COLLOCATIONS AND THE REPRESENTATION OF POLARITY

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Abstract.

We will discuss the distribution of the German verb *fackeln* (*hesitate*; *dither*, in the sense of acting nervously or indecisively). It is a Negative Polarity Item which must also fall in the scope of a durational modifier. We will argue that a collocation module is needed to account for the obligatory presence of the durational modifier. The collocational requirement has to be expressed with reference to the logical form of the modifier. We, then, can show that the negation sensitivity can be accounted for by the same collocational mechanism, making reference to the logical form of the licensing context rather than to its entailment properties. We will present an analysis within the framework of Head-Driven Phrase Structure Grammar (HPSG).

1. Introduction*

Formal lexicalist grammars emphasize a devision of labor in the architecture of grammars. A small set of general principles of grammar controls the realization of lexical elements in well-formed linguistic structures. The lexical elements themselves have idiosyncratic properties, such as their phonology, meaning and syntactic category, which are not predictable from general principles but have to be specified in the lexicon. Among the idiosyncratic properties we find the selectional requirements of syntactic or semantic functors. When we consider large corpora, however, we observe that current implementations of this architecture leave a set of phenomena unaccounted for that have been described as the *collocational restrictions* of lexical items. As we will show, these restrictions can go beyond mere statistical tendencies and should thus be regarded as belonging to the linguistic knowledge of speakers. Given that they concern properties of linguistic structures that are outside the domain of selectional restrictions, we will argue for their integration in formal grammars by an extension of the ontology of lexical signs that will permit their inclusion in lexical specifications. Supplementing the lexical extension, a collocation module of grammar enforces their realization in linguistic structures by a general principle.

2. Data

The German verb *fackeln* has two meanings: (i), *to burn* occurring mainly with particles such as *ab-* (*flare off*); (ii), *to dither, to shilly-shally.* We will focus on this second meaning.

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In the COSMAS-I corpus (`www.ids-mannheim.de/~cosmas`), there are 280 occurrences of this use. 241 (86%) are in the combination *nicht lang(e) fackeln*, illustrated in (1).

(1) Der neue Geschäftsführer fackelte nicht lange.
the new manager dithered not long
'The new manager didn't dither very long.'

The remaining 39 (14%) occurrences contain: 22 (7.86%) with *lang(e)* and other negative markers (as *ohne* (*without*), *nie* (*never*), see (2a)), 3 (1.1%) with a durational modifier and a negative element both different from *lange* and *nicht*, see (2b). In 2 (0.7%) cases *lange* occurs, but no negative element (2c). There are 9 (3.2%) instances of *nicht* and no durational modifier (2d) and 3 (1.1%) contain a negative marker different from *nicht* (*ohne* (*without*) in all these examples) but no durational modifier (2e).

(2) a. Ohne lange zu fackeln, rannte der Helfer in die Wohnung.
without long to dither ran the helper into the apartment
'The helper ran into the apartment without dithering very long.'

b. Es gebe zwei Punkte, in denen die Politesse keine Minute fackle, ...
there are two points at which a traffic warden no minute dithers
'There are two points at which a traffic warden wouldn't dither a minute.'

c. Harsche SVP-Kritik erntete die Regierung dafür, dass sie so lange fackle
harsh SVP criticism reaped the government that for that it so long dithered
'The government reaped harsh criticism from the SVP for dithering so long.'

d. Aber Margret Thatcher hat nicht gefackelt.
but Margret Thatcher has not dithered 'But Margret Thatcher didn't dither.'

e. Ohne zu fackeln, zückte einer von ihnen ein Messer.
without to dither drew one of them a knife
'One of them drew a knife without dithering.'

We can add introspective and further corpus data to these observations. As a result, we find that the verb *fackeln* may occur with a wide range of durational modifiers and in many contexts that license NPIs. The defalcation of one of these requirements decreases grammaticality significantly.

(3) a. Keiner hat einen Moment gefackelt, bevor er ins Wasser gesprungen ist.
nobody has a moment dithered before he into the water jumped has
'Nobody dithered a moment before jumping into the water.'

b. ? Keiner hat gefackelt, bevor er ins Wasser gesprungen ist.
Nobody has dithered before ... 'Nobody dithered before ...'

c. *? Peter hat einen Moment gefackelt, bevor ...
Peter has a moment dithered before ...
'Peter dithered a moment before ...'

d. * Peter hat gefackelt, bevor ...
Peter has dithered before ... 'Peter dithered before ...'

We conclude that for its linguistic contexts of occurrence, the verb *fackeln* requires: (1) to be in the scope of a durational modifier and (2) that the verb and the modifier be in the scope of an NPI licensing operator. While this generalization covers the introspective and most of the corpus data (94,96%), examples such as (2c–e) suggest that further research is needed to amend the generalizations to include the remaining data.

The verb *fackeln* is a particularly good example for multiple co-occurrence conditions. However, Hoeksema (2001) shows that many NPIs in English and Dutch are subject to additional occurrence restrictions. He calls them *secondary restrictions*. For example the expression *for love or money* is an NPI that needs to occur in modal or irrealis contexts. In a negative episodic statement, it can only be interpreted literally (Hoeksema (2001)).

(4) a. I wouldn't talk to him for love or money.

b. John did not date her for love or money, but at the behest of his father.

Hoeksema also identifies NPIs that are sensitive to the occurrence of quantifiers:

(5) a. Niet alles was rozengeur en maneschijn. (Dutch)
not all was rosescent and moonshine 'Not everything was coming up roses.'

b. * Het leven is allerminst rozengeur en maneschijn. (Dutch)
the life is not at all rosescent and moonshine (van der Wouden (1997):139)

Hoeksema's findings are based on corpus investigations. For many of the items the secondary restriction is a strong tendency in the corpus rather than a strict requirement. Interestingly, this "tendency character" of the data is not limited to secondary restrictions of NPIs, but is also attested for NPIhood proper. Hoeksema (1994) discusses a class of words that he calls *quasi-NPIs*. These are verbs like *bother* and *matter* which show a strong tendency to occur in negative contexts but for which non-negative occurrences are attested, too. Investigating the historical development of the modern Dutch NPI *enig* (*some/any*) from the 15th century on, Hoeksema (2001) shows that *enig* gradually shifted from a freely occurring item, to a quasi-NPI and finally became a full NPI in modern Dutch.

Thus, Hoeksema's data suggest two things: First, there is no quantitative difference between the polarity requirements of an element and other, "secondary", requirements. Second, occurrence tendencies can be observed in corpora but are not easily accessible for grammaticality judgments. These tendencies may ultimately lead to strict occurrence restrictions which can be both attested and tested and therefore, need to be considered part of the linguistic knowledge of a native speaker. In the case of *fackeln* both occurrence requirements have reached this level, which makes this item a particularly clear case.

3. A Collocation Module for Formal Grammars

The traditional grammatical mechanism to account for the obligatory co-occurrence of two elements is *selection*. The theory of selection incorporated in HPSG assumes that a head selects its complements, and an adjunct selects the head. Building on this assumption, the obligatory presence of the DM can only be enforced by the verb *fackeln* if the DM is a complement rather than an adjunct.

Semantically, *fackeln* is synonymous to the verb *zögern* (*hesitate*). This verb is atelic and, therefore, compatible with durational modifiers. Nonetheless neither corpus data nor intuitive data suggest that such a modifier is obligatory. We can substitute *zögern* for *fackeln* in our examples without changing the meaning or the structure of the sentences in Section 2. Thus, there is no independent semantic or syntactic evidence for a complementhood of the DM. Instead the synonymy of the two verbs strongly suggests that the DM should be treated in a parallel way in both cases, i.e., as an adjunct.

This is especially clear if we compare *fackeln* with *dauern* (*take (time)*) for which a durational adverbial is also present in almost all corpus examples.[1]

(6) Die Vorstellung dauerte drei Stunden.
the presentation lasted/took three hours

For *dauern*, the status of the DM is open to debate. The logical structure of the verb *dauern* is different from that of *fackeln*: in the first case, the DM is interpreted as the duration of the subject, whereas in the second it is interpreted as the duration of the dithering. The special interpretation of the durational adverbial with *dauern* motivates a treatment as a semantic argument and, consequently, as a syntactic complement. However, such motivation is absent for *fackeln*.

Alternatively, Steinitz (1988) assumes that the DM that accompanies *dauern* can be treated as an adjunct, instead of as a complement. Its obligatory occurrence follows from the fact that the verb *dauern* is semantically very weak. Therefore, without a further specification of the duration time, a sentence that contains *dauern* is odd. The verb *fackeln* on the other hand is not semantically weak, or otherwise, so should be its synonym *zögern* for which the DM is fully optional. Thus, whatever explanation is considered in the case of *dauern* cannot be applied to *fackeln*.

If we accept on the basis of the available empirical evidence that the DM is an adjunct rather than a complement in the case of *fackeln*, the verb *fackeln* cannot be said to select the DM. Furthermore, there is no independent semantic mechanism or pragmatic constraint to which the obligatory presence of the DM could be reduced. It follows that there is no possibility for a verb to enforce the presence of an adjunct.

Selection is certainly not the right term for the kind of co-occurrence pattern reported in Section 2; it seems more fitting to characterize the phenomenon with the notion *collocation*. In HPSG — and similarly in GPSG, GB, LFG, Categorial Grammar, and even Construction Grammar — collocations have not yet been integrated into the architecture of grammar. The collocational behavior of elements has been largely ignored in formal linguistics. The importance of collocations has been asserted most prominently in the London School (Firth (1957:190–215)) and its descendants (Butler (1985); Sinclair (1991)). There, a lexical element is defined and particularized by its collocational restrictions.

> "The defining feature of a lexical item, by which such an item is recognized, is its pattern of co-occurrence with other items, that is its *collocational* behavior.

[1]Exceptions are occurrences of *dauern* in modal contexts:

(i) So ein Verfahren kann dauern.
such a procedure can take (a while)

A lexical item is recognized as different from other lexical items because its total pattern of collocation is unique." Butler (1985:130)

It should be noted, though, that under its most neutral definition, the term collocation refers to any statistically remarkable co-occurrence of elements in a corpus. In the present paper, we want to ignore co-occurrence patterns that can be reduced to effects of thematic coherence (*milk—cow*) or to syntactic and semantic selection (*read—book*). Instead, we will focus on co-occurrence patterns that seem unpredictable from discourse structure or grammatical properties of the elements that make up a text, and, thus, on patterns that can provide us irrefutable arguments for the necessity of a collocation module.

Within the framework of theoretical assumptions of current formal theories of grammar, the collocational behavior of lexical elements should follow from a speaker's linguistic knowledge. Just as knowledge of grammatical principles can only be accessed indirectly via grammaticality judgments, knowledge of collocational restrictions can only be studied indirectly. Hereby, looking at corpus data is indispensable, because — as mentioned at the end of Section 2 — collocational restrictions often are not as strict as grammatical principles. In some cases of strong collocational restrictions, however, we are able to use grammaticality judgments as well. This case was exemplified by the convergence of corpus data and the introspective data for *fackeln* above.[2]

Faced with the obligatory presence of the durational modifier for *fackeln* we acknowledged the necessity of a collocation module. For its integration we will now introduce the attribute COLL at the level of *signs*. The value of COLL is a list. It is empty for non-lexical signs. A lexical sign has exactly one element in its COLL value: the root sign of the utterance in which it occurs. This is enforced by a principle, the COLL PRINCIPLE:[3]

(7) The COLL PRINCIPLE:
If a sign a dominates a sign b which has a non-empty COLL value, then the element in b's COLL value is a sign c such that c dominates a.

Having introduced the prerequisites of a collocation module, we can specify the requirements that the verb *fackeln* imposes on its occurrences as part of its lexical entry.

(8) Sketch of the lexical entry of *fackeln* (preliminary version):

$$\begin{bmatrix} \textit{word} \\ \text{PHON}\ \langle \textit{fackeln} \rangle \\ \text{SYNS LOC} \begin{bmatrix} \text{CAT HEAD}\ \boxed{2}\ \textit{verb} \\ \text{CONTENT}\ \ \mathsf{hesitate}'(e,x) \end{bmatrix} \\ \text{COLL}\ \langle \boxed{1} \rangle \end{bmatrix} \begin{array}{l} \textbf{and} \quad \texttt{dominates}(\boxed{1},\boxed{3}) \\ \textbf{and} \quad \boxed{3}\begin{bmatrix} \text{SYNS LOC} \begin{bmatrix} \text{CAT HEAD MOD} \begin{bmatrix} \text{LOC CAT HEAD}\ \boxed{2} \end{bmatrix} \\ \text{CONTENT}\ \ldots \mathbf{dur}'(e) \ldots \end{bmatrix} \end{bmatrix} \end{array}$$

In (8) we specify that the sign in the COLL list must dominate a modifier which (i) modifies the verb *fackeln* and (ii) has a durational semantics. The first requirement is directly stated by tag $\boxed{2}$. For the second, we assume that we can identify the class of durational modifiers by their CONTENT values, i.e., their *logical form*. Following Kamp and Reyle (1993), we posit a semantic constant **dur′** whose interpretation is the duration of an event and which occurs in the logical form of all durational modifiers.

[2]Another instance of such conversion is found with so called *cranberry words* (Aronoff (1976)) such as *headway*. Richter and Sailer (2002) show that the distribution of these elements cannot be accounted for by selection or other mechanisms of HPSG. Using the collocation module presented here, however, these data can be predicted.

[3]See Sailer (2000) and Richter and Sailer (2002) for a formalization of this principle in RSRL, the underlying description language of HPSG (Richter et al. (1999), Richter (2000)).

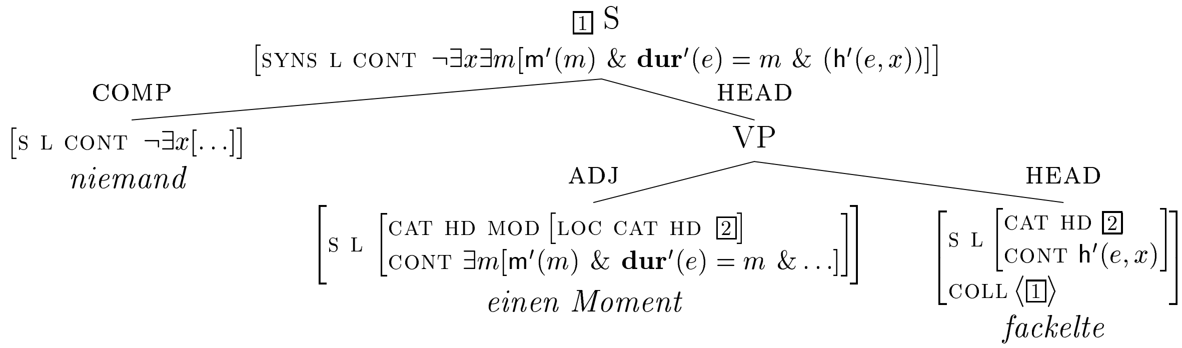

Figure 1: The analysis of *(dass) niemand einen Moment fackelte* (*(that) nobody dithered a moment*)

In Figure 1 the analysis of a sentence that contains *fackeln* is given.[4] We postulate terms of a higher-order language as the values of the CONTENT attribute, but we remain agnostic as to the mechanism of combinatorial semantics. As it stands, our proposal is compatible with an approach that relies on lambda conversion in combination with a flexible type shifting system à la Hendriks (1993) (explored for HPSG in Sailer (2000)), or with a more specialized semantic combinatorics such as *Lexical Resource Semantics* (see Richter and Sailer (2001a,b)).

The figure shows that COLL is not a selection attribute: The DM is introduced into the sentence by the traditional head-adjunct-scheme of Pollard and Sag (1994) and, therefore, the verb does not select its modifier. The COLL list of a word contains the highest node in the structure, which is enforced by the COLL PRINCIPLE. By this assumption, a lexical element can impose idiosyncratic restrictions on the sentences in which it may occur, i.e., the COLL specification can be seen as a global filter rather than as a selection requirement.

Our collocation module is powerful enough that in principle, any property of an utterance can be taken as a collocational requirement of a word in that utterance. For the data considered in this paper, we need (i), the selectional relation between *fackeln* and its collocate, the DM, and (ii), the logical form of the DM. We do not need its phonology. For other phenomena with a collocational character, like the *a*/*an* alternation in English, phonological information does play a crucial role (see Asudeh and Klein (2002)). We leave to further investigation to determine how a formal theory of collocations can be made more constrained.

As detailed in Section 2, many collocational patterns take the form of co-occurrence tendencies rather than the form of strict restrictions. In the present formalization, we only capture the strict cases. This reflects our view that these collocation restrictions are lexicalized and, therefore, need to be considered part of a native speaker's linguistic competence — for weaker restrictions such a claim might be too strong.

4. A Representational Theory of PI Licensing

The most successful theories of PI licensing rely on the entailment properties of the context in which a PI may or may not occur. Such entailment-based theories (EBT) have been proposed in Fauconnier (1975), Ladusaw (1980) and refined in Zwarts (1981, 1986, 1997). Downward entailing (DE) environments are those which allow inferences from sets to sub-

[4]The semantic constants hesitate′ and moment′ are abbreviated with h′ and m′.

sets. For example the sentence *Nobody likes vegetables* implies *Nobody likes carrots*, whereas *Everybody likes vegetables* does not imply *Everybody likes carrots*. The EBT advances the insight that NPIs can only occur in DE contexts. The use of entailment notions allows the grouping of contexts created by *not*, *nobody*, *few*, *seldom* for which a purely syntactic characterization is not plausible. Not withstanding its merits, the EBT encounters severe problems with PI licensing in embedded sentences, in conditionals and in questions (see van der Wouden (1997) for discussion).

In the EBT, the class of DE operators is divided into several subclasses: *ultra strong* negation, as introduced by negative particles like *nicht* (*not*) is called *antimorphic* and shows further entailment properties. These additional properties can be broken down in two entailment properties which correspond to the de Morgan laws of negation. These properties are called *anti-additivity* and *antimultiplicativity*. For an anti-additive operator f (such as *niemand* (*nobody*)) the following holds: $f(X \cup Y) = f(X) \cap f(Y)$. Analogously, with an antimultipicative operator (like *nicht jeder* (*not everyone*)) the following equation can be observed: $f(X \cap Y) = f(X) \cup f(Y)$ (see Kas (1993) for details). Zwarts (1997) shows that for some NPIs, a simple DE context is enough, whereas others require contexts that are at least anti-additive (but not antimultiplicative), some even require antimorphic contexts. As pointed out in van der Wouden (1997:134–141) there are no NPIs attested that can occur in an antimultiplicative context but not in an anti-additive context. This observation is unanticipated — and so far unexplained — within the EBT.

If we consider the logical form of the licensing operators instead of their entailment properties, there is a natural account of the antimultiplicativity problem: A PI is in the scope of an antimorphic negation if in the logical form of a sentence, there is no other semantic operator intervening between the negation and the semantic contribution of the PI. The PI is in an anti-additive context, if there is only an indefinite intervening between the negation and the PI. Finally, if there are other operators intervening, in particular "real" quantifiers the PI is in a weakly negative, i.e., simply downward-entailing context. Such contexts are created by words as *wenige* (*few*) or *kaum* (*hardly*).

To characterize all DE operators as introducing negation ("$\neg$") to the logical form of the sentence, we allow some semantic decomposition at the level of logical form, as is done in Stechow (1993, 1996) and Przepiórkowski and Kupść (1999). For example, the logical form of the DE quantifier *wenige* (*few*) is taken to be $\neg\mathsf{many}'[\ldots]$. Thus, it meets our characterization of what constitutes a simply DE context. The table in (9) indicates the logical form of some NPI-licensers of different licensing strength.[5]

(9)

entailment classification	example	representational characterization
antimorphic	*nicht* (*not*)	$\neg[\ldots\phi\ldots]$
anti-additive	*niemand* (*nobody*)	$\neg\exists[\ldots\phi\ldots]$
downward entailing	*wenige* (*few*)	$\neg\mathsf{many}'[\ldots\phi\ldots]$

The representational reformulation of the hierarchy of negations fixes the antimultiplicativity problem: All antimultiplicative natural language operators are of the form "*not every–*". In the representational approach, these operators receive a logical form which contains a negation and a universal quantifier ("$\neg\forall$"). This representational characterization leads us to expect that these operators create contexts which form a natural class with those of simple DE-operators, i.e., contexts in which a quantifier intervenes between

[5]For simplicity, we encode negative indefinites as existential quantifiers. The contrast between existential and universal quantification has been amply noted (e.g., Partee (1987), Zimmermann (1993)).

the negation and an NPI which is to be licensed. This observation suggests that the representational approach to NPI licensing can explain the lack of a class of NPIs which would be systematically predicted under the EBT.

In van der Wouden (1997) a link was made from collocations to PI licensing. Van der Wouden assumes an EBT, where the characterization of the entailment requirements is considered a collocational restriction. Given the collocation module of Section 3, we can attempt to integrate van der Wouden's proposal explicitly. At first blush, doing so presents complications because the architecture of a linguistic sign in HPSG does not encode its entailment properties. Thus, we would need to introduce this information in order to adopt an EBT. On the other hand, we have seen in (9) that we can reformulate the entailment notions in representational terms. Our collocation module of Section 3 allows us to refer to the logical form of a licenser, in the case above the durational modifier. We would expect that reference to other operators, like negation and quantifiers, is also being made in the collocational requirements of lexical items. Thus, our collocation module provides the necessary means to express polarity requirements.

Given the representational recoding of the entailment definitions, we can integrate the polarity requirements of the verb *fackeln* into its lexical entry.

(10) Sketch of the lexical entry of *fackeln* (final version):

$$\begin{bmatrix} \textit{word} \\ \textsc{phon}\ \langle \textit{fackeln} \rangle \\ \textsc{syns loc} \begin{bmatrix} \textsc{cat head}\ \boxed{2}\ \textit{verb} \\ \textsc{content}\ \ \mathsf{hesitate}'(e,x) \end{bmatrix} \\ \textsc{coll} \left\langle \boxed{1} \left[\textsc{s l cont}\ \ldots\neg[\ldots\mathsf{hesitate}'(e,x)\ldots]\ldots\right] \right\rangle \end{bmatrix} \begin{array}{l} \textbf{and } \texttt{dominates}(\boxed{1},\boxed{3}) \\ \textbf{and } \boxed{3}\begin{bmatrix} \textsc{s l} \begin{bmatrix} \textsc{cat head mod} \left[\textsc{l cat head}\ \boxed{2}\right] \\ \textsc{content}\ \ldots\mathbf{dur}'(e)\ldots \end{bmatrix} \end{bmatrix} \end{array}$$

With this lexical entry, we can analyze a typical sentence containing *fackeln* in Figure 1. The collocational requirements of the verb are met: (i), the CONTENT value of sign $\boxed{1}$ contains a negation operator that has scope over the constant contributed by the verb, and (ii), the sign in its COLL list, $\boxed{1}$, dominates a DM which modifies the verb.

In light of a collocation mechanism like ours, the data of Hoeksema (2001) are not surprising. It is only natural that a lexical element restricts the logical form of the sentences in which it occurs in various respects. In the case of *for love or money* in (4), the relevant item is required to be in the scope of a negation and a modal operator in the logical form of the sentence. In the example in (5), negation and a quantifier are required.

In the present approach, multiple co-occurrence requirements are captured in a unified way. No distinction is made between "primary" and "secondary" licensing of NPIs, to repeat Hoeksema's terminology. We achieve a unified theory by adopting a representational theory of NPI licensing rather than introducing a different machinery, as would be needed for an EBT. Furthermore, we can express the required degree of negativity by referring to constants that are needed independently in the logical form of a sentence to express the right readings. This is a clear advantage over theories which encode NPI requirements by the percolation of diacritic markings (Dowty (1993)).

5. Conclusion

We argued that a collocation module is needed to account for the distribution of lexical elements as the verb *fackeln*. Its requirement of a durational modifier is a classical collocational property. Once a collocation module is introduced, it can also comprise the second distributional restriction of *fackeln*, namely its limitation to negative contexts. Reformulating the hierarchy of licensing strength for PIs of Zwarts (1997) in terms of the logical form of the licensers, we have seen that a representational theory is capable of making the same distinctions as the EBT without being confronted with the antimultiplicativity problem. Finally, studies like Hoeksema (2001) have revealed that many PIs show additional collocational restrictions. Our approach is the first to capture this observation collectively.

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