Negative Polarity Items in Questions: Strength as Relevance

Robert van Rooy
ILLC/University of Amsterdam

Abstract

The traditional approach towards (negative) polarity items is to answer the question in which contexts NPIs are licensed. The inspiring approaches of Kadmon & Landman (1990, 1993) (K&L) and Krifka (1990, 1992, 1995) go a major step further: they also seek to answer the question of *why* these contexts license NPIs. To explain the appropriate use of polarity items in questions, however, we need to answer an even more challenging question: why is a NPI *used* in a particular utterance in the first place? K&L and Krifka go some way to answer this question as well in terms of an entailment-based notion of strength, but I seek to give the question a somewhat 'deeper' explanation. Strength will be though of as 'relevance' or 'utility', which only in special cases reduces to entailment. In questions, the information theoretical notion of 'entropy' will play a crucial role: NPIs are used in a question to increase the average informativity of its answers. To account for the rhetorical effect of the use of some NPIs in questions, I propose a domain widening analysis of so-called 'even NPIs'.

1 Introduction

According to Ladusaw (1979), amongst many others, the distribution of polarity items in questions can easily be stated: Polarity items, whether positive or negative, can appear freely in questions independent of the occurrence of triggers (like negation) and anti-triggers. As far as purely syntactic and semantic analyses of NPI licensing is concerned, it seems that there is nearly nothing of interest to say about questions as a licensing category.[1] As observed mostly by Borkin (1971), however, systematic correlations exist between restrictions of appropriate use of questions containing these polarity items and speakers' assumptions and expectations. Only a *pragmatic* account of polarity items seems to be able to say something about this. Recently, Kadmon & Landman (1990, 1993) and Krifka (1990, 1992, 1995) argued that we should not be satisfied by merely *characterizing* the contexts in which polarity items are licensed, but should also *explain why* these contexts do so. This suggests that their analyses are, in principle, well-suited to explain Borkin's observations. Indeed, I will argue that they are, but also that their brief remarks concerning NPIs in questions will neither suffice nor are they fully explanatory. Their analyses of NPIs in questions is either rather stipulative, or not in harmony with the proposed analysis of NPIs in assertions. In this paper I will explain the distribution of polarity items in questions by (i) arguing for a non-standard analysis of *even*-type NPIs which is close to Kadmon & Landman's analysis of *any*; and (ii) generalizing K&L's and Krifka's crucial notion of *strength* for assertions in a natural and systematic way to that of *maximal entropy* for questions. I will discuss the occurrence of polarity items in both *information-seeking* and *rhetorical* readings of questions in terms of maximizing entropy. Moreover, I will explain why asking a question with maximal entropy is optimal to look for, by reducing it to

[1] But see section 3 of this paper and Han & Siegel (1996) for more discussion and/or explicit disagreement.

maximization of utility. I will show that maximization of utility also explains why NPIs are used in assertions, thereby providing a uniform analysis of NPI-distribution.

This paper is organized as follows. In section 2, I will motivate Kadmon & Landman's and Krifka's 'strengthening' analyses of NPIs by iterating arguments of them and others of why the more traditional accounts of Fauconnier, Ladusaw, and Linebarger won't suffice. Section 3 deals with NPIs in information-seeking questions. It starts with a discussion of how far questions give rise to downward entailing (DE) contexts and with some observations concerning the use of NPIs in questions, and continues with Krifka's appealing analysis of the use of NPIs in such questions. In section 4, I review some proposals of how to deal with NPIs in (or that give rise to) *rhetorical* questions. I will defend the view that rhetorical questions are really information-seeking, although the question is open with respect to a minimum quantity only. Domain extension and a presupposition of *even*-type NPIs are crucial to account for this. In section 5, I will propose that the *strength* for questions should be instantiated by *entropy*. This proposals will be backed up later by relating entropy to utility. The paper ends with some conclusions and outlook to further research.

2 From scale reversal to strengthening

Fauconnier (1975a, b) noted that expressions that typically 'license' negative polarity items, like negation, *surprise* and *doubt*, have something in common: they *invert scales*. From this he hypothesized that we can *characterize* NPI-licensing contexts as those contexts that do so. What's more, Fauconnier suggested that *because* expressions like *lift a finger*, *bat an eye* and *one sound* denote the lowest endpoints of a scale, they *can* function (just) as NPIs (highest-endpoint) in negative contexts.

Fauconnier proposed to give a *pragmatic* analysis of NPI licensing in terms of scale-reversal contexts. Ladusaw (1979) proposed to give a *semantic* characterization of such contexts independently of scales. He noted that clauses embedded under negation and other scale-reversal contexts are *downward entailing*. Context $X - Y$ is downward entailing (DE) iff from the truth of $X\alpha Y$ and the fact that β entails[2] α we can conclude to the truth of $X\beta Y$. Thus, a context is DE iff an expression occurring in it can be replaced by a semantically stronger expression *salva veritate*.

Although the analysis of NPI licensing in terms of DE contexts is very successful, there are a number of problems with it. A first problem is that it cannot account for the *fine-structure* of polarity licensing: it seems that some NPIs, like *as much as a dime*, have stronger contextual requirements than others like *any* and *ever*. Zwarts (1981, 1986), Hoeksema (1986) and van der Wouden (1994) characterized different 'negative' contexts algebraically, and proposed that these different kinds of contexts license different kinds of NPIs. Only for *weak* NPIs like (unstressed) *any* and *ever* (or its Dutch translations) is it enough, according to their proposals, that the contexts are DE. Another need for fine-structure follows from Linebarger's (1980) observed contrast between (1a) and (1b): the item *as much as* in the restriction of *every* is licensed in case the whole sentence expresses a necessary, but not in case it expresses an accidental generalization.

(1) a. Every restaurant that charges *so much as a dime* for iceberg lettuce ought to be closed down.

b. ?? Every restaurant that charges *so much as a dime* for iceberg lettuce has four stars in the handbook.

Heim (1984) observes that this contrast does not occur for *any* and *ever* and suggests a distinction between, on the one hand, NPIs for which DEness suffices to license, and, on the other,

[2]Where the notion of entailment is polymorph, applied to multiple types.

Fauconnier-type NPIs that denote *minimal* values. For minimizers a DE context is not enough to license the NPI. Following an earlier suggestion of Schmerling (1971), she proposes that their licensing conditions should involve the presuppositions of *even*, and thereby making licensing depending on common grounds in which a sentence can be uttered felicitously.

But even if we limit ourselves to weak NPIs like *any* and *ever*, the logico-semantic analysis of Ladusaw is problematic. First, if *any* has a free choice (FC) reading it can occur in a non-DE context. Second, as observed by Linebarger (1980, 1987), Heim (1984) and Jacobs (1991), NPIs are sometimes licensed in contexts (e.g. comparatives, or under *surprise*) that are on their standard analyses not DE according to Ladusaw's definition. Linebarger (1980) argues that, as a result, we should give up on the DE analysis and proposes an alternative hypothesis building on Baker's (1970) account of direct and indirect licensing. Baker proposed that a NPI is licensed either directly by negation, or indirectly when the sentence in which the NPI occurs *entails* a sentence that directly licenses the NPI. Linebarger proposes that for indirect licensing the 'entailment' should be weakened to *implicature*.[3,4]

Linebarger's analysis of indirect licensing, however, is problematic. Most worrying, perhaps, is that even in her own words (1987, p. 381), her analysis remains 'frustratingly unalgorithmic' (see Kadmon & Landman 1993 and Krifka 1995 for more discussion). But if both Ladusaw's and Linebarger's analyses are problematic, what, then, is the right way to go?

Before we can answer this question, Kadmon & Landman (1990, 1993) and Krifka (1990, 1992, 1995) argue, we should take into consideration some additional shortcomings of the standard DE analysis.[5] First, Ladusaw's analysis leaves it unclear why *any* indicates a reduced tolerance for exceptions. Second, on Ladusaw's analysis it is mysterious why *any* in the restrictor argument of *each* and *both* are (normally) unacceptable. Third, Kadmon & Landman (1993) argue that although *glad that* does not give rise to a DE context, it still licenses *any* when the resulting sentence has a so-called 'settle for less' interpretation. Fourth, and most relevant for this paper, a DE analysis might give a reasonably good *description* of the contexts that license NPIs, it does *not* at all *explain* why this is the case. Moreover, for the analysis it would be irrelevant what the NPIs by themselves mean. Though it is true that many negative polarity items that carry the 'implicature' of a licensing requirement are idiomatic, it is equally true that becoming a negative polarity item is productive. This suggests that the reason why some expressions are (only) licensed in DE contexts has something to do with the *meaning* of these expressions.

The approaches of Kadmon & Landman (1990, 1993) and Krifka (1990, 1992, 1995) try to account for these problems by taking the meaning of negative polarity items into account.[6]

Primarily to account for the reduced tolerance of exceptions and to give a uniform analysis of PS and FC *any*, Kadmon & Landman (1990, 1993) argue that an NP of the form *any CN* should be interpreted like the corresponding indefinite *a CN*, but where the domain of quantification over which the indefinite with *any* ranges is *wider* than the domain of *a CN*, and where the sole difference between PS and FC *any* lies in the fact that the latter, but not the former, is interpreted generically.

[3] A similar suggestion was made by Reinhard (1976).

[4] Linebarger also proposed a somewhat different analysis of 'direct licensing' in terms of immediate scope in order to account for so-called 'intervention effects'. Because intervention effects won't be important in this paper, I won't go into the details of Linebarger's syntactic analysis.

[5] I will ignore here, and in the rest of the paper, the problem of how to account for *any* under its free choice reading.

[6] See also Lahiri (1998) for a similar approach. It should be noted that Giannakidou's (1997) very different analysis to explain the distribution of polarity items takes their meanings into account as well. In my own terms she argues, for instance, that *any* is a *marked* indefinite. On the extra assumption that unmarked indefinites at top (sentential) level have a 'specific' interpretation, *any* is licensed only in modal or non-episodic contexts where the indefinite cannot be interpreted specifically. Though interesting, and potentially relevant for NPIs in information-seeking questions, I will mostly ignore her approach in the rest of this paper.

They note that in terms of this 'widening' analysis of *any*, the unacceptability of this item under *each*,[7] and the licensing of *any* under *glad that* with a 'settle for less' interpretation, can be explained naturally. What still needs to be explained, however, is why *any*, and other NPIs, are typically licensed in DE contexts only. Thus, we still need an explanation of why (2a) is unacceptable, but (2b) is not:

(2) a. *John ate *anything*.

b. John did**n't** eat *anything*.

Kadmon & Landman (1990, 1993) propose to account for this by a second meaning-part of *any*: the interpretation of the sentence after domain widening has to be *stronger* than before widening. Because extension of the domain over which (kind of) things John might eat would make 'John ate something' only weaker, i.e. less informative, (2a) is correctly predicted to be unacceptable. Sentence (2b), on the other hand, gets a stronger, more informative, interpretation after domain widening, and is thus predicted to be acceptable. Thus, the licensing of NPIs in DE contexts does not have to be stipulated, but falls out as a 'theorem' of their analysis.

Notice that in distinction with Ladusaw's analysis of NPI licensing in terms of DEness, an explanation in terms of widening and strengthening, just like Fauconnier's and Heim's analyses, crucially involves the sentence with the NPI itself: the interpretations of the sentence before and after widening are compared with respect to their strengths. In fact, Kadmon & Landman argue themselves that this is one of the crucial advantages of the widening approach compared to Ladusaw's analysis. It is needed, for instance, to explain why *any* can be licensed under *glad*. Notice, moreover, that any analysis that makes use of a comparison between propositions in terms of their strength, one of which is the interpretation of a sentence with a NPI, presupposes that the sentence with the NPI *has* an interpretation. Thus, to speak with Ladusaw (1995), sentences with non-licensed NPIs are not ill-formed because they have no meaning,[8] but rather their meaning is ill-suited to accomplish the *conventionally* required goal of strengthening the statement.

Kadmon & Landman's explanation of the licensing of *any* in DE contexts is very intuitive and extends naturally to other polarity items.[9] DE-licensing results from the conventional meaning of the NPI expression: domain widening and strengthening. Now, domain-widening seems a natural meaning to associate with an expression, but that doesn't seem to be the case with strengthening. In fact, I find Kadmon & Landman's explanation of licensing in DE contexts natural and appealing only *because* they can reduce it to the very *general* notion of *strengthening*, a notion used to explain many *pragmatic* phenomena. By making the strengthening requirement part of the conventional, semantic, meaning of the NPI, however, the 'explanation' of DE-licensing loses much of its initial appeal. It suggests that the strengthening requirement that Kadmon & Landman associate with NPIs is equally arbitrary as Ladusaw's DE-licensing requirement, or, say, the conventional way we associate 'chairs' with chairs.[10]

Independently of Kadmon & Landman (1990, 1993), Krifka (1990, 1992, 1995) developed his own account of NPI licensing that aims to give a 'deeper' *pragmatic* explanation of why NPI sentences should involve strengthening. Following Fauconnier (1975a,b, 1980) and Heim (1984), he tries to *reduce* NPI licensing to *scalar implicature*, giving the analysis a Gricean motivation. He

[7]For a somewhat similar explanation of this fact, although stated in somewhat different terms, see Giannakidou (1997, p. 139).

[8]Such an account would be counterintuitive anyway, because it is forced to claim that ill-formed *Meg ate any fruitcake* becomes well-formed, suddenly, when embedded under *I doubt that*.

[9]Note that Krifka's (1992, 1995) analysis of *ever* closely resembles K&L's domain-widening analysis of *any*.

[10]Of course, it is always a question what pragmatics should explain: why speakers implicate something in that particular situation, or why the conventional meaning associated with an expression could have become the one it is? See van Rooy (in press) for extensive discussion.

argues that NPIs are conventionally associated with *scales* and that these NPIs themselves denote the *minimal elements* of these scales. Krifka's Gricean reduction of NPIs to scalar implicatures means that the speaker must have a *good reason* to use the sentence with the NPI instead of a sentence where the NPI is *substituted* for an alternative of the scale.[11] Assuming with Grice that in most situations the speaker should, or wants to, express the *strongest* claim he can make, this gives rise to the (scalar) implicature that any sentence resulting from the substitution of the NPI by an alternative of the scale is false.[12]

The main goal of Krifka's analysis is to *explain why* NPIs are licensed in the contexts that they are. And just like for Kadmon & Landman, this explanation crucially involves (i) the *meaning* of the polarity item; (ii) the *comparison with* interpretations of *alternative* sentences; and (iii) a notion of *strength*. Why are NPIs typically licensed in DE contexts only, i.e., why is (2b) acceptable, but (2a) not? The explanation is basically the same as the one offered by K&L but now given a Gricean motivation: after substitution of *anything* by a more specific alternative, the resulting sentence gets stronger in case of (2b), but not in case of (2a). The reason is, as already noted by Fauconnier (1975a,b) and Ladusaw (1979), that in case the NPI is the weakest element of a scale, the sentence (2a) remains the weakest element of the (induced) scale formed by the sentential frame 'Mary saw -', but that the induced scale *reverses* once embedded in a DE context (as in (2b)), turning weakest elements into strongest ones. Because the pragmatic condition requires (via implicature and/or appropriateness condition) that the NPI sentence must be the strongest, i.e. most informative, one of the alternatives, (2a) is acceptable, but (2b) is not.

K&L (1993) note that (in)appropriateness in general cannot explain (un)grammaticality and suggest that the licensing of NPIs in (non-)DE contexts is so hard-wired that it cannot be reduced to mere (in)appropriateness. Krifka (1995) counters this objection, however, by noting that his explanation of the (non)licensing of NPIs is based on something *more general* than mere (in)appropriateness in a conversation: a declarative sentence with a NPI in a (non)DE context is *systematically* (weaker) stronger than the corresponding alternatives. As a result, we don't have to build the notion of 'strength' into the conventional meaning of the NPI as K&L do.

Krifka can account for many properties of *any* without making use of domain extension. In fact, he argues that this is needed, too, because in mathematical sentences, for instance, *any* can occur without there being a domain extension involved:

(3) This sequence doesn't contain *any* prime numbers.

Indeed, in this sentence no widening of the domain of prime numbers seems to be involved.[13]

But, then, how does Krifka account for those examples for which Kadmon & Landman crucially rely on domain widening, as the indication of reduced tolerance for exception? Krifka (1995) suggests that this effect takes place only in case the NPI is used *emphatically*, and argues that emphatically used, or *strong*, NPIs have a non-exhaustive meaning, which essentially comes down to the claim that the existential quantifier associated with the NPI can range over more minor things than any of its alternatives. Krifka (1995) suggests that this difference between weak and strong NPIs, with exhaustive and non-exhaustive scalar alternatives, respectively, also accounts for some of the distribution effects of NPIs that Zwarts (1981) intended to capture by algebraic means.

[11] This motivation itself follows, of course, from Gricean pragmatics as well: Polarity items are typical examples of *marked* expressions. The use of such an expressions gives rise to an implicature via Grice's maxim of manner.

[12] Krifka (1992) suggests that in this way he can also account for the FC reading of *any*. I won't go into that here.

[13] For a more K&L-style analysis to account for this, see Chierchia (ms). This paper also gives the K&L analysis of domain-extension a more compositional outlook.

3 NPIs in information seeking Questions

3.1 Observations

Although it is well known that questions license NPIs, the standard accounts always had difficulty to explain why. Questions don't need to contain a negation, as the earliest analysis of Klima (1964) would demand, and neither are questions downward entailing in any straightforward way. To see the latter, notice that according to the most reasonable entailment relation between questions, one question *entails* another, if every complete answer to the former is also a complete answer to the latter.[14] To illustrate the fact that polar questions are not downward entailing in their subject position, consider the following interrogatives:

(4) a. Are John and Mary sick?

b. Is John sick?

It is clear that (4a) does not entail (4b), because the negative answer to the former is still compatible with both answers to (4b). Yes-no questions are not downward entailing in their predicate position either, because the negative answer of (5) doesn't resolve (4b).

(5) Is John sick and did he go to a doctor?

Just like polar questions, *wh*-questions are also not downward entailing in predicate position: a full answer to (6a) need not be a full answer to (6b):

(6) a. Who are sick and went to a doctor?

b. Who are sick?

However, *wh*-questions are downward entailing with respect to their subject position. The *wh*-question resulting from enlarging the domain over which the *wh*-phrase ranges entails the question before domain extension. That is, every full answer to (7a) entails a full answer to (7b).

(7) a. Who of John, Mary and Sue are sick?

b. Who of John and Mary are sick?

Thus, from a DE point of view we expect NPIs only to be licensed in questions if they occur in the restriction of a *wh*-question. Similarly, only in case a negative polarity item occurs in this position, it holds that a question with, say, *any* entails the corresponding question with alternative *some* after domain extension. However, NPIs are licensed not only in subject position of *wh*-questions, but in predicate position of *wh*-questions and in polar questions as well:

(8) a. Who, of those who has *ever* been to China, climbed the Chinese Wall?

b. Who has *ever* been to China?

(9) a. Did someone here who has *ever* been to China climb the Chinese Wall?

b. Have you *ever* been to China?

[14] This is of course the entailment relation defended by Groenendijk & Stokhof (1984), but also taken over (at least implicitly) by some proponents of the Hamblin/Karttunen question semantics like Roberts (1996).

To account for such cases we have to look for an alternative proposal.[15]

This alternative proposal also has to account for the fact that questions also allow for *positive* polarity items (PPIs) like *rather* and *pretty*, and this typically in questions which *do* contain an explicit negation:[16]

(10) a. Would(n') t you *rather* stay here?

b. Aren't you *pretty* tired?

It appears as if polarity items can occur freely in questions. Borkin (1971) observes, however, that this is not true. The acceptability of questions with NPIs and PPIs varies with context: questions in which a negative answer is expected allow for NPIs, while questions which expect a positive answer license PPIs.[17] With respect to polar questions, this holds for both their positive (PPQ) and negative (NPQ) variants.

3.2 Krifka: using NPIs to reduce bias

Take polar question q? with meaning $Q = \{q, \neg q\}$ and assume that the questioner takes the negative answer to be more likely than the positive answer: $P(\neg q) > P(q)$. Suppose that we now replace within q the expression *some* by *any*, which comes with the usual domain extension. This results in new question $Q' = \{q', \neg q'\}$. The negative answer of this new question will be stronger than the most expected answer of the old question: $\neg q' \models \neg q$. Now one might propose that it is not so much the question itself that licenses the NPI or PPI, but rather the expected answer. Combined with a DE or domain-extension analysis of NPIs, this means for polar questions that if the expected answer is negative, the NPI is licensed.[18] For *wh*-questions this means that NPIs are licensed in case the expected answer is *Nobody*. Although this proposal may look reasonable at first sight, it actually makes a much too strong demand on situations in which questions with NPIs can be used appropriately. The analysis works only if the most expected negative answer (of a polar question) is not just *more likely* than the positive answer, but the questioner also has to think that the *positive answer* is *not possible* at all. The reason is that if the positive answer is not

[15] Although a proponent of the DE approach might claim that a polar question is really a *wh*-question in disguise. Indeed, this is basically what Higginbotham (1993) proposes. For independent reasons, such an analysis for polar questions has also been suggested by Aloni & van Rooy (2002). They predict that an indefinite inside a (*wh* and polar) question extends the assignment in case it is not 'intervened' by an externally 'static' negation or quantifier. Thus, such an indefinite turns, for instance, a polar question into a *wh*-question. If we assume that *any* is an existential quantifier with a larger domain than *some*, we predict that the question with *any* entails the corresponding question with *some*. And indeed, this seems natural to assume for a polar question as (i) that intuitively corresponds with the *wh*-question (ii) under its *mention some* reading.

(i) Does *some/any*body have a light?

(ii) Who has got a light?

Thus, it seems that for the above examples the standard DE-notion of licensing is sufficient, just as the entailment-notion of strength. However, I don't believe, that this can be the general story. First, it could in principle only work for NPIs with an *indefinite* meaning. But even if we limit ourselves to 'indefinite' NPIs like *any* and *ever*, the analysis seems natural only for polar questions that can be read as *wh*-questions with a *mention some* reading. For examples with more substantial nouns than 'body' or 'thing' such as (iii) it seems less natural to assume that the NPI gives rise to a new *wh*-phrase.

(iii) Does Sue have *any* potatoes? $\neq$ (iv) What (amount of) potatoes does Sue have?

[16] See Borkin (1971) and Pope (1972).

[17] Where 'expectation of a negative answer' isn't necessarily equivalent with 'believe that positive answer is false'.

[18] This is much like Ladusaw's (1979) proposal to account for NPIs in questions. Somewhat in the same spirit, Giannakidou (1997) and Han (2001) (who builds on Progovac (1993)) seek to account for the licensing of NPIs in rhetorical questions by assuming that these questions actually have the same *meaning* (not only extension, as Karttunen would predict, but even intension) as the negative assertion. However, not only do I not believe that they predict correctly, even if they would do so, their analysis remains unexplanatory: we would also like to know *why* the negative polarity item has the effect of making the question rhetorical.

ruled out, domain extension can have the effect that the actual answer is *weaker* than the question without the NPI, because $q \models q'$. Unfortunately, most questions in which a NPI occurs, e.g. (8a) and (9b), do not rule out positive answers at all.

Although the polarity of the expected answer is crucial for the licensing of polarity items, our above reasoning suggests that it is wrong to look *only* at the expected answer: the other answer(s) have to be taken into account as well. We should not just look at the informativity of the *most expected* answer, but rather at the *average* informativity of *all* the answers before and after domain extension. In fact, this is basically what Krifka's proposal comes down to.

Based on very general considerations, Krifka (1990, 1992, 1995) proposes that a NPI is used in a (polar) information-seeking question to turn a biased question into an unbiased one. He motivates this analysis by noting that, everything else being equal, *general* questions are normally preferred to specific ones.

Comparing the positive answer to a polar question like *Is the card that you drew from the deck the seven of diamonds?* with its negative answer, it is clear that the former is much more informative than the latter. The informativity of the possible answers to the question *Is the card a diamond?* are much more alike. In many circumstances the overall information gain of the latter, more general, question is higher than that of the more specific variant. Krifka notes that in comparison with an interrogative sentence containing an alternative value of a scale, the interrogative containing a NPI denoting its *minimal* value (or after domain widening) denotes a *more general question* in the sense discussed above in case the negative answer is more likely than the positive answer. Thus, speaking in terms of domain extension, in case the speaker considers the negative answer to (11a), which asks about recent visits, more likely than the positive answer, (11b) will normally express a more general question.

(11) a. Have you been to China?

b. Have you *ever* been to China?

Because general information-seeking questions are, according to Krifka, normally preferred to specific ones, a NPI is allowed in such questions in case the likelihood of the negative answer is larger than that of its positive counterpart. Notice that this analysis can be extended straightforwardly to PPIs in questions: on the assumption that a PPI *strengthens* the application conditions, a PPI makes a question more general as long as the positive answer is more likely.

I find Krifka's proposal very appealing. Still, in Krifka's papers it remains unclear why general questions should be preferred to specific ones and how his account of polarity items in questions can be related to his analysis of these items occurring in assertions. Above, I already suggested an answer to these questions: a general question is preferred to a specific one, because its *average informativity* is higher. In section 5, I will work out this suggestion in more detail. Moreover, I will show why this increasing average informativity is desirable.

4 Rhetorical questions and the meaning of 'even'-NPIs

As observed by Borkin (1971) and Heim (1984), there exists a distinction in distribution between NPIs like (unstressed) *any* and *ever*, and NPIs like *lift a finger* and *bat an eye* in questions. Whereas the former type of NPIs can be used in standard information-seeking questions and don't need to be stressed (see above), the latter type of polarity items require *stress* to be acceptable and give the question a *rhetorical* reading.

(12) a. Did John *lift a finger* to help Mary?

b. Who *lifted a finger* to help Mary?

c. Did John *bad an eye* when the boss came around?

d. Who *bats an eye* when the boss comes around?

Borkin (1971) observes that the occurrence of these NPIs – i.e., the NPIs that 'occur with *even*' – also give rise to rhetorical readings of *negative* polar questions.

(13) a. Doesn't Lois drink *a drop* of liquor?

b. Doesn't Lois drink *even a drop* of liquor?

c. *Isn't Eli *all that* proud?

d. *Isn't Eli *even all that* proud?

She notes that what is presupposed in (13a) is the *general* statement that Lois doesn't drink liquor, leaving it open whether she doesn't drink ANY liquor at all, i.e. not even mild ones or minor quantities. So, the presupposition, or strong expectation, of the negative answer does **not** concern the question with the NPI, but rather the question *without* the NPI, or with an alternative of the NPI. This seems to be the case not only for negative polar questions, but for positive polar questions as well. To account for the rhetorical effect of strong NPIs in questions, I suggest a proposal along the lines of Kadmon & Landman (1990).

4.1 Kadmon & Landman and NPI-minimizers

Discussing the occurrence of *any* in (14),

(14) Does Sue have *any* potatoes?

Kadmon & Landman (1990) suggest that the question does not give rise to the strong expectation that Sue doesn't have any potatoes whatsoever, but to a somewhat weaker one instead. If in a context 'potatoes' would normally mean 'cooking potatoes', the effect of *any* in (14), according to their intuitions, is that it gives rise to the expectation that Sue doesn't have any *cooking* potatoes, leaving it open whether she still has other potatoes. As should be obvious, this intuition is the same as we have discussed above w.r.t. NPIs that 'go with *even*'.

As usual, Kadmon & Landman (1990) account for this intuition in terms of *domain widening* and *strengthening*. In the case of assertions, strengthening came down to *informativity*, routinely reduced to entailment. But we have seen already that the notion of (downward) entailment doesn't work for the licensing of NPIs in questions. Indeed, turning question (15) into (14) by means of domain widening due to the substitution of *some* by *any* doesn't make the latter entail the former.

(15) Does Sue have *some* potatoes?

For this reason they invent a new notion of strengthening between questions:

- Question Q' *strengthens* Q exactly when Q is already answered, but Q' is still unanswered.

With the additional assumption that a negative answer to question (14) is expected/presupposed with respect to the limited domain, they explain why the NPI is licensed by noting that the question is still not settled with respect to an extended domain.

I share the intuitions behind K&L's analysis of a question like (14) and agree that domain *widening* and something like their notion of *strength* is crucial for the analysis. However, I think there are two good reasons for why their analysis is not completely sufficient. First, I find their

analysis of a question like (14) appealing only in case the NPI is *stressed*.[19] I don't think the proposed analysis is suited to account for *information-seeking* questions where *any* is not stressed, because for these questions the analysis is still based on a too strong assumption: though a negative answer to (14) is also in those cases more likely, even with respect to a limited domain the positive answer is not ruled out. Second, even if K&L's analysis of questions with stressed *any* is appealing to account for the rhetorical effect, this part also leaves something to be desired: (i) How come that also *even*-NPIs occurring in questions give rise to rhetorical effects? For K&L's proposal to be a general solution, also *even*-NPIs have to be analyzed somehow in terms of domain widening; (ii) The comparative relation of *strength* between questions used by K&L looks *stipulative*, and defined just to account for the problem at hand. Can we account for the same intuition without making use of this stipulative notion? Before I will propose a more general relation of strength between questions, I will first discuss the effect of *even*-NPIs in questions. What is so critical about *even*-NPIs that they give rise to rhetorical questions? The fact that they denote *minimal* values, or that they come with a *presupposition*? I will argue that we need both assumptions.

It might seem as if we can simply adopt Fauconnier's (1980) reasoning for why *even*-type NPIs in questions (always) give rise to a *rhetorical effect*. Remember that according to Fauconnier many NPIs denote *minimal* endpoints of scales. It follows that they behave similarly to superlatives, giving rise to universal readings:

(16) a. I wonder if it rained (even) *a drop*.

b. Every amount of rain that could have fallen is such that I wonder if it (actually) fell.

From this it follows, he suggests, that if an agent has reason to question the truth of $R(\cdot)$ with respect to even a *minimal* value x of a scale, he *implicates* disbelief regarding all less minimal alternatives of x. What holds for indirect questions under *wonder*, holds, according to Fauconnier, for direct questions as well: If I wonder if p holds, I am not sure whether p holds, and this normally is also a necessary condition for directly asking p? For this reason, direct questions with NPIs that denote minimal values, like (17), also implicate that the speaker disbelieves the truth of all alternatives with less minimal values. This, in turn, implicates (according to Fauconnier) that a question like (17) has the rhetorical effect saying that the addressee didn't help the speaker at all.

(17) Did you *lift a finger* when I needed it?

I find Fauconnier's analysis very appealing, but incomplete. It is based on the intuitive, but still unexplained, assumption that questioning the truth of $R(\cdot)$ with respect to the *minimal* value of a scale *implicates* the disbelief regarding all less minimal alternatives. The question that remains to be answered is how we can account for this implicature. Fauconnier suggests that this follows from the meaning of NPIs: the fact that they denote small quantities. But this by itself can't be enough. As discussed by Bolinger (1972), there are expressions that denote small quantities, like *an indication*, *a tad* and most obviously *a little*, which either do not allow negation or don't imply in such contexts the presence of no quantity at all. It follows that these expressions can't function as negative polarity items,[20] and, we might add, they also don't give rise to rhetorical readings when used in questions. But if this is so, an analysis that tries to explain the rhetorical effect solely in terms of the assumption that NPIs denote minimal quantities won't do.[21] To account for the searched for implicature, or so I will argue, we have to take the *presupposition* of *even*-NPIs seriously.

[19] Remember that according to Krifka (1995) only stressed *any* should be treated as a strong NPI.

[20] Ducrot (1973) discusses the difference between the French adverbs *peu* (little) and *un peu* (a little) and notes that while the former behaves like a NPI, the latter behaves more like a PPI.

[21] Krifka's (1990, 1992, 1995) proposed analysis for NPIs in rhetorical questions is essentially based on the same idea as Fauconnier's and fails for the same reason.

4.2 The presupposition of 'even'

According to Fauconnier (1975a,b), Karttunen & Peters (1979) and others, sentence (18a) implicates/presupposes (18b):

(18) a. Mary can even speak *French*.

b. French is the least likely language that Mary can speak

Under negation this implication reverses: (19a) presupposes that French is the *most* likely language that Mary can speak, i.e. (19b). This effect occurs because, as Karttunen & Peters (1979) predict, *even* has wide scope over the negation and the proposition that Mary can speak French is most unlikely.

(19) a. Mary can not even speak *French*.

b. French is the most likely language that Mary can speak.

As observed already by Horn (1971), a question like (20) which contains *even* can have two readings: one which implicates/presupposes that French is the least, the other that French is the most likely language that Mary can speak.

(20) Can Mary even speak *French*?

Now suppose that the questioner actually made one of those presuppositions mentioned above. In that case the question is predicted to have a rhetorical reading only. The reason is that the answer is either (18a) with presupposition (18b), or its negation (19a) with presupposition (19b). In case the context in which the question is asked satisfies one or the other presupposition, the question is predicted to allow for only a positive or only a negative answer, for reasons of presupposition satisfaction of the answer. But this means that the question functions rhetorically, and acts practically as an assertion.

As already observed by Borkin (1971), Fauconnier (1975a,b) and Heim (1984), the occurrence of *even* has no semantic/pragmatic effect in combination with strong NPIs like *lift a finger*. This suggests that these NPIs share the presupposition(s) of *even*. Indeed, also Krifka (2001) assumes that strong NPIs have this presupposition. This explains, according to Guerzoni (2001), the rhetorical effect of strong NPIs in questions. But why show these questions only the *negative* rhetorical force? The reason for this, as shown by Lahiri (1998), follows from the *semantic* meaning of the strong NPIs: NPIs like *lift a finger* denote *minimal* elements of a scale. Assuming an *at least* reading of these elements, it can safely be assumed in any context that the sentence with the minimal value is the most likely to be true. Notice that this allows for a negative answer to a question like (21), because presupposition and assertion are then in accordance with each other.

(21) Did John *lift a finger* to help Mary?

For the positive answer, however, this is not the case. As stressed by Guerzoni (2001), the positive answer is predicted not to be possible, because it leads to an *inconsistency* between semantic meaning and presupposition. Thus, in any context only a negative answer to (21) can be given, which explains its particular rhetorical force. Building on Lahiri (1998), a similar analysis for constituent questions can now be developed as well.

Although the occurrence of *even* in a question seems to suffice to turn a proper information-seeking question into a rhetorical one, the reason behind this doesn't seem to be that only one of the answers can satisfy the presupposition of the question. With Borkin (1971), I believe that a question like (21) still is, in principle, information-seeking, although only with respect to a

ridiculously small quantity of help. Still intuitively speaking, also the positive answer to (21) is possible, but even that answer has, practically speaking, the same effect as the negative answer. Recall Borkin's (1971) discussion of the effect of NPIs that 'go with *even*' (like *a drop*) in negative polar questions like (13a).

(13a) Doesn't Lois drink *a drop* of liquor?

According to Borkin, (13a) presupposes the *general* statement that Lois doesn't drink liquor, leaving it open whether she doesn't drink ANY liquor at all, i.e. not even mild ones or minor quantities. But this questionability is unexpected given Guerzoni's proposal. Thus, with Kadmon & Landman (but also Fauconnier and Krifka), I think that the rhetorical force should result from the limited way in which the question is still information-seeking. Perhaps this just means that NPIs like *a drop* doesn't share a presupposition with *even* after all. I won't adopt this way out, however, but want to suggest, rather, that the problems are due to the standard presupposition associated with *even*.

4.3 *Even*-NPIs and domain widening

In the previous section I claimed that Guerzoni's predictions concerning questions that contain *even*-NPIs are too strong due to her adoption of the standard presupposition associated with *even*. According to Horn's (1969) original analysis of *even*, a sentence like (22)

(22) Even *John* likes Mary

asserts that John likes Mary, and presupposes that (i) somebody else likes Mary, and (ii) that it is unexpected that John likes Mary. Fauconnier (1975a,b) argued that this presuppositional analysis is too weak. From a sentence like (23a) we typically infer that (23b) is true:

(23) a. *Even the pope* is tempted to use contraceptives.

b. Everybody is tempted to use contraceptives.

To account for this inference, Fauconnier argued that just like superlatives, also items that associate with *even* mark the end of a scale, in this case one of informativity/surprisal. Thus, the (second) presupposition should rather be that an item associating with *even* is the *least likely* to satisfy the propositional schema. This presupposition was adopted by Karttunen & Peters (1979) and we saw it to be crucial for Guerzoni's (2001) analysis of rhetorical questions.

Kay (1990) argues, however, that items that associate with *even* don't necessarily mark the endpoint of a scale. Although (24a) and (24b) are appropriate, it can hardly be argued that the associated items denote such endpoints:[22]

(24) a. Not only did Mary win the first round match, she even made it to the *semi-finals*.

b. The administration was so bewildering that they even had *lieutenant colonels* making major policy decisions.

[22]Also, an 'even more challenging question' doesn't need to be the most challenging question, I think. The following discourse gives another problematic example:

(i) Who came? Mary. Even John. AND even Bill.

Kay (1990) discusses similar examples involving *even* and *let alone*:

(ii) A: Have you read So-and-so's letter?
B: Listen, I haven't even had time to stack my mail, let alone open it, let alone read it!

But if the items do not denote endpoints of scales, the universal presupposition Fauconnier and Karttunen & Peters (1979) associate with *even* must be too strong as well.

Does this mean that we should go back to Horn's analysis? Well, not exactly. First, because, as noted by Kay (1990), a sentence like (22) cannot really serve well as a conversation opener, although there is nothing in Horn's (1969) analysis that can explain this. Second, as noted by Kay, it is unclear how examples like (25a)-(25b) could be analyzed just in terms of 'surprise':[23,24]

(25) a. Mary knows every place on earth.

b. She has *even* been to BORneo!

How could it still be surprising, Kay wonders, that Mary knows Borneo, if we already know that she knows every place on earth? Kay argues that to account for such examples we should make crucial use of his scalar models. Krifka (1995) explicitly discusses the above example, and gives an, I think, more natural motivation for why *even* is appropriate in (25b). He crucially makes use of the assumption that the proposition that Mary knows Borneo is informative or surprising even after the truth of (25a) is assumed, which is only possible if we take *Borneo* **not** to be in the domain of quantification of *every* of the first sentence. Thus, what *even* seems to indicate here is some kind of *domain extension*.

Still, much in the spirit of Kay (1990), I would like to adopt an analysis of *even* along the following lines: Sentence (22) asserts that John likes Mary, and presupposes that (i) there is a salient set of alternatives to John all members of which like Mary, and (ii) John is more unlikely to like Mary than any of these alternatives.[25] The condition that the assertion must be informative requires that John is not part of the salient set of alternatives all of whose members are presupposed to like Mary.[26] Being weaker than Fauconnier's and K&P's analysis, it has no problem to account for (24a) and (24b). Kay (1990) attributes to Kiki Nikiforidou the observation that *even*-sentences give rise to universal conclusions most naturally in case these sentences are uttered 'out of the blue'. The reason for this, I think, is that now the alternative items are *all* those that could *possibly* be alternatives to the associated item. Notice, moreover, that on the newly proposed analysis we predict that (25b) presupposes that Mary has been to all salient places on earth discussed above, which is exactly what (25a) asserts. The informativity of (25b), however, demands that the quantifier in (25a) ranges over a non-universal set.

But can our crucially weaker analysis of *even* than the one that drives Guerzoni's analysis also account for the rhetorical force of questions of strong NPIs? Let us look first at question (20) repeated below:

(20) Can Mary even speak *French*?

If declarative sentence (18a) gives rise to the presupposition that for any x of a set of salient languages the proposition expressed by 'Mary speaks x' is non-assertable because its truth is already presupposed, it is only natural to assume that interrogative sentence (20) gives rise to the

[23] A sequence like 'Nobody recognized me. Not even my wife' would be another problematic example.

[24] Kay (1990) also discusses some examples for which an analysis in terms of 'surprise' seems unnatural. He notes himself in footnote 21 that for these cases an analysis of 'expected value' would predict correctly. This suggests that an analysis of 'even' along the lines of Ducrot (1973) and Merin (1999) is appropriate here. Although these analyses are closely related with what I am going to propose, and although 'informativity' is (provably) a special case of 'expected value' rather than the other way around (cf. van Rooy, to appear), I won't go into their interesting analyses, however.

[25] Examples discussed by Wilkinson (1996) concerning embeddings under *sorry* and *glad* suggest that our account of *even* prefers Karttunen & Peters's (1979) scopal analysis to Rooth's (1985) ambiguity analysis. Notice that Wilkinson also gives a for me crucial defense of the 'existential' presupposition associated with *even*.

[26] Notice the resemblance of this analysis of *even* with that of additive particles like *too*, *also* and *as well*.

presupposition that for any x of a set of salient languages, the question expressed by 'Does Mary speak x?' is *unquestionable* because the question is settled already. The appropriateness of the question requires, however, that the issue whether Mary speaks French is still open. Suppose that there are four salient languages: English, Dutch, German and French. Suppose, furthermore, that it is either presupposed to be *more* likely that Mary can speak any of {English, Dutch, German} than that she can speak French, or that it is presupposed that this is *less* likely. Notice that both of these presuppositions are consistent with the assumption that the question expressed by 'For any x of a set of salient languages, is it true that Mary speaks x?' is settled. Thus, the observed fact that (20) can have two kinds of readings follows from our analysis of *even* when it is assumed that Mary is either less likely to be able to speak French than any of its alternatives, or more likely.

Back to strong NPIs and rhetorical readings. We assume with Krifka (1995) and Guerzoni (2001) that strong NPIs (i) denote a *minimal* value, and (ii) share a presupposition with *even*. However, I will assume that the 'less likely than' part of the presupposition is not taken over from this particle. This is also not needed to explain the crucial observation that we can add *even* to a sentence like (26a) without change of meaning.

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

b. John didn't *even* lift a finger to help Mary.

Due to the fact that *lift a finger* denotes a minimal value and has an *at least* reading, together with the natural assumption that 'help' behaves monotone upwards, i.e., that if 'help(x)' is true and x is a bigger amount of help than y, then also 'help(y)' is true, it follows that from 'John did x to help Mary' we can always entail that 'John lifted a finger to help Mary'. Thus, the 'additional' implication of (26b) that 'lifting a finger' is the most likely amount of help that John gave to Mary follows already from the fact that the NPI denotes a *minimal* value.

Now consider (21) again:

(21) Did John *lift a finger* to help Mary?

Due to our presupposition and appropriateness condition, we predict that the question 'Did John do x to help Mary?' is already settled for a salient set of alternatives, though not for the minimal value denoted by the NPI itself. On the assumption that the minimal value has an *at least* reading, we can now *explain* the implicature on which Fauconnier's (1980) analysis relies, namely that for all alternative values of x it is assumed that John did not do x to help Mary.[27] First, it seems reasonable to assume that out of context, the salient set of alternative quantities selected are all quantities of help except for the minimal value. Now, (21) presupposes that for each member x of this set 'John did x to help Mary' is either known to be true or known to be false. Due to the fact that *lift a finger* denotes a minimal value and that 'help' behaves monotone upwards, it follows that if there were an x such that 'John did x to help Mary' is presupposed to be true for any alternative amount of help x, this presupposition would make question (21) unquestionable, and, thus, inappropriate. This means that for question (21) to be still open and appropriate, it has to be the case that for any amount of help x, John didn't help Mary with this amount,[28] except, perhaps with respect to the minimal quantity. But this is enough to derive the rhetorical meaning: John either *only* did the very minimal to help Mary, or nothing at all. Practically, this means that he didn't do anything substantial at all, which indeed is the rhetorical effect of the question.[29]

[27] This implicature, in turn, is derived in a way very similar as Lahiri (1998) and Guerzoni (2001) derive the negative rhetorical effect. But there are some crucial differences: (i) they assume that the question has either a positive or a negative presupposition, while I only assume that for all alternatives the question is settled; (ii) I crucially assume that the question is open, while they do not.

[28] This is thus the predicted presupposition that is compatible with the assumption that question (21) is still open.

[29] Notice that our analysis works well not only for *minimizer*-NPIs, but also for *even*-type *maximizer*-NPIs like *in a million years*. The rhetorical effect of (i) can be explained in the same way as (21):

Our analysis accounts for the rhetorical effect of the negative polar question (27) that John is not going to help at all as well.

(27) Isn't John going to lift a finger to help?

By a similar reasoning as before, the reason for unquestionability of all salient non-minimal quantities of help cannot be that it is already assumed that John is going to give them, for that would make (27) itself unquestionable. As a result, it must be presupposed (or implicated after presupposition accommodation) that John is not going to give any substantial amount of help, giving rise to the rhetorical reading.

Note that our analysis also accounts naturally for our intuitions concerning the presupposition and meaning of (14).

(14) Does Sue have ANY potatoes?

This, of course, should not really be surprising: our account of the rhetorical effect of questions containing *even*-type NPIs was based on the assumption that *even* extends the domain. Assuming that stressed *any*, 'comes with even', our analysis of (14) comes down to Kadmon & Landman's (1990). But the similarity to their analysis suggests that we also have to take over one of their problems: how to give a *uniform* analysis of strength that accounts for both questions and assertions?

5 Entropy, Relevance and Strength

In the previous section I have argued to account for NPIs in *information-seeking* questions along the lines of Krifka (1990, 1992, 1995), while for *rhetorical* questions we need an analysis like that of Kadmon & Landman (1990). According to Krifka, weak NPIs are permitted in *information-seeking* questions as long as they make the question *more general* than the corresponding question without the NPI. Kadmon & Landman (1990) propose that (stressed) *any* is permitted in a rhetorical question because it turns a settled issue into an *unsettled* one. Both analyses demand that NPIs *weaken* the satisfaction conditions with respect to their alternatives. *Widening* the domain of quantification is perhaps the most obvious, though not the only, way to achieve this. Thus, making a question more general, and turning a settled into an unsettled question are much alike. The crucial difference between NPIs in rhetorical and information-seeking questions – the fact that for rhetorical readings the question must be settled for less minimal values – is due to the fact that only in the former case we associate a presupposition with the NPIs that it shares with *even*. Thus, disregarding the presupposition, we can think of K&L's comparative notion of strength as a special case of Krifka's comparative relation between questions. This leaves us with the following questions: First, why should a *general* question in general be *preferred* to a more *specific* one? Second, how can this notion of generality be seen as a special case of *strength*? In this section I will answer both questions by adopting standard techniques used by statisticians, though not semanticists and/or pragmatists, relating generality of questions and informativity of assertions to notions like entropy, relevance and/or utility.

5.1 The informativity of a question

To determine the informative value of a question, we will follow the lead of Bar-Hillel & Carnap (1953). They discuss the problem of how to determine the *estimated* amount of information conveyed by the outcome of an *experiment* to be made. They equate the value of an experiment with its estimated amount of information, and assume that the possible outcomes denote propositions

(i) Would you, in a million years, do that?

such that the set of outcomes are mutually exclusive and jointly exhaust the whole state space. In other words, they assume that the set of possible outcomes *partitions* the set of relevant states. Adopting Groenendijk & Stokhof's (1984) partition semantics of questions, this suggests that their notion of the value of an experiment, which by itself was based on Shannon's (1948) notion of the *Entropy* of a *source*, can be used to measure the informativity value of a *question* as well. For obvious reasons, I will denote the informative value of question Q by $E(Q)$, which will be defined as follows:

$$E(Q) \quad = \quad \sum_{q \in Q} P(q) \times -log_2 P(q)$$

To explain this measure, consider the question *Who of John, Mary and Sue are sick?* This question gives rise to *three* relevant issues: whether John, whether Mary, and whether Sue are sick or not.[30] The three issues together give rise to $2^3 = 8$ relevantly different states of the world, and assuming that it is considered to be equally likely for all of them to be sick or not, and that the issues are independent of one another, it turns out that all 8 states are equally likely to be true. The measure $-log_2 P(q)$ was called the *informativity value* of the *proposition* q, $\inf(q)$ by Bar-Hillel & Carnap (1953). Thus, we can define the informativity value of question Q also as the estimated or *average* informativity value of the (complete) answers as follows:

$$E(Q) \quad = \quad \sum_{q \in Q} P(q) \times \inf(q)$$

The informativity of any arbitrary proposition A with respect to our 8 different states of the world equals the number of the above 3 binary issues solved by learning A. Thus, in case I learn (just) that John is sick, one of the above three binary issues, i.e. *yes/no*-questions, is solved, and the informativity of the proposition expressed by the sentence *John is sick* $= J$, $\inf(J)$, is 1. Notice that proposition J is compatible with 4 of the 8 possible states of nature, and on our assumptions this means that the probability of J, $P(J)$, is $\frac{1}{2}$. To determine the informational value of a proposition, we looked at the negative logarithm of its probability, where this logarithmic function has a base of 2. Recalling that the logarithm with base 2 of n is simply the power to which 2 must be raised to get n, it indeed is the case that $\inf(J) = 1$, because $-\log_2 P(J) = -\log_2 \frac{1}{2} = 1$, due to the fact that $2^{-1} = \frac{1}{2}$. Learning that both Mary and Sue are sick however, i.e. learning proposition $M \wedge S$, has an informative value of 2, because it would resolve 2 of our binary issues given above. More formally, only in 2 of the 8 cases it holds that both women are sick, and thus we assume that the proposition expressed, $M \wedge S$, has a probability of $\frac{1}{4}$. Because $2^{-2} = \frac{1}{4}$, the amount of information learned by $M \wedge S$, $\inf(M \wedge S)$, is 2.

Recall that any complete answer to our above question Q will reduce our 8 possibilities to 1. Thus, any complete answer, q, will have an 'inf'-value of 3, i.e. it will resolve all three of the relevant binary issues. But if each answer to the question has an informative value of 3, the *average* amount of information conveyed by the answers, and thus the informative value of the question, $E(Q)$, should be 3 as well. And indeed, because each of the complete answers has a probability of $\frac{1}{8}$ to be true, the informative value of the question is according to the above formula equated with $(\frac{1}{8} \times 3) + ... + (\frac{1}{8} \times 3) = 8 \times (\frac{1}{8} \times 3) = 3$. In general it will hold that when we have n mutually exclusive answers to a question, and all the answers are considered to be equally likely true, the informative value of the question can simply be equated with the informative value of each of its answers, which is $-\log_2 \frac{1}{n} = \log_2 n$. The informative value of the question *Will the outcome of the*

[30] If $\mathcal{Q}$ is a set of *whether*-questions about individuals, Higginbotham (1996) showed us how we can turn this set of questions into one partition corresponding with the Groenendijk & Stokhof meaning of a *who*-question: $\{\bigcap\{f(Q) : Q \in \mathcal{Q}\} : f$ is a choice function selecting an element from a set$\}$.

flipping of an unbiased coin be heads?, for instance, will be 1, because the question has 2 answers, which by assumption are equally likely to be true.

What if not all of the n answers are equally likely to be true? In that case some answers have a higher informative value than $\log_2 n$, and others have a lower one. It turns out, however, that the *average* amount of information conveyed by the answers will in that case be *lower* than in case the answers are equally likely to be true. Consider, for instance, the flipping of a *biased coin*, whose chance to come up heads after flipping is $\frac{3}{4}$. Because the 'inf'-value of outcome/answer *Heads* is in that case $-\log_2 \frac{3}{4} = 0.415$, and the 'inf'-value of answer *Tails* is $-\log_2 \frac{1}{4} = 2$, the *average* amount of information of the answers is $(\frac{3}{4} \times 0.415) + (\frac{1}{4} \times 2) = 0.811 < 1$. Thus, although one of the answers has an informative value that is 2 times as high as the informative values of the outcomes/answers in case of an unbiased coin, the average amount of information of the answers turns out to be lower.

This is in general the case: the informative value of question Q defined as above is *maximal* just in case the answers are all equally likely to be true. And this seems to confirm to our intuitions. If you want to be sure to find out after 3 *yes/no*-questions which of the 8 states of our toy-example actually obtains, we should ask the three *yes/no*-questions which have maximal E-value. That is, we should ask for each individual separately whether he or she is sick, which all have an 'inf'-value of 1, and we should not ask *risky* questions that might, but need not, convey more information, like *Are John and Mary the ones who are sick?*

Having defined when a question has its maximal informative value, we now would like to know under which circumstances it reaches its *minimal* value. Intuitively, a question is (at least) valueless in case you already know the answer to the question. And, unsurprisingly, this is what comes out: $E(Q) = 0$ just in case only one answer has a positive probability (and thus has probability 1), and for all other cases the question has a value strictly higher than 0.

5.2 NPIs and entropy

Our aim was to define an ordering relation between questions (partitions) that captures both Krifka's (1990, 1992, 1995) and Kadmon & Landman's (1990) comparative relation between questions. I claim that the ordering relation induced by entropy is the one we were looking for. Take a polar question, $Q = \{q, \neg q\}$, and assume that the question is *biased*: its negative answer, $\neg q$, is taken to be more probable than its positive answer. In the extreme case this is because it is already *settled* that $\neg q$ is true, $P(\neg q) = 1$ and $P(q) = 0$. Notice that in case the question is settled already, its entropy is *minimal*, 0, but also that in case the question is just biased its entropy is *not* as *maximal* as it could be: there is a closely related other question with a higher entropy or informativity value. We have seen that according to Krifka a NPI is used in *information-seeking* questions to turn a biased question into a (more) unbiased one, while K&L propose that due to the use of a NPI like (stressed) *any* a settled question becomes unsettled. Indeed, suppose that we turn Q into Q' by making use of a NPI. This NPI *weakens* the satisfaction conditions for the positive answer, q', and *strengthens* the satisfaction conditions for the negative answer $\neg q'$. This cannot only result in turning settled Q into unsettled Q', but also in changing biased Q into less, or even un-, biased Q'. What is important is that in both cases the entropy of the question increases: $E(Q') > E(Q)$. Thus, the ordering relation between questions induced by our notion of entropy captures both of the comparative notions of K&L and Krifka. This suggests that for polar questions, *strength* should be defined in terms of entropy.

For constituent questions something similar holds. Let us represent such interrogative sentences as $[wh\ x : Sx]?Mx$. We first look at the effect of NPIs in the *predicate* position of such a question. Assuming that the NPI turns question Q into Q' by changing predicate M into M' which has weaker satisfaction conditions. Suppose now that for any individual d in the domain over which wh ranges that is known to have property S is such that the difference between $P(d \in \bar{M})$ and

$P(d \in M)$ is greater or equal than the difference between $P(d \in \bar{M}')$ and $P(d \in M')$, where $\bar{M}$ denotes the complement of M. This condition holds in particular, though not exclusively, in case no S is expected to have property M, though at least some individuals satisfying S might have property M'. Notice that in the latter case K&L would say that NPI *any* strengthens the question. What is important to observe is that the constituent question Q' has a higher entropy than Q if and only if the above condition, of which K&L's situation is again a special case, is satisfied. Thus, also here it is natural to reduce strength to entropy.

What about the effect of NPIs occurring in the *subject* position of a constituent question? The effect of the NPI is now to *widen* the *domain* over which the *wh*-phrase ranges. As we saw already in section 3.1, constituent questions are DE in subject position, meaning that the effect of turning Q into Q' now has as result that Q' *entails* Q: every (total) answer to Q' will also be a (total) answer to Q. If we want to account for NPIs in questions in terms of entropy, the ordering relation induced by entropy should better relate with the ordering relation induced by entailment. And, indeed, this is the case: if Q' entails Q it will also be the case that $E(Q') \geq E(Q)$, whenever the entropies are determined with respect to the same probability function.[31]

In this section I have shown how the comparative relations between questions proposed by K&L and Krifka can be reduced to entropy, suggesting that for questions, strength should be instantiated as entropy. Moreover, I have argued that entropy is also the natural cousin of the notion of strength they used for assertions: for assertions strength was instantiated as informativity, and we have seen that the entropy of a question measures the *average* informativity of its answers. Still, you might wonder, why should entropy be such a natural measure? In fact, why should informativity be so important for the occurrence of NPIs in sentences in the first place?

5.3 Relevance, entailment and entropy

Intuitively, information is of value because it allows us to make better informed decisions. In cooperative language use this means that *giving* information is useful for the same reason. The value of information is studied in Decision Theory. Suppose our agent is faced with a set of actions $\mathcal{A} = \{a_1, a_2, ..., a_n\}$ (think of them as primitives) that she can perform. Her *decision problem* is then the dilemma of which one of those actions she should take. Suppose an agent's decision problem is represented by a triple like $\langle W, \mathcal{A}, \geq \rangle$ where W is the set of worlds that the agent considers possible, representing her *beliefs*; $\mathcal{A}$ the set of actions she considers; and '$\geq$' a preference relation between world-action pairs ($\geq \subseteq W \times \mathcal{A}$) representing her *desires*. Which action should our agent choose? This is clear when there is one *dominating* action: an action that is preferred to all others in all worlds she considers possible. The existence of such a dominating action is rare, however. Still, also in case there is no such an action we can say what our agent should *not* do: she should not perform an action that is (strictly) *dominated* by another action. Let's define $\mathcal{O}^o(S)$ as the set of non-dominated actions after S is learned: $\{a \in \mathcal{A} | \neg \exists a' \in \mathcal{A} : \forall w \in S : \langle w, a' \rangle > \langle w, a \rangle\}$ (where '$>$' is defined as usual in terms of '$\geq$'). Notice that this set may be smaller, but certainly not larger, than the set of actions that might be optimal after you learn the trivial proposition, i.e. $\mathcal{O}^o(\top)$. We say that proposition S gives *relevant* information just in case the set of non-dominated actions after learning S strictly decreases. Similarly, we say that S is *more relevant* than T with respect to decision problem DP, $S >^o_{DP} T$, iff $\mathcal{O}^o(S) \subset \mathcal{O}^o(T)$, i.e., learning S helps more to resolve the decision problem than learning T does.

In general, it obviously holds that if $S \subseteq T$, then also $\mathcal{O}^o(S) \subseteq \mathcal{O}^o(T)$. Thus, new information can never be undesirable in the sense that it increases the uncertainty of the decision (i.e., makes more actions potentially optimal). Although the reverse does not hold, something more general is

[31] Later we will see that under *natural* special cases also the following converse fact holds: Q' entails Q if the entropy of Q' is greater than or equal to the entropy of Q with respect to all probability functions.

the case: if $\mathcal{O}^o(S) \subseteq \mathcal{O}^o(T)$ holds for *every* decision problem, it also is the case that $S \subseteq T$. Thus, we have the following

Fact: $S \subseteq T$ iff $\forall DP : S \geq^o_{DP} T$.[32]

I would like to suggest that this fact explains why entailment plays such an important role for the licensing of NPIs, giving rise to DEness as a *conventional* (default) licensing context. A NPI is (normally) licensed in an assertion only in case that it can be *assured* that the expression with the NPI is more relevant (in cooperative contexts) than any of its alternatives. Thus, for **assertions** the licensing condition can be motivated in terms of utility, or relevance.

Can we now also define a comparative ordering relation between *questions*? The following proposal is straightforward: $Q \geq^o Q'$ iff $\forall q \in Q : \exists q' \in Q' : q \geq^o q'$. From the fact proved above and the definition of $Q \sqsubseteq Q'$, or $Q \models Q'$ (for every element of Q there is an element of Q' such that the former entails the latter), we immediately have the following

Fact: $Q \sqsubseteq Q'$ iff $\forall DP : Q \geq^o_{DP} Q'$.

Thus, one question entails another just in case it is *always* more (or equally) useful.

The relevance-based ordering relations defined above were induced by a *qualitatively* given decision problem. The beliefs were represented simply by a set of possible worlds and the desires by an ordinal preference relation. What resulted was a *partial* ordering. However, we argued that at least for questions we need the notion of *entropy*, a *quantitative* measure which gives rise to a *total* ordering of questions. And, indeed, a more quantitative measure is required if we want to compare questions like *Who of John and Mary came?* with *Did Sue come?*. Can we also give a decision theoretic motivation for why such a quantitative measure should be relevant for rational language users?

It turns out that we can, if we consider decision problems where both the beliefs and preferences are given a *quantitative*, or *cardinal*, representation. In these cases a decision problem is modeled as a quadruple like $\langle W, P, \mathcal{A}, U\rangle$, where W is again a set of worlds; P is a probability function over W representing our agent's beliefs; $\mathcal{A}$ the set of actions the agent considers; and U a cardinal utility function which maps world-action pairs to real numbers, representing (together with P) her desires. The *expected utility* of action a, $EU_P(a)$, with respect to probability function P is

$$EU_P(a) \quad = \quad \sum_w P(w) \times U(w, a).$$

By assuming a cardinal decision problem, we can make definite predictions (or recommendations) for what our agent should choose. The *decision criterion* with respect to such decision problems is to choose that action which has the highest expected utility:

$$\text{choose } a_i \text{ such that } EU_P(a_i) \quad = \quad \max_{a \in \mathcal{A}} EU_P(a)$$

We might say that $max_{a \in \mathcal{A}} EU_P(a)$ measures the *value* of decision problem $\langle W, P, \mathcal{A}, U\rangle$. After learning proposition S, the new decision problem is $\langle W, P_S, \mathcal{A}, U\rangle$ (where for all w, $P_S(w) = P(w/S)$). Now we can determine the utility value of proposition S as follows:

[32] **Proof**: We know already that if $S \subseteq T$ then for all decision problems DP: $S \geq^0_{DP} T$. To prove the other way round, suppose that $\forall DP : S \geq^o_{DP} T$, but $S \not\subseteq T$. Then $\exists w \in S : w \notin T$. But then we can think of a relation $>$ and an action a such that $\forall a' \neq a : \langle w, a\rangle > \langle w, a'\rangle$ and $\forall w' \in T : \langle w', a'\rangle > \langle w', a\rangle$. Thus, $a \in \mathcal{O}^o_{DP}(S)$, but $a \notin \mathcal{O}^o_{DP}(T)$, which is in contradiction with what we assumed.

$$UV(S) \quad = \quad \max_{a \in \mathcal{A}} EU_{P_S}(a) - \max_{a \in \mathcal{A}} EU_P(a)$$

In terms of the utility value of propositions, we can now determine the utility values of *questions*. We say that the *expected* utility value of question Q, $EUV(Q)$, is the *average* utility value of its possible answers:

$$EUV(Q) \quad = \quad \sum_{q \in Q} P(q) \times UV(q)$$

As a special case of Blackwell's (1953) theorem we can prove the following fact:

Fact: $\quad Q \sqsubseteq Q' \quad$ iff $\quad \forall DP : EUV_{DP}(Q) \geq EUV_{DP}(Q')$

Thus, just as for qualitative decision problems, here we would also be able to motivate why entailment matters for the licensing of NPIs. However, we argued that the licensing of questions is much less restricted than that of assertions, and much more dependent on the *beliefs* of the questioner. This suggests that for questions we should not quantify over all decision problems, but stick to a particular one. Moreover, it suggests that somehow we have to play down the role of utilities. In the previous section we have made crucial use of Shannon's (1948) information theoretic notion of *entropy* to account for the dependence of NPI-licensing on the beliefs of the agent. In order to give a *uniform*-like analysis of licensing conditions for NPIs, we have to relate the notion of 'entropy' to that of the notion of 'expected utility value' discussed above.

Recall that with respect to a probability function P we can determine the entropy of a question Q. Suppose that the agent's decision problem is now to find out which element of Q is true. In such a situation where only truth is at stake, the entropy of a questions models the difficulty of the decision: the decision which element of Q is true is most difficult when its elements are considered equally likely. New information might *reduce* this *entropy*. If $E^P_{q'}(Q)$ denotes the entropy of Q with respect to probability function P after q' is learned, we can equate this reduction of entropy, $E^P(Q) - E^P_{q'}(Q)$, with the *relevance*, or *informativity value* of q' with respect to decision problem Q and P, $IV^P_Q(q')$. The *expected informativity value* of question Q', $EIV^P_Q(Q')$, can be defined as the *average* relevance of its possible answers: $EIV^P_Q(Q') = \sum_{q' \in Q'} P(q') \times IV^P_Q(q')$. Now it can be shown (van Rooy, to appear) that if the decision problem is which of the answers to Q is true, the relevance of question Q', $EUV(Q')$ reduces to $EIV^P_Q(Q')$. Moreover, if Q is a more fine-grained question partition than Q', $EIV^P_Q(Q')$ itself comes down to the entropy of Q': $E(Q')$. On the assumption that the questioner wants to ask the most useful question, this means that in the special cases under discussion, she should ask the question with the highest entropy. Previously we argued that a NPI is typically used in a question to increase its entropy. In this section we have seen that this is a rational thing to do: the expected utility (or relevance) of a question is higher – in the natural special cases mentioned – exactly in case its entropy is higher.

5.4 Strength: informativity or relevance?

Although in the previous section I gave a relevance-based *motivation* for the licensing conditions of assertions and questions, until now I have assumed that for assertions strength should always be measured by informativity: an assertion is stronger just in case it denotes a more informative proposition, where informativity is measured in terms of entailment. And, indeed, the fact that minimizer-NPIs like *a dime* are licensed in DE contexts can be explained naturally in terms of this notion of strength. In a recent discussion, Israel (2001) calls the attention to NPIs like *all that* and *long* that *don't* denote minimal quantities. He notes that their use under a negation makes the resulting sentence *less* rather than *more* informative.

(28) a. He is not *all that* clever.

b. This won't take *long*.

It should be clear that the existence of such examples is a threat to any approach that tries to explain the acceptability of NPIs under negation in terms of a notion of strength. Indeed, if strength should always be measured in terms of informativity, (28a) and (28b) are clear counterexamples to the proposed analysis. On the other hand, Israel suggests a Gricean explanation for why NPIs might be used to *weaken* a claim: it might work in the speaker's disadvantage to *commit* herself to a stronger proposition (in a situation where complete cooperation fails). Still, the question arises whether we cannot account for this intuition in terms of strength once we assume that strength should be measured in terms of relevance. I will suggest that this question can be answered positively due to the fact that the relevance of a proposition does, in general, not behave monotone increasing with respect to informativity.

Until now we have assumed that the relevance of an utterance should always be measured in terms of the way it helps to resolve an agent's decision problem. Notice that the *goal* of resolving one's decision problem corresponds with a proposition: being in a world where you know which action you should perform. But, of course, resolving one's decision problem is only one goal one might have. In general, we might just say that an agent wants to reach a goal, and that the relevance of a proposition is measured in terms of the way in which updating an information state (representing, for instance, the common ground of the participants of the conversation) with this proposition comes closer to this goal. In fact, Merin (1999) makes use of such a relevance-function. He measures the utility of a proposition with respect to probability function P and goal-proposition g in terms of (something like) the statistical notion of relevance: $r_g(S) = P(g/S) - P(g)$. Thus, S has a greater relevance than T if and only if S makes 'goal'-proposition g more likely than T does. What is remarkable about this notion of relevance is that it can happen that if $S \models T$ and $g \not\models S$, it might be the case that $r_g(S) < r_g(T)$: a more informative proposition can be less relevant. Although this property might be surprising, I think it is a desirable one, for in terms of it we can give a relevance-based explanation of Israel's (2001) assumption that, in special cases, committing oneself might be disadvantageous.

Until now we have assumed that S, for instance, just denotes the proposition expressed by 'S'. But now suppose that goal-proposition g denotes the set of worlds where certain facts hold *and* where the speaker doesn't make many commitments. Assume also that if a speaker says 'S', she is committed to S, and that 'commitment' acts like a necessity operator: the set of worlds in which speaker s is committed to S, $[[com(s, S)]]$ is equated with $\{w \in W : \ commit(s, w) \subseteq S\}$. Now it follows that if our speaker s asserts 'S' instead of 'T' and S entails T, $S \subseteq T$, it also holds that $[[com(s, S)]] \subseteq [[com(s, T)]]$. Now we can explain why in case S entails T, it still might be more useful to assert T. It might be that $r_g([[com(s, T)]]) > r_g([[com(s, S)]])$, because asserting '$S$' commits one to more than asserting 'T': $[[com(s, T)]] \supseteq [[com(s, S)]]$. I conclude that while sentences like (28a) and (28b) with non-minimizer NPIs are clear counterexamples to the 'strength-as-informativity' approach, they are not counterexamples if one assumes that strength should be measured in terms of relevance. The fact stated in the previous section that in completely cooperative situations relevance behaves monotone increasing w.r.t. informativity strongly suggests, however, that there can be such a difference only in case the preferences of the participants of the conversation are not in complete alignment. And this makes sense: only in those cases it can be disadvantageous to make strong commitments.

6 Conclusion and outlook

In this paper I have shown how we can extend Kadmon & Landman's and Krifka's explanatory analysis of NPI licensing from assertions to questions. K&L and Krifka make crucial use of domain extension and a notion of strength. In this paper it is shown that both of these are crucial for giving an explanatory analysis of NPI licensing in questions as well. However, strength should now be thought of in terms of entropy: i.e. *average* informativity. The rhetorical readings resulting from the use of so-called *even*-type NPIs are explained in terms of the meaning and presupposition of these NPIs; they involve domain widening. In the final main section of this paper I have given a motivation for why entailment and entropy are natural notions of strength for assertions and questions, respectively. Moreover, I have shown what they have in common: in both cases domain widening should have the result that the speaker increases the utility of the utterance used. Finally, I have suggested that a more general relevance-based analysis is to be preferred above a purely informational-based one: although the use of some NPIs seems to make the resulting assertion less, rather than more, informative than the corresponding assertion without these NPIs, the use of these NPIs, arguably, still makes the resulting assertions more relevant.

In this paper I have limited myself to the use of NPIs in assertions and questions, thereby ignoring other speech acts like concessions and demands. For these speech acts a notion of strength also seems crucial. However, strength doesn't seem to be reducible to informativity here. In Lakoff's (1970) threat *If you eat any Loxo, I'll batter you*, for example, the domain extension effect of *any* makes, intuitively, the threat stronger, but reducing this to informativity seems, at best, unnatural. As suggested very briefly by Merin (1994), it seems natural to make use of relevance here. How exactly to instantiate strength in this case, however, must be a concern for the future.

Author's address

Robert van Rooy
ILLC/University of Amsterdam
Nieuwe Doelenstraat 15
1012 CP Amsterdam
email: vanrooy@hum.uva.nl

Acknowledgements

My interest for polarity items was triggered during my stay at M.I.T. in spring of 2000. The basic idea behind the paper goes back to early 2001. A paper by, and especially discussion with, Elena Guerzoni (end 2001), however, helped me to realize that the analysis of rhetorical questions I had in mind wouldn't quite suffice. Though it didn't make me exactly happy at the time, I thank her for criticizing me after all. The main ideas behind this paper were presented at an internal colloquium at the university of Amsterdam, and at the Utrecht-Amsterdam workshop on negative polarity. Thanks to Maria Aloni, Raffaella Bernardi, Alastair Butler, Paul Dekker, Manfred Krifka, Marie Nilsenova, Katrin Schulz, Martin Stokhof, and some anonymous reviewers for the Journal of Semantics for discussion and to Darrin Hindsill for checking grammar and spelling. The research of this work is supported by a fellowship from the Royal Netherlands Academy of Arts and Sciences (KNAW), which is gratefully acknowledged.

References

[1] Aloni, Maria & Robert van Rooy (2002), 'The dynamics of questions and focus', In Barker et al. (eds.), *Proceedings of Semantics and Linguistic Theory (SALT) 12*, CLC Publications, San Diego.

[2] Baker, Carl. L. (1970), 'Double Negation', *Linguistic Inquiry*, **1**: 169-187.

[3] Bar-Hillel, Yehoshua & Rudolph Carnap (1953), 'Semantic Information', *Proceedings of the Symposium on Applications of Communication Theory*, Butterworth Scientific Publications, London.

[4] Blackwell, David. (1953), 'Equivalent comparisons of experiments', *Annals of Mathematical Statistics*, **24**: 265-72.

[5] Bolinger, Dwight. (1972), *Degree Words*, Mouton, The Hague.

[6] Borkin, Ann (1971), 'Polarity items in questions', *Chicago Linguistic Society*, **7**: 53-62.

[7] Chierchia, Gennaro (ms), 'Scalar implicatures, polarity phenomena, and the syntax/pragmatics interface', University of Milan.

[8] Ducrot, Oswald (1973), *La peuvre et le dire*, Mame, Paris.

[9] Fauconnier, Giles (1975a), 'Pragmatic scales and logical structure', *Linguistic Inquiry*, **6**: 353-375.

[10] Fauconnier, Giles (1975b), 'Polarity and the scale principle', *Chicago Linguistic Society*, **11**: 188-99.

[11] Fauconnier, Giles (1980), 'Pragmatic entailment and questions', In J.R. Searle et al. (ed.), *Speech act theory and pragmatics*, Reidel, Dordrecht.

[12] Giannakidou, Anastasia (1997), *The Landscape of Polarity Items*, Ph.D. thesis, University of Groningen.

[13] Groenendijk, Jeroen & Martin Stokhof (1984), *Studies in the Semantics of Questions and the Pragmatics of Answers*, Ph.D. thesis, University of Amsterdam.

[14] Guerzoni, Elena. (2001), '*Even*-NPIs in questions' In: R. van Rooy & M. Stokhof, *Proceedings of the 13th Amsterdam Colloquium*, ILLC, Amsterdam.

[15] Hamblin, C. L. (1973), 'Questions in Montague English', *Foundations of Language*, **10**: 41-53.

[16] Han, Chung-Hye, (2001), 'Deriving the interpretation of rhetorical questions', In: *Proceedings of WCCFL 16*.

[17] Han, Chung-Hye & Laura Siegel (1996), 'Syntactic and semantic conditions on NPI licensing in questions', In *Proceedings of WCCFL 15*.

[18] Heim, Irene, (1984), 'A note on negative polarity and downward entaillingness', In: *Proceedings of NELS 14, GLSA*, University of Massachusetts, Amherst, pp. 98-107.

[19] Higginbotham, James, (1993), 'Interrogatives', In: K. Hale & S. Keyser (ed.), *The view from building 20. Essays in linguistics in honor of Sylvain Bromberger*, M.I.T. Press, Cambridge.

[20] Higginbotham, James (1996), 'The semantics of questions', In: S. Lappin (ed.), *The Handbook of Contemporary Semantic Theory*, Basil Blackwell, Oxford.

[21] Hoeksema, Jacob (1986), 'Monotonicity phenomena in natural language', *Linguistic Analysis*, **16**: 25-40.

[22] Horn, Laurence, R. (1969), 'A presuppositional approach to *only* and *even*', *Chicago Linguistic Society*, **5**: 98-107.

[23] Horn, Laurence, R. (1971), 'Negative transportation: Unsafe at any speed?', *Chicago Linguistic Society*, **7**: 120-133.

[24] Horn, Laurence, R. (1972), *On the Semantic Properties of Logical Operators in English*, Ph.D. thesis, UCLA.

[25] Horn, Laurence, R. (1989), *A Natural History of Negation*, The University of Chicago Press, Chicago and London.

[26] Israel, Michael (2001), 'Minimizers, maximizers and the rhetoric of scalar reasoning', *Journal of Semantics*, **18**: 297-331.

[27] Jacobs, Joachim (1991), 'Negation', In: A. von Stechow & D. Wunderlich (eds.), *Handbuch der Semantik*, Athenäum, Kronberg.

[28] Kadmon, Nirit & Fred Landman (1990), 'Polarity sensitive any and free choice any', In: M. Stokhof & L. Torenvliet (eds.), *Proceedings of the Seventh Amsterdam Colloquium*, pp. 227-251, ITLI, Amsterdam.

[29] Kadmon, Nirit & Fred Landman (1993), 'Any', *Linguistics and Philosophy*, **16**: 353-422.

[30] Karttunen, Lauri & Stanley Peters (1979), 'Conventional implicature', In: C.-K. Oh and D. Dinneen (eds.), *Syntax and Semantics, Presupposition*, Vol. 11, Academic Press, New York, pp. 1-56.

[31] Kay, Paul (1990), 'Even', *Linguistics and Philosophy*, **13**: 59-111.

[32] Klima, Edward (1964), 'Negation in English', In: J.A. Fodor and J. Katz (eds.), *The structure of language*, Englewood Cliffs: Prentice-Hall.

[33] Krifka, Manfred (1990), 'Polarity phenomena and alternative semantics', In: M. Stokhof & L. Torenvliet (eds.), *Proceedings of the Seventh Amsterdam Colloquium*, pp. 277-301, ITLI, Amsterdam.

[34] Krifka, Manfred (1992), 'Some remarks on polarity items', In: D. Zaefferer (ed.), *Semantic Universals and Universal Semantics*, Floris Publications, Berlin.

[35] Krifka, Manfred (1995), 'The semantics and pragmatics of polarity items', *Linguistic Analysis*, **25**: 209-258.

[36] Ladusaw, William, A. (1979), *Negative Polarity as Inherent Scope*, Ph.D. thesis, University of Texas, Austin.

[37] Ladusaw, William, A. (1996), 'Negation and polarity items', In: S. Lappin (ed.), *The Handbook of Contemporary Semantic Theory*, Basil Blackwell, Oxford.

[38] Lahiri, Utpal (1998), 'Focus and Negative Polarity in Hindy', *Natural Language Semantics*, **6**: 57-125.

[39] Lakoff, Robin (1970), 'Some reasons why there can't be any some-any rule', *Language*, **45**: 608-615.

[40] Linebarger, Marcia. (1980), *The Grammar of Negative Polarity*, Ph.D. thesis, M.I.T., Cambridge.

[41] Linebarger, Marcia (1987), 'Negative Polarity and Grammatical Representation', *Linguistics and Philosophy*, **10**: 325-387.

[42] Merin, Arthur (1994), 'Algebra of elementary social acts', *Foundations of Speech Act Theory*, Routledge, London.

[43] Merin, Arthur (1999), 'Information, relevance, and social decisionmaking', In: L. Moss, J. Ginzburg, M. de Rijke (eds.), *Logic, Language, and Computation. Vol. 2*, CSLI, Stanford.

[44] Pope, Emile (1972), *Questions and Answers in English*, Ph.D. thesis, MIT, Cambridge, Massachusetts.

[45] Progovac, Liljiane (1993), 'Negative polarity: entailment and binding', *Linguistics and Philosophy*, **16**: 149-180.

[46] Reinhard, Tanya (1976), 'Polarity reversal: logic or pragmatics?', *Linguistic Inquiry*, **7**: 697-705.

[47] Roberts, Craige (1996), 'Information structure in discourse: towards an integrated formal theory of pragmatics', In: J. Hak Yoon and A. Kathol (eds.), *Ohio State University Working Papers in Linguistics, volume 49*.

[48] Rooth, Mats (1985), *Association with Focus*, Ph.D. thesis, University of Amherst, Massachusetts.

[49] Rooy, Robert van (in press), 'Signaling games select Horn strategies', *Linguistics and Philosophy*.

[50] Rooy, Robert van (to appear), 'Utility, informativity, and protocols', *Journal of Philosophical Logic*. (presented at LOFT 5: Logic and the Foundations of the Theory of Games and Decisions, 2002)

[51] Schmerling, Susan (1971), 'A note on negative polarity', In: *Papers in Linguistics*, 4.1, Linguistic Research Inc, Champaign.

[52] Shannon, Claude (1948), 'The Mathematical Theory of Communication', *Bell System Technical Journal*, **27**: 379-423 and 623-656.

[53] Wilkinson, Karina (1996), 'The scope of *even*', *Natural Language Semantics*, **4**: 193-215.

[54] Wouden, Ton van der, (1994), *Negative Contexts*, Ph.D. thesis, University of Groningen.

[55] Zwarts, Frans (1981), 'Negatief polaire uitdrukkingen', *Glot*, **4**: 35-132.