An Approach to Polarity Sensitivity and Negative Concord by Lexical Underspecification*

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Abstract

This paper presents a dynamic semantic approach to the licensing of Polarity Sensitive Items (PSIs) and *n–words* of Negative Concord. We propose that PSIs are unified by the semantic *scale property*, which is responsible for their sensitivity to the context; we develop a semantic licensing analysis based on Fauconnier's (1975) scales and Ladusaw's (1979) notion of entailment. The first part of the paper concludes with a formalization of semantic licensing in the sense of Ladusaw (1979) within HPSG (see, e.g., Pollard and Sag (1994)) which allows for a uniform treatment of the licensing of PSIs and *n–words* of Negative Concord and accounts for the disambiguating nature of PSIs in scopally ambiguous sentences.

The second part of the paper is concerned with the limitations of semantic licensing, which, we claim, needs to be sensitive to the context. We present the discussions of, e.g., Heim (1984) and Israel (1996) with respect to the importance of the context in particular licensing constellations, and then turn to linearity constraints on licensing. We present data from German which may not be accounted for by linearity constraints and sketch an analysis for this data which supports the necessity of context–sensitive semantic licensing.

1 Introduction

The natural language phenomenon Polarity Sensitivity (PS) has been much discussed in formal linguistics within the last thirty odd years. Klima (1964) has brought attention to Polarity Sensitive Items (PSIs), whose name reflects the early intuitions about their analysis: these elements are sensitive to the context to the extent that they may only be interpreted in particular contexts. Consider the following examples.

(1) a. John didn't *ever* meet his professor for lunch.
b. *John *ever* met his professor for lunch.

(2) a. Mary is *rather* clever.

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b. *Mary isn't *rather* clever.

The examples in (1) and (2) illustrate the two types of PSIs typically distinguished, namely Negative Polarity Items (NPIs) and Positive Polarity Items (PPIs), respectively. The NPI *ever* in (1) a. is acceptable in the context of sentential negation, but not in the positive counterpart in (1) b. The PPI *rather*, on the other hand, is interpretable in the positive sentence in (2) a., but not in the negated version in (2) b. In (1) and (2), the presence of sentential negation determines the grammaticality of the respective PSI. Klima (1964) thus proposes to characterize the environments suitable for PSIs by the morpho–syntactic feature NEG: NPIs must be c–commanded by the functional projection NEG whereas PPIs may not be c–commanded by NEG. Although this accounts for the examples in (1) and (2), Klima needed to revise this approach since NPIs are licensed in a variety of environments, partially illustrated in (3), which may not plausibly be characterized by NEG.

(3) a. I doubt that Chris will win *a red cent*.
b. Sandy payed the bill without *ever* finishing the drink.
c. Every person who *ever* walked this earth is guilty.
d. Did Sandy *ever* read the newspaper?

In (3), the NPIs are licensed by the adversative predicate *doubt*, the preposition *without*, the restriction of the determiner *every* and the question mode, respectively.[1] Further such environments are indirect questions, conditionals, comparatives and certain adverbs like, e.g., *rarely* (see, e.g., Ladusaw (1979) for an overview). In order to characterize these environments in which NPIs are licensed, Klima stipulates that the environments are marked by the morpho–syntactic feature [AFFECTIVE +]; NPIs are thus licensed when c–commanded by such an environment, while PPIs (which are acceptable in some of these environments) may not be c–commanded by negation.

This brief discussion of Klima's early analysis of PS illustrates the questions which still today must be answered by an analysis of the licensing of PSIs: (i) *Why are PSIs sensitive to the context?*, (ii) *What makes a context in which a PSI occurs suitable for the PSI?*, and (iii) *What is the nature of the link between a PSI and the context in which it is licensed?* In this paper, we propose a dynamic semantic account of the licensing of PSIs. We assume that *n–words* of Negative Concord are a special type of PSI such that our analysis also accounts for these elements. We argue that PSIs are sensitive to the context due to the *scale property*, which unifies these elements of natural language, and define conditions on contexts in which they may be successfully interpreted (section 2). One such condition is based on Ladusaw's (1979) semantic characterization of operators which create entailment environments, which is presented in section 3. In section 4, we present a formalization of Ladusaw's (1979) semantic licensing condition in HPSG (see, e.g., Pollard and Sag (1994) and Sag and Wasow (1999)) for which we assume a dynamic semantics (see, e.g., Kamp and Reyle (1993)). Central to the formalization is the representation of PSIs as presupposition triggers which allows PSIs to express their licensing

[1] To see that these elements function as licensers, consider the sentences in (i) in which the licensing elements of (3) are substituted by non–licensers.

(i) a. *I think that Chris will win *a red cent*.
b. *Sandy payed the bill but *ever* finished the drink.
c. *Many people who *ever* walked this earth are guilty.
d. *Sandy *ever* read the newspaper.

conditions on the context. Section 5 turns to the limitations of semantic licensing. We argue that semantic licensing needs to be sensitive to contextual information. We present the discussions of Heim (1984) and Israel (1996) with respect to the importance of the context in particular licensing constellations and then turn to linearity constraints on licensing. We present data from German which may not be accounted for by linearity constraints and sketch an analysis for this data following our analysis in section 2 which supports the necessity of context–sensitive semantic licensing. Section 6 concludes the paper.

2 Polarity Sensitive Elements of Natural Languages

In this paper we propose an analysis of context–sensitive semantic licensing which accounts for PSIs as well as *n–words* of Negative Concord, which constitute a further type of sensitive element of natural language.

2.1 Negative Concord

Negative Concord occurs in a variety of Romance and Slavic languages and, for instance, in Bavarian German and African American Vernacular English (AAVE), though not in High German or Standard English (SE). The phenomenon is characterized by the occurrence of multiple negative expressions in an utterance which result in an interpretation expressing a single negation. This is illustrated by the examples in (4) and (5) from AAVE and Italian, respectively.

(4) He didn't see no cats. (AAVE)
≈ He didn't see any cats. (SE)

(5) Non ha visto nessun gatto. (from Tovena (1996))
not has seen no cat
'S/he hasn't seen any cat.'

Both sentences in (4) and (5) exhibit sentential negation as well as a negatively quantified object phrase, but they express only a single negation. The example in (6) from Polish illustrates five negative expressions which result in a single negation interpretation for the proposition (example from Przepiórkowski and Kupsc (1996)).

(6) Nikt nigdy nikogo niczym nie uszczeŚliwił.
nobody–NOM never nobody–GEN nothing–INS not made happy
'Nobody has ever made anybody happy with anything.'

n–words of Negative Concord contribute to a single negation to be expressed by the sentence. Their distribution is, similarly to that of PSIs as introduced in the introduction, restricted to certain contexts. This is illustrated by the examples in (7) which correspond to (4), (5) and (6), respectively.

(7) a. *He saw no cats. (AAVE)
b. *Ha visto nessun gatto. (Italian)
has seen no cat
c. *Nikt nigdy nikogo niczym uszczeŚliwił. (Polish)
nobody–NOM never nobody–GEN nothing–INS made happy

The examples in (7) differ from those in (4), (5) and (6) in that they lack sentential negation which results in the *n–words* not being licensed. In order to account for the restricted distribution of *n–words* of Negative Concord, we assume that *n–words* are NPIs in a sense to be specified in section 4 (see also, e.g., van der Wouden and Zwarts (1993) and Giannakidou (1998)).

The data in (8) from Italian (see, e.g., Tovena (1996)) illustrates that *n–words* in certain contexts may receive an interpretation as a negative quantifier.

(8) a. Chi ha cantato? Nessuno.
who has sung nobody
'Who did sing? Nobody.'

b. Nessuno ha cantato.
Nobody has sung
'Nobody sang.'

Clearly, an analysis of the interpretation of *n–words* must account for the various interpretations of *n–words*. However, for instance, in Slavic languages *n–words* do not have this double function but are always sensitive to the context. In fact, Giannakidou (1998) claims that there exist five types of languages classified according to the number of *n–word* paradigms, the availability of NC and the number of non–negative environments *n–words* are allowed to occur in. In this paper, we focus on the licensing aspect of *n–words* which are sensitive to the context and propose that their restricted distribution may be accounted for by the semantic licensing analysis formulated for PSIs. (See, e.g., Ladusaw (1992) and Tovena (1996) for analyses of NC where *n–words* may receive both interpretations.)

2.2 A Semantic Property of PSIs

In this section, we discuss the interpretation of PSIs and propose that PSIs are unified by the semantic *scale property*, which is responsible for their sensitivity to the context. The idea that PSIs are interpreted relative to a scale is based on an account of the interpretation of PSIs presented by Fauconnier (1975). In his analysis, he assumes that PSIs are quantificational superlatives with respect to a scale identified in the context. Consider the example in (9).

(9) Sandy cannot solve *any* problem.

Fauconnier argues that the NPI *any* in (9) points to the lowest proposition on the scale induced by the propositional schema 'Sandy cannot solve problem X' which is ordered relative to the degree of difficulty of the problem X. Such a scale is illustrated in (10).

(10) Sandy cannot solve Fermat's Theorem
...
...
Sandy cannot solve 1+1

Given common sense background assumptions ('Anybody who can solve problem A can solve problem B which is easier than A') and Fauconnier's analysis of *any* as a pointer to the lowest proposition on the scale, (9) allows the pragmatic inference that there is no problem at all which Sandy can solve; i.e., the NPI triggers a pragmatic inference on the scale. In Fauconnier's analysis, NPIs are licensed if the scale in the context supports the quantificational character of the NPI. In order for NPIs to be licensed, the scale must support pragmatic inferences up the scale (as, e.g., the scale in (10) does). PPIs, on the other hand, point to a high proposition of the scale in the context which again must support its quantificational character. The scale created by the positive counterpart of (9), namely *Sandy can solve problem X*, creates a scale which supports pragmatic inferences in the other, i.e., downward direction, which is appropriate for PPIs.

(11) Sandy can solve Fermat's Theorem
...
...
Sandy can solve 1+1

The scales in (10) and (11) differ, according to Fauconnier, because of the presence of negation in (10) which functions as a *scale reverser*. In Fauconnier's analysis, NPIs are only licensed in scales which contain a scale reverser. We define a scale as in (12).

(12) **Definition of a Scale S**
A scale S which is associated with a propositional schema $\langle\tau,t\rangle$ for any type τ is a set of propositions S_i ordered relative to the values of τ.

In this paper, we follow Fauconnier (1975) in assuming that PSIs must be interpreted relative to a scale in the context.[2] However, we assume that it is a semantic rather than pragmatic property unifying the class of PSIs which makes them require a scale in the context. We refer to this property as the *scale property*, which is illustrated with the following examples.

(13) a. Mary is *pretty* clever.
b. I doubt that John *ever* met Andrew.

The *scale property* requires that both PSIs in (13) a. and b. must be interpreted against a scale identified in the context. In the case of the PPI *pretty* in (13) a., the scale is an ordering based on the degree of cleverness and (13) a. expresses that the degree of cleverness which applies to the individual referred to by 'Mary' is high. In (13) b., the scale with respect to which the NPI *ever* is interpreted is a set of propositions of the form 'John met Andrew at time t' which are ordered with respect to possible instantiations of the time t at which John might have met Andrew. The scale property is defined as follows.[3]

(14) **Scale Property**
In order for a PSI to be interpretable, the context must provide for an appropriate scale.

Notice that the scale property as given in (14) solely expresses that in order for a PSI to be interpretable in a particular context, the context must provide for a scale but that we have not yet formulated what we assume an 'appropriate' scale for a particular PSI to be.

A first requirement concerns the type τ of the instantiations for which the scale expresses an ordering. Since the type τ depends on the type of the particular PSI considered, the scale against which a PSI is interpreted in a particular context must be identified in relation to the

[2]See, e.g., Krifka (1989, 1995), Dowty (1994) and Israel (1996) for other analysis of the interpretation and licensing of PSIs which relate to Fauconnier's early scalar analysis.

[3]Note that elements like *very* or *really* also must be interpreted with respect to a scale. However, whereas the scale against which these elements are interpreted is the element modified, the elements which create the scale for PSIs do not stand in a particular syntactic dependency to PSIs (c.f., section 5).

PSI. Therefore, the scale in (13) a. ranges over degrees of a property (cleverness) whereas the scale in (13) b. ranges over times.

A second requirement, already identified by Fauconnier (1975), is that the scale must support inferences in a particular direction. Here, the scale reversing elements are of particular importance. Ladusaw (1979) succeeds in presenting a semantic characterization of these elements which we assume to form part of the conditions on the licensing of PSIs. Our next steps in this paper are as follows. We present Ladusaw's semantic characterization of scale reversing elements and his entailment–based licensing analysis in section 3. In section 4, we formalize in HPSG an analysis of semantic licensing based on his account. Section 5 returns to context–sensitive semantic licensing which refers to scales as outlined in this section.

3 Entailment–based Licensing

Ladusaw (1979) presents a semantic characterization of the scale reversing elements of Fauconnier and provides for an account of the licensing of PSIs. Ladusaw's characterization is based on the semantic notion of *entailingness* which is related to Fauconnier's pragmatic scales. Consider the examples in (15).

(15) a. John cooked a cabbage.
b. John cooked a vegetable.

(15) a. presents an *upward entailing* context since it supports inferences from subsets to supersets; i.e., (15) a. entails (15) b. since if John cooked a cabbage, it must also be true that he cooked a vegetable because all cabbages are vegetables. PPIs may occur in upward entailing contexts. On the other hand, as Ladusaw shows, NPIs occur in downward entailing contexts. A context is *downward entailing* if it supports inferences from supersets to subsets.[4] Consider the examples in (16).

(16) a. John doesn't own a car.
b. John doesn't own a Porsche.

The context in (16) a. is downward entailing: if (16) a. is true, (16) b. must be true, too; if John doesn't own a car, it must be true that he doesn't own a Porsche either. Ladusaw argues that negation licenses NPIs because negation creates a downward entailing context. The particular success of Ladusaw's analysis is that he shows that the elements in whose context NPIs may occur (some were illustrated in the introduction in section 1) all create downward entailing environments. These elements, which we refer to as *scale reversing elements*, may therefore be given a semantic characerization as in (17).

(17) **Scale Reversing Element (SRE)**
An element R is scale reversing if and only if whenever $P \models Q$ it holds that $R(Q) \models R(P)$

For instance, *every* is scale reversing in its restriction since *Every human breaths* entails *Every woman breaths.* The semantic definition of scale reversing elements as elements which create a downward entailing environment is exploited in Ladusaw (1979) to account for the licensing of

[4]Figure 1 presents a formal definition of these contexts.

PSIs: NPIs are licensed if they are in the scope of a SRE and PPIs are licensed if they are in the scope of an operator which creates an upward entailing environment.

Ladusaw's (1979) characterization of environments for PSIs is successfully applied to a variety of languages (see, e.g., van der Wouden (1994) for German, English and Dutch, and Nam (1994) for Korean and Japanese) and further refined by, e.g., van der Wouden (1994) and Zwarts (1993, 1996) to account for finer distinctions among PSIs. Their results are summarized in Figure 1.

operator $\mathcal{R}$	**Environment created**	**PSIs licensed**	example
weak SRE (e.g., *at most n*)	downward–entailing $\alpha \subseteq \beta \rightarrow \mathcal{R}(\beta) \subseteq \mathcal{R}(\alpha)$	weak NPI weak PPI	*any* *rather*
strong SRE (e.g., *no one*)	anti–additive $\alpha \subseteq \beta \rightarrow \mathcal{R}(\beta) \subseteq \mathcal{R}(\alpha)$ and $R(\beta \cup \alpha) \rightarrow \mathcal{R}(\beta) \cap \mathcal{R}(\alpha)$	weak NPI strong NPI	*any* *yet*
superstrong SRE (e.g., *not*)	anti–morphic $\alpha \subseteq \beta \rightarrow \mathcal{R}(\beta) \subseteq \mathcal{R}(\alpha)$ and $\mathcal{R}(\beta \cup \alpha) \rightarrow \mathcal{R}(\beta) \cap \mathcal{R}(\alpha)$ and $\mathcal{R}(\beta \cap \alpha) \rightarrow \mathcal{R}(\beta) \cup \mathcal{R}(\alpha)$	weak NPI strong NPI superstrong NPI	*any* *yet* *a bit*
upward entailing (e.g., *at least n*)	upward–entailing $\alpha \subseteq \beta \rightarrow \mathcal{R}(\alpha) \subseteq \mathcal{R}(\beta)$	weak PPI strict PPI	*rather* *some*

Figure 1: Strengths of Entailment and PSIs

As illustrated in Figure 1, there exist three types of SREs according to the strength of the environment they create (refer to the second column of Figure 1 for the respective formal definitions): weak SREs create downward entailing environments as illustrated above, strong SREs creating not only downward entailing but even anti–additive environments. The formal property 'anti–additive' is illustrated in (18).

(18) a. No one sings or laughs.
b. No one sings and no one laughs.

The noun phrase *no one* is a strong SRE and therefore supports the entailment from (18) a. to (18) b.. Finally, superstrong SREs create environments which are downward entailing, anti–additive and anti–morphic. The anti–morphic property of the superstrong SRE *not* is illustrated in (19).

(19) a. John does not sing and laugh.
b. John does not sing or John does not laugh.

These three classifications are motivated by subgroupings among the PSIs which are only licensed in the context of particular operators. Thus, whereas superstrong SREs license all three types of NPIs (superstrong, strong and weak NPIs), strong SREs only license strong and weak NPIs and weak SREs only license weak NPIs. (See van der Wouden (1994) and Zwarts (1993, 1996) for more examples.) Upward entailing environments are created by operators referred to as *upward entailing* in Figure 1. In their context, strict as well as weak PPIs are licensed. The latter; i.e., weak PPIs, are also licensed in the context of weak SREs. We assume that *n–words* of NC are stong NPIs since they may be licensed by strong SREs like *nobody* as well as superstrong SREs like sentential negation.

4 Semantic Licensing in HPSG

In this section we formalize Ladusaw's entailment–based licensing approach as presented above.[5] We proceed as follows. Section 4.1 introduces the underspecified dynamic semantics we assume for HPSG in this paper and briefly discusses the conception of presuppositions in dynamic semantics. Section 4.2 presents the central part of the formalization, namely the representation of PSIs. Section 4.3 illustrates how the entailment contexts are introduced by the operators. Section 4.4 presents an example and illustrates how the formalization is suited to capture the desambiguating nature of PSIs in scopally ambiguous contexts.

4.1 Underspecified Semantics and Presuppositions

In this paper, we assume a dynamic semantics for HPSG which allows for underspecified representations. In particular, we assume *Minimal Recursion Semantics* (MRS) (see, e.g., Copestake et al. (1995) and Copestake et al. (1997)), which is a version of *Underspecified Discourse Representation Theory* (UDRT, see Reyle (1993)). MRS is formalized in terms of feature structures, which makes it easily compatible with HPSG. In this section, we briefly illustrate the motivation for underspecified semantic representations and their formalization in MRS as well as the concept of a presupposition in dynamic semantics.

Semantic ambiguities arise to a great extent in utterances of natural language sentences. An ambiguity may be resolved by considering the context in which the utterance was made, but, in order to assign a representation to an isolated sentence we need a representation which captures possible ambiguities and serves as the input to the resolution component. Semantic theories like UDRT or MRS create such underspecified representations. To illustrate their working, consider the example in (20) a. and its representations in First–Order Predicate Logic in (20) b. and c.

(20) a. Every woodpecker claims a tree.
b. $\exists x(tree(x) \wedge \forall y(woodpecker(y) \longrightarrow claim(y,x)))$
c. $\forall y(woodpecker(y) \longrightarrow \exists x(tree(x) \wedge claim(y,x)))$

(20) a. is ambiguous due to two possible scopal relations of the two noun phrases: (20) b. represents the interpretation of (20) a. in which the quantified noun phrase *every woodpecker* is interpreted within the scope of the indefinite noun phrase *a tree* such that (20) a. expresses that there exists a specific tree which every woodpecker claims. In (20) c., the indefinite noun phrase is interpreted within the scope of the quantificational noun phrase. Here, (20) a. receives an interpretation in which every woodpecker claims a tree which may be different for the individual woodpeckers. Since the intended reading of (20) a. may only be determined with further context, we need a representation of (20) a. which captures both readings represented in (20) b. and c.

In an underspecified semantics, the lexical elements of an utterance introduce to the representation semantic relations whose argument slots are pointers to other semantic relations. Thus, the underspecified semantic representation is 'flat' since the scopal relations are expressed by co–indexation rather than structurally as in (20) b. and c. Furthermore, the formalism does not

[5]The analysis presented in this section is a refined version of Tonhauser (1999).

require all arguments of a semantic relation to be filled initially; a slot may be left underspecified in order to indicate that there exist alternative resolutions for this slot. (21) presents the underspecified semantic representation of (20) a.

(21) {top(*l*0), *l*1: exists(x,*l*2,*l*6), *l*2: tree(x), *l*3: every(y,*l*4,*l*7), *l*4: woodpecker(y), *l*5: claim(s,y,x)}

The representation in (21) is an unordered set of semantic relations which are identified by labels. The arguments of the complex relations (e.g., quantifiers) are identified by labels, too; these need to be identified with labels pointing to semantic relations. Notice that two argument labels in (21) are not identified with labels pointing to semantic relations, namely *l*6 and *l*7 which represent the scopal arguments of the two quantifiers, respectively. Therefore, the representation in (21) is *underspecified*; depending on the resolution of these labels, the representation results in either of the two interpretations identified for (20) a. The two possible resolutions for (21) are given in (22) a. and b. which are analogues of (20) a. and b.

(22) a. {top(*l*1), *l*1: exists(x,*l*2,*l*3), *l*2: tree(x), *l*3: every(y,*l*4,*l*5), *l*4: woodpecker(y), *l*5: claim(s,y,x)}
b. {top(*l*3), *l*1: exists(x,*l*2,*l*5), *l*2: tree(x), *l*3: every(y,*l*4,*l*1), *l*4: woodpecker(y), *l*5: claim(s,y,x)}

The constraints which limit the possible resolutions are introduced lexically as well as during the construction. For example, the label identifying the main verbal predicate is subordinate to all other labels; therefore, in (21), *l*5 must be subordinate to both labels identifying the scope arguments of the determiners; i.e., $l6 < l5$ and $l7 < l5$. The scope labels must in turn be subordinate to the top label *l*0 which results in the ambiguity of (21) since no constraint specifies the <–relation between *l*6 and *l*7. In a resolved representation, the outscopes relation < between labels must obey the constraints introduced during the construction as well as minimally the following two constraints: (i) a unique top label to which all other labels are subordinated must exist; and (ii) the resolved representation must be an irreflexive partial lattice (see Reyle (1993) and Copestake et al. (1997) for precise formalizations).

In MRS, the semantic relations and the outscopes relation between labels are expressed in terms of feature structures. The structure in (23) is the MRS–analogue of (21). In general, the feature HANDEL identifies a semantic relation (i.e., handles correspond to the labels above) such that HANDEL $\boxed{0}$ in (23) identifies the semantic representation of the utterance. The value of the feature INDEX is the type assigned to the semantic relation, here, a situation. The value of the feature LISZT is the list of semantic relations of a proposition. It is the union of the LISZT values of the semantic relations of the utterance. The semantic relations in LISZT as well as their argument positions are identified by handles, too.[6] The value of the feature H–CONS is the set of constraints on the resolution of the <–relation between handles. As exemplified above, the constraint $\boxed{0} < \boxed{5}$ requires that the highest semantic relation of the proposition must outscope the semantic relation introduced by the verbal predicate and both quantifier scope handles must outscope the handle of the verbal predicate ($\boxed{7} < \boxed{5}$, $\boxed{6} < \boxed{5}$) such that the either quantifier may be the highest semantic relation of a resolved representation ($\boxed{0} \in \{\boxed{1}, \boxed{3}\}$).[7]

[6]The remaining features in the semantic relations should speak for themselves: BV identifies the bound variable of the quantifier, RESTR(iction), UND(ergoer).

[7]Notice that certain handle relations of (22) are already resolved to make the illustration easier; for instance, the handles identifying the restrictions of the quantifiers have already been identified with the handles identifying *tree* and *woodpecker*. These resolutions are constrained by the syntactic analysis. See, e.g., Schiehlen (1999) for a formalization of the interface between syntax and semantics and semantic construction.

(23)
$$\begin{bmatrix} \text{HANDEL } \boxed{0} \\ \text{INDEX } s \\ \text{LISZT } \left\langle \begin{matrix} \begin{bmatrix} \textit{every\_rel} \\ \text{HANDEL } \boxed{3} \\ \text{BV } i \\ \text{RESTR } \boxed{4} \\ \text{SCOPE } \boxed{7} \end{bmatrix}, \begin{bmatrix} \textit{woodpecker\_rel} \\ \text{HANDEL } \boxed{4} \\ \text{INST } i \end{bmatrix}, \\ \begin{bmatrix} \textit{claim\_rel} \\ \text{HANDEL } \boxed{5} \\ \text{INDEX } s \\ \text{ACTOR } i \\ \text{UND } u \end{bmatrix}, \begin{bmatrix} \textit{some\_rel} \\ \text{HANDEL } \boxed{1} \\ \text{BV } u \\ \text{RESTR } \boxed{2} \\ \text{SCOPE } \boxed{6} \end{bmatrix}, \begin{bmatrix} \textit{tree\_rel} \\ \text{HANDEL } \boxed{2} \\ \text{INST } u \end{bmatrix} \end{matrix} \right\rangle \\ \text{H–CONS } \left\{ \boxed{0} < \boxed{5}, \boxed{7} < \boxed{5}, \boxed{6} < \boxed{5}, \boxed{0} \in \left\{ \boxed{1}, \boxed{3} \right\} \right\} \end{bmatrix}$$

An underspecified representation forms the input to the resolution mechanism where it is resolved by contextual information. In this respect, presuppositions play a central role in dynamic semantic theory since they allow to express that the interpretation of a particular element depends on the context. To illustrate this dependency, consider the example in (24).

(24) Last August, a whale got lost in the San Francisco Bay. After three days, it found its way back to the Pacific.

The past tense predicate *found* as well as the pronoun *it* of the second sentence of the discourse in (24) both impose constraints on the context as a part of their interpretation. Past tense requires a past eventuality in the context to function as its antecedent and *it* requires a previously introduced individual within the context. In dynamic semantics, such constraints are formalized as presuppositions which must be resolved in the context according to the binding constraints introduced by the presupposition triggers (see, e.g., Kamp and Rossdeutscher (1994)).

4.2 Polarity Sensitive Items as Presupposition Triggers

Recall from Figure 1 in section 3 that each of the five types of PSIs is licensed in particular environments only. Figure 2 represents these constraints from a lexicalist perspective: we assume that a PSI introduces a constraint on the context within which it may appear; i.e., a presupposition which ensures that the context is suitable for the PSI.

PSI	constraint on context
weak NPI	weak SRE
strong NPI	strong SRE
superstrong NPI	superstrong SRE
weak PPI	weak SRE or upward entailing operator
strict PPI	upward entailing operator

Figure 2: Lexical Constraints of PSIs

Before we turn to the lexical entries which encode these requirement, we present a type hierarchy which the lexical entries refer to. In HPSG, types are employed to express generalizations about, e.g., words and phrases. They are represented in multiple inheritance type hierarchies which represent distinct dimensions of constraints on words or phrases. (See, e.g., Sag (1997) and Sag and Wasow (1999) for extensive analyses using type hierarchies.) One particular property of type hierarchies we make use of in this paper, concerns the behavior of types with regards to unification: two types may only be unified if there exists a type which is subsumed by both types.[8] We propose the following type hierarchy in order to encode the licensing strengths of the operators and the constraints on the context introduced by PSIs.

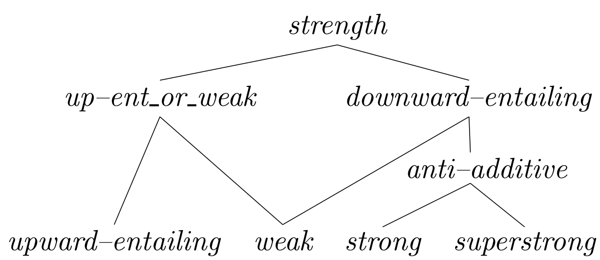

Figure 3: Type Hierarchy for *strength*

The maximal types of this type hierarchy; i.e., *upward entailing, weak, strong* and *anti–morphic* encode the respective strength of the operators summarized in Figure 1. (We illustrate in section 4.3 how these types are encoded in the lexical entries of the operators.) The type hierarchy also captures the requirements of the respective PSIs on the context: according to Figure 2, each type of PSI requires a particular operator in the context which creates an environment of appropriate strength and direction: *upward entailing* (strict PPIs), *up_ent_or_weak* (weak PPIs), *downward entailing* (weak NPIs), *anti–additive* (strong NPIs) or *superstrong* (superstrong NPIs). To illustrate the practicability of the type hierarchy, consider the constraint introduced by a weak NPI which requires a downward entailing SRE in the context. Since the type with which weak, strong and superstrong SREs are marked, respectively, may each unify with *downward entailing*, any licenser of one of the types is appropriate for the NPI. The type hierarchy therefore encodes the subset relation of the SREs as illustrated in Figure 1.[9] On the other hand, a strong NPI which requires its licenser to be of type *anti–additive* is not licensed by a licenser marked *weak*: this is accounted for since there is no common subtype for *weak* and *anti–additive* and therefore their unification fails.

We may now turn to presenting the lexical entry for PSIs. We assume that PSIs are assigned the type *psi_rel* which requires a PSI to introduce a constraint on the context which ensures that the context contains an operator appropriate for the particular PSI. Clearly, each type of PSI specifies the particular constraint it imposes on the operator. We illustrate this analysis with

[8] For instance, a type hierarchy for German requires all nominal predicates to be marked for number: a nominal predicate like *Kuchen* (‘cake’) would be marked by the supertype *number* since it is not possible to determine the number for this predicate without context. Once the nominal predicate is in the context of a determiner, e.g., *jeder* (‘every’) which requires its nominal predicate to be marked *sing* in the number specification, the predicate *Kuchen* is marked *sing*, too. This is possible since *sing* is a type subsumed by both types involved; i.e., *number* and *sing*.

[9] Giannakidou (1998) claims that (non)veridicality rather than entailingness is the property to which PSIs in Greek are sensitive. We believe that these properties may be incorporated to the account presented here since Giannakidou (1998) writes that entailingness is a particular manifestation of the concept of (non)veridicality.

the relevant part of the lexical entry for the NPI *ever* given in (25).

(25)
$$\left[\begin{array}{l} \text{LISZT} \left\langle \left[\begin{array}{l} \textit{ever\_rel} \\ \text{HANDEL } \boxed{1} \\ \text{LIC } \left[\text{DOM } \boxed{2}\right] \end{array}\right] \right\rangle \\ \text{H–CONS} \left\{ \left[\begin{array}{l} < \\ \text{LIC} \left[\begin{array}{l} \text{DOM } \boxed{2} \\ \text{STR } \textit{downward–entailing} \end{array}\right] \\ \text{PSI } \boxed{1} \end{array}\right] \right\} \end{array}\right]$$

The presupposition introduced by PSIs is expressed via an underspecified constraint on the outscopes relation between handles which is introduced to H–CONS. In (25), *ever* triggers a presupposition which requires the context to provide for a licenser (LIC) whose strength (STR) is *downward–entailing* and which outscopes the PSI; i.e., $\boxed{2} < \boxed{1}$. (Notice that it is not the handle of the LICenser which needs to outscope the handle of the PSI but rather the DOM(ain) handle of the licenser. We turn to the feature DOM in the next section.) Furthermore, the semantic relation of *ever* in LISZT includes the feature LIC such that, if the constraint is successfully resolved and a licenser has been identified, the representation of the PSI allows to identify the element which functions as its licenser.[10]

4.3 The Representation of Licensing Environments

The operators identified in Figure 1 inherit from the type *lic_rel* which identifies them as licensers. This type requires the semantic relation of the operator to include the feature LIC which identifies the strength (STR) of licensing of the particular element as well as its DOM(ain) of licensing. To illustrate these specifications, consider the relevant part of the lexical entry of the licenser *every* given in (26).

(26)
$$\left[\begin{array}{l} \text{LISZT} \left\langle \left[\begin{array}{l} \textit{every\_rel} \\ \text{HANDEL } \boxed{3} \\ \text{RESTR } \boxed{4} \\ \text{SCOPE } \boxed{5} \\ \text{LIC} \left[\begin{array}{l} \text{DOM } \boxed{4} \\ \text{STR } \textit{strong} \end{array}\right] \end{array}\right] \right\rangle \end{array}\right]$$

The quantifier *every* creates an environment in its restriction which is downward entailing and anti–additive; it is therefore assigned the type *strong*. In order to encode that *every* only licenses NPIs in its restriction, the handle of the feature DOM(ain) is co–indexed with the handle of the feature RESTR. Therefore, any NPI whose handle is subordinated to the DOM handle in a resolved representation must appear within the restriction of *every* due to the co–indexation. It is necessary to encode the domain of licensing since the lexical operators differ not only with respect to the strength of the environment created but also with respect to which of

[10]This is necessary, e.g., in order to account for the unavailability of NPIs in the scope of two strong licensers as discussed in Baker (1970) or in a constellation where there is a universal quantifier intervening between a licenser and the NPI as discussed in Linebarger (1987).

their semantic domains introduces the licensing environment. For instance, the quantifier *no* introduces a strong environment in its restriction and scope; its lexical entry therefore identifies the handles of the DOM and HANDEL features; *few*, on the other hand, which only licenses in its scope, identifies the handle of DOM with the handle of the feature SCOPE. Similarly, the conditional *if* identifies the handle of DOM with the handle identifying the antecedent since *if* licenses NPIs only in its antecedent.

We are now ready to illustrate how our formalization accounts for the licensing of PSIs.

4.4 Semantic Licensing and Scope Disambiguation

This section illustrates the semantic licensing analysis formalized in the preceding sections and its interaction with semantic scope. Consider the following example.

(27) Every child who has *ever* eaten chocolate is addicted to it.

In (27), the NPI *ever* is licensed since it occurs in the restriction of the licenser *every*. For reasons of space, the MRS representation of (27) given in (28) only includes the semantic relations of the NPI *ever* and of the licensing element *every* in the value of the LISZT feature. Furthermore, the H–CONS feature only includes the underspecified constraint introduced by the NPI.

(28)

$$\begin{bmatrix} \text{LISZT} \left\langle \begin{bmatrix} \textit{every\_rel} \\ \text{HANDEL } \boxed{1} \\ \text{RESTR } \boxed{2} \\ \text{SCOPE } \boxed{3} \\ \text{LIC} \begin{bmatrix} \text{DOM } \boxed{2} \\ \text{STR } \textit{strong} \end{bmatrix} \end{bmatrix}, \begin{bmatrix} \textit{ever\_rel} \\ \text{HANDEL } \boxed{4} \\ \text{LIC} \begin{bmatrix} \text{DOM } \boxed{5} \end{bmatrix} \end{bmatrix} \right\rangle \\ \text{H–CONS} \left\{ \begin{bmatrix} < \\ \text{LIC} \begin{bmatrix} \text{DOM } \boxed{5} \\ \text{STR } \textit{downward–entailing} \end{bmatrix} \\ \text{PSI } \boxed{4} \end{bmatrix} \right\} \end{bmatrix}$$

The underspecified constraint on the handles $\boxed{5}$ and $\boxed{4}$ in H–CONS which was lexically introduced by the NPI, requires to identify some semantic relation in the LISZT value which is identified as a licenser and furthermore is compatible with the STR value *downward entailing* which the NPI requires in order to be licensed. The resolution component checks the semantic relations in LISZT and finds the semantic relation introduced by *every* suitable for co–indexation: *every* is identified as a licenser and its licensing strength *superstrong* is sufficient for the NPI. Therefore, resolution the restriction of *every* as the licenser of *ever* and identifies $\boxed{5}$ with $\boxed{2}$.

We assume that *n–words* of NC are formalized as strong NPIs. The examples in (4) to (7) are accounted by the formalization presented so far since *n–words* are licensed if they are outscoped by a strong SRE which is the case in (4) to (6) but not in (7).

Finally, we illustrate how our formalization accounts for the disambiguating nature of PSIs contexts with scope ambiguities. Consider the examples in (29).

(29) a. Nobody talks to a friend who cheated at school.

b. Nobody talks to a friend who *ever* cheated at school.

(29) a. is ambiguous due to the two possible scopings of the two noun phrases *nobody* and *a friend*. (29) b., however, which contains the NPI *ever* in the relative clause modifying *a friend*, may only receive an interpretation in which *nobody* outscopes the indefinite noun phrase *a friend*. Since our formalization of semantic licensing of PSIs refers to the outscopes relation, which also expresses the scope relations between quantifiers, the analysis (29) b. receives naturally accounts for the disambiguating nature of *ever*: the NPI requires to be outscoped by its licenser; i.e., *nobody*, but at the same time it must be outscoped by the restriction of *a friend*. This is only possible of *nobody* outscopes *a friend*.

5 Semantic Licensing in Context

The analysis of licensing we have formalized in the previous section is based on Ladusaw's (1979) analysis of operators which create upward or downward entailing environments in whose scope PPIs or NPIs are licensed, respectively. In this section, we discuss data which show that semantic licensing does not suffice to account for the distribution of PSIs in English and German. Several detailed analysis of particular PSIs have been presented to account for their distribution and interpretation (see, e.g., Kadmon and Landman (1993) for *any* or Tovena (1996) for *until*); others have argued that contextual information must be taken into account (see, e.g., Heim (1984), Linebarger (1987), Israel (1996)). We believe that Ladusaw's semantic analysis of operators is an essential part of the analysis of the licensing of PSIs but, based on the discussion in this section, we argue that semantic licensing must be sensitive to contextual information in various ways. Before turning to linearity constraints on licensing we present the arguments of Heim (1984) and Israel (1996) with respect to semantic licensing and context.

5.1 Heim (1984) and Israel (1996): Context and Semantic Licensing

In Heim (1984), Irene Heim discusses the licensing of NPIs in the context of conditionals, whose antecedent is generally taken to license NPIs as illustrated in (30).

(30) If she has *ever* written a book, she must be proud of herself.

Given Ladusaw's (1979) analysis of licensing environments, the conditional *if* must trigger a downward entailing environment in order for the NPI *ever* in (30) to be acceptable within the antecedent of the conditional. In fact, a popular analysis of the conditional *if…then…* is in terms of the truth functional connective of material implication → which supports the following inference.

(31) *If* p *then* $r \models$ *If* q *then* r where $q \models p$.

Since this inference pattern identifies *if* as creating a downward entailing environment, Ladusaw's analysis should be supported. However, as Heim (1984) points out, natural language sentences of the form *if…then…* do not generally support (31). For instance, even if (32) a. is true, this is not necessarily the case for (32) b.

(32) a. If she has written a book, she must be proud of herself.

b. If she has written a book and shot herself right afterward, she must be proud of herself.

In order to account for why NPIs may occur within conditionals, Heim proposes that the elements which trigger environments in which NPIs may occur, need not trigger a downward entailing environment in all contexts but only in those which support certain context–dependent background assumptions. To illustrate this, consider the following examples.

(33) If she has written two books, she must be proud of herself.

(34) a. If she has written one book she must feel rather bad.
b. #If she has written two books she must feel rather bad.

The examples in (33) and (34) illustrate the kind of context–dependency Heim has in mind: the strengthening of the antecedent of (32) a. as in (33) is contextually plausible and supports the inference pattern in (31). The strengthening of the antecedent of (34) a. as in (34) b., however, is rather unplausible as in the strengthening in (32) b. and therefore does not support the inference pattern. Heim proposes that conditionals of the form *if...then...* in natural language utterances only then support the inference in (31) if certain background assumptions are supported. For the examples above, the background assumption is something like (A).

(A) If writing one object A makes you feel proud and if B is a superset of A, the writing of B will make you feel proud.

Summarizing, conditionals may be analyzed as creating downward entailing environments in their antecedents if certain contextual background assumptions are supported. Heim proposes that Ladusaw's semantic licensing analysis must be extended to take into account such contextual information.

A related problem with Ladusaw's analysis arises with the determiner *exactly n*, which Linebarger (1987) identifies as not being downward entailing. Still, it may license NPIs as illustrated in (35).

(35) Exactly three of the guests had *so much as* a drop of whiskey.

The following examples illustrate that the determiner is neither upward nor downward entailing since neither (36) b. nor c. may be inferred from (36) a.

(36) a. Exactly three professors read a novel last night.
b. $\not\rightarrow$ Exactly three professors read a book last night. (not upward entailing)
c. $\not\rightarrow$ Exactly three professors read a trashy romance novel last night. (not downward entailing)

Israel (1996) discusses the licensing properties of *exactly n* and finds that what licenses NPIs is not the semantic meaning assigned to the determiner but rather the way it is used in discourse. The meaning definition of *exactly n* is symmetric as in *not more than n and not less than n.* However, in examples like (36) a., *exactly n* is understood to express *exactly three professors and no more than three*; i.e., its understood meaning is not symmetric to the extent that it makes only the upper bound explicit. Given this understood meaning, the NPI *so much as* in (35) is licensed since *exactly three* is understood as *no more than three* which creates a downward entailing environment. Similar to Heim, Israel argues that Ladusaw's semantic account of licensing needs to be able to incorporate this kind of contextual information in order to succeed.

5.2 Semantic Licensing and Linearity Constraints

The particular problem with semantic licensing we discuss in this paper concern the linearity constraints on licensing. So far, we only presented examples in English and German in which the NPIs did not appear in sentence initial position. (37) a. illustrates that the NPI *a red cent* is not grammatical in this particular position.

(37) a. **A red cent* is rarely collected.
b. Rarely, *a red cent* is collected.
c. All the members of the committee rarely are in the room.

The NPI *a red cent* is not licensed in (37) a. although the adverb *rarely* may license the NPI in (37) b. and *rarely* may outscope the subject noun phrase as illustrated by the ambiguity of (37) c. Thus, although the NPI in (37) a. is semantically outscoped by a potential licenser it is not licensed in this context. The unavailability of (37) a. is therefore not accounted for by the analysis we have formalized in section 4.[11]

Ladusaw proposes to solve this problem by supplementing his semantic definition of licensing with a Linearity Constraint as given in (38) (see, e.g., Ladusaw (1979), page 85, and Ladusaw (1992), page 245).

(38) **Ladusaw's Linearity Constraint**
The licenser must linearly precede the NPI if they are in the same clause.

This constraint accounts for the ungrammaticality of (37) a. but notice the relativization of the constraint to *...if they are in the same clause*. This is necessary to account for data like (39).

(39) That *anyone* could pass the exam is extremely unlikely.

The "Same Clause"–Constraint, as we refer to it, ensures that the NPI *anyone* which precedes its licenser in (39) is still licensed. However, the following data from German invalidates the "Same Clause"–Constraint. First, consider the topicalization data in (40). In (40) a., the NPI *sonderlich* which modifies the predicative phrase *begeistert* is licensed by the negation *nicht*. In (40) b., the predicative phrase is partially fronted which results in a constellation in which the NPI precedes its licenser but is still licensed.

(40) a. Peter war nicht *sonderlich* begeistert von dem Vorschlag.
Peter was not particularly excited of the suggestion
'Peter was not particularly excited about the suggestion.'
b. *Sonderlich* begeistert war Peter nicht von dem Vorschlag.
particularly excited was Peter not of the suggestion

[11]Notice that languages differ with regards to whether the linear order of the elements involved in licensing matter or not. For instance, NPIs in Korean and Japanese as illustrated in (i) and (ii), respectively, are licensed in sentence initial position (see, e.g., Nam (1994) and Kim (1995)).

(i) a. *amwuto* o-cianh-ass-ta (Korean)
anyone come-not-Pst-Dcl
'Noone came.'
b. *daremo* ko–naka–tta (Japanese)
anyone come–not–Past
'Noone came.

‘Peter wasn’t particularly excited about the suggestion.’

Furthermore, the German deontic verbal NPI *brauchen* (‘need’) may be linearly succeeded by its licenser, which may occur, e.g., as an argument ((41) a.) or as a adjunct ((41) b.) of the embedded infinitive.

(41) a. Peter *braucht* keine Schuhe zu putzen.
Peter needs no shoes to clean
‘Peter doesn’t need to clean shoes.’

b. Peter *braucht* die Schuhe niemals zu putzen.
Peter needs the shoes never to clean
‘Peter doesn’t ever need to clean the shoes.’

The examples in (40) and (41) empirically invalidate Ladusaw’s “Same Clause”–Constraint. Consequently, it is not clear how to maintain his Linear Licensing constraint. Furthermore, it is not clear how to relate the semantic *scale property*, which we take to be responsible for the sensitivity and licensing of PSIs, to constraints on the linear order of the elements involved in licensing. We believe that in order to account for these examples we must make explicit reference to the scale in the context against which PSIs are interpreted. We argue that the NPIs in (40) and (41) are licensed because the context provides for a scale within which the NPI is interpreted whereas this is not the case for (37) a. The next section sketches our account.

5.3 Context–dependent Semantic Licensing

In section 2, we proposed that PSIs are unified by the semantic *scale property* which requires them to be interpreted against an ‘appropriate’ scale in the context. One of the conditions on the ‘appropriate’ scale was identified to be the strength and direction of entailment which is conditioned by the operators in the context. We presented Ladusaw’s and Zwart’s definition of operators and formalized semantic licensing in HPSG in section 4. However, whereas Ladusaw assumes that it suffices for a PSI to be outscoped by an appropriate operator in order to be licensed, we assumed in section 2 that this is only one part of the licensing condition: the context must furthermore provide for a scale in which the PSI may be interpreted. The definition of licensing is given in (42).

(42) **Context–Sensitive Semantic Licensing**
A PSI ϕ is licensed in the proposition ψ and the context c if and only if

a. the context provides for an appropriate scale against which ϕ may be interpreted and

b. the proposition provides for an operator which semantically outscopes ϕ.

We assume that the operator, which must semantically outscope the PSI, ensures that the scale against which the PSI is interpreted has the appropriate direction and strength of entailment. The context within which the scale for the PSI must be identified may be the local context as in the examples in (13) or the global context of the utterance. We assume that the NPI in (37) a. is not licensed since neither the local nor the global context provide for a scale for the NPI in sentence–initial position. We now sketch analyses of (40) and (41) which demonstrate how the context here satisfies the requirement in (42) b.

Consider the topicalization data first. We assume that the topicalization structure is supported by the context. In (43), a question justifies the topicalization of (40) and serves as its context.

(43) A: How did Peter like the suggestion?
B: [Sonderlich begeistert $_F$] war er nicht.
particularly excited was he not

The meaning of a question may be given as the set of possible answers which differ with respect to the element questioned. Under this view, the meaning of the question in (43) would be a set of propositions of the form 'Peter was X' where X specifies the possible feelings of Peter towards the suggestion which are ordered relative to their strength. The prominent position of the topicalized element of the answer in (43) is justified since it matches the element which the question inquires about (see, e.g., Büring (1997)). The NPI *sonderlich* is licensed in this particular context because it is interpreted in the set of alternative answers provided by the question which form a scale (see, e.g., Reis (1977) and Rooth (1992)). The NPI still needs to be outscoped by a scale reversing element as illustrated in (44).

(44) B: *Sonderlich begeistert war er.

Thus, the NPI *sonderlich* is licensed in the topicalized position since the context justifies the topicalization and provides for a scale against which the NPI may be interpreted. At the same time, the NPI is outscoped by an SRE which guarantees that the scale has the appropriate strength and direction of entailment.

For the verbal NPI *brauchen*, we follow Krifka (1989, 1995) in assuming that certain NPIs may introduce a scale themselves against which they are interpreted. Consider the following example.

(45) John didn't lift a finger to help Mary.

The NPI *lift a finger* introduces a scale about the amount of help John gave Mary such that (45) expresses that John didn't help Mary at all since the NPI *lift a finger* refers to the bottom of the scale. Thus, the NPI itself provides for its scale in the local context. Deontic *brauchen*, which receives an interpretation like *must* except that it is an NPI, is interpreted against a scale of permissive attitudes as in (46) which *brauchen* itself introduces to the context.

(46) $must < should < may$

Again, the NPI may precede its licenser since the context provides for a scale in which the NPI is interpreted. The outscoping SRE fulfills the second condition on semantic licensing as defined in (42).

Clearly, the analyses presented in this section are mere sketches of an idea which need further investigation and formalization. However, we believe that our proposal is in the same spirit as the proposals of Heim (1984) and Israel (1996) and allows to account for data of German not discussed so far.

6 Conclusions

This paper has presented a dynamic semantic account of the licensing of PSIs and *n–words* of NC. Central to the account is the semantic *scale property* of PSIs which is formalized such that PSIs introduce a presupposition which ensures that there is an operator in the context which provides for the appropriate entailment environment. We illustrated how semantic licensing accounts for a uniform licensing of PSIs and *n–words* of NC as well as the disambiguating nature of PSIs.

In the second part of the paper we turned to linearity constraints on licensing. We presented data from German which may not be accounted for by linearity constraints and sketched how context–sensitive semantic licensing may account for the data. We believe that the analysis provides for a promising combination of semantic licensing with contextual information. Future research should provide for a thorough formalization of the analysis and discuss how it deals with further data; e.g., like the data in (47).

(47) a. I DO *give a damn*!
b. John DOES *have a hope in hell* in passing the test.
c. *Bert DID *ever* kiss Mary.
d. *Bush DOES care about the homeless *at all*.

We also believe that an investigation on behalf of the discourse function of PSIs would contribute to accounting for their distribution.

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