

# NPI Licensing, Intervention and Discourse Representation Structures in HPSG

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Negative Polarity Items (NPI) are expressions that only occur in sentences that are somehow “negative” (or “affective”, Klima (1964)). The typical examples are English *any* and *ever*. NPIs have puzzled linguists working in syntax, semantics or pragmatics, but no final conclusion as to which module of the grammar should be responsible for the licensing has been reached. Within HPSG interest in NPI has started only relatively recently with Tonhauser (2001) and Richter and Soehn (2006). While superficially very different, the two papers agree in many respects. In particular they both assume a theory of NPI licensing that is based on the denotation of the licensing contexts, in the spirit of Ladusaw (1980) and Zwarts (1997). Since HPSG’s CONTENT value is a semantic representation, the integration of such a denotational theory cannot be done directly. In the present paper I build on these two previous studies, but I show that it is possible to formulate a theory of NPI licensing that uses purely representational notions. For this enterprise, I adopt the framework of *Discourse Representation Theory* (DRT, Kamp and Reyle (1993); von Stechow et al. (2004)). In contrast to most other frameworks in semantics, DRT attributes theoretical significance to the representation of meaning, i.e. to a “logical form”, and not only to the denotation itself. This makes DRT particularly well-suited for my purpose.

## Data

I only consider two basic facts about NPIs that are commonly acknowledged in the literature, leaving many other aspects aside: the distinction between weak and strong NPIs and so-called intervention effects in NPI licensing. I also limit myself to NPIs in declarative clauses.

There are (at least) two types of NPIs, *strong* and *weak* NPIs (Zwarts, 1997). Strong NPIs can only occur in the scope of a clausemate negation, as expressed in English with a negated auxiliary or an n-word (such as *nobody*), and in the restrictor of a universal quantifier or the antecedent of a conditional. Weak NPIs are furthermore possible in the scope of expressions such as *few N*. If no such licenser is present in a sentence, both weak and strong NPIs are ungrammatical. Prototypical data are shown in (1) and (2).

- (1) Distribution of a strong NPI:
  - a. Pat won’t lift a finger to help me.
  - b. Nobody will lift a finger to help me.
  - c. Every student who lifts a finger will pass the exam.
  - d. If a student lifts a finger, he will pass the exam.
  - e. \*Few students lift a finger to help me.
  - f. \*Pat will lift a finger to help me.
- (2) Distribution of a weak NPI:
  - a. Pat didn’t budge during the experiment.
  - b. Nobody budged during the experiment.
  - c. Every student who budged during the experiment was excluded from further participation.
  - d. If a student budged during the experiment he was excluded from further participation.
  - e. Few students budged during the experiment.
  - f. \*Pat budged during the experiment.

The second observation that I discuss are so-called *intervention effects*: There may not be a quantifier intervening between the NPI and its licenser, as illustrated with the minimal pair in (3).

- (3)
  - a. Kim didn’t give any apple to every teacher.
  - b. \*Kim didn’t give every teacher any apple.

## Previous Approaches

The most influential theory in NPI research, Ladusaw (1980) and Zwarts (1997), states that NPIs must occur in a *downward-entailing* context, i.e. a context that allows inference from supersets to subsets. For strong NPIs this context must even be *anti-additive*, i.e. display an entailment behavior that is even closer to that of negation than simple downward-monotonicity. The entailment-based approach is very successful in accounting for the basic distribution of NPIs. However, some of its problems are: (i) Simple downward-monotonicity is probably not correct, but a form of *Strawson monotonicity* (von Stechow, 1999)

is needed to capture NPIs in the antecedent of a conditional. (ii) In sentence (3-b), the context of the NPI is still downward-entailing, notwithstanding the intervening universal quantifier (Jackson, 1995). In this case the entailment-based theory lacks the means to limit the domain of the licensing.

Tonhauser (2001) attempts to encode an entailment-based theory of NPI licensing using a version of *Minimal Recursion Semantics* in which potential licensers indicate the licensing strength of their scopal arguments. Thus, *every* has a specification in its semantics that its restrictor is a licenser of strength *anti-additive*. The lexical specification of an NPI then includes a constraint in its HANDLE-CONSTRAINTS-list that there must be some operator of the right strength that has scope over the NPI. Tonhauser’s theory shows the paradox of an HPSG rendering of entailment-based notions: when we look at the denotation of an expression, it is natural to talk about the entailments of the expression. This is what made the entailment-based theories for NPIs so attractive. In a representational framework such as HPSG, however, the entailment behavior has to be explicitly encoded in the structure. In the case of Tonhauser, this is done with otherwise unmotivated diacritic marking.

Richter and Soehn (2006) use a similar theory of semantic combinatorics, *Lexical Resource Semantics*. In addition they assume a theory of collocation as used in Soehn (2004) for idioms. They use a feature COLL whose value indicates the lexically specified collocational restrictions of a sign. The COLL-list contains objects of sort *barrier*, which specify the syntactic domain within which the requirement must be fulfilled, such as the sentence or the utterance that contains the NPI<. A *barrier* object has an attribute LF-LIC whose value is the semantic representation of the specified syntactic domain. The lexical specification of an NPI, then, imposes a relational constraint on which operators must have scope over the semantic contribution of the NPI. The relations used follow the licensing strengths of Zwarts (1997), but extend them to be able to capture NPIs in interrogatives and imperatives. In the talk, I discuss two aspects of the theory in Richter and Soehn (2006): First, similar to Tonhauser (2001), the theory is based on semantic notions which cannot be directly expressed in a representational framework. Second, I will argue in favor of a characterization of the licensing domain in terms of the logical form of a sentence rather than in terms of syntactic domains.

## Discourse Representation Structures in HPSG

I assume that the CONTENT value of a sign is a *Discourse Representation Structure* (DRS, Kamp and Reyle (1993); von Stechow et al. (2004)). The use of DRT semantics within HPSG is not wide-spread, but has a number of predecessors, such as Frank and Reyle (1995), Eberle (1997), Holler (2003), Arnold (2004), Marshall and Sáfár (2004) to name just a few. My analysis does not depend on which combinatorial mechanism is used to arrive at the logical form of a complex sign.

I use the standard definitions for DRT, which I restate briefly for the sake of completeness. A DRS is a pair consisting of a universe of discourse referents ( $U$ ) and a set of conditions ( $C$ ). For reasons of space, I use the so-called linear notation for DRSs, writing  $[x_1, \dots, x_n : \phi_1, \dots, \phi_m]$  for a DRS with the universe  $\{x_1, \dots, x_n\}$  and a set of conditions  $\{\phi_1, \dots, \phi_m\}$ . I indicate an empty universe as  $\emptyset$ . Conditions are either atomic ( $x_1 = x_2$ , or  $R(x_1, \dots, x_n)$ ) or of the form  $\neg K$ ,  $K_1$  **or**  $K_2$ ,  $K_1 \Rightarrow K_2$ . The interpretation of a DRS is formulated in terms of its *context change potential*. In other words, a DRS maps an input information state  $g$  into some output information state  $h$ , where an information state is conceived of as a function from the set of discourse referents to the individuals in the model. Following Muskens (1996), a DRS denotes a set of pairs of information states, where  $[[x_1 \dots x_n : C_1 \dots C_m]] = \{\langle g, h \rangle \mid g[x_1 \dots x_n]h \ \& \ h \in [C_1] \cap \dots \cap [C_m]\}$ . A condition denotes a set of information states, where  $[x_1 = x_2] = \{g \mid g(x_1) = g(x_2)\}$ ,  $[R(x_1 \dots x_n)] = \{g \mid \langle g(x_1), \dots, g(x_n) \rangle \in [R]\}$ ,  $[\neg K] = \{g \mid \neg \exists h \langle g, h \rangle \in [K]\}$ ,  $[K_1 \text{ or } K_2] = \{g \mid \exists h (\langle g, h \rangle \in [K_1] \text{ or } \langle g, h \rangle \in [K_2])\}$ , and  $[K_1 \Rightarrow K_2] = \{g \mid \forall h (\langle g, h \rangle \in [K_1] \rightarrow \exists i \langle h, i \rangle \in [K_2])\}$ . This language naturally extends to generalized quantifiers, using conditions of the form  $Qx K_1 K_2$ , for some determiner  $Q$ , some variable  $x$  and DRSs  $K_1$  and  $K_2$  (von Stechow et al., 2004).

DRT uses a traditional notion of *subexpression* or *component*. In addition there is a notion of *accessibility*: a DRS  $K$  is accessible from an expression  $\phi$  iff (i)  $\phi$  is a subexpression of  $K$ , or (ii) there is a condition of the form  $K \Rightarrow \phi$  or  $Qx K \phi$ , (iii) or  $\phi$  and  $K$  are in the transitive closure of (i) and (ii).

As is common practice in DRT, I assume lexical decomposition. In particular, I decompose downward-entailing operators into a combination of a negation and an upward-entailing operator which is in the scope of the negation. Thus n-words such as *nobody* are represented as a negation and an indefinite ( $\neg[x : \dots]$ ); quantifiers such as *few* are represented as  $\neg[\emptyset : \mathbf{many}xK_1K_2]$ .

## Analysis I: DRT

In (4) I sketch the DRSs for the sentences in (2). I use eventuality variables  $e$  and  $e'$ , and I only mention the relevant conditions. Note that the universal quantifier and the implication have the same DRT-representation.

- (4) Simplified DRSs for the sentences in (2):
- a.  $[\emptyset : \neg[e : \mathbf{budge}(e, \mathbf{pat})]]$

- b.  $[\emptyset : \neg[x, e : \mathbf{budge}(e, x)]]$
- c.  $[\emptyset : [x, e : \mathbf{budge}(e, x)] \Rightarrow [e' : \mathbf{be-excluded}(e', x)]]$
- d.  $[\emptyset : [x, e : \mathbf{budge}(e, x)] \Rightarrow [e' : \mathbf{be-excluded}(e', x)]]$
- e.  $[\emptyset : \neg[\emptyset : \mathbf{many}x[x : \mathbf{student}(x)]] [e : \mathbf{budge}(e, x)]]$
- f.  $*[e : \mathbf{budge}(e, \mathbf{pat})]$

In (a) and (b) the semantics of the NPI is a condition in a sub-DRS of the negation. In (c) and (d) it occurs in the antecedent of a conditional DRS. I assume that these contexts are *NPI-licensing DRSs*. This notion is defined in (5).

- (5) A DRS  $K$  is an *NPI-licensing DRS* in a larger DRS  $K'$  iff  $K$  occurs in  $K'$  as part of a condition of the form  $\neg K$  or  $K \Rightarrow K''$ .<sup>1</sup>

I use this notion to express a necessary condition for the occurrence of NPIs:

- (6) General structural constraint on NPI licensing:  
The logical form of an NPI must be a subexpression of an NPI-licensing DRS.

The sentences in (1-f) and (2-f) violate this constraint, which accounts for their ungrammaticality. Similarly, the NPI is not licensed in the scope of a universal quantifier, as shown in (7). While the DRS  $[x : \mathbf{student}(x)]$  is an NPI-licensing DRS in this sentence, the DRS that contains the NPI is not a sub-DRS of this DRS.

- (7) a. \*Every student gives a damn about syntax.  
b.  $[\emptyset : [x : \mathbf{student}(x)] \Rightarrow [\emptyset : \mathbf{give-a-damn}(x)]]$

In addition to this general structural constraint we also need special constraints for the different kinds of NPIs. If we compare the semantic representation of a sentence that contains an n-word, (4-b), with that of a sentence that contains a downward-entailing quantifier such as *few*, (4-e), the latter contains an additional DRS with a non-empty universe that is accessible from the NPI. I will refer to accessible DRSs with a non-empty universe that intervene between an NPI and its licensing DRS as *potential interveners*.

- (8) A DRS  $K$  is a *potential intervener* for an NPI  $\phi$  in a DRS  $K'$  iff<sup>2</sup>
  - $K'$  is an NPI licensing DRS that contains  $\phi$  and  $K$ ,
  - $K$  is accessible from  $\phi$ , and
  - $K$  has a non-empty universe

I use this notion to express the different occurrence requirements of strong and weak NPIs.

- (9) Special constraints:
  - a. Weak NPI: There is at most one potential intervener for the NPI in its NPI-licensing DRS.
  - b. Strong NPI: If there is a potential intervener for the NPI in its NPI-licensing DRS, then it must be identical to the NPI licensing DRS.

In the case of (4-e) there is a potential intervener  $[x : \mathbf{student}(x)]$ . This DRS is accessible from the DRS that contains the NPI (the restrictor of a quantifier is accessible to its scope). This DRS has a non-empty universe (its universe contains the variable bound by the quantifier). Nonetheless, since it is the only such DRS, the special constraint in (9-a) is satisfied.

The constraint in (9-a) also accounts for intervention effects. The DRS for sentence (3-b) is given in (10). The semantics of the NPI *any* is the discourse referent  $y$ . The DRS has two potential interveners for the NPI: The licensing DRS itself ( $[e : \dots]$ ) and the restrictor of the universal quantifier ( $[x : \mathbf{teacher}(x)]$ ). Both are a subexpression of the licensing DRS, both have a non-empty universe, and both are accessible from the NPI. Thus, there are two potential interveners and the constraint in (9-a) correctly excludes this sentence.

- (10)  $[\emptyset : \neg[e : [x : \mathbf{teacher}(x)] \Rightarrow [y : \mathbf{apple}(y), \mathbf{give}(e, \mathbf{kim}, x, y)]]]$

Sentence (3-b) contrasts with the example in (11): A universal quantifier in the scope of verbal negation blocks NPI licensing, but the NP *not every* is a licenser for weak NPIs. In (11-b) I abbreviate the semantic representation of the NPI as **npi**. In contrast to (3-b), the NPI-licensing DRS has an empty

<sup>1</sup>To remove the disjunction from the definition, I could assume that  $\neg K$  is actually represented as the fully equivalent condition  $K \Rightarrow \mathbf{false}$ . Then the antecedent of an implication remains the only type of NPI-licensing DRS.

<sup>2</sup>To be precise:  $\phi$  is the smallest DRS that contains the semantic contribution of the NPI.

universe in (11). Thus, the DRS is analogous to that in (4-e) above: there is only one potential intervener and the weak NPI is possible.

- (11) a. Not every musician could help sneezing during the performance.  
 b.  $[\emptyset : \neg[\emptyset : [x : \mathbf{musician}(x)] \Rightarrow [e : \mathbf{npi}(e, x)]]]$

For strong NPIs we require that if there is a potential intervener, it must be the NPI-licensing DRS itself. This constraint excludes the licensing of a strong NPI in the scope of *few* in (1-e) or in the scope of *not every N*. Strong NPIs are correctly predicted to be possible in the immediate scope of a negation or a negative indefinite and in the restrictor of a universal quantifier or in the antecedent of an implication.

## Analysis II: HPSG Encoding

To integrate my analysis into HPSG, I follow Richter and Soehn (2006) in adopting a collocational approach to NPI licensing. In the presentation I will focus exclusively on the NPI properties of the lexical items, leaving aside other collocational requirements they may have. For the pure NPI requirements it is possible to use a simplified variant of the theory in Richter and Soehn (2006). In addition, I will reduce Richter and Soehn’s syntactic characterization of the licensing to properties of the logical form of a sentence. Thus the only syntactic property required of the licenser is that it be the content of a sign that dominates the NPI in the syntactic structure.

I adopt the `COLL` feature from Richter and Soehn (2006). In contrast to their theory, I assume that an NPI has an object of sort *lf-licenser* on its `COLL` list. An *lf-licenser* object has an attribute `LF-LIC` whose value is a DRS. There is a general principle of the grammar, inspired by — but logically simpler than — the *Licensing Principle* in Richter and Soehn (2006) which guarantees that the `LF-LIC` values on a word’s `COLL` list are identical to the logical form of some sign that dominates the word.

- (12) Licensing Principle: in every unembedded sign  $s$ , for each lexical sign  $w$  in  $s$ : every *lf-licensing* object that occurs on  $w$ ’s `COLL` value has an `LF-LIC` value that is identical to the `CONT` value of some sign  $s'$  that dominates  $w$  in  $s$ .

We need relations that correspond to the notions *NPI-licensing DRS* and *potential intervener* as defined in (5) and (8) above. The relation `npi-lic-drs` holds of a pair  $\langle k, k' \rangle$  iff  $k$  is an NPI-licensing DRS in  $k'$ . Furthermore, I assume a general relation of subexpressionhood, written as  $\leq$ . These two relations are needed to express the general structural constraint on NPI licensing from (6). Furthermore, I assume a relation `potential-intervener` that holds of a triple  $\langle k, p, k' \rangle$  iff  $k$  is a potential intervener for the logical form of an NPI  $p$  in a larger structure  $k'$ . Note that all these notions are defined purely in terms of the semantic representation and do not refer the denotation.

With the help of these relations, we can formalize the lexical specifications of a weak and a strong NPI schematically in (13) and (14). In both cases,  $\boxed{1}$  is the semantics of the NPI and  $\boxed{2}$  is the semantics of a larger sign that contains the NPI-licensing DRS  $\boxed{3}$  for the NPI. The general structural constraint is expressed by the line “`npi-lic`( $\boxed{3}, \boxed{2}$ ) &  $\boxed{1} \leq \boxed{3}$ ”. The condition below this line expresses the special constraint for weak NPIs in (13). Correspondingly, in (14) the line below the general structural constraint is a direct rendering of the interpretive constraint of strong NPIs.

- (13) Schematic lexical specification of a weak NPI:

$$\left[ \begin{array}{l} \text{SYNS LOC } [\text{CONT } \boxed{1}] \\ \text{COLL } \left\langle \left[ \begin{array}{l} \textit{lf-licensing} \\ \text{LF-LIC } \boxed{2} \textit{ drs} \end{array} \right] \right\rangle \end{array} \right] \quad \& \exists \boxed{3} \left( \begin{array}{l} \text{npi-lic}(\boxed{3}, \boxed{2}) \ \& \ \boxed{1} \leq \boxed{3} \\ \& \ \neg \exists \boxed{4} \exists \boxed{5} \left( \begin{array}{l} \boxed{4} \neq \boxed{5} \\ \& \ \text{potential-intervener}(\boxed{4}, \boxed{1}, \boxed{3}) \\ \& \ \text{potential-intervener}(\boxed{5}, \boxed{1}, \boxed{3}) \end{array} \right) \end{array} \right)$$

- (14) Schematic lexical specification of a strong NPI:

$$\left[ \begin{array}{l} \text{SYNS LOC } [\text{CONT } \boxed{1}] \\ \text{COLL } \left\langle \left[ \begin{array}{l} \textit{lf-licensing} \\ \text{LF-LIC } \boxed{2} \textit{ drs} \end{array} \right] \right\rangle \end{array} \right] \quad \& \exists \boxed{3} \left( \begin{array}{l} \text{npi-lic}(\boxed{3}, \boxed{2}) \ \& \ \boxed{1} \leq \boxed{3} \\ \& \ \forall \boxed{4} (\text{potential-intervener}(\boxed{4}, \boxed{1}, \boxed{3}) \rightarrow \boxed{4} = \boxed{3}) \end{array} \right)$$

The specifications in (13) and (14) are necessarily very schematic. It is known that NPIs show variation with respect to their licensing contexts. Since the theory developed in this paper encodes the licensing requirement as a lexical property of an NPI, it allows to impose further restrictions on individual NPIs or to loosen the restrictions for more permissive NPIs. At the same time, the schematic specifications exemplify the distinctions that are generally acknowledged to play a role in NPI licensing beyond finer idiosyncratic variation.

## Conclusion

The integration of a theory of NPI licensing has to face two problems: first, how to characterize the licensing domain and second, how to encode the context requirement of an NPI inside its lexical entry.

This paper attempts to make an original contribution to the first of these two questions, while building on an earlier HPSG analysis within a collocational framework for the second question.

The use of DRT allows for a purely representational formulation of the contexts in which NPIs can occur. Instead of listing all NPI licensers individually or marking them explicitly as licensers, the decomposed semantic representation of the licensers is sufficient. Since licensers such as *few* introduce a negation and a quantifier, the occurrence constraints of NPIs immediately account for the fact that only weak NPIs are possible in such constellations. The constraints also immediately capture the attested intervention effects. Future work has to show whether reasonable logical forms can be given for non-declarative sentences which allow for a natural extension of the present theory to NPI licensing contexts such as interrogatives and imperatives.

The CONTENT value in HPSG is a semantic representations rather than a semantic denotation. The present study shows that a strictly representational theory of NPIs can capture the insights of the entailment-based theory of NPI licensing, at the same time overcoming its problems.

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