were collected by means of so-called map tasks (cf. Anderson et al., 1991; Brown et al., 1984). Grønnum (2009) used this method to collect materials for a Danish Spontaneous Speech corpus (DanPASS). Part of these materials was used for our experiment and we made Swedish recordings in the same manner. The map tasks result in speech which is syntactically varied but the variation in content words in the material is rather limited. For this reason we also had the speakers describe pictures showing common words and activities. This method has been developed by van Bezooijen and van den Berg (1999). The other half of the sentences were taken from this material.

2.1.2.1. Map task. The map task involved the cooperation of two participants who knew each other well in order to make them feel as comfortable as possible. They were seated in separate locations, one of which was the phonetic department's recording studio at the University of Copenhagen, while the other was a recording facility established for the purpose in the main control room, with curtains of very heavy material surrounding the speaker. The speakers communicated via headsets. They were recorded through professional headset microphones (Voice Technologies VT700), directly onto CD-ROM (HHB Professional Compact Disc Recorder CDR-850) to separate channels in a stereo recording. In this way recordings of good quality were achieved.

Each participant had a map. One, the instruction giver, had a route on his or her map; the other, the instruction follower, did not. Their goal was to collaborate so as to reproduce the giver's route on the follower's map. The maps were not exactly identical: landmarks were missing on one or the other map, a landmark might appear twice – in two different locations – on one map but not on the other; and the same landmark may have slightly different names on the two maps. This gave rise to a true negotiation, with questions and answers, backtracks, etc. Participants were explicitly informed about these irregularities in written instructions prior to the recording. It was left to them, however, to discover how and where the maps or the designations differed, and to supply the missing items and correct names on their respective maps. Each pair of speakers completed four different sets of maps.

2.1.2.2. Picture descriptions. The pictures to be described by the speakers showed five different everyday situations including common objects in and around the house: a woman peeling potatoes in a kitchen, a baby in a living room, a couple and their baby sleeping in a bed room, a shopping street with two women, and a garden with laundry on a clothes-line. The subjects were asked to describe

the pictures as detailed as possible, including the position of people and objects with respect to each other.

2.1.2.3. Selection of sentences. From the recordings, six sentences or fragments were selected per speaker from the map task materials and another six from the picture description task. The selection of the sentences was based on the following criteria:

- Sentences should contain six or seven words only.
- Sentences should constitute single prosodic entities, i.e. contain no internal audible phrase boundaries.
- Sentence types should vary.
- Swedish and Danish sentences should be as similar as possible in terms of vocabulary and sentence type.
- Words should be in both the Danish and Swedish top-5000 frequency lists.
- Words should be cognates in Danish and Swedish.

In (3) and (4) we give examples of Danish and Swedish spontaneous sentences, respectively. The complete list of sentences in both languages can be found in Appendix B.

- (3) *Så den hedder altså den grønne sø* (Danish)
'So that is called the green lake'
- (4) *Nedanför sängen sitter det en liten råtta* (Swedish)
'Under the bed there is a little rat'

2.1.3. Isolated cognate words

Ideally, the same words should be tested as were used in the SUS items. This would provide the best basis for a comparison of the intelligibility results of these to kinds of stimulus materials. However, it would result in a design which would demand the testing of too many groups of subjects or in too long test sessions. For this reason we took care to select the isolated words on the basis of the same criteria as the words in the SUS items. This still makes it possible to compare the results. We decided to include only nouns so that the subjects had a cue to syntactic category as in the case of the SUS items.

The 24 words were selected in the same way as the words in the SUS-generator. This means that the words met the following criteria:

- monosyllabic,
- cognates,
- among the 5000 most frequent words,
- singular,
- unambiguous in terms of their phonological shape and syntactic category.

The mean relative frequencies of the words were almost the same in the two languages (0.013 for Danish ranging between 0.002 and 0.042, and 0.010 for Swedish ranging between 0.003 and 0.030). The correlation between the Swedish and Danish word frequencies is high ($r = 0.89$). Examples of cognate words are given in (5). A complete

listing of the Swedish and Danish isolated cognates is given in [Appendix C](#).

(5)

Danish		Swedish		English
hund	[hunʰ]	hund	[hønd]	‘dog’
hav	[hau]	hav	[ha:v]	‘sea’
luft	[lofd]	luft	[løft]	‘air’
bror	[brø:ɾ]	bror	[brø:r]	‘brother’

2.1.4. Non-cognates

Listeners with prior experience with the L2 would be able to understand the language on the basis of knowledge and not on the basis of linguistic similarity only. In order to quantify the amount of experience of the listeners with the L2, they were asked to translate 12 non-cognate L2 words. Since non-cognates are per definition unintelligible to listeners with no prior experience with the L2, the number of correctly translated non-cognates is a priori a good measure of experience. The non-cognates were presented to the L2 listeners only, together with the isolated cognate words. We are not aware of prior use of this method of determining a listener’s familiarity with a closely-related neighboring language.

The non-cognates were selected from top-5000 in the frequency lists that were also used for the SUS-tests (see [Section 2.1.1](#)). It is important that the words are frequent because otherwise the listeners may never have heard them even though they had experience with the L2. The mean relative frequency of both the Swedish and the Danish non-cognates is 0.008, ranging from 0.002 to 0.039 for Danish and from 0.002 to 0.037 for Swedish. Examples of non-cognates are given in (6). The complete list is given in [Appendix D](#).

(6)

Swedish	English	Danish	English
fråga	‘question’	evne	‘ability’
känsla	‘feeling’	avis	‘newspaper’
hot	‘threatening’	skuffelse	‘disappointment’
pojke	‘boy’	værelse	‘room’

2.1.5. Speakers

The three youngest male speakers from the DanPASS corpus (see [Section 2.1.2](#)) were selected. They were born in either 1976 or 1977. They were (former) students from the Department of General and Applied Linguistics at the University of Copenhagen, and they hailed from the greater Copenhagen area. The spontaneous speech which had already been recorded of these speakers was used. The same speakers were asked to come back for a recording of the SUS sentences and the isolated words.

The Swedish speakers were matched as well as possible with the Danish speakers. They had the same age, originated

from Stockholm and were students of linguistics at the University of Stockholm. New recordings of all speaking styles were made in the same way as for the Danish speakers.

2.1.6. Speech manipulations

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 imitated a situation where the speaker is in the midst of a crowd of people. Babble noise is held to be the most effective and least obnoxious masker of speech. We used babble noise produced at TNO Soesterberg, which is composed of digital recordings of 100 speakers in a cafeteria.⁴ We then eliminated remaining fluctuations in intensity by applying hard limiting (reducing high intensity portions by 6 dB, as implemented in Adobe Audition software) so that the remaining intensity fluctuations were virtually nil. An extremely stable portion with a duration of approximately 10 s was then selected as our fixed basic noise.

The noise was amplitude modulated so 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 to the original recording, in steps of 3 dB from 0 to –9 dB speech-to-noise ratio (SNR) (i.e. from easy to difficult). This resulted in five different versions. Version 1 is the downsampled copy of the original recording (‘clean’), version 2 was mixed with 0 dB noise (noise has the same level as the target speech), 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.

2.2. Experiment

2.2.1. Design

A total of 12 spontaneous sentences, twelve SUS items, 24 isolated cognate words and 12 non-cognate words were tested. The SUS items and the isolated cognate words were tested in a crossed design so that all sentences and words by each of the six speakers were tested. The spontaneous sentences are all different and for this reason a crossed design is not necessary for this type. First the isolated words (cognates and non-cognates) were tested, next the SUS items, and finally the spontaneous sentences.

Each listener listened to two spontaneous sentences, two SUS items and four isolated words for each of the three L1 and L2 speakers (see overview in [Table 1](#)). Half of the listeners listened to the neighboring language first (part A of table) and the other half listened to their own language first (part B of table). Twelve groups of listeners had to be tested in total.

⁴ This babble noise can be downloaded from <http://spib.rice.edu/spib/data/signals/noise> (last accessed 19 January 2010).

Table 1

Overview of the number of test items per listener. A: listeners who begin with speakers of the neighboring language. B: listeners who begin with speakers of their own language.

A	L2 speakers			L1 speakers			Total
	A	B	C	D	E	F	
Cognates	4	4	4	4 ($\times 5$ SNR)	4 ($\times 5$ SNR)	4 ($\times 5$ SNR)	72
Non-cognates	4	4	4				12
SUS	2	2	2	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	36
Spontaneous	2	2	2	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	36
B	L1 speakers			L2 speakers			Total
	A	B	C	D	E	F	
Cognates	4 ($\times 5$ SNR)	4 ($\times 5$ SNR)	4 ($\times 5$ SNR)	4	4	4	72
Non-cognates				4	4	4	12
SUS	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2	2	2	36
Spontaneous	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2 ($\times 5$ SNR)	2	2	2	36

The test was carried out on the computer.⁵ All subjects listened to the stimuli via headphones, individually or in small groups. While the isolated words were presented only once, the read and spontaneous sentences were presented twice, with a 1-s pause in between the first presentation and the repetition, in order to exclude effects of memory limitations.

2.2.2. Listeners

Eighteen Danish and 24 Swedish listeners were tested. The Danish subjects were university students from Roskilde University, all living at the Island of Sealand with a mean age of 24.2 years ranging from 20 to 27 years. These listeners spoke the same standard variety of Danish as the speakers. The Swedish students were from Stockholm University with a mean age of 22.6 years ranging from 19 to 27 years. These listeners spoke the same variety of standard Swedish as the Swedish speakers did. None of the listeners reported hearing problems.

In addition to translation of non-cognates (see Section 2.1.4) the listeners were asked how much contact they had with the neighboring language in its spoken form. They rated the frequency of contact (live and/or through spoken media) on a 6-point scale as follows: (1) ‘daily’, (2) ‘more than once a week’, (3) ‘more than once a month’, (4) ‘more than once a year’, (5) ‘less than once a year’ and (6) ‘never’.

The results (see Section 3) showed that the Danish listeners were more familiar with spoken Swedish (as evidenced by the number of non-cognates they translated correctly and by the self-estimated intensity of contact with the neighboring language) than the Swedes were with spoken Danish. A difference in familiarity with the neighboring language would explain an asymmetry in mutual intelligibility between the two languages, should it be found. We therefore decided to extend the group of Danish listeners by including 30 listeners who hailed from the Århus area, which is much further away from the Swedish

border, and who could accordingly be expected to have less familiarity with spoken Swedish. We then selected a group of 20 Swedish listeners from the original 24, and a group of 20 Danish listeners from the augmented group such that the two groups were matched in terms of familiarity with the neighboring language.

3. Results

We will first present the results of the intrinsic intelligibility tests, i.e. when speakers and listeners share the same native language (Section 3.1). Here we test the hypothesis that Swedish listeners will understand the Swedish speakers under more adverse speech-to-noise ratios while Danish listeners can only understand the Danish speakers when the SNR is more benign. In the second part of the analysis we will deal with the cross-linguistic part of the experiment, where Danish listeners respond to Swedish speakers and Swedish listeners decode Danish speakers. Here we expect to replicate the asymmetry observed before between Danish and Swedish (see references in Section 1), even if the expected difference in intrinsic intelligibility should not be obtained. The cross-linguistic comparison will be made twice. The first time we will compare the intelligibility of the neighboring language for the exact same groups of listeners who also participated in the intrinsic intelligibility test (Section 3.2). The second time we will include only groups of the Danish and Swedish listeners that we matched in terms of familiarity with the neighboring language (Section 3.3).

3.1. Intrinsic intelligibility

Intelligibility was expressed as the percentage of content words correctly reported, disregarding any errors in the recognition of function words (in SUS items and spontaneous sentences). Misspellings, which hardly ever occurred, were not counted as errors.

Fig. 1A–C presents percentages of correctly recognized content words in each of the three parts of the experiment, i.e. for cognate words, words in SUS items and words in

⁵ For details of the experimental procedure including verbatim text of the instructions (in Danish and in Swedish), see <http://www.let.rug.nl/dsic>.

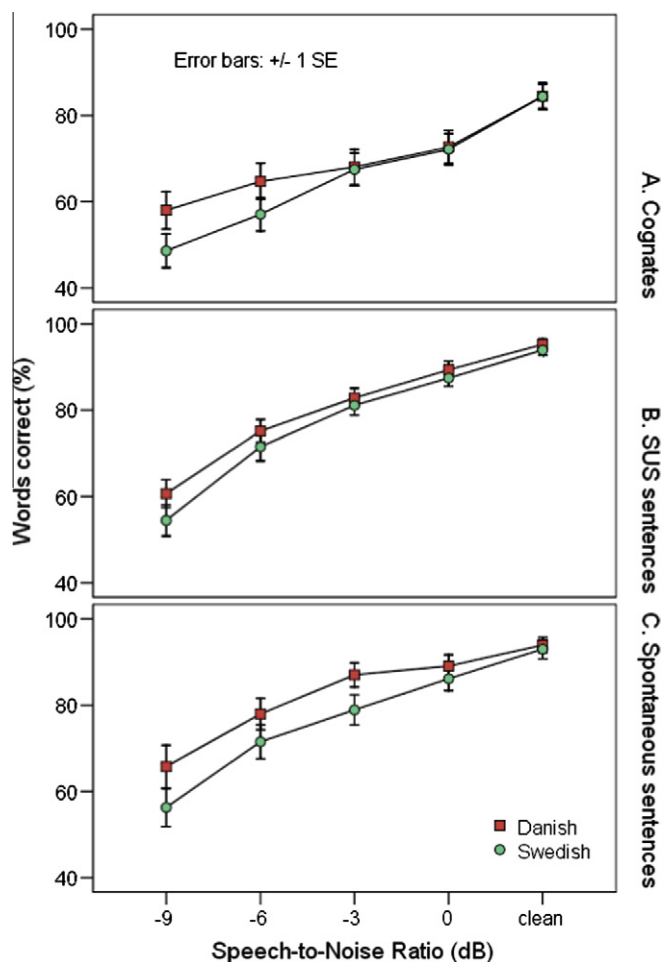


Fig. 1. Intrinsic intelligibility of Danish and Swedish. Percentage of correctly recognized target words as a function of speech-to-noise ratio and broken down by speaker/listener group. The test battery comprised three components: cognate words (panel A), words in SUS sentences (panel B) and words in spontaneous sentences (panel C). Swedish means are based on 24 listeners, Danish means on 18 listeners. The error bars are ± 1 standard error of the mean.

spontaneous sentences, respectively. In the panels the scores are broken down by Speech-to-Noise Ratio (SNR) plotted from left to right from adverse to benign, with separate lines for Danish and Swedish speakers/listeners.

The results were analyzed by a repeated-measures Analysis of Variance (RM-ANOVA) with SNR and test component as within-listener factors, and language of speaker/listener as a between-subjects factor. Within each test component, the data were averaged over speakers (three speakers per language) and over items (24 for cognate words, and 12 items for the two sentence components each).

The results of the ANOVA are summarized in Table 2. The ANOVA shows a main effect of test component. This effect is caused by the lower overall mean scores on the cognates. Since the effect is found in both the Danish and the Swedish half of the data, the component \times language interaction is insignificant and can be disregarded.

All three panels of Fig. 1 show the same effect of SNR: the percentage of words correctly recognized increases

Table 2

Effects and interactions in within-language intelligibility test. Degrees of freedom of numerator (df1) and denominator (df2) terms, F ratio (F) and probability (p) are indicated ($\alpha = 0.05$).

Effect/interaction	df1	df2	F	p
Language (L)	1	40	<1.0	ins
SNR (S)	4	160	151.7	<0.001
Test component (T)	2	80	14.5	<0.001
L \times S	4	160	1.2	ins
L \times T	2	80	<1.0	ins
S \times T	4	320	3.8	=0.002
L \times S \times T	8	320	<1.0	ins

monotonically from about 50 for the -9 -dB SNR to roughly 90 for the most benign SNR ('clean'). The main effect of SNR is significant (see Table 2). There is no interaction between SNR and language. There is, however, a small interaction between SNR and test component. No other interactions reach significance. Crucially, the results also show that there is no overall difference in performance level between the Danish and the Swedish speaker/listener combinations. In fact, the Danish listeners seem to withstand a more adverse SNR than the Swedes but the difference fails to reach significance.

3.2. Cross-language intelligibility

In the preceding section we established that Danish is not intrinsically less intelligible than Swedish. In the present section we will check to what extent we can replicate the previously reported finding (see Section 1) that Danes understand spoken Swedish better than Swedes understand spoken Danish. For this part of the data analysis we only use the versions of the materials that were presented in quiet ('clean'). Fig. 2 shows the results. It plots percent correctly recognized (i.e. translated) content words separately for the three test components (cognate words in panel A, words in SUS items in panel B and words in spontaneous sentences in panel C). In each panel we present the means for four combinations of speaker and hearer native language.

The data were analyzed by an RM-ANOVA, with stimulus language (Danish, Swedish), test component (cognates, SUS, Spontaneous) as within-listener factors, and native language of the listener as a between-subjects factor. As before, the data were accumulated over speakers and items. The results are summarized in Table 3.

The results show that the three test components are roughly equally difficult so that there is no effect of test component. Overall, the Danish materials are more difficult to understand than the Swedish counterparts, which yields a significant effect of stimulus language. As we have seen in the previous section, however, the two languages are equally difficult for native listeners (recognition scores around 90%); therefore the effect of stimulus language is entirely due to the asymmetry in the cross-language conditions. Indeed, Danish listeners obtain a mean correct word recognition scores with the Swedish materials of 70%, while

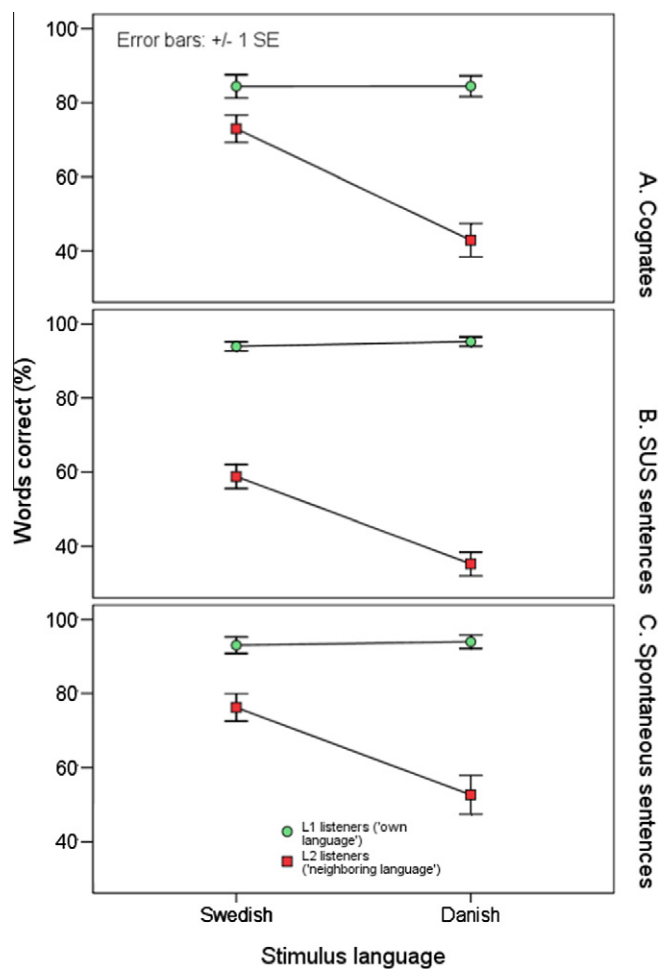


Fig. 2. Intelligibility scores (percent correctly recognized words) for Swedish and Danish materials as perceived by L1 listeners (decoding their own language) and by L2 listeners (decoding the neighboring language). Swedish means are based on 24 listeners, Danish means on 18 listeners. Further see Fig. 1.

Table 3
Effects and interactions in cross-language intelligibility test. Further see Table 2.

Effect/interaction	df1	df2	<i>F</i>	<i>p</i>
Listener type (L)	1	45	170.6	<0.001
Stimulus language (S)	1	45	23.5	<0.001
Test component (T)	2	45	1.7	n.s.
L × S	2	45	42.4	<0.001
L × T	2	45	6.2	0.004
S × T	2	45	<1.0	n.s.
L × S × T	2	45	<1.0	n.s.

Swedish listeners have much poorer recognition scores with the Danish materials, with a mean of 43%. As a result, the interaction between stimulus language and listener language is significant. Moreover, we find this configuration of results for each of the three test components, so that there is no third-order interaction.

Finally, there is a small interaction between listener type and test component. In the SUS sentence part of the test

the discrepancy between listening to the own language (almost perfect scores) and to the neighboring language (between 40% and 60% correct word recognition) is larger than in the other two test components. Apparently, the SUS test polarizes relative to the other tests.

3.3. Controlling for familiarity with the neighboring language

In total 24 Swedish and 18 Danish listeners participated in the experiment. Since we aimed to test the mutual intelligibility of Standard Swedish and Standard Danish, speakers and listener groups had to be sampled from areas where the standard varieties of the languages are spoken, i.e. in the Stockholm and Copenhagen areas. Stockholm is geographically much further away from the border Danish–Swedish border than Copenhagen. One would expect language contact and familiarity with the neighboring language to be asymmetrically distributed between the Swedish and Danish listener groups, such that Danes have more contact and familiarity with Swedish than vice versa. In order to ascertain to what extent familiarity with the neighboring language might have brought about the asymmetry in mutual intelligibility as determined in Section 3.2, we analyzed the results of two familiarity measures collected in the experiment. We computed the percentage of correctly translated non-cognates in the neighboring language for the Danish and Swedish listeners. We also asked our listeners, before running the listening test, to rate the intensity of their contact with the neighboring language. Ideally, our Danish and Swedish listeners should be perfectly matched on both familiarity measures.

Table 4 cross-tabulates the self-estimated intensity of contact with the neighboring language against the number of non-cognates correctly translated, for Swedish and Danish listener groups separately.

The assumption of no familiarity with the neighboring language is largely met by the Swedish listeners. Twenty-two out of 24 Swedish listeners are unable to translate even a single Danish non-cognate, one Swede correctly translated two non-cognates, and one even three, even though all non-cognates were chosen to be highly frequent words in the language. Since this functional measure hardly varies in the Swedish listener group, it does not correlate with the self-reported intensity of contact with the neighboring language, Spearman's $\rho = -0.046$ (n.s.).

The assumption is not met in the case of our Danish listeners. The Danes always recognize at least three of the 12 Swedish non-cognates, and five Danes get more than 50% of the non-cognates. Closer inspection of the Danish responses reveals that the same three non-cognates were always correctly translated by all listeners. These were the Swedish words *fråga* ‘question’, *pojke* ‘boy’ and *flicka* ‘girl’. We argue, in hindsight, that these three words are not indicative of lexical knowledge of Swedish. Danes recognize *fråga* as a cognate of German *Frage*, which they learnt

Table 4
Self-estimated frequency of contact with the neighboring language in spoken form cross-tabulated against number of correctly translated high-frequency non-cognates, for Swedish ($N = 24$) and Danish ($N = 18$) listeners.

Contact	No. of con-cognates translated correctly (max = 12)										Total	
	0	1	2	3	4	5	6	7	8	9		10
<i>Listener group</i>												
Swedish												
Daily												0
>1 × week	2											2
>1 × month	4											4
>1 × year	8		1	1								10
<1 × year	6											6
Never	2											2
Danish												
Daily												0
>1 × week				1	1				1			4
>1 × month				1	4	2	0	2			1	9
>1 × year				4			1					5
<1 × year												0
Never												0

at school. They may know *pojke* and *flicka* from a popular song (*Sköna flicka*, ‘pretty girl’ by Kim Larsen), which is sung in Danish but contains a few lines in Swedish, German and French. We therefore decided to discard these three words as indices of language contact with Swedish. But even if we do, the Danish listeners on average have a non-negligible lexical knowledge of Swedish. Moreover, lexical knowledge correlates weakly but significantly with self-estimated language contact, $\rho = -0.444$ ($p = 0.032$, one-tailed).

The Danish and Swedish listener groups differ in terms of both variables capturing experience with the neighboring language, $\chi^2(4) = 11.6$ ($p = 0.020$) for self-estimated contact and $t(18.9) = 3.3$ ($p = 0.004$, two-tailed, with Levene’s correction for unequal variances) for percentage of correctly translated non-cognates. A multiple regression analysis predicting the cross-language intelligibility scores from the two familiarity measures shows that familiarity does indeed explain a substantial amount of the variance in the intelligibility scores, i.e. $R^2 = 40.1\%$, $F(2, 39) = 13.1$ ($p < 0.001$) for isolated cognates, $R^2 = 25.5\%$, $F(2, 39) = 6.7$ ($p = 0.003$) for SUS-items, and $R^2 = 26.5\%$, $F(2, 39) = 7.0$ ($p = 0.002$) for spontaneous sentences.

In the remainder of this section we will try to show that the asymmetry in mutual intelligibility between Danish and Swedish persists even when we eliminate the difference in familiarity with the neighboring language. We composed Danish and Swedish listener groups which were matched for familiarity partly by selecting specific individuals from the existing dataset, and by enlisting a new group of Danish listeners who live far away from the Swedish border, thereby reducing the likelihood of language contact with Swedish.

First, from the original group of 18 Copenhagen listeners we selected seven individuals who did not know any of the nine crucial non-cognate Swedish words that had been included in the isolated word recognition test as a means to

check the subjects’ lexical knowledge of the neighboring language. This selection of speakers was too small to make any meaningful comparisons with the Swedish group, so as a second step we reran the experiment with an additional group of 30 listeners from the Århus area (tested at Århus University using exactly the same setup and procedures as explained in Section 2). From these 30 listeners we selected only those who were unable to translate any of the nine crucial non-cognates, which limited their number to 16. This left a group of 7 (Copenhagen) plus 16 (Århus) listeners with no functional lexical knowledge of Swedish. From this set of 23 we finally eliminated three listeners who claimed they had exposure to Swedish on a weekly basis, leaving a group of 20 Danish listeners with exposure to Swedish between at least once a month and less than once a year. Table 5 summarizes the distribution of the 20 Danes and 20 Swedes over the remaining contact categories.

As a result of the trimming and recomposition of the Danish and Swedish listener groups, no significant differences remain between the listener groups in terms of lexical knowledge of or familiarity with the neighboring language, $\chi^2(2) = 1.8$ ($p = 0.403$). If prior exposure and familiarity with the non-native language were indeed the cause of the asymmetry in mutual intelligibility between Danes

Table 5
Samples of Danish ($N = 20$) and Swedish ($N = 20$) listeners, with no lexical knowledge of the neighboring language and matched for self-estimated frequency of contact with the neighboring language.

Exposure to neighboring language	Danes	Swedes
1. Daily	0	0
2. Once a week	0	0
3. One a month	7	4
4. Once a year	10	10
5. Less than once a year	3	6
6. Never at all	0	0
Total	20	20

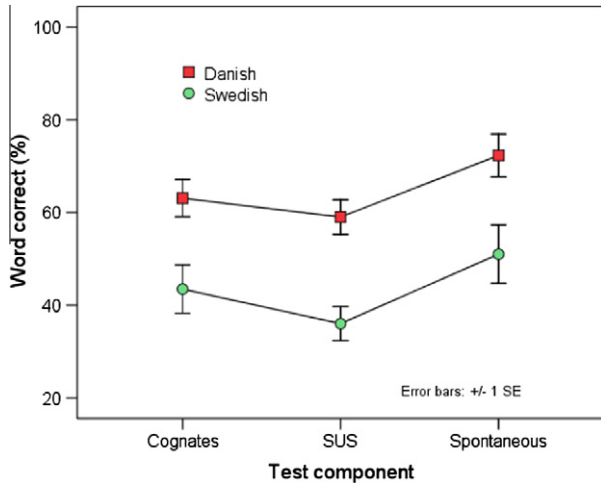


Fig. 3. Intelligibility scores (percent correctly recognized words) obtained on three test components by Danish listeners decoding Swedish (squares) and by Swedish listeners decoding Danish (circles). Listener groups (20 Danes, 20 Swedes) were matched with respect to lexical knowledge of and familiarity with the non-native language. Error bars are \pm standard error of the mean.

and Swedes, no asymmetry should be found in the cross-language intelligibility scores.

Fig. 3 displays the mean word recognition scores obtained in each of the three test components (isolated cognates, SUS items, spontaneous sentences) by Danes listening to Swedish (squares) and by Swedes listening to Danish (circles). The data were submitted to an RM-ANOVA with test component as a within-listener factor and native language of the listener (and by implication the stimulus language) as a between-listener factor.

Overall, Danes decoding Swedish materials obtain a mean score of 66% correct word recognition, while Swedes responding to Danish materials obtain a mean score of 44%. The difference of 22 percentage points in favor of the Danish listeners is highly significant, $F(1, 38) = 20.9$ ($p < 0.001$). As before, the effect of test component is also highly significant, $F(1.9, 71.7) = 12.6$ ($p < 0.001$). Recognizing the key words in the spontaneous sentences (64% correct) is easier than recognizing the targets in either the isolated cognates (54% correct) or in the SUS part of the test (50% correct), which do not differ significantly from each other (Bonferroni post hoc test with $\alpha = 0.05$). The interaction between the listener group and the test component is non-significant, $F(1.9, 71.7) < 1$.

In the less stringently controlled datasets where the listener groups were not matched for familiarity with the neighboring language, the asymmetry was somewhat stronger, with an overall mean score for Danes listening to Swedish materials of 70%, and 43% correct for Swedes responding to Danish. The mean difference of 27 percentage points is only marginally larger than the one obtained for the present controlled datasets. The results of this control experiment therefore show that the asymmetry in mutual intelligibility between Danish and Swedish largely

persists even when the listener groups are equalized in terms of familiarity with the neighboring language.

4. Discussion and conclusions

In this study we aimed to find an explanation for the often observed asymmetry in mutual intelligibility between Swedish and Danish. The simplest possible explanation for the fact that Danes understand Swedish more readily than Swedes understand Danish would be that spoken Danish is intrinsically difficult. And indeed, there is abundant circumstantial evidence supporting the view that spoken Danish is intrinsically more difficult than other Scandinavian languages. We also expected to find that Danish listeners would have greater problems decoding Danish speech in sentences rather than in isolated words, since more assimilation and reduction phenomena are reported across word boundaries than word internally. The results of our intelligibility test, however, show that Danish is as easy (or as difficult) to understand for Danish native listeners as is Swedish for Swedish native listeners. Moreover, we did not find a larger discrepancy in performance between recognition at the word and sentence level, whether in read-out semantically unpredictable sentences or in sentences taken from spontaneous interaction in map tasks.

At the same time, our study replicated the asymmetry between spoken Danish and Swedish. Our Danish listeners were clearly better at understanding the Swedish version of the materials than vice versa. However, when we compared the relative familiarity of the original (Copenhagen) Danish and (Stockholm) Swedish listener groups with the neighboring language, it was found that the Danish listeners were clearly more familiar with spoken Swedish than the Swedes were with spoken Danish, and that a substantial percentage of the cross-language intelligibility scores could be accounted for by the difference in familiarity with the neighboring language.

In order to rule out experience with the neighboring language as a confounding factor in the experiment, we recruited a new group of Danish listeners from the Western part of the country, i.e. in Århus, where contact with Swedish and Swedish-spoken media would be minimal. It was shown that the asymmetry in cross-language intelligibility was largely maintained: the asymmetry amounted to 27 percentage points favoring Swedish when the Danish and Swedish listener groups were not matched for experience with the neighboring language, of which no less than 22 percentage points persisted when we reran the experiment with matched listener groups. If it is accepted that the matching of our listener groups (on the basis of self-reported contact and knowledge of non-cognate vocabulary in the other language) is basically valid, and that using other measures of familiarity or experience with the neighboring language would not yield basically different results, then we may conclude that difference in familiarity with the neighboring language can at best explain only a relatively small part

of the asymmetry in mutual intelligibility between Danish and Swedish.

If the asymmetry in mutual intelligibility between Danish and Swedish cannot be explained by poorer intrinsic intelligibility of Danish (relative to that of Swedish) nor by differences in familiarity with, or attitude towards, the neighboring language, then what other factor (or factors) may account for the difference? At this time we believe that the relationship between the orthography and the pronunciation in Danish and Swedish is the most promising source of explanation for the asymmetry in mutual intelligibility of the spoken language. There is increasing psycholinguistic evidence that hearing sounds also activates a visual orthographic representation of these sounds (e.g. Perre and Ziegler, 2008; Perre et al., 2009). When a Danish listener hears the Swedish sound sequence [hønd] dog', a sequence which is unknown in Danish, the sounds still activate the visual representation *hund*, which is the orthographic shape of the Danish word for dog, although the final /d/ is not pronounced in Danish. Conversely, when a Swede hears the Danish sounds [hun'], no visual word shape ending in *d* is activated, so that the recognition of the Swedish word *hund* is not facilitated through orthographic mediation. It is this possibility that we will investigate in the immediate future.

Appendix A. Semantically unpredictable sentences

S2 = Transitive structure: det + adj + noun + trans verb + det + noun.

S3 = Imperative structure: trans verb + det + noun + conj + det + noun.

S4 = Interrogative structure: quest + trans verb + det + noun + det + adj + noun.

S5 = Relative structure: det + noun + trans verb + det + noun + rel pron + intrans verb.

	Danish	Swedish	English
S2 1.	En rød nat tager et navn	En röd natt tar ett namn	'A red night takes a name'
5.	En fri jord svarer en ven	En fri jord svarar en vän	'A free earth answers a friend'
9.	En stærk chef ejer en smag	En stark chef äger en smak	'A strong boss owns a taste'
S3 2.	Kend en skyld eller et krav	Känn en skuld eller ett krav	'Know a fault or a demand'
6.	Vis en sol og en bog	Visa en sol och en bok	'Show a sun and a book'
10.	Støt et valg og en strøm	Stöd ett val och en ström	'Support a choice and a current'

	Danish	Swedish	English
S4 3.	Hvor elsker en sten et sent hul?	Var älskar en sten ett sent hål?	'Where does a stone love a late hole?'
7.	Hvordan når et brud et fint ben?	Hur når ett brott ett fint ben?	'How does a break reach a nice leg?'
11.	Hvornår lægger en prins en lav skov?	När lägger en prins en låg skog?	'When does a prince lay a low forest?'
S5 4.	Et æg kræver en tekst som håber	Ett ägg kräver en text som hoppas	'An egg demands a text that hopes'
8.	Et folk deler et job som går	Ett folk delar ett jobb som går	'A people shares a job that walks'
12.	Et greb køber en jagt som lyser	Ett grepp köper en jakt som lyser	'A grasp buys a hunt that shines'

Appendix B. Spontaneous sentences

	Swedish	English
1A.	Den är väldigt långt upp till höger	'It is very far up to the right'
2A.	Vad var det du hade där	'What was it you had there?'
3A.	Men du hade den där parkerade bilen	'But you had that parked car'
4A.	Så har du får och getter eller	'So do you have sheep and goats or'
5A.	Du går på högra sidan om den	'You go on the right side around it'
6A.	Så svänger du ner då till vänster	'Then you turn down then to the left'
7A.	På bordet står en skål med frukter	'On the table is a bowl with fruits'
8A.	Dom här tre husen står på rad	'These three houses are in a row'
9A.	Så har vi fyra stycken ägg	'Then we have four eggs'
10A.	Så hänger här tre saker i krokar	'Then here three things are hanging on hooks'
11A.	Så har vi den fjärde bilden	'Then we have the fourth picture'
12A.	Så har vi ett stort hus	'Then we have a big house'
1B.	Att vi kommer runda din privata mark	'That we will go around your private land'

	Swedish	English		Danish	English
2B.	Sedan ska vi göra en liten sväng neråt	'Next we will make a small turn downwards'	1D.	Det er et dårligt kort jeg har	'It is a bad map that I have'
3B.	Jag har en parkerad lastbil längst upp	'I have a parked lorry right at the top'	2D.	Du skal syd om den store klippe	'You must go south of the large rock'
4B.	De har bytt plats på dem	'They have swapped their places'	3D.	Men det er et meget lille stykke	'But it is a very short distance'
5B.	Den ligger lite sydöst om start	'It lies a little south east of start'	4D.	Det var der hvor vi startede	'That is where we started'
6B.	Där kan du svänga skarpt uppåt	'There you can turn sharply upwards'	5D.	Den ligger på din højre side	'It lies at your right hand'
7B.	Barnet hänger över kanten och gråter	'The child hangs over the edge and cries'	6D.	Og så er du ved målet	'And then you reach the goal'
8B.	I höger bilden har vi ett bord	'In the right picture we have a table'	7D.	Huset til venstre det har en skorsten	'The house at the left has a chimney'
9B.	Nedanför ugnen ligger det en katt	'Beneath the oven lies a cat'	8D.	På den nederste hylde der er en ost	'On the bottom shelf there is a cheese'
10B.	I bilden syns det tre stora hus	'In the picture three big houses can be seen'	9D.	Man ser i øvrigt dørene til husene	'Furthermore you see the doors of the houses'
11B.	Butiken längst till vänster har en dörr	'The shop furthest to the left has a door'	10D.	Han har den venstre arm under hovedet	'He has his left arm under his head'
12B.	Nedanför sängen sitter det en liten råtta	'Beneath the bed there is a little rat'	11D.	Nedenfor på gulvet der er en mus	'Below on the floor there is a mouse'
1C.	Det ligger som mitt på pappret	'It lies in the middle of the paper'	12D.	Bagved stolen der står en spand	'Behind the chair there is a bucket'
2C.	Så har jeg en parkerad lastbil	'Then I have a parked lorry'	1E.	Har du den parkerede lastbil	'Do you have the parked lorry?'
3C.	Har du ett horn där någonstans	'Do you have a horn somewhere there?'	2E.	Så den hedder altså den grønne sø	'So it is called the green lake'
4C.	Den gröna sjön har jag långt upp	'The green lake I have toward the top'	3E.	Den går du også syd om	'You should go south of that as well'
5C.	Jag har en stor klippa längre ner	'I have a large rock further down'	4E.	Så der bevæger du dig over mod øst	'So there you move towards the east'
6C.	Men det sitter en och sover	'But somebody sits sleeping'	5E.	Så du er gået over broen nu	'So you have crossed the bridge now'
7C.	Då har jag en bild framför mig	'Then I have a picture in front of me'	6E.	Og så går du mod syd	'And then you go southwards'
8C.	På bordet så står det en gryta	'On the table there is a pan'	7E.	Midt på billedet er der et hus	'In the middle of the picture there is a house'
9C.	Så står det två personer och samtalar	'Then two people are standing talking to each other'	8E.	Huset har en dør til venstre	'The house has a door at the left hand'
10C.	Där vi har ett hus mitt i bilden	'There we have a house in the middle of the picture'	9E.	Nederst på billedet er der en hund	'At the bottom of the picture there is a dog'
11C.	Till höger så strålar det en sol	'At the right side a sun is shining'	10E.	Det venstre hus har en skorsten	'The house to the left has a chimney'
12C.	Dar ligger ett par och sover	'There lies a couple sleeping'	11E.	Og til højre ligger der en ost	'And at the right side there is a cheese'
			12E.	I højre side er der en seng	'On the right side there is a bed'
			1F.	Vent lidt den skal jeg lige have	'Wait a minute I have to have that one'
			2F.	Og så går du mod syd	'And then you go southwards'

	Danish	English
3F.	Den skal du syd om mod vest	'You go south of it westwards'
4F.	Jeg har også kun en grøn sø	'I also only have one green lake'
5F.	har du en anden sø siger du	'You have another lake you say'
6F.	Så skal du mod sydøst	'Then you must go southeast'
7F.	På billedet er der et hus	'In the picture there is a house'
8F.	Så tager jeg billede nummer tre	'Then I take picture number three'
9F.	På øverste hyld står der æh brød	'On the top shelf there is um bread'
10F.	Billede nummer fire forestiller en dame	'Picture number four depicts a lady'
11F.	Bagved sengen er der en væg	'Behind the bed there is a wall'
12F.	På bordet der står der en gryde	'On the table there is a pan'

Appendix C. Isolated words and their phonetic transcriptions according to Molbæk Hansen (1990) for Danish and Hedelin (1997) for Swedish (All Swedish monosyllabic nouns have accent 1)

#	Danish	Swedish	English
1.	tryk [tʁøŋ]	tryck [trʏk]	'pressure'
2.	hund [hun']	hund [hønd]	'dog'
3.	hav [hɑ u]	hav [hav]	'sea'
4.	luft [lofd]	luft [løft]	'air'
5.	bror [brø u]	bror [brør]	'brother'
6.	træ [tʁe']	trä [trɛ]	'tree'
7.	syn [sy'n]	syn [syn]	'sight'
8.	øl [øl]	öl [øl]	'beer'
9.	fart [fɑ'd]	fart [fɑt]	'speed'
10.	stil [sdi'l]	stil [sti:l]	'style'
11.	tur [tu' u]	tur [tør]	'tour'
12.	magt [mɑgd]	makt [markt]	'power'
13.	fred [fʁeð]	fred [fred]	'peace'
14.	brev [brø u]	brev [brɛv]	'letter'
15.	søn [søn]	son [son]	'son'
16.	kraft [krɑfd]	kraft [kraft]	'strength'
17.	bil [bi'l]	bil [bil]	'car'
18.	barn [bɑ'n]	barn [ban]	'child'
19.	råd [rɑð]	råd [rod]	'advice'
20.	ord [o' u]	ord [ud]	'word'
21.	sag [sɛ' i]	sak [sak]	'case'
22.	vej [v ai]	väg [vɛg]	'road'
23.	liv [li' u]	liv [liv]	'life'
24.	lyst [løsd]	lust [løst]	'desire'

Appendix D. Non-cognate words

#	Danish	Swedish
1.	gæld 'debt'	fråga 'question'
2.	uge 'week'	känsla 'feeling'
3.	evne 'ability'	vecka 'week'
4.	avis 'newspaper'	tvekan 'doubt'
5.	bolig 'residence'	syfte 'aim'
6.	bund 'bottom'	tidning 'newspaper'
7.	tavshed 'silence'	flicka 'girl'
8.	trussel 'threat'	botten 'bottom'
9.	vrede 'anger'	yrke 'profession'
10.	skuffelse 'disappointment'	hot 'threat'
11.	værelse 'room'	pojke 'boy'
12.	adgang 'entrance'	våning 'flat'

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