A corpus-based approach to topic in Danish dialog

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Abstract

We report on an investigation of the pragmatic category of topic in Danish dialog and its correlation to surface features of NPs. Using a corpus of 444 utterances, we trained a decision tree system on 16 features. The system achieved near-human performance with success rates of 84–89% and $F_1$-scores of 0.63–0.72 in 10-fold cross validation tests (human performance: 89% and 0.78). The most important features turned out to be preverbal position, definiteness, pronominalisation, and non-subordination. We discovered that NPs in epistemic matrix clauses (e.g. “I think . . .”) were seldom topics and we suspect that this holds for other interpersonal matrix clauses as well.

1 Introduction

The pragmatic category of topic is notoriously difficult to pin down, and it has been defined in many ways (Büring, 1999; Davison, 1984; Engdahl and Vallduví, 1996; Gundel, 1988; Lambrecht, 1994; Reinhart, 1982; Vallduví, 1992). The common denominator is the notion of topic as what an utterance is about. We take this as our point of departure in this corpus-based investigation of the correlations between linguistic surface features and pragmatic topicality in Danish dialog.

Danish is a verb-second language. Its word order is fixed, but only to a certain degree, in that it allows any main clause constituent to occur in the preverbal position. The first position thus has a privileged status in Danish, often associated with topicality (Harder and Poulsen, 2000; Togeby, 2003). We were thus interested in investigating how well the topic correlates with the preverbal position, along with other features, if any.

Our findings could prove useful for the further investigation of local dialog coherence in Danish. In particular, it may be worthwhile in future work to study the relation of our notion of topic to the $C_b$ of Grosz et al.s (1995) Centering Theory.

2 The corpus

The basis of our investigation was two dialogs from a corpus of doctor-patient conversations (Hermann, 1997). Each of the selected dialogs was between a woman in her thirties and her doctor. The doctor was the same in the two conversations, and the overall topic of both was the weight problems of the patient. One of the dialogs consisted of 125 utterances (165 NPs), the other 319 (449 NPs).

3 Method

The investigation proceeded in three stages: first, the topic expressions (see below) of all utterances were identified¹; second, all NPs were annotated for linguistic surface features; and third, decision trees

1 Utterances with discourse regulating purpose (e.g. yes/no-answers), incomplete utterances, and utterances without an NP were excluded.
were generated in order to reveal correlations between the topic expressions and the surface features.

3.1 Identification of topic expressions

Topics are distinguished from topic expressions following Lambrecht (1994). Topics are entities pragmatically construed as being what an utterance is about. A topic expression, on the other hand, is an NP that formally expresses the topic in the utterance. Topic expressions were identified through a two-step procedure; 1) identifying topics and 2) determining the topic expressions on the basis of the topics.

First, the topic was identified strictly based on pragmatic aboutness using a modified version of the ‘about test’ (Lambrecht, 1994; Reinhart, 1982).

The about test consists of embedding the utterance in question in an ‘about-sentence’ as in Lambrecht’s example shown below as (1):

(1) He said about the children that they went to school.

This is a paraphrase of the sentence the children went to school which indicates that the referent of the children is the topic because it is appropriate (in the imagined discourse context) to embed this referent as an NP in the about matrix clause. (Again, the referent of the children is the topic, while the NP the children is the topic expression.)

We adapted the about test for dialog by adding a request to ‘say something about . . . ’ or ‘ask about . . . ’ before the utterance in question. Each utterance was judged in context, and the best topic was identified as illustrated below. In example (2), the last utterance, (2-D3), was assigned the topic TIME OF LAST WEIGHING. This happened after considering which about construction gave the most coherent and natural sounding result combined with the utterance. Example (3) shows a few about constructions that the coder might come up with, and in this context (3-iv) was chosen as the best alternative.

(2) D3 sid ned og lad mig høre, Annette (made-up name) sit down and let me hear, Annette
P1 jeg skal bare vejes I shall just be weighed
P2 og så skal jeg have svar fra sidste gang and then shall I have answer from last time
D2 så skal vi se en gang then let us see one time
D3 det... er... fjorten dage siden du blev vejet... it... is... fourteen days since you were weighed...

(3) i. Say something about THE PATIENT (=you).
ii. Say something about THE WEIGHING OF THE PATIENT.
iii. Say something about THE LAST WEIGHING OF THE PATIENT.
iv. Say something about THE TIME OF LAST WEIGHING OF THE PATIENT.

Creating the about constructions involved a great deal of creativity and made them difficult to compare. Sometimes the coders chose the exact same topic, at other times they were obviously different, but frequently it was difficult to decide. For instance, for one utterance Coder 1 chose OTHER CAUSES OF EDEMA SYMPTOM, while Coder 2 chose THE EDEMA’S CONNECTION TO OTHER THINGS. Slightly different wordings like these made it impossible to test the intersubjectivity of the topic coding.

The second step consisted in actually identifying the topic expression. This was done by selecting the NP in the utterance that was the best formal representation of the topic, using 3 criteria:

1. The topic expression is the NP in the utterance that refers to the topic.
2. If no such NP exists, then the topic expression is the NP whose referent the topic is a property or aspect of.
3. If no NP fulfills one of these criteria, then the utterance has no topic expression.

In the example from before, (2-D3), it was judged that det ‘it’ (emphasized) was the topic expression of the utterance, because it shared reference with the chosen topic from (3-iv).

If two NPs in an utterance had the same reference, the best topic representative was chosen. In reflexive constructions like (4), the non-reflexive NP, in this case jeg ‘I’, is considered the best representative.

(4) men jeg har ikke tabt mig but I have not lost me (i.e. lost weight)

In syntactically complex utterances, the best representative of the topic was considered the one occurring in the clause most closely related to the topic. In the following example, since the topic was THE PATIENT’S HANDLING OF EATING, the topic expression had to be one of the two instances of jeg ‘I’. Since the topic arguably concerns ‘handling’ more than ‘eating’, the NP in the matrix clause (emphasized) is the topic expression.
A final example of several NPs referring to the same topic has to do with left-dislocation. In example (6), the preverbal object 'him' is immediately preceded by its antecedent 'my father'. Both NPs express the topic of the utterance. In Danish, resumptive pronouns in left-dislocation constructions always occur in preverbal position, and in cases where they express the topic there will thus always be two NPs directly adjacent to each other which both refer to the topic. In such cases, we consider the resumptive pronoun the topic expression, partly because it may be considered a more integrated part of the sentence (cf. Lambrecht (1994)).

The intersubjectivity of the topic expression annotation was tested in two ways. First, all the topic expression annotations of the two coders were compared. This showed that topic expressions can be annotated reasonably reliably ($\kappa = 0.70$ (see table 1)). Second, to make sure that this intersubjectivity was not just a product of mutual influence between the two authors, a third, independent coder annotated a small, random sample of the data for topic expressions. This showed that topic expressions can be annotated reasonably reliably ($\kappa = 0.70$ (see table 1)).

3.2 Surface features

After annotating the topics and topic expressions, 16 grammatical, morphological, and prosodic features were annotated. First the smaller corpus was annotated by the two main coders in collaboration in order to establish annotating policies in unclear cases. Then the features were annotated individually by the two coders in the larger corpus.

**Grammatical roles.** Each NP was categorized as grammatical subject (sbj), object (obj), or oblique (obl). These features can be annotated reliably (sbj: $C_1 = 208, C_2 = 207, C_1+2 = 207, \kappa_{sbj} = 0.70$; obj: $C_1 = 110, C_2 = 109, C_1+2 = 106, \kappa_{obj} = 0.97$; obl: $C_1 = 30, C_2 = 50, C_1+2 = 29, \kappa_{obl} = 0.83$).

**Morphological and phonological features.** NPs were annotated for pronominalisation (pro), definiteness (def), and main stress (str). (Note that the main stress distinction only applies to pronouns in Danish.) These can also be annotated reliably (pro: $C_1 = 289, C_2 = 289, C_1+2 = 289, \kappa_{pro} = 1.00$; def: $C_1 = 319, C_2 = 318, C_1+2 = 318, \kappa_{def} = 0.99$; str: $C_1 = 226, C_2 = 226, C_1+2 = 203, \kappa_{str} = 0.80$).

In addition to this, NPs occurring in pre-verbal position were annotated for whether they were repetitions of a left-dislocated element (ldis). Example (8) further exemplifies the three position-related features.

All three features can be annotated highly reliably (pre: $C_1 = 142, C_2 = 142, C_1+2 = 142, \kappa_{pre} = 1.00$; post: $C_1 = 88, C_2 = 88, C_1+2 = 88, \kappa_{post} = 1.00$; ldis: $C_1 = 2, C_2 = 2, C_1+2 = 2, \kappa_{ldis} = 1.00$).

**Marked NP-fronting.** This group contains NPs fronted in marked constructions such as the passive (pas), clefts (cle), Danish ‘sentence intertwining’ (dsi), and XVS-constructions (xvs).

NPs fronted as subjects of passive utterances were annotated as +pas.

A cleft construction is defined as a complex construction consisting of a copula matrix clause with a relative clause headed by the object of the matrix clause. The object of the matrix clause is also an argument or adjunct of the relative clause predicate. The clefted element det ‘that’, which we annotate as +cle, leaves an ‘empty slot’, $e$, in the relative clause, as shown in example (10):

(10) det er jo ikke [+cle det,] du skal tabe dig it is after all not [+cle that,] you shall lose weight af $e$, som sådan from $e$, as such

Danish sentence intertwining can be defined as a special case of extraction where a non-WH constituent of a subordinate clause occurs in the first
position of the matrix clause. As in cleft constructions, an ‘empty slot’ is left behind in the subordinate clause. NPs in the fronted position were annotated as +dsi:

\[ [+_{dsi} \text{det.}] \text{tror jeg ikke det gor } e, \]
\[ [+_{dsi} \text{that.}] \text{think I not it does } e, \]

The XVS construction is defined as a simple declarative sentence with anything but the subject in the preverbal position. Since only one constituent is allowed preverbally\(^2\), the subject occurs after the finite verb. In example (12), the finite verb is an auxiliary, and the canonical position of the object after the main verb is indicated with the ‘empty slot’ marker \( e \). The preverbal element in XVS-constructions is annotated as +xvs.

\[ [+_{xvs} \text{det.}] \text{har jeg altså haft } e, \text{ for [+}_{xvs} \text{that.}] \text{have I truly had } e, \text{ before } \]

All four features can be annotated highly reliably
\( (\text{pas: } C_1 = 1, C_2 = 1, C_{1+2} = 1, \kappa_{\text{pas}} = 1.00; \text{cle: } C_1 = 4, C_2 = 4, C_{1+2} = 4, \kappa_{\text{cle}} = 1.00; \text{dsi: } C_1 = 3, C_2 = 3, C_{1+2} = 3, \kappa_{\text{dsi}} = 1.00; \text{xvs: } C_1 = 18, C_2 = 18, C_{1+2} = 18, \kappa_{\text{xvs}} = 1.00). \)

**Sentence type and subordination.** Each NP was annotated with respect to whether or not it appeared in an interrogative sentence (int) or a subordinate clause (sub), and finally, all NPs were coded as to whether they occurred in an epistemic matrix clause or in a clause subordinated to an epistemic matrix clause (epi). An epistemic matrix clause is defined as a matrix clause whose function it is to evaluate the truth of its subordinate clause (such as “I think . . . ”). The following example illustrates how we annotated both NPs in the epistemic matrix clause and NPs in its immediate subordinate clause as +epi, but not NPs in further subordinated clauses. The +epi feature requires a +/-sub feature in order to determine whether the NP in question is in the epistemic matrix clause or subordinated under it. Subordination is shown here using parentheses.

\[ [+_{epi} \text{jeg}] \text{tror mere ([+}_{epi} \text{sub}] \text{det er fordi (at [+}_{epi} \text{I}] \text{think rather ([+}_{epi} \text{sub it}] \text{is because (that [+}_{sub} \text{man}] \text{spiser p\text{\’}r [+}_{sub} \text{dumme [daspersk] ik]) [+}_{sub} \text{you}] \text{eat at [+}_{sub} \text{stupid times] right)}} \]

All features in this group can be annotated reli-

\(^2\) Only one constituent is allowed in the *intrasentential* preverbal position. Left-dislocated elements are not considered part of the sentence proper, and thus do not count as preverbal elements, cf. Lambrecht (1994).

\(^{3}\) “Relevant features” were determined in the following way: A DT was generated using a data set consisting only of NPs annotated identically by the two coders in all the features, i.e. the 16 surface features as well as the topic expression feature. The features constituting this DT, i.e. pro, def, sub, and pre, as well as the topic expression category, were relevant features for the third data set, which consisted only of NPs coded identically by the two coders in these 5 features.

### 3.3 Decision trees

In the third stage of our investigation, a decision tree (DT) generator was used to extract correlations between topic expressions and surface features. Three different data sets were used to train and test the DTs, all based on the larger dialog.

Two of these data sets were derived from the complete set of NPs annotated by each main coder individually. These two data sets will be referred to below as the ‘Coder 1’ and ‘Coder 2’ data sets.

The third data set was obtained by including only NPs annotated identically by both main coders in relevant features\(^3\). This data set represents a higher degree of intersubjectivity, especially in the topic expression category, but at the cost of a smaller number of NPs. 63 out of a total of 449 NPs had to be excluded because of inter-coder disagreement, 50 due to disagreement on the topic expression category. This data set will be referred to below as the ‘Intersection’ data set.

A DT was generated for each of these three data sets, and each DT was tested using 10-fold cross validation, yielding the success rates reported below.

### 4 Results

Our results were on the one hand a subset of the features examined that correlated with topic expressions, and on the other the discovery of the importance of different types of subordination. These results are presented in turn.

### 4.1 Topic-indicating features

The optimal classification of topic expressions included a subset of important features which appeared in every DT, i.e. +pro, +def, +pre, and –sub. Several other features occurred in some of the DTs, i.e. dsi, int, and epi. The performance of all the DTs is summarized in table 2 below.

\[ \begin{array}{l}
\text{int: } C_1 = 55, C_2 = 55, C_{1+2} = 55, \kappa_{\text{int}} = 1.00; \\
\text{sub: } C_1 = 117, C_2 = 111, C_{1+2} = 107, \kappa_{\text{sub}} = 0.93; \\
\text{epi: } C_1 = 38, C_2 = 45, C_{1+2} = 37, \kappa_{\text{epi}} = 0.92.
\end{array} \]
The DT for the Coder 1 data set contains the features def, pro, dsi, sub, and pre. According to this classification, a definite pronoun in the fronted position of a Danish sentence intertwining construction is a topic expression, and otherwise it is a topic expression if it occurs in the preverbal position. If it does not occur in preverbal position, but in a question, it is also a topic expression unless it occurs in an epistemic matrix clause. Success rate: 85%. \( F_1 \)-score: 0.67.

The Coder 2 DT contains the features pro, def, sub, pre, int, and epi. Here, if a definite pronoun occurs in a subordinate clause it is not a topic expression, and otherwise it is a topic expression if it occurs in the preverbal position. If it does not occur in preverbal position, but in a question, it is also a topic expression unless it occurs in an epistemic matrix clause. Success rate: 89%. \( F_1 \)-score: 0.63.

Finally, the Intersection DT contains the features pro, def, sub, and pre. According to this DT, only definite pronouns in preverbal position in non-subordinate clauses are topic expressions. The DT has a high success rate of 89% in the cross-validation test — which is not surprising, given that a large number of possibly difficult cases have been removed (mainly the 50 NPs where the two coders disagreed on the annotation of topic expressions). \( F_1 \)-score: 0.72.

Since there is no gold standard for annotating topic expressions, the best evaluation of the human performance is in terms of the amount of agreement between the two coders. Success rate and \( F_1 \) analogs for human performance were therefore computed as follows, using the figures displayed in table 1.

| Data set     | Coder 1 | Coder 2 | Intersect. | Human |
|--------------|---------|---------|------------|-------|
| Total NPs    | 449     | 449     | 386        | 449   |
| Success rate | 84%     | 85%     | 89%        | 89%   |
| Precision    | 0.77    | 0.74    | 0.79       | 0.79  |
| Recall       | 0.53    | 0.61    | 0.67       | 0.77  |
| \( F_1 \)-score | 0.63  | 0.67    | 0.72       | 0.78  |

Table 2: Success rates, Precision, Recall, and \( F_1 \)-scores for the three different data sets. For comparison, we added success rate and \( F_1 \) analogs for human performance.

4.2 Interpersonal subordination

We found that syntactic subordination does not have an invariant function as far as information structure is concerned. The emphasized NPs in the following examples are definite pronouns in preverbal position in syntactically non-subordinate clauses. But none of them are perceived as topic expressions.

14) så det kan godt være at hvis man har... tabt noget so it may well be that if you have... lost some mere i løbet af ugen ik’ more during the week right

15) jeg tror mere det er fordi at man spiser på I think rather it is because that you eat at dumme tidspunkter ik’ stupid times right

The reason seems to be that these NPs occur in epistemic matrix clauses (+epi).

The following utterances have not been annotated for the +epi feature, since the matrix clauses do not seem to state the speaker’s attitude towards the truth of the subordinate clause. However, the emphasized NPs seem to stand in a very similar relation to the message being conveyed, and none of them were perceived as topic expressions.

16) men altså jeg har bare bemærket at at det but you know I have just noticed that that er blevet værre ik’ has become worse right

17) og det kan man da sige på tre uger det er and that you though say in three weeks that is da ikke vildt meget surely not wildly much

This suggests that a more general type of matrix clause than the epistemic matrix clause, namely the interpersonal matrix clause (Jensen, 2003) would be relevant in this context. This category would cover all of the above cases. It is defined as a matrix clause that expresses some attitude towards the mes-
sage conveyed in its subordinate clause. This more general category presumably signals non-topicality rather than topicality just like the special case of epistemic subordination.

5 Summary and future work

We have shown that it is possible to generate algorithms for Danish dialog that are able to predict the topic expressions of utterances with near-human performance (success rates of 84–89%, $F_1$ scores of 0.63–0.72).

Furthermore, our investigation has shown that the most characteristic features of topic expressions are preverbal position (+pre), definiteness (+def), pronominal realisation (+pro), and non-subordination (–sub). This supports the traditional view of topic as the constituent in preverbal position.

Most interesting is subordination in connection with certain matrix clauses. We discovered that NPs in epistemic matrix clauses were seldom topics. In complex constructions like these the topic expression occurs in the subordinate clause, not the matrix clause as would be expected. We suspect that this can be extended to the more general category of inter-personal matrix clauses.

Future work on dialog coherence in Danish, particularly pronoun resolution, may benefit from our results. The centering model, originally formulated by Grosz et al. (1995), models discourse coherence in terms of a ‘local center of attention’, viz. the backward-looking center, $C_b$. Insofar as the $C_b$ corresponds to a notion like topic, the corpus-based investigation reported here might serve as the empirical basis for an adaptation for Danish dialog of the centering model. Attempts have already been made to adapt centering to dialog (Byron and Stent, 1998), and, importantly, work has also been done on adapting the centering model to other, freer word order languages such as German (Strube and Hahn, 1999).

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