COMPLEMENT ANAPHORA AND NEGATIVE POLARITY ITEMS[1]

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Abstract

Based on data from German, I call attention to a so far unnoticed relationship between data on complement set anaphora and strong negative polarity items (NPI). In particular, I show that if a quantified NP can serve as antecedent of a complement set anaphor, it can also license strong NPIs. I provide a lexical decomposition analysis using Discourse Representation Theory.

1 Introduction

In this paper I examine a relationship between the contexts in which so called *complement set anaphora* (CA) are possible and the contexts in which negative polarity items (NPI) can occur. Example (1) below has an interpretation of the pronoun *they* in the second clause such that the pronoun refers to those congressmen that do not admire Kennedy. Under this interpretation, the pronoun is called a complement set anaphor because it refers to the intersection of the restrictor and the complement set of the scope of its antecedent quantifier (*few congressmen*) rather than referring to the intersection of the sets denoted by the restrictor and the scope. It has been observed that such an interpretation is only possible if the antecedent is a downward monotone quantifier (Sanford, Moxey and Paterson 1994).

(1)   Complement set anaphora (CA):
        Few congressmen admire Kennedy.
        They think he's incompetent.
        they = the congressmen that don't admire Kennedy

Downward monotonicity also plays a central role in the description of the contexts in which negative polarity items occur (Ladusaw 1980). In (2) the NPI *ever* is possible because it occurs in the scope of the downward monotone quantifier *few congressmen*.[1]

(2)   Negative polarity items (NPI):
        Few congressmen have <u>ever</u> admired Kennedy.

Even though for both phenomena downward monotonicity is important, the relationship between the two has not received attention so far. In Section 2 I present data on both complement set anaphora and negative polarity items. This leads to a generalization that if a quantified NP can establish an antecedent of a complement set anaphor, it can also license a strong NPI in its scope.[2] In Section 3 I examine to what extent this generalization is compatible with previous

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[1]CAs and NPIs are underlined and the antecedent or licenser is given in bold face throughout.

[2]The distinction between *weak* and *strong* NPIs will be illustrated in Section 2.2.

analyses of both phenomena. Section 4 contains my analysis, which is expressed in terms of *Discourse Representation Theory* (DRT, Kamp and Reyle (1993)).

2   Data

I present the basic data on complement set anaphora and the generalization on their distribution in Section 2.1. Section 2.2 gives an overview of several types of NPIs. In Section 2.3 I focus on special cases of NPI licensing which are important for the purpose of this paper.

2.1   Complement Anaphora

There are in principle three possibilities of reference for a plural pronoun that is anaphorically linked to an antecedent NP. These are illustrated with the sentences in (3), taken from Nouwen (2003). The sentences were chosen to make a particular reading more plausible than the others.

(3)　　a.　Reference set anaphor (Refset anaphor):
　　　　　　Few congressmen admire Kennedy, and they are very junior.
　　　　　　they: the congressmen that admire Kennedy
　　　　b.　Complement set anaphor (Compset anaphor, CA):
　　　　　　Few congressmen admire Kennedy. They think he's incompetent.
　　　　　　they: the congressmen that don't admire Kennedy
　　　　c.　Maximal set anaphor (Maxset anaphor):
　　　　　　Few MPs attend the morning meetings, but they all attend the Friday afternoon drinks.
　　　　　　they: the MPs

In (3-a) the pronoun *they* refers to the congressmen that admire Kennedy, i.e. it refers to the intersection of the set of congressmen and the set of Kennedy-admirers. This reading is called the *reference set* (refset) reading. The sentences in (3-b) are a repetition of example (1) above. Here, a reading is possible in which *they* refers to the intersection of the congressmen and the non-Kennedy-admirers. This reading is called the complement set (compset) reading. Finally, the pronoun *they* can also be used to refer to the set that contains all elements in the denotation of the restrictor. In (3-c) *they* can be used to refer to all MPs independent of whether they attend the morning meetings or not. This is called the maximal set (maxset) reading.

While a refset and a maxset reading are always possible for an anaphorically linked plural pronoun, the availability of a compset reading is highly restricted. In the following I focus on the compset reading. Nouwen (2003) demonstrates that compset readings are only possible for a plural pronoun if the antecedent is a monotone decreasing proportional quantifier.

A quantifier is *downward monotone* (or downward entailing, or monotone decreasing) if it allows inferences from supersets to subsets, i.e. a quantified NP Q is downward entailing iff whenever a set X is a subset of a set Y, we can infer $Q(X)$ from $Q(Y)$. In (4) a number of downward monotone quantifiers is given. The inference is shown for one example in (5).

(4)　　Downward monotone quantifiers:　*none of the students; few of my students*

(5)　　**None of the students** like vegetables. $\rightarrow$ **None of the students** like brocoli.

Not all NPs are downward monotone. In (6) examples of upward monotone and non-monotone quantifiers are given and their failure in inferences of the type in (5) is illustrated in (7).

(6)   a.   upward monotone quantifiers: some students, every student
      b.   non-monotone: three students

(7)   a.   Some students like vegetables. $\not\to$ Some students like brocoli.
      b.   Three students like vegetables. $\not\to$ Three students like brocoli.

The example in (8) shows that quantifiers that are not downward monotone do not allow for complement set anaphora.[3]

(8)   Some congressmen attended the meeting. They were too busy (#CA)

Nouwen (2003) shows that downward monotonicity is not sufficient as a characterization of the possible antecedents of compset anaphora (see (10-a) below). The antecedent must also be *proportional*. This notion also stems from the theory of generalized quantifiers. A determiner can be proportional or cardinal. For a cardinal determiner *Det* the denotation of $Det(A)(B)$ only depends on the size of the intersection of A and B. For a proportional determiner, the denotation of $Det(A)(B)$ also depends on the size of A. If a quantifier $Det(A)$ is proportional, the restrictor set A is presupposed. In (9-a) some downward monotone proportional quantifiers are given; (9-b) contains an example of a downward monotone cardinal quantifier.

(9)   a.   Downward monotone proportional quantifiers:
           few of the ten students, most of the students, at most 10% of the students
      b.   Downward monotone cardinal quantifiers: *less than 4 students*

The examples in (10) show that a compset anaphor is not possible with a downward monotone cardinal quantifier such as *less than 30 MPs*, whereas it is possible with the minimally different proportional quantifier *less than 30% of the MPs*.

(10) a.   Less than 30 MPs attended the meeting. They were too busy. (#CA)
      b.   **Less than 30% of the MPs** attended the meeting. <u>They</u> were too busy. (CA)

2.2   Negative Polarity Items

We can now turn to negative polarity items (NPI). I mainly use German data from now on. Ladusaw (1980) has formulated the observation that NPIs occur only in the scope of monotone decreasing operators. This is shown with the distribution of the German NPI *jemals* ('ever'). The NPI is not in the scope of a downward monotone operator in (11-a), and the sentence is ungrammatical. In (11-c) and (11-b) there is a downward monotone quantifier in the subject position and the NPI is interpreted in the scope of these quantifiers. Thus, the licensing requirements of the NPI are fulfilled and the sentences are fine.

(11) a.   *Peter hat <u>jemals</u> etwas   von Zafón gelesen.
           (Peter has <u>ever</u>   something by Zafón read)
      b.   **Niemand** hat <u>jemals</u> etwas   von Zafón gelesen.
           (Nobody has <u>ever</u>   something by Zafón read)
           'Nobody has ever read anything by Zafón.'
           (monotone decreasing, cardinal)
      c.   **Wenige Buchhändler in Barcelona** haben <u>jemals</u> von Zafón gehört.
           (Few   booksellers   in Barcelona have <u>ever</u>   of Zafón heard)

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[3]I indicate the unavailability of a reading with the symbol "#".

'Few booksellers in Barcelona have ever head of Zafón.'
(monotone decreasing, proportional)

Zwarts (1997) shows that there are NPIs of different strength. A *weak* NPI such as *jemals* in (11) is fine in the scope of a downward monotone operator. Other NPIs impose stronger requirements on their context. Those NPIs are called *strong* NPIs. The licensing pattern of a strong NPI is shown in (12).

(12)   *auch nur irgendetwas* ('anything at all')

    a. **Niemand** hat <u>auch nur irgendetwas</u> von Zafón gelesen.
        (Nobody has <u>anything at all</u>   by Zafón read)
        'Nobody has read anything at all by Zafón.'

    b. *__Wenige Buchhändler__ haben <u>auch nur irgendwas</u> von Zafón gehört.
        (Few booksellers   have <u>anything at all</u>   of Zafón heard.)

According to Zwarts (1997) strong NPIs require an anti-additive context. Anti-additivity is defined as an entailment property, similar to downward monotonicity. A function f is anti-additive iff $f(A \cup B) \leftrightarrow f(A) \cap f(B)$. In the present paper we are mainly concerned with licensers that are quantified NPs in the subject position of a clause. For such expressions anti-additivity holds iff the following holds for any two VPs: NP (VP$_1$ or VP$_2$) $\leftrightarrow$ (NP VP$_1$) and (NP VP$_2$). In (13) some anti-additive expressions are listed. The relevant inference pattern is shown in (14). While anti-additive NPs pass this test, the NP *few students* only allows for the inference in one direction and can, thus, be shown not to be anti-additive.

(13)   Anti-additive NPs: *none of the N*, *no N*, *no one*

(14)   a. No one danced or sang $\longleftrightarrow$ No one danced and no one sang.
      b. Few students danced or sang $\not\longleftrightarrow$ Few students danced and few students sang.

With the notion of anti-additivity Zwarts can characterize the distribution of strong NPIs such as *auch nur irgendetwas* in (12) above: The NPI is licensed in the scope of the anti-additive subject NP *niemand* ('nobody'), but not in the scope of *wenige N* ('few N'), which is downward monotone but not anti-additive.

In (15) I list further strong NPIs for German, English and Dutch from Zwarts (1997). The data in (16) and (17) illustrate the occurrence restriction to anti-additive contexts for two of them.

(15)   Strong NPIs from (Zwarts 1997):

    a. German: *auch nur irgend-* ('any- at all'), *sonderlich* ('especially'), *einen Mucks machen* ('make a noise'), *nennenswert* ('worth mentioning')
    b. English: *lift a finger*, *any . . . at all*, *until*.
    c. Dutch: *ook maar iets* ('anything at all')

(16)   *sonderlich* ('especially'):

    a. **Niemand** fand das Buch <u>sonderlich</u> spannend
        (Nobody found the book particularly exciting)

    b. *__Wenige Leser__ fanden das Buch <u>sonderlich</u> spannend.
        (Few readers found the book particularly exciting)

(17)   *einen Mucks machen* ('to make a noise')

a. **Niemand** traute sich, <u>einen Mucks zu machen</u>
  (nobody   dared   to make a noise)
  b. ***Wenige**   trauten sich, <u>einen Mucks zu machen</u>
  (Few people dared   to make a noise)

2.3   Strong NPIs in Non-anti-additive Contexts

So far we have seen that there is a partial overlap between the characterization of the antecedent of a compset anaphor and the licenser of an NPI: both must be downward monotone. However, for the compset anaphora the antecedent had to be proportional. For NPIs the proportional/cardinal distinction seems to play no role, but a stronger notion of downward monotonicity is relevant for some NPIs. Next I look at data which contain strong NPIs in contexts which are not anti-additive. I will argue that in those contexts the licenser is proportional.

Let me first point to two occasions in which the occurrence of a strong NPI in a context which is downward monotone but not anti-additive was commented on in the literature. The first are examples from Krifka (1995), the second is data from van der Wouden (1995).

Krifka (1995) rejects Zwart's distinction between weak and strong NPIs. Krifka provides the example in (18-a) and we find the example embedded in the quotation in (18-b).

(18)   a.   **Hardly ANYONE** <u>lifted a finger</u> to help me.
       b.   "we perhaps even do not want to rule out combinations like *fewer than three girls did anything at all* by fundamental principles".

A second observation is due to van der Wouden (1995). As the data in (19) show, *ook maar iets* ('anything at all') is a strong NPI in Dutch.

(19)   a.   Niemand heeft <u>ook maar iets</u> gezien.
            (no one   has   anything at all seen)
            'No one has seen anything at all.'
       b.   ***Weinig mensen** hebben <u>ook maar iets</u> gezien.
            (few people   have   anything at all seen)

With (20) van der Wouden (1995) shows that *ook maar iets* is licensed in the scope of *weinig mensen* ('few people') in a negative raising construction:

(20)   **Weinig mensen** herinneren zich   [<u>ook maar iets</u> gezien te hebben]
       (few people   remember themselves anything at all seen   to have)
       'Few people remember having seen anything at all.'

We can supplement Krifka's and van der Wouden's observations with a third observation. If a simply monotone decreasing quantifier is used in a proportional way we observe an increase in the grammaticality of the use of a strong NPI. I will indicate this increase with a "?" as in (21-b). As usual when subtle empirical differences are involved, not all speakers share all the judgments. Nonetheless, the general tendency was confirmed that a sentence is judged more acceptable if the set denoted by the restrictor of the subject quantifier is presupposed. Thus, percent expressions as in (21-b) and (23-b) presuppose a contextually salient set of pupils, and in (22-b) the possessive pronoun suggests that the set of the speaker's pupils is presupposed.

(21)   a.   *Höchstens 3 Schüler fanden das Buch <u>sonderlich</u> spannend.
             At most   3 pupils   found this book particularly exciting.

      b. ?Höchstens 10% der   Schüler fanden das Buch <u>sonderlich</u> *spannend.*
          At most   10% of the pupils   found this book particularly exciting.

(22)   a. *Nicht mehr als   3 Schüler haben im   Matheunterricht <u>einen Mucks gemacht</u>
          No   more than 3 pupils have during math classes   <u>a noise made</u>

      b. **Nicht mehr als 3 meiner 30 Schüler** haben im   Matheunterricht
          No more than 3 of my 30 pupils   have   during math classes
          <u>einen Mucks gemacht</u>.
          a noise made

(23)   a. *Nicht mehr als   3 Schüler haben <u>auch nur irgendetwas</u> gelernt.
          No   more than 3 pupils have <u>anything at all</u>   learnt.

      b. **Nicht mehr als 10% der Schüler** haben <u>auch nur irgendetwas</u> gelernt.
          No more than 10% of the pupils   have <u>anything at all</u>   learnt.

With this observation we can take a new look at Krifka's and van der Wouden's data. In (18-a) it seems that the speaker has a particular set of candidates for help in mind. Similarly the sentence in (18-b) can be felicitously uttered in a context in which the overall group out of which the three girls stem is known.

Finally we can return to van der Wouden's example in (20). Even though we lack the context for this example, it seems that we find negative raising readings typically with presupposed subjects. In German, and similarly for Dutch, an impersonal pronoun *es* (*er* for Dutch) in a clause-initial position is only compatible with a non-specific reading of an indefinite subject Non-specific indefinites are typically non-presuppositional.

Sentence (24-a) is an instance of negative raising. The use of the NPI *brauchen* ('need') in the subordinate clause is a clear diagnostic for negative raising. In (24-b) the non-specific construction is chosen. The sentence is ungrammatical because the NPI is not licensed. This shows that a negative raising interpretation is excluded with this kind of impersonal subjects. Thus, a clearly non-presuppositional subject cannot occur in a negative raising construction.[4]

(24)   a. Peter hat nicht gedacht, dass jemand   anzurufen <u>braucht</u>.
          (Peter has not thought that someone call   need)
          'Peter didn't think that someone needed to call.'
      b. *Es hat jemand   nicht gedacht, dass Peter anzurufen <u>braucht</u>.
          (it has someone not   thought that Peter call   need)

If we reconsider van der Wouden's example in (20) it seems plausible that the sentence is uttered in a context in which it is known what event the people don't remember having seen and who the possible subjects are.

The observations on the licensing of strong NPIs in contexts which are not anti-additive bring us back to the conditions on CAs. Section 2.1 has shown that CAs are only possible with a downward monotone proportional quantifier. Strong NPIs are standardly assumed to be licensed in the scope of downward monotone anti-additive operators (Section 2.2). In this section I have argued that strong NPIs can also occur in the scope of monotone decreasing proportional quantifiers. Thus, the observations in this section can be combined in the following generalization: If a quantified NP can establish an antecedent for a CA, it can also license a strong NPI.

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[4]In so far as sentence (i) is grammatical at all, it can only have a a specific reading of *jemand* ('someone').
 (i) ?? Jemand   hat nicht gedacht, dass Peter anzurufen <u>braucht</u>.
     (someone has not thought that Peter call   need)

3 Previous Approaches

In this section, I test to what extent theories of NPIs and CAs are compatible with the data from the previous section. I first discuss theories of NPI licensing and then theories of CA.

3.1 Theories of NPI Licensing

I referred to the monotonicity-based theory of NPI licensing of Ladusaw (1980) and Zwarts (1997) in Section 2.2. This theory relies on the monotonicity behavior of the licenser but does not mention whether it is proportional or cardinal. As shown in (14-b) *few students* is not anti-additive. The inference pattern in (25) shows that in its proportional use such as in *few of my ten students* the quantifier *few N* is not anti-additive either.

(25)   Few of my 10 students danced or sang
        $\not\longrightarrow$ Few of my 10 students danced and few of my 10 students sang.

Thus, the entailment-based approach cannot give a direct answer to the question why a proportional downward-entailing quantifier can license strong NPIs whereas a cardinal quantifier cannot. Furthermore there is no connection to the data on complement set anaphora.

Krifka (1995) doubts the existence of the weak/strong distinction as defined in Zwarts (1997). Instead, Krifka differentiates between NPIs in emphatic and non-emphatic contexts. The NPI that require emphatic contexts correspond most closely to Zwarts' strong NPIs in that clauses with *not* and *nobody* are considered to constitute emphatic contexts. However, negation is not required for a context to be emphatic, instead what is needed is a licenser that is "extreme" with respect to the contextually salient alternatives. Under this view, *nobody* is extreme since it asserts that a property holds for none of the potential candidates.

Given Krifka's theory the relative well-formedness of (26) should be connected to the fact that the subject quantifier is proportional, i.e. the restrictor is presupposed.

(26)   Nicht mehr als   10% meiner Studenten fanden den Artikel <u>sonderlich</u>   spannend.
        (no   more than 10% of my students   found the paper   particularly exciting)

Such a connection is in fact possible. If the set of students is known, we may have an expectation of what is an extreme value. In (26) 10% might be considered an extremely low value in a given context. We may wonder, however, why the NPI *sonderlich* ('particularly') should be sensitive to such extreme values.

In a non-presuppositional (cardinal) use of the quantifier, it may be harder to determine whether the indicated quantity is extreme in a given context. This shows that a Krifka-style theory of NPI licensing is in principle compatible with the NPI data. However, the relationship between the NPI data and the complement set anaphora, then remains a coincidence.

As a third theory of NPI licensing let us review the approach of Linebarger (1980) and Linebarger (1987). Linebarger provides two mechanisms for NPI licensing: direct and indirect licensing. First, an NPI is (directly) licensed if it is in the immediate scope of a negation in the Logical Form of the sentence. Second, an NPI is (indirectly) licensed if the original utterance implicates a sentence within which the NPI is directly licensed. This implicated sentence is called the *negative implicatum*. Licensing by *few* is such an instance of indirect licensing. In (27) a negative implicatum for a sentence containing an NPI is shown.

(27)   **Few students** did <u>any</u> homework.

Negative implicatum: Many students did**n't** do <u>any</u> homework.

There is at least one problem with this approach. The implicature in (27) is only valid under a proportional reading of *few students*. The cardinal reading of *few* is compatible with a scenario in which there are no students.[5] In the case of an empty restrictor set, however, the implicature does not hold. Nonetheless weak NPIs such as *any* in (27) are also licensed under a cardinal reading of *few*. Thus, Linebarger's theory of indirect licensing cannot account for the occurrence of weak NPIs in the scope of cardinal *few*. In general, her theory ignores the cardinal/proportional distinction which seems to be central for the data discussed in the present paper.

My analysis in Section 4 combines insights from all of these approaches. In particular, the importance of the context and the validity of the implicature in (27) plays a central role.

3.2 Theories of CA

Next I consider approaches to compset anaphora. From the point of view of theoretical semantics, CAs are a rather unexpected phenomenon. In particular explicit theories of discourse anaphora such as *Discourse Representation Theory* (DRT, Kamp and Reyle (1993)) do not predict such readings.

The original data on CAs stem from psycholinguistic research such as Sanford et al. (1994) and Sanford, Williams and Fay (2001). The authors argue that the antecedent of a CA must be monotone decreasing. Furthermore, they observe that the tendency for a CA is not the same for all downward monotone antecedents. In particular, *no more than* triggers a CA reading more easily then *at most*. However, the influence of the cardinal/proportional distinction is not investigated, nor is there any connection made to NPI licensing.

Within formal semantics, Kibble (1998) analyzes CAs as e-type pronouns. In Kibble's theory some quantifiers introduce both a reference and a complement set, either of which can be used as the antecedent of the pronoun. Such a theory assumes that the sentence that contains the antecedent has the same interpretation independent of whether it is continued with a CA, a reference set anaphor or a maximal set anaphor. This means that if a sentence can be continued with a complement set anaphor, it could alternatively be continued with a reference set anaphor. This prediction is, however, not correct. The examples in (28) contains a strong NPI in the first clause. This sentence can be continued with a compset anaphor as in (28-a). A reference set anaphor is not possible, as shown in (28-b).

(28)   Nicht viele meiner Schüler fanden das Buch <u>sonderlich</u> spannend.
         (not   many of my pupils   found the book particularly exciting)

      a.   ?Sie   fanden es sogar extrem   langweilig. (CA)
            (They found it even extremely boring.)
      b.   *Sie   wollten sogar gleich die Fortsetzung lesen. (Refset)
            (They wanted even at once the continuation read)

Nouwen (2003) rejects Kibble's e-type pronoun approach to CAs. Instead, Nouwen uses ranked constraints to determine whether a reference or a complement set can be inferred and used as antecedent to a pronoun. With a proportional downward monotone quantifier the complement set can be inferred as a discourse referent and, thus, as an antecedent for a CA. For a reference

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[5]Under the cardinal reading **few** AB is true iff the cardinality of $A \cap B$ is below a threshold, which is trivially true if A is empty.

set anaphor no such inference is needed. A discourse referent will be established directly in the interpretation of the antecedent clause. By this asymmetry between the refset and the compset anaphora reading of a plural pronoun, Nouwen derives the more marked character of the CA reading. Nonetheless, Nouwen's theory shares with Kibble's approach the fact that the clause that contains the antecedent has the same semantics independent of the continuation.[6]

This brief review of approaches to CA leads to a picture similar to that motivated by considerations of NPIs. The existence of CA readings and the occurrence of strong NPIs in non-anti-additive contexts are theoretically problematic phenomena. The theories discussed above all present important insights into the respective phenomena, but fail to derive the facts from Section 2 in a straightforward way.

4 Analysis: Lexical Decomposition and Equivalence of Representations

The theory that I am going to develop in this section is formulated in terms of DRT. I adopt the standard mechanism for the construction of antecedents to plural anaphora from Kamp and Reyle (1993). So far there is no description of NPIs within DRT. I simply assume that a strong NPI is licensed if it occurs in a DRS which is in the immediate scope of a negation operator. To derive the data on compset anaphora and strong NPIs in non-anti-additive contexts I propose a lexical decomposition of quantifiers and allow for a mapping between semantically equivalent DRSs. Both of these mechanisms are common within DRT.[7]

Let us consider example (29) to give a sketch of the analysis. I assume that downward monotone quantifiers are systematically represented as the combination of a negation and an upward monotone quantifier (Section 4.1). In the case of (29-a) the negation is already overtly present. The subject quantifier in this sentence is proportional and presupposes a set of students. With this presupposition, the inference in (29-b) is valid (see Section 4.2). Consequently, (29-a) and (29-b) have the same logical form under the relevant reading.

(29)   a.   No more than 10% of my students attended the meeting.
       b.   → At least 90% of my students did not attend the meeting.

In such a logical form the negation is within the scope of a quantifier rather than having scope over it. Thus, the pattern is analogous to the negative implicature assumed by Linebarger (1980). In (29-b), the subject combines with a negated VP. In this constellation we expect that strong NPIs are possible inside the VP. Furthermore a pronoun that takes as antecedent the reference set of (29-b) behaves like a compset anaphor to (29-a). This brief characterization of the approach illustrates how I will try to reduce the unexpected occurrences of strong NPIs and the licensing of CAs to standard cases of NPI licensing and cross-sentential co-reference respectively.
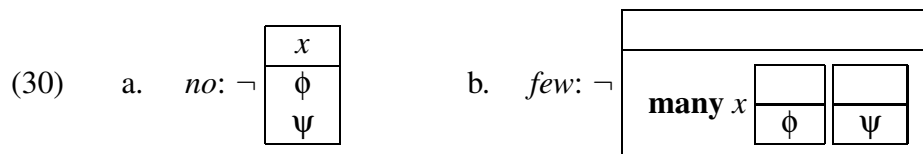
4.1 Lexical Decomposition of Downward Monotone Quantifiers

I assume that each downward monotone quantifier can be represented with a negation in its logical form. This is straightforward for expressions such as *nobody* and *no more than 90%*. However, I extend this treatment to other downward monotone quantifiers as well. In (30) two examples for the proposed decomposition are given. The determiner *no* is treated as a negative

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[6]The same criticism applies to Hardt (2005) where it is explicitly assumed that the semantic representation of the antecedent clause is the same, but a plural pronoun infers its referent — which could be among others the refset or the compset, depending on salience in the context.

[7]For example Krahmer and Muskens (1995) use both mechanisms: They decompose *forget* into ¬ *remember*, and they allow for a mapping between DRSs if these are equivalent, as in the case of their Merging Lemma.

indefinite (see (30-a)), i.e. a negation is introduced in its logical form which introduces a variable in its scope. The restrictor of the determiner is indicated with φ, the scope with ψ.
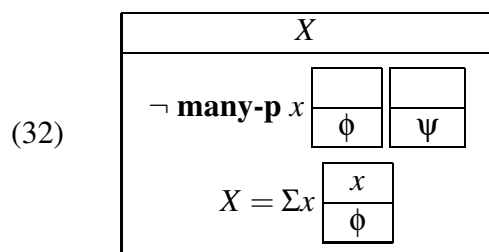
(30)   a.   *no*: ¬ $\begin{array}{|c|}\hline x \\ \hline \phi \\ \hline \psi \\ \hline \end{array}$ b.   *few*: ¬ $\begin{array}{|c|}\hline \\ \textbf{many } x \begin{array}{|c|c|}\hline \phi & \psi \\ \hline \end{array} \\ \hline \end{array}$

(31)   Two meanings of **many**:

   a.   proportional meaning (**many-p**): a large percentage of the elements in φ is in ψ.
   b.   cardinal meaning (**many-c**): a large number of elements is in φ and in ψ at the same time.

The determiner *few* introduces a negation which takes scope over a quantifier. According to the DRT treatment of generalized quantifiers in terms of duplex conditions, we indicate the quantifier, the variable it binds, its restrictor (again φ) and its scope (ψ). For the two readings of *few* we assume two different quantifiers: **many-p** for the proportional reading and **many-c** for the cardinal reading. The definitions are given in (31-a) and (31-b) respectively.

4.2   Presupposition of the Restrictor Set

Since van der Sandt (1992) it is common to assume that presuppositions are also part of DRSs. Since a proportional quantifier such as **many-p** in (31-a) presupposes the restrictor set, we introduce this set into the DRS. Thus, under its proportional reading *few* will be represented as in (32). *X* is the presupposed discourse referent. It is defined as denoting the set of all *x* which satisfy the description in the restrictor (φ).

(32) $\begin{array}{|c|}\hline X \\ \hline \neg\; \textbf{many-p } x \begin{array}{|c|c|}\hline \phi & \psi \\ \hline \end{array} \\ X = \Sigma x \begin{array}{|c|}\hline x \\ \hline \phi \\ \hline \end{array} \\ \hline \end{array}$

Up to here, this is all standard DRT. As noticed in connection with example (27), we can push down the negation and flip the quantifier if the restrictor set is presupposed. This is reminiscent of the first order equivalence of $\neg\exists x\phi$ and $\forall x\neg\phi$. There, the existential quantifier is "flipped" into a universal quantifier and the negation is pushed down into the scope of the new quantifier. While this hold in first order logic, the equivalence does not hold for generalized quantifiers. A counterexample was discussed with the cardinal reading of *few* in connection with example (27) above. However, for proportional quantifiers the following holds:
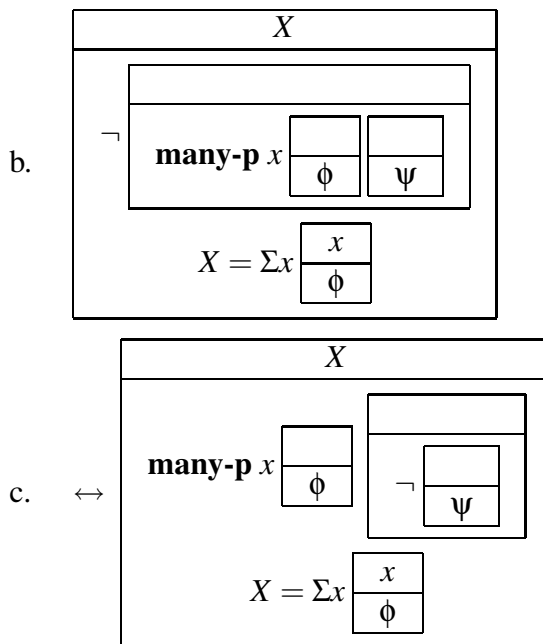
(33)   For each proportional quantifier Q: $\neg Q x(\phi)(\psi)$ is equivalent to $Q'x(\phi)(\neg\psi)$ for some quantifier Q'.

In (34) the validity of this equivalence is illustrated with two informal examples. For the equivalence in (33) to be applicable to (34-b), we must assume a decomposition analysis of *few*, as suggested in the example. Note that in the case of *many* the quantifier does not need to be changed.

(34) a. No more than 10% of my students attended the class.
          ↔ At least 90% of my students did not attend the class.
      b. Few of my students attended the class.
          (= Not many of my students attended the class.)
          ↔ Many of my students did not attend the class.

The diagrams in (35) show the DRSs for the logically equivalent readings in (34-b). The equivalences are given schematically in (35-a). In (35-b) the representation with wide scope of the negation is indicated, and (35-c) shows the representation with narrow scope of the negation.

(35) a. *few*: $\neg\mathbf{many\text{-}p}\, x(\phi)(\psi) \leftrightarrow \mathbf{many\text{-}p}\, x(\phi)(\neg\psi)$

      b.

$$
\boxed{\begin{array}{c} X \\ \hline \neg\;\boxed{\mathbf{many\text{-}p}\; x \boxed{\begin{array}{c}\\ \hline \phi\end{array}}\boxed{\begin{array}{c}\\ \hline \psi\end{array}}} \\[2ex] X = \Sigma x \boxed{\begin{array}{c} x \\ \hline \phi\end{array}} \end{array}}
$$

      c. ↔

$$
\boxed{\begin{array}{c} X \\ \hline \mathbf{many\text{-}p}\; x \boxed{\begin{array}{c}\\ \hline \phi\end{array}}\;\boxed{\neg\;\boxed{\begin{array}{c}\\ \hline \psi\end{array}}} \\[2ex] X = \Sigma x \boxed{\begin{array}{c} x \\ \hline \phi\end{array}} \end{array}}
$$

There are two important observations to be made when we consider the DRSs in (35). First, of course, the equivalence in (33) does not hold for the corresponding cardinal quantifier, because the cardinal reading does not introduce a discourse referent for the restrictor set X as a discourse referent. Second, from the perspective of dynamic semantics the two representations are not only truth-conditionally equivalent, but they also have the same dynamic behavior, i.e. in both cases X is the only discourse referent that is directly available in a following DRS. Thus, the two representations are strongly equivalent. This, however, is exactly the constellation in which Krahmer and Muskens (1995) apply a mapping from one DRS to another.

This consideration concludes the specific assumptions made in this paper. In the next subsection, I show that the two representations in (35) allow us to derive the three possible continuations (maxset, refset and compset) with the original mechanism for plural anaphora from Kamp and Reyle (1993).
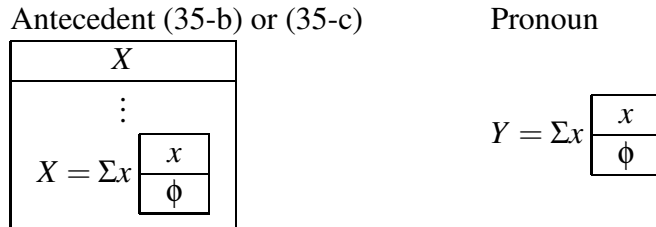
4.3 Possible Continuations

In the last two subsections we were concerned with the construction of the right DRS for the antecedent clause for a sentence that contains a plural discourse anaphor. Kamp and Reyle (1993) assume that there are two ways in which a plural anaphor can be linked to a quantified antecedent: either the restrictor set or the set consisting of the elements in the intersection of the

scope and the restrictor of the antecedent quantifier. With these two mechanisms we get exactly the three possible continuations.
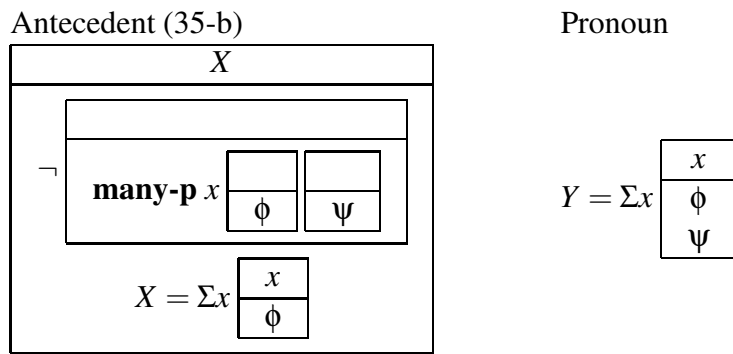
Let us first consider the maxset reading. For this reading, it is immaterial which of the two representations of the antecedent clause we take from (35). In both cases, the antecedent quantifier has the restrictor ϕ which can be used to build an antecedent set for the pronoun. This is shown in (36), repeating example (3-c) to illustrate the reading.

(36)   Maxset: Few congressmen admire Kennedy, but they all like his wife.
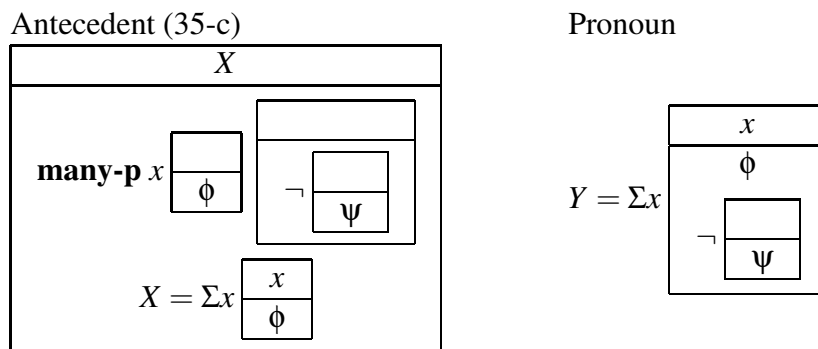
Antecedent (35-b) or (35-c)   Pronoun

$$X = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \end{array} \qquad Y = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \end{array}$$

In (37) the representation of the antecedent clause from (35-c) is used. The pronoun in the second clause takes the intersection of the restrictor (ϕ) and the scope (ψ) as its antecedent. The example in (3-a) is used again for illustration.

(37)   Refset: Few congressmen admire Kennedy, and they are very junior.

Antecedent (35-b)   Pronoun

$$X = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \end{array} \qquad Y = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \psi \\ \hline \end{array}$$

with: $\neg$ **many-p** x, restrictor ϕ, scope ψ

The same mechanism is used for the compset reading in (38). In contrast to the choice of (35-b) as the representation of the antecedent clause for the refset continuation, the representation from (35-c) is chosen for the compset continuation. Thus, the scope of the quantifier is given as $\neg\phi$, which corresponds to a compset reading.

(38)   Compset: Few congressmen admire Kennedy. They think he's incompetent.

Antecedent (35-c)   Pronoun

$$X = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \end{array} \qquad Y = \Sigma x \begin{array}{|c|} \hline x \\ \hline \phi \\ \hline \neg\,\psi \\ \hline \end{array}$$

with: **many-p** x, restrictor ϕ, scope $\neg\psi$

Assuming lexical decomposition of downward-monotone quantifiers in combination with the mapping between equivalent DRSs we can derive exactly the three possible continuations dis-

cussed in the introduction just using the standard DRT mechanisms for plural pronouns. Note that this theory captures the distributional generalization on CA in Nouwen (2003) since the equivalence in (33) only holds for proportional quantifiers.

At the end of Section 4.2 we noted that the two different DRSs for a sentence with proportional *few* have the same dynamic meaning. Nonetheless they clearly differ in their behavior with respect to plural pronouns which take the NP with *few* as their antecedent. The crucial aspect is that this type of anaphoric discourse relation is done with special mechanisms in DRT rather than dealt with by the core dynamic semantics.

4.4 Negative polarity items

To complete the analysis we take a look at the licensing of strong NPIs next. According to Zwarts' theory, strong NPIs are licensed in anti-additive contexts which are typically constituted by the scope of expressions like *nobody*, i.e. so-called n-words. On the standard assumption that n-words are analyzed as negative indefinites this means for a DRT representation that (the semantic representation of) a strong NPI may occur in a DRS K iff $\neg K$ is part of the semantic representation of the utterance. With such a semantic representation, any theory of NPI licensing should be able to predict that strong NPIs can occur.

The DRS in (35-b) can be used for a refset continuation. If there is a strong NPI inside the scope of the quantifier, i.e. inside what is abbreviated as ψ, this strong NPI is not in the right constellation to be licensed since it is not in a DRS in the immediate scope of a negation. However, in the DRS of a sentence which allows for a CA continuation such as (35-c) the negation is lower in the semantic structure and has immediate scope over semantic material from the VP. If a strong NPI is part of ψ now, it ends up in the immediate scope of the negation. Thus a logical form which allows for a strong NPI is found.

This is illustrated in (39). The sentence in (39-a) is treated as equivalent to the sentence in (39-b) from the point of view of semantic representation. In (40) the DRS of this sentence is given. In this DRS the strong NPI *auch nur irgendetwas* ('anything at all') is an indefinite, i.e. we treat the introduction of the discourse referent y as the semantic representation of the strong NPI. This is marked in (40) by underlining y in the universe of the relevant DRS. In the given representation, the NPI $\underline{y}$ occurs in a DRS in the immediate scope of a negation. Thus, the strong NPI is possible.

(39) a. Nicht mehr als 10% der Schüler haben <u>auch nur irgendetwas</u> gelesen.
           (not more than 10% of the pupils have <u>anything at all</u>   read)
      b. ↔ At least 90% of the pupils did**n't** read <u>anything at all</u>.

(40)
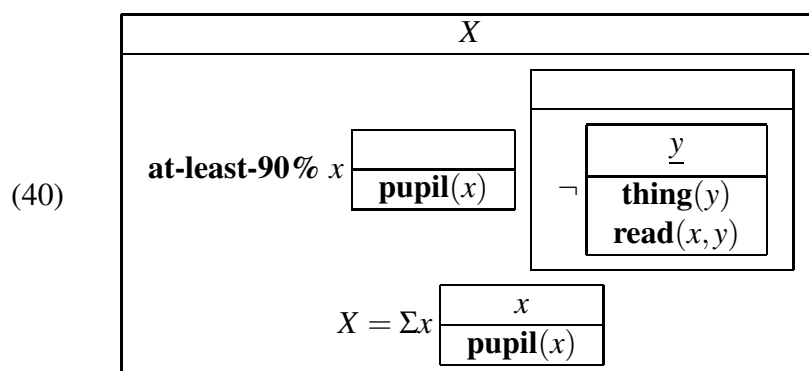
In Section 4.3 I have shown that if we allow for two different semantic representations for

downward-monotone proportional quantifiers we can account for refset and compset continuations based on these two representations. In the present subsection it was shown that the representation that I assume for the antecedent clause of a compset anaphor is such that a VP-internal strong NPI occurs in the immediate scope of a negation.

4.5 Predictions of the theory

In Section 2.3 the following empirical generalization was formulated: If a quantified NP can establish an antecedent for a CA, it can also license a strong NPI. This generalization follows directly from the analysis presented in Sections 4.3 and 4.4: we need a negation in the scope of the quantifier for both CAs and strong NPIs. To achieve this, however, the negation must be, metaphorically speaking, "lowered". Such lowering is only possible for downward-monotone proportional quantifiers.

This theory also predicts the data discussed in (28), repeated as (41): if we use a strong NPI with a downward-monotone proportional quantifier in the antecedent clause, a refset continuation should not be possible. Sentence (41-a) contains a compset continuation, sentence (41-b) a refset continuation. While the compset continuation may not be absolutely perfect, the refset continuation is clearly ungrammatical.

(41) Nicht viele meiner Schüler fanden das Buch <u>sonderlich</u> spannend.
       (not   many of my pupils   found the book particularly exciting)

   a. ?Sie   fanden es sogar extrem   langweilig. (CA)
        They found it even extremely boring.
   b. *Sie   wollten sogar gleich die Fortsetzung lesen. (Refset)
        They wanted even   at once the continuation read

The contrast in (41) provides strong support for our assumption that the semantic representation of the antecedent clause for a refset continuation is different from that needed for a CA.

5   Conclusion

I have provided new data for both the study of complement anaphora and the study of polarity items. The sketched analysis attempts to provide a unified account for these phenomena. If this theory is correct, there is no need to stipulate that in certain circumstances, a complement set can be introduced as a discourse referent. Instead, such a discourse referent, where appropriate, follows from the position of the negation in the decomposed logical form of an expression.

The central observation in this paper is based on Nouwen's generalization that compset anaphora require a downward-monotone proportional antecedent. With DRT, a framework was chosen that assigns theoretical importance to the semantic representation and within which lexical decomposition and the mapping between equivalent representations is part of the usual analytic tools. Furthermore DRT provided us with a theory of cross-sentential plural anaphora.

The major weakness of the present paper certainly is that the grammaticality status of individual examples is not fully clear, especially the grammaticality of strong NPIs in the scope of non-anti-additive subjects. We cannot remedy this for the time being, but rely on the observation that at least the contrasts between cardinal and proportional examples points in the direction pursued in this paper. Nonetheless, the present proposal can be understood as one attempt to make Krifka's and others' intuitions that such licensing is possible under some circumstances more precise.

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