3 Distributed Representation Formalisms for Discourse Particles

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There are so far no descriptively and explanatorily adequate approaches to discourse particles. As spoken language phenomena, traditional representations either consist of enumerations of their possible readings, or of a single, very abstract invariant meaning, so that they are of no use for automatic speech processing. The present paper provides a conception, based on analyses of large corpora, in which different levels of generalization constitute a generative mechanism. Two formalisms, Construction Grammar (Fillmore and Kay 1995) and the inheritance lexicon formalism ILEX/DATR (Gibbon 1992), which support the distributed representation of discourse particles, will be discussed and evaluated according to the present purposes.

Für Diskurspartikeln als Phänomene gesprochener Sprache gibt es derzeit noch keine deskriptiv und explanatorisch adäquaten Repräsentationen. Bisherige Ansätze bestehen entweder in Auflistungen der möglichen Bedeutungen, oder in zu abstrakten invarianten Bedeutungsbeschreibungen, so daß die Repräsentationen für die automatische Sprachverarbeitung unbrauchbar sind. In der vorliegenden Arbeit wird dagegen eine Konzeption vorgeschlagen, die auf einem generativen Mechanismus beruht, der sowohl durch den Grammatikformalismus Construction Grammar (Fillmore and Kay 1995), als auch durch einen vererbungsbasierten Lexikonformalismus wie beispielsweise ILEX/DATR (Gibbon 1992) unterstützt wird. Die beiden Möglichkeiten werden hier gegeneinander abgewogen.

3.1 Introduction

During the last two decades, since the interest in spontaneous spoken language started to grow, discourse particles, which cover discourse markers, sequentially dependent elements which bracket units of talk (Schiffrin 1987, p. 31), and also modal and other sentence medial particles, began to get attention by linguists. However, approaches to the analysis of discourse particles so far are not satisfactory. In particular, flat, enumeration-based representations like those proposed in the literature cannot account for the productivity, systematicity, and variability of the meanings and functions of discourse particles. In the following, a solution will be proposed which is based on the distribution of information on different levels of generality. Two formalisms will be discussed which both support the distributed representation suggested in this paper. The first is Construction Grammar (Fillmore and Kay 1995), a unification-based grammar formalism which is principally suited for the description of discourse particles since it associates form and meaning components and is directly devoted to the integration of pragmatic information. The other formalism is the lexicon model ILEX

(Gibbon 1992), based on DATR (Evans and Gazdar 1990), whose generalization hierarchy can account for the productivity and systematicity of discourse particles.

3.2 Problems with traditional approaches to discourse particles

3.2.1 Restricted perspectives on the study of discourse particles

There are several major interrelated problems with the accounts of discourse particles so far. Firstly, discourse particles have usually been studied from a certain theoretical perspective. Interest in very specific properties of discourse particles resulted in very restricted viewpoints on spoken language phenomena. This caused a serious problem for the description and representation of discourse particles. So far either their discourse structuring features have been considered from the perspective of conversation or discourse analysis (cf. Stenström 1994; Schiffrin 1987), or their semantic contributions, for instance in functional pragmatics (Ehlich 1986) or in semanticist approaches (Wierzbicka 1991), were analyzed, or their formal properties were studied (Daly-Kelly 1995; O'Shaughnessy 1993), but hardly any attempts were made to combine the different features of discourse particles. However, discourse particles could be usefully employed in speech processing systems if their properties were represented successfully (Schmitz and Fischer 1995). Therefore, as a first step, the approach to be developed here has to integrate all aspects of discourse particles, syntactic, prosodic, semantic, and pragmatic. A comprehensive representation could then support automatic speech processing in the following ways:

- The analysis and description of position, context, and distribution could help to reduce the number of errors in speech recognition systems. For instance, the recognition of discourse particles might prohibit the creation of word graphs which contain parts of a discourse particle (Fischer and Johanntokrax 1995).
- Discourse particles can be significantly correlated to dialogue acts which constitute the macro-structure of dialogues. The occurrence of a discourse particle therefore points to a certain dialogue act, a fact which can be used for automatic macro-structural construction (Fischer et al. 1995).
- Knowledge about the occurrence of a discourse particle can support automatic segmentation of turns into utterances (Fischer et al. 1995).
- A representation of the behaviour of discourse particles with respect to speech repairs, break–offs, or restarts might support the successful parsing of these spoken language phenomena (Fischer and Johanntokrax 1995).

3.2.2 The particle-paradox

An approach which relates formal and semantic pragmatic properties of discourse particles could also elegantly deal with the fact that discourse particles can have so many different readings in different contexts. How-

ever, so far no semantic description has been provided which can handle the problem that one discourse particle may fulfil many different functions which are usually associated with different word classes. The approaches to a description of discourse particles which attempted a complete account of their meanings and functions can be criticized either for being too abstract and not restrictive enough so that they cannot capture the function of an individual instance of a discourse particle, or for splitting the particle in so many different meanings that they cannot account for the unity of the sign and cause the number of possible readings of an utterance to explode. This dilemma is commonly referred to as the 'particle paradox' (Weydt and Hentschel 1983, pp. 3-4): "So entsteht für den Lexikographen die Gefahr des Partikelparadoxons: Die Beschreibung einzelner Varianten verstellt dem Benutzer das Verständnis dafür, wie diese Varianten zusammenhängen; die Beschreibung der übergreifenden Bedeutung hingegen bleibt zu allgemein, um die Einzelfälle plausibel werden zu lassen."
For example, Wierzbicka's analysis of *oh* as "I feel something" (Wierzbicka 1991) is too general to point out in detail what the function of *oh* in "Oh" why don't you swing by my dorm sometime"(VERBMOBIL corpus mmgn_10_08) is. On the other hand, Helbig (1988), pp. 165–172, for instance distinguishes nine meanings of German *ja*, categorizing it as *Abtönungs-, Grad- and Antwortpartikel.* Wolski (1986), pp. 504–505, provides an example entry for *ja* which contains ten different readings which are grouped into *sentence equivalent* and stressed and unstressed modal particle. Other approaches, for example (Weydt and Hentschel 1983, pp. 13–14), only consider *ja* in one of its functions, listing the other uses as homonyms.

3.2.3 Introspective methods

The neglect of the discourse function *take-up* in most of the descriptions mentioned above, i.e. the occurrence of *ja* in utterances like "ja, da kann ich leider nicht", in which it functions as a turn-taking signal which indicates contact, perception, and understanding to the hearer as well as continuity, which in the German VERBMOBIL corpus of 67801 words (Verbmobil-Database-TP14 1995) was found to be the most common function of *ja* (67.3%), shows clearly that the authors concentrated on introspective methods and native speaker intuitions. To get an accurate picture of the functions of a discourse particle, corpora of spontaneous spoken language have to be consulted and analyzed.

3.2.4 Discourse particles in automatic speech processing

Finally, the attempts to lexicalize discourse particles so far have been oriented at the respective purposes the dictionaries in which the information was to be included is supposed to fulfil (Bastert 1985). So far there is no description of discourse particles which would aim at a comprehensive account of the different functions discourse particles can fulfil and their basic meanings that is explicit and complete enough to be useful for automatic speech processing. Traditional lexica (Helbig 1988; Weydt and Hentschel 1983; Wolski 1986) were mainly oriented towards language learners. There are no means for the representation of discourse particles in computer accessible dictionaries or databases yet. The role of discourse particles in automatic speech processing used to end with their detection and elimination. For instance, O'Shaughnessy (1993), p. 2187, writes "The pauses and restarts are described acoustically ... to ensure their proper elimination from consideration in speech recognition systems". To sum up, there are no representations of discourse particles for automatic speech processing systems. Existing approaches are mainly aimed at language learners, and research interests constrained the available information on discourse particles. More comprehensive approaches often relied on introspective methods. However, most importantly, traditional approaches, being flat, enumeration based representations, cannot offer a solution to the so-called particle-paradox, so the representations either consist in long lists of possible meanings or in abstract descriptions of the invariant meanings of discourse particles which are then not suitable to explain the individual occurrences in context. Thus, what is necessary for a satisfactory linguistic and computationally useful description of discourse particles is a unified theory which relies on distributional analyses of spontaneous spoken language corpora instead of introspective methods, which is computer-accessible, and which most importantly provides a natural and elegant account of the fact that discourse particles can get many different readings depending on their context.

3.3 Distributed representations for discourse particles

The solution to the representational problems consists in a feature-based distributed representation of the different kinds of properties of discourse particles on different levels of generality. The current approach involves not only a generative mechanism to cope with the many readings of discourse particles which the enumeration-based lexicon had to struggle with, but also a representation of their complete range of features, which is necessary for any contribution of discourse particles to automatic speech processing.

3.3.1 Method

The data about discourse particles which are to be lexicalized were obtained with the following methodological steps:

- Semi-automatic distributional analyses of two large German corpora (Verbmobil-Database-TP14 1995; Verbmobil-Database-95 1995; Sagerer et al. 1994) were carried out.
- At the same time, a descriptive inventory was developed (Schmitz and Fischer 1995).

- The speech signal was analyzed regarding the intonation contours of discourse particles.
- The relevant phonological variants of each discourse particle were determined, represented in SAMPA (Wells et al. 1992), and combined under one lemma.
- In hypothesis-test-cycles, discourse functions could be identified which involve stable patterns of features on syntactic, prosodic, and functional levels. In the representational approach here proposed, these discourse functions are interpreted as productive templates which assign certain meaning aspects to discourse particles, bound to certain syntactic and prosodic contexts.
- A highly schematic meaning was assigned to every discourse particle and tested by means of testframes which were developed for this purpose (Fischer forthcoming).
- The tests were applied to the meaning aspects of discourse functions as well.

For each discourse particle, exactly one highly schematic meaning entry is assumed. Furthermore, the discourse functions, which have a long tradition in discourse analysis, and by means of distributional analyses have been found to be stable feature bundles, are here interpreted as templates consisting of formal, i.e. syntactic and prosodic, as well as semantic and pragmatic properties. So all other aspects than the idiosyncratic properties of each discourse particle are derived from general templates which contain the context dependent information. The plurality of meanings is created by general information represented in templates which are taken to be form–meaning pairs, i.e. constructions (Goldberg 1995, p. 1). Consequently, the number of possible readings which have to be lexicalized is drastically reduced. The approach proposed here ignores the possible boundaries of word classes in favor of a general and unified theory which can explain adequately the semantic relationships between the different occurrences of discourse particles. The meanings of German *ja*, for example, one of 30 discourse particles analyzed so far (Fischer 1995), are thus derived from general principles, i.e. *ja* does not have nine or so meanings in the word classes *answer signal*, *discourse marker*, *modal particle*, it may have these readings in certain well-defined contexts which are accounted for in meaning-form templates. The representation allows analysis and generation not only of actual discourse particles but also of potential ones. This way, the productivity of discourse functions can be accounted for, for example, items of different word classes, such as *nun, oh, ach, also, ja, o.k., aber, ähm, gut* etc. can act as *take-up*s, while *ähm, äh, also, ja*, but also phrases like *was ich noch sagen wollte* can function as *fillers*, and many more items could be creatively employed in these functions.

srs	[ ]
cat	discourse particle
lex	+
sem	[think_same(S,H)]
phon	/ja/, /jA/
orth	ja

Figure 3.1: The *ja* Construction.

3.3.2 Discourse particles in construction grammar

The interpretation of templates representing discourse functions as constructions makes it possible to treat discourse particles as part of a sentence grammar, so a discourse function can be seen as a construction of grammar just like the determination construction (Fillmore and Kay 1995, p. 3-33) or the ditransitive construction (Goldberg 1995). The features of Construction Grammar (CG) (Fillmore and Kay 1995), "a *non-modular, generative, non-derivational, monostratal, unification-based* grammatical approach which aims at *full coverage* of the facts of any language under study without loss of *linguistic generalizations*, within and across languages" (Kay forthcoming), supports the integration of discourse particles into a grammatical framework. A grammar is seen as "composed of conventional associations of form and meaning". Furthermore, "any of the kinds of information that have been called 'pragmatic' by linguists may be conventionally associated with a particular linguistic form and therefore constitute part of a rule (construction) of a grammar" (Kay forthcoming). To include traditionally pragmatic objects such as discourse particles in the grammar, is therefore perfectly compatible with the basic ideas of CG. Another property of CG which supports the aims of the representation here proposed is the fact that CG treats lexical items and more abstract constructions as basically similar. The German discourse particle *ja* will be represented here as an example for an independent, very specific construction (see Figure 3.1).
The invariant, highly schematic meaning of *ja*, formulated in Natural Semantic Metalanguage (Wierzbicka 1986), is taken to be "You and I think the same", which is formalized as shown in Figure 3.1. The feature [*srs* +/-] (subject requirement satisfied) gives a good account of the fact that some discourse particles constitute dialogue acts themselves, depending on which function they fulfil. *Ja* is a complete utterance when it functions as a *backchannel*, but not if it is used as a *take-up* initially, as a *check* finally, or as a modal particle medially. For this reason, *ja* is unspecified for *srs.*

The value for the attribute *srs* is contributed by the respective discourse function the *ja*-construction unifies with. CG is an excellent formalism to account in a natural way for the fact that discourse particles can occur in different places with different functions. The lexical construction for *ja* can unify with the first box in the representation of the discourse function *backchannel*, for instance, since the values of the attributes do not conflict. It would be desirable if the formalism was restrictive enough so that it could license only those constructions which really occur. For a discourse particle, its semantic features determine which discourse functions it can fulfil, however, the lexical item usually shares its semantic feature with only one of the pragmatic properties of the construction. A unification formalism like CG does not allow such an operation since it cannot be known in advance which of them would unify. For example, *ja*, symbolizing "You and I think the same", can be used as a *backchannel* with the interactive functions (cf. Allwood et al. 1992) "I want to speak with you" (contact), "I have heard what you are saying" (perception), and "You and I think the same" (understanding) because the third pragmatic feature of the *backchannel* and the symbolic meaning of *ja* unify. Often, however, a connection can only be implied, i.e. a more powerful semantic network, in which the different relationships are modelled, might be necessary. For instance,*ja* also functions as a *take-up* with the features "I have heard what you are saying" (perception) and "I want to say the same" (continuity) where it is necessary to infer that you can only say the same if you think the same. Furthermore, the symbolic content of a discourse particle is regarded as its semantics, however, speech management (SM), turn-taking (TT), and interactive functions (IF) are taken to be pragmatic features, so their values cannot be used to motivate a match because the attributes are different. Consequently, the composition mechanism of CG has to be supported by other sources in order to constrain the unification of constructions which would otherwise result in infelicitous utterances. The most important problem about CG is that although it perfectly accounts for the productivity, generality, and systematicity of discourse functions and it therefore could be a suitable representation formalism for discourse particles, it cannot prohibit infelicitous utterances, and consequently it cannot appropriately motivate felicitous ones. This is due to the lack of a fine-grained semantic mechanism. However, currently there is no such mechanism available at all, so this is not a criticism restricted to CG.

There are also some minor, more technical problems with CG, for instance, the decision of which part of the *backchannel* construction is the head of the whole construction. For *backchannel*, it must be the discourse particle since the second box may be empty, as indicated by the Kleene star, which symbolizes zero, single, or multiple instantiation of some other constituent. However, if a sentence follows the discourse particle, its features will not be

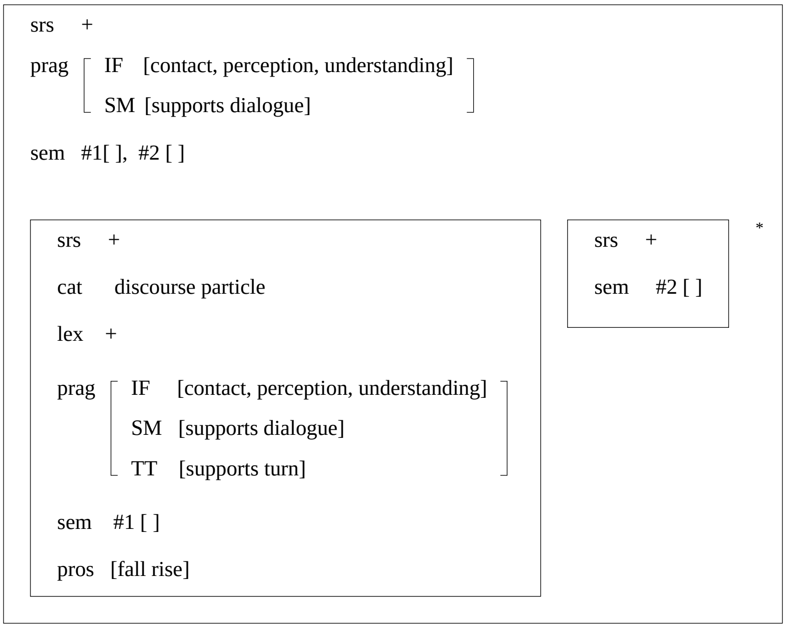

Figure 3.2: The *backchannel* Construction.

automatically passed up to the mother construction as head features would because of the subset principle (Fillmore and Kay 1995). This, however, would be counter-intuitive. On the other hand, it is not clear whether all pragmatic features of a discourse particle should be passed up to the larger construction. For example, it is true that *oh* functions as a turn-taking signal in "Oh why don't you swing by my dorm sometime" (VERBMOBIL corpus mmgn_10_08), but being a turn-taking signal is certainly not a feature of the whole utterance. However, if it is not passed up, it is lost. Finally, there is some interesting information about discourse particles which was gained in distributional analyses which has no room in CG. To include probabilistic data about the syntactic position, speech-act occurrence, or the discourse functions into CG, which is useful for macro-structural identification, speech recognition, and automatic segmentation, is impossible since weighted values do not unify. These problems which partly occur in connection with our specific interests and which do not interfere with the important insights CG can provide, and partly apply to all grammar formalisms so far, have led us to choose another representation formalism which was specifically designed to represent lexical information.

3.3.3 Discourse particles in ILEX / DATR

The lexicon model ILEX (Gibbon 1992), based on DATR (Evans and Gazdar 1990), allows a distributed representation of the meanings of discourse particles on different levels of generality. The features of the representation formalism, local and global inheritance, default assignment, and template composition, support the most important idea here proposed, i.e. to account for the various readings of discourse particles by means of generative constructions, in a natural and elegant way if applied as a distributed representation of their general and idiosyncratic properties. As in CG, the lexical entries are maximally underspecified. The entry for *ja* in ILEX/DATR contains, besides the idiosyncratic orthographic, phonological, and semantic information, also a pointer, the empty path, to the more general root node *Discourseparticle* at which all general information, true for all or most discourse particles (Willkop 1988), is stored. This information will be inherited by means of so-called local inheritance by each discourse particle unless it is overridden by idiosyncratic information at the lemma nodes. The features for sententiality and intonation contour are dependent on the discourse function the discourse particle participates in. The representation at the general form node therefore points to the respective path where the information is available. It also contains references to the distribution in syntactic contexts the discourse particle can occur in:

```
Ja:
<>             ==   Discourseparticle
<phon>         ==   ('/ja/,/jA/')
<orth>         ==   ja
<sem>          ==   ('think_same(S,H)')
<syn>          ==   ('90.6% initial, 7.6% medial, 0.8% final').

Discourseparticle:
<>             ==   ()
<morph>        ==   no_inflection
<sentential>   ==   "<pragfunction>"
<cat>          ==   discourse_particle.
```

The information about the syntactic position of a discourse particle is not only the first available from a speech recognition system, but also the most important in predicting the discourse function. Therefore, only the syntactically distinguished nodes hold pointers to the respective discourse functions which contain statistical information:

```
Ja_init:
<>             ==   Ja
<pragfunction> ==   ('67.3%' "Take-up:<constr>",
                     '26.1%' "Backchannel:<constr>").
```

By means of these weighted pointers, the difficulty of constraining the possible matches correctly is avoided. Self-evidently, this is not an entirely

satisfactory solution since it would be more desirable to have a generative function which creates felicitous utterances by means of general principles and procedures. However, this way the actual probabilistic distribution of discourse particles can be accounted for.
The template nodes, representing the discourse functions, contain the context specific syntactic, prosodic, and pragmatic attributes, which are accessed by means of an even more general template, *Discoursefunction*. The quotation marks around the paths point back to the node where the query started from. This mechanism is referred to as global inheritance. However, by means of the quotation marks around nodes, a new global environment is temporarily created.

```
Discoursefunction:
<>             ==   ()
<constr>       ==   ("<speechmanagement>" "<turn-taking>"
                     "<interactivefunct>" "<syn>" "<sentential>"
                     "<pros>").
```

The discourse functions the discourse particle *ja* can fulfil, and which also determine its intonation contour and sententiality, are the following:

```
Take-up:
<>                       ==   Discoursefunction
<speechmanagement>       ==   (supports planning and voice
                               adaptation)
<turn-taking>            ==   (turn supporting signal)
<interactivefunct>       ==   (signals perception, continuity)
<sentential>             ==   non-sentential
<syn>                    ==   utterance_initial
<pros>                   ==   (falling intonation).

Backchannel:
<>                       ==   Discoursefunction
<speechmanagement>       ==   (supports dialogue)
<turn-taking>            ==   (supports turn)
<interactivefunct>       ==   (contact, perception, understanding)
<pros>                   ==   (fall rise intonation)
<sentential>             ==   sentential
<syn>                    ==   initial.
```

The attribute *sentential* accounts for the dependence or independence of a discourse particle as an utterance of their own when used in a certain discourse function (CG's srs). Stressed and unstressed modal particles often vary according to their functions. Since in the corpus there were no occurrences of the stressed version of *ja*, it is not considered here. Furthermore, if there had been any occurrences of medial *ja* in which it functions as an intensifier in enumerations, a reading which is consistently discussed in the literature (e.g. Helbig 1988, p.169), it would have been treated here as an appropriateness-repair marker (Levelt 1983). However, medial *ja* occurred only as an unstressed modal particle in the corpora consulted.

```
Modalparticle_unstressed:
<>                  ==   ()
<syn>               ==   medial
<stress>            ==   unstressed
<sentential>        ==   non-sentential
<pragfunction>      ==   ('presupposes S,' "<sem>").
```

The representation is accessed by means of individual queries, for example:

```
Ja_init:<pragfunction> = 67.3% supports planning and voice
                         adaptation turn supporting signal
                         signals perception, continuity
                         non-sentential falling intonation
                         26.1% supports dialogue supports turn
                         contact, perception, understanding fall
                         rise intonation.
Ja_init:<phon>         = /ja/,/jA/.
Ja_med:<pragfunction>  = presupposes S, think_same(S,H).
```

By means of the 'node'-software (Gibbon 1993), the ILEX/DATR theory is interpreted so that all 'intelligent' queries are evaluated. The resulting theorems are automatically converted into a UNIX database format (Fischer 1995). The information about discourse particles stored in the database currently contributes to automatic segmentation, macro-structure detection, and to keyword spotting (Fischer et al. 1995).

3.4 Conclusion

In this paper, it was argued that traditional approaches suffer from their reliance on introspective methods, from restrictive research interests, and especially from representations in flat, enumeration-based lexica. The approach introduced here was based on extensive analyses of spontaneous spoken language dialogues in which discourse functions were identified as stable patterns of features on the syntactic, prosodic, and pragmatic levels of description. These were interpreted as generative templates in two different representational formalisms: Construction Grammar (CG) and ILEX. In the inheritance lexicon ILEX, pointers to the productive templates are necessary to account for the relation between discourse particles and their possible functions. These however may be used to represent statistical information about their actual distribution. In the grammar formalism, so far such devices would be necessary as well because the theory lacks an adequate semantic mechanism to sufficiently constrain infelicitous constructions on the one hand, and to motivate possible matches on the other. However, CG does not provide such a device. So although in the long run an entirely generative representation for discourse particles is more desirable, at present, ILEX seems to offer the best possible solutions for a representation formalism for discourse particles.

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