To appear in Riemer, Nick (ed.), *Routledge Handbook of Semantics*, Routledge, London.

NEGATION AND POLARITY

Doris Penka, University of Konstanz

1. Introduction

Negation is a very basic and central concept in human cognition and language and has been investigated by philosophers and linguists going at least as far back as Aristotle. It is thus far beyond the scope of the present chapter to provide a summary of research on the semantics of negation (see Horn 2001 for a comprehensive overview also on the history on the study of negation). Closely related to negation is the notion of polarity, i.e. whether a statement is negative or affirmative. Expressions that are sensitive to the polarity have been a very prominent topic in linguistic research within the framework of generative grammar for the past fifty years. In this respect, too, I will not be able to do justice to the vast literature on the topic. I will instead focus on recent advances in the analysis of negation and polarity within the framework of formal semantics, hoping to provide the reader with a useful and concise summary of the state of the art.

The topics addressed in this chapter concern different types of negation (sentential, constituent, lexical and meta-linguistic negation) as well as the interaction of negation with other semantic operators (so-called neg-raising and negative concord). In the area of negative and positive polarity items, I summarize different proposals for a semantic characterization of the contexts in which they are licensed, discuss varieties of negative polarity items, and address possible sources of polarity sensitivity.

2. Negation

In logic, negation is a one-place operator that reverses the truth-value of a proposition. Negation applied to sentence that is false results in a true statement and vice versa. Thus, sentence (1b) is true in exactly the situations in which (1a) is false.

(1) a. It is raining.
b. It is not raining.

While from a logical perspective negation as a truth functional operator is quite a simple notion, the way negation is used and expressed in natural languages paints a highly complex picture that has intrigued linguists for a long time. In the following, I discuss the different

ways in which negation occurs in natural languages and how it enters into the semantic composition.

2.1 Types of negation

2.1.1 Sentential negation and constituent negation

Linguists differentiate between (at least) three kinds of negation, depending on the level of the clause formation where it enters into the composition: Sentential negation applies to full clauses or complete propositions, constituent negation to a particular part of the clause, and lexical negation at the word level.

(2) a. It is not raining. — sentential negation
b. It rained not long ago. — constituent negation
c. unhappy, impossible, non-human — lexical negation

When the negation operator takes scope above the entire clause, we are dealing with a clear case of sentential negation. In this case it is possible to use the paraphrase "it is not the case that …" (*It is not raining* for instance can be paraphrased as *It is not the case that it is raining*.) In contrast, a negation that does not refer to the entire clause but only to a particular part of it as in (2b) is a case of constituent negation. Lexical negation applies to a word to yield a meaning that is its opposite.

In practice, this tripartite classification is not always easy to apply and there are cases that are not as clear-cut as one would wish. A number of tests to distinguish between sentential and constituent negation were introduced by Klima (1964). They are illustrated in (3) and (4) and classify as sentential negation the negation occurring in sentences that can combine with positive tag questions, *neither* tags and the appositive tag *not even*, and as constituent negation otherwise.

(3) Sentential negation:

John didn't find a job, / did he / *didn't he?
〈 and neither did Mary / *and so did Mary.
\ not even a part time one / *even a part time one.

(4) Constituent negation:

/ didn't he / *did he?

John found a job not far away, 〈 and so did Mary / *and neither does Mary.

\ even a well-paid one/ *not even a well-paid one.

There are, however, several problems with Klima's tests. First, they are tailored to English and some of them are not applicable to other languages at all. Second, as pointed out by Payne (1985), what these tests really seem to be sensitive to is whether negation is the operator taking widest scope. Finally, it has been questioned whether "constituent negation" is a useful notion at all (see Jacobs 1982; Dahl 1993 a.o). Note that instances of so-called constituent negation can usually be paraphrased by a relative clause involving sentential negation, e.g. (4) as (5).

(5) John found a job at a place that is not located far away.

This suggests that what is at the heart of the distinction between sentential and constituent negation is the scope relation between the negation operator and the main predicate. In the case of sentential negation in (3), the main predicate *find* is interpreted in the scope of negation and it is asserted that there was no event of John finding a job (in the time period under consideration). Sentence (4) with constituent negation on the other hand asserts that there was an event of John finding a job, and the negation operates on an implicit location predicate. Following Acquaviva (1997), sentential negation can be defined as a negation operator having the main predicate in its scope. Other cases involving a negative particle or adverb can be subsumed under the term of constituent negation.

2.1.2 Lexical negation and antonymy

Certain negative affixes like English *un-* and *in-* contribute negation at the word level. In contrast to sentential negation, lexical negation does not necessarily result in a contradictory opposite but in many cases merely in a contrary opposite (see Horn 2001). Contrary opposition is defined by the logical Law of Contradiction, according to which the two opposites cannot be simultaneously true. Contradictory opposition is additionally subject to the Law of the Excluded Middle, which holds that one of the opposed elements must be true. Two statements that are in contradictory opposition thus cannot be false at the same time, either. Sentential negation yields a contradictory opposite, since e.g. the sentences *Mary is happy* and *Mary is not happy* can neither be simultaneously true nor be simultaneously false in the same situation. Prefixing *un-* on the other hand yields a contrary opposite: the sentences *Mary is happy* and *Mary is unhappy* cannot be simultaneously true, but they can be

simultaneously false as witnessed by the fact that *Mary is neither happy nor unhappy* makes a felicitous assertion. This can be explained by the fact that *un-* in this example prefixes to the gradable adjective *happy*, which is associated with a scale. This scale can be partitioned into three segments as shown in (6): the lower part on which the unhappy individuals are located, the upper part where the happy individuals are located, and in between a neutral interval that contains the individuals that are neither happy nor unhappy.

(6) ----------|----------|----------→

unhappy happy

While the sentence *Mary is unhappy* expresses that Mary is located on the lower, "unhappy" part of the scale, *Mary is not happy* is true if she is located in the complement of the "happy" part, i.e. either the neutral or the "unhappy" interval.

It has also been proposed that in general, the marked term of antonymous pairs of gradable adjectives like *short* (as opposed to *tall*) should be analysed in terms of negation. An open question is whether the decomposition into negation and the unmarked adjective should take place in the syntax or the lexicon (see Heim 2008).

2.1.3 Metalinguistic negation

While the types of negation considered so far operate on the truth-conditional content, albeit applying at different positions both at the word and clausal level, it has been argued that negation can also be used at a metalinguistic level (see in particular Horn 1985 and Horn 2001). In this metalinguistic use, negation is not about the truth or falsity of a proposition, but rather about the assertability of an utterance. Rather than denying the truth of the positive counterpart, metalinguistic negation is used to object to its assertability. An example is the following, which does not entail that the object under discussion is not a car. As the continuation makes clear, it conveys that calling it simply a car is inappropriate.

(7) This is not a car. This is a Rolls-Royce.

Another case arguably involving metalinguistic negation is (8), an example which has figured prominently in the philosophical and linguistic literature on presuppositions. Here the second sentence makes prominent a reading of the first sentence where the existence of the king of France is not presupposed.

(8) The king of France is not bald. There is no king of France.

While negation usually does not affect presuppositions, the negation in this example operates on the presupposition triggered by the definite article, namely that there is a king of France. As the continuation makes clear, the first sentence does not deny the truth of the propositional content that the king of France is bald, but rather rejects the assumption that there is a king of France. It would typically be used to reject the previous utterance *The king of France is bald* on grounds of its presupposition.

Metalinguistic negation can be used to object to any aspect of a previous utterance, including its presuppositions (as in (8)), its implicatures (as in (9a)), its pronunciation (as in (9b)), or its style or register (as in (9c)). Cases of metalinguistic negation typically involve an otherwise literal repetition of the utterance objected to, where the word or expression responsible for the felt inappropriateness bears stress. (This is why metalinguistic negation is sometimes also called "echoic").

(9) a. John didn't eat SOME of the cake. He ate all of it.
b. This is not a para`DOX. It is a `paradox.
c. Sue did not go to the LOO. She went to the toilet.

Because metalinguistic negation does not operate on the same level as the clause in which it occurs, it does not interact in the same way as sentential negation with other items in the clause. In particular, metalinguistic negation does not license negative polarity items or anti-license positive polarity items (see below). The latter is exemplified in sentence (9a), which involves *some*, which is generally regarded as a positive polarity item and replaced by *any* under negation.

2.2. Interaction of negation and other elements

2.2.1 Negative quantifiers and Negative Concord

Language can express negation not only by a negation particle or adverb, but also by quantifiers like *nobody* or *nothing.* These also contribute sentential negation, according to the definition introduced above, as they render the main predicate in the scope of negation. (10a), where negation is expressed by a negative quantifier, for instance, is semantically equivalent to (10b) with a negative adverb.

(10) a. John has no dog.
b. John doesn't have a dog.

Expressions like *no dog, nobody* or *nothing* are generally assumed to denote negated existential quantifiers. While this analysis seems appropriate for languages like English, it is problematic for many other languages, where negative quantifiers co-occur with negative adverbs or other negative quantifiers without yielding a reading with double negation. This is illustrated in the following examples from Polish and Italian.

(11) a. Nikt nie przyszedł. (Polish)
nobody not came
'Nobody came.' (not: 'Nobody didn't come.' ='Everybody came.')
b. Nessuno ha visto nessuno. (Italian)
nobody has seen nobody
'Nobody saw anyone.' (not: 'Nobody saw nobody.' = 'Everybody saw somebody.')

This phenomenon, where multiple negative constituents in the same clause only contribute one instance of negation to the semantic meaning, is known as negative concord. It is in fact found in the majority of the world's languages (see Haspelmath 2005). Negative concord poses a challenge to the assumption that expressions like *nessuno*, also dubbed n-words, denote negated existential quantifiers. If the lexical meaning of these expressions is inherently negative, then why do they not always contribute negation to the interpretation? But assuming that they are semantically non-negative is also problematic, as in certain cases they do contribute negation to the semantics. This double-faced nature of n-words is evident in the Italian example (11b), where the first instance of *nessuno* seems to contribute negation, but the second instance does not. Even in languages like Polish, where n-words are generally accompanied by a clause-mate negative particle, there are context where n-words by themselves contribute negation, in particular when they are used in isolation as answer to a wh-question, as in (12).

(12) Kto przyszedł? – Nikt. (Polish)
Who came? Nobody. (='Nobody came.')

In fact, the ability of n-words to be interpreted as negative quantifiers when they are used as fragment answers can be used as diagnostics to differentiate between n-words and so called negative polarity items, which exhibit a strong affinity to negation without being semantically negative (see Haspelmath 1997 for the test). While a detailed discussion of negative polarity items is deferred to section 3 below, one crucial difference should be mentioned here: in contrast to n-words, negative polarity items always have to co-occur

with a negative expression and can never by themselves contribute negation to the interpretation.

Basically, three types of approaches to negative concord have been proposed in the literature. The first takes the ambivalent behaviour of n-words at face value and assumes that they are lexically ambiguous between inherently negative quantifiers and non-negative indefinites. The challenge for such approaches (Herburger 2001) lies in explaining why the distribution of the alleged two lexical items is governed by structural factors (e.g. the first occurrence of *nessuno* in (11b) has to be the negative variant, and the second *nessuno* the non-negative one). The second type of approaches maintains that expressions like *nessuno* are semantically negative quantifiers, and extra assumptions are employed to explain that not every negation is factored into the meaning of the sentence. Haegeman and Zanuttini (1996) propose a rule of negative absorption, according to which multiple negation operators are turned into a single one. De Swart and Sag (2002) formalise absorption of negative quantifiers as resumption in a polyadic quantifier framework. The third line of approaches, finally, starts from the opposite assumption and argues that n-words are semantically non-negative. In order to explain why n-words do in certain configuration contribute negation, these analyses assume that the semantic negation can be realized covertly. Analyses in this spirit can again be divided into different camps. Laka (1990) and Giannakidou (1998, 2000) propose that n-words are negative polarity items. A problem with subsuming n-words under negative polarity items is the fact that there are certain crucial differences between n-words and NPIs, in particular the above-mentioned ability of n-words to serve as negative fragment answers. Ladusaw (1992) argues that n-words differ from ordinary negative polarity items by their ability of self-licensing, which means that the presence of an n-word is sufficient to trigger a covert negation operator in the clausal structure. This view is fleshed out by Zeijlstra (2004), who analyses negative concord as syntactic agreement and proposes that n-words are (possibly redundant) markers of sentential negation.

There is evidence that even in languages like English, which do not allow negative concord, expressions like *nobody* do not denote negated existential quantifiers. This comes from the fact that the negation they contribute does not always take scope from the same position as the existential quantifier. This is illustrated by the following examples from German and English. As the paraphrases make clear, these sentences give rise to a reading (called split scope reading, see Jacobs 1980; Geurts 1996; de Swart 2000) where negation takes scope over the modal predicate, while the indefinite meaning component is interpreted with narrow scope (resulting in a *de dicto* reading).

(13) a. Die Medizin muss kein Arzt verabreichen. (German)
the medicine must no doctor administer
'It is not necessary that a doctor administers the medicine.'
b. There can be no doubt.
'It is not possible that there is any doubt.'

Considering such readings with split scope of negative quantifiers, Penka (2011) proposes to extend Zeijlstra's (2004) analysis in terms of syntactic agreement also to languages that do not exhibit negative concord. The different co-occurrence patterns of negative quantifiers and negative adverbs observed in different languages are accounted for by two parameters: (i) whether the negation operator associated with negatively marked indefinites has to be covert or whether it may be realized in the form of a negative adverb or particle; (ii) whether one semantic negation can simultaneously license several negative indefinites or whether there has to be a one-to-one relation between markers and negation operators.

2.2.2 Neg-raising

When negation is combined with certain clause embedding verbs like *believe*, a reading results where negation refers to the embedded clause. Consider (14a), which is usually interpreted as equivalent to (14b). This is stronger than the literal reading *It is not the case that according to what John believes, Mary is sick*, which leaves open the possibility that John has no opinion about Mary's state of health. Other similar verbs like *know* do not behave in this way and (15a) is not equivalent to (15b).

(14) a. John doesn't believe that Mary is sick.
b. John believes that Mary isn't sick.

(15) a. John doesn't know that Mary is sick.
b. John knows that Mary isn't sick.

This phenomenon, where the negation appears in the matrix clause while it seems to be interpreted in the embedded clause, is called neg-raising. Other predicates that allow, and in fact, prefer a reading involving neg-raising include *think, want,* and *seem* (see Horn 1978 for a more comprehensive list).

(16) a. John doesn't think that it will rain today. → John thinks that it will not rain today.

b. John doesn't want Mary to leave. → John wants Mary not to leave.

c. It doesn't seem that it will rain today. → It seems that it won't rain today.

Early analyses (starting with Fillmore 1963) assumed that neg-raising is due to syntactic movement of the negation operator. (This is also the origin of the term neg-raising. It was coined in the days of early transformational grammar, when "deep structure" was assumed to be the input for semantic interpretation. The transformational neg-raising rule involved raising the negation to the matrix clause from an embedded position in the "deep structure". For a critical review of syntactic analyses see Horn 1978.) Semantic and pragmatic accounts in contrast hold that negation is interpreted in its surface position, and that the stronger reading comes about via certain semantic or pragmatic principles. The basic idea, going back to Bartsch (1973), is that neg-raising is due to the Law of the Excluded Middle. That is, it is assumed that a person either believes *p* or that she believes *not-p*. Having no opinion and considering both *p* and *not-p* as possible is excluded. From this assumption, the neg-raising interpretation follows immediately from the literal meaning: "It is not the case that *x* believes *p*" together with "*x* believes *p* or *x* believes *not-p*" entails "*x* believes *not-p*". There are different proposals regarding the source of the assumption of the Excluded Middle. Horn (2001) derives it as an implicature via a general pragmatic principle akin to Grice's Maxim of Relevance, according to which the hearer should read as much as possible into a statement. Gajewski (2005) argues against Horn's proposal because the class of neg-raising predicates does not seem to be entirely determined by their lexical semantics – while e.g. *want* is a neg-raising predicate, *desire* is not. He proposes instead that the Excluded Middle is a lexical presupposition associated exclusively with neg-raising predicates.

3. Negative polarity items

Negative polarity items (NPIs) are words or expressions that can only occur in a limited set of environments, prototypically in the scope of negation. The prime example is English *any*, which is illicit in affirmative sentences like (17a), but fine in negative sentences like (17b).

(17) a. *The burglar left any traces.

b. The burglar didn't leave any traces.

Other well-known examples of NPIs are the temporal adverb *ever* and certain idiomatic phrases such as *lift a finger* and *drink a drop.*

(18) a. Nobody/ *everybody in my family has ever lived abroad.

b. None / *all of the neighbours lifted a finger to help.

c. John never/*always drinks a drop.

NPIs can not only occur in the scope of negation and other expressions that are arguably associated with negation, but also in certain other environments. These include, amongst others, the contexts exemplified in (19):

(19) a. Scope of semi-negative quantifiers and adverbs like *few, at most, rarely, hardly* etc.:
John hardly ever says anything.

b. Complement clauses of "negative" predicates like *doubt*:
I doubt that anyone saw anything.

c. Clauses headed by *without*:
Sue left without telling anyone.

d. Clauses headed by *before*:
Mary left before Bill could say anything.

e. Relative clauses modifying a universal quantifier:
Everyone who saw anything should report to the police.

f. Antecedents of conditionals:
If the burglar left any traces, we will find them.

g. Comparison clauses:
Fred is more intelligent than anyone I ever met.

h. Questions:
Did you see anything unusual last night?

Considering the diverse contexts in (19), the following questions arise:

(20) (i) What notion of "negativity" is common to all the environments where NPs are licit?

(ii) What precisely are the licensing requirements of NPIs?

There are different ways of viewing the licensing requirements of polarity items, either in terms of environments in which they are licensed, or in terms of expressions that serve as licensors. Instead of (20-i) one can alternatively ask what kinds of expressions serve as licensors of NPIs, and this is the way the question has usually been stated (e.g. in Ladusaw 1997). While both perspectives prima facie seem equivalent, the second view also raises questions on the structural relationship between NPIs and their licensors and has triggered a lot of work on the syntactic side of NPI licensing (Progovac 1994; Hoeksema 2000, a.o.).

See Homer (forthcoming) for arguments that the licensing of polarity sensitive items should be viewed in terms of contexts rather than operators.

The questions in (20) have guided research on NPIs over the past five decades. In his seminal study, Klima (1964) proposed that NPIs are licensed by expressions which he labelled "affective". But giving semantic content to the notion of affectiveness has turned out to be a challenge. There have been attempts to relate affective environments to sentential negation (Baker 1970; Linebarger 1980, 1987) such that NPIs are licensed either by a negation operator or via a negative sentence implied by the original utterance. (19b), for example, can be claimed to imply *I don't think that anyone saw anything*. Such approaches, however, suffer from the problem that it is impossible to restrict negative implications to only the sentences in which NPIs are licensed, because there are many entailments of any given proposition and many different representations for those entailments.

3.1 Semantic characterization of licensing contexts

Ladusaw (1979), building on the work of Fauconnier (1975, 1979), gave a characterization of the contexts in which NPIs are licensed based on the formal semantic notion of monotonicity or entailment. Most contexts permit inferences from sets to supersets, i.e. from the more specific to the more general. For instance, as a poodle is a specific kind of dog, the inference from (21a) to (21b) is valid. Such kinds of contexts are called upward entailing. Under negation, however, the direction of entailment is reversed, and inferences from sets to subsets are valid. Therefore (22b) follows from (22a). Such contexts where entailment is from the general to the specific are called **downward entailing** (DE) or monotone decreasing.

(21) a. John owns a poodle.
b. John owns a dog.

(22) a. John doesn't own a dog.
b. John doesn't own a poodle.

A formal definition of downward entailment is given in (24). It is based on a cross-categorial notion of entailment symbolised by "⇒", as defined in (23) (from von Fintel 1999: 100).

(23) Cross-categorial entailment:

a. For *p, q* of type t: $p \Rightarrow q$ iff $p = 0$ or $q = 1$.

b. For *f, g* of type $<\sigma,\tau>$: $f \Rightarrow g$ iff for all *x* of type σ: $f(x) \Rightarrow g(x)$.

(24) A function *f* of type $<\sigma,\tau>$ is **downward entailing** if and only if for all *x, y* of type σ such that $x \Rightarrow y$: $f(y) \Rightarrow f(x)$.

Downward entailment constitutes a generalized notion of negativity, which does not only comprise the scope of negation but many other linguistic contexts. Consider, for example, some of the contexts where NPIs are licensed from (19). They can be shown to be DE by the validity of the following inferences:

(25) Clauses headed by *without*:
The cat walked across the yard without being caught by a dog. ⇒
The cat walked across the yard without being caught by a poodle.

(26) Relative clauses modifying a universal quantifier:
a. Everyone who owns a dog has to pay a dog licence fee. ⇒
b. Everyone who owns a poodle has to pay a dog licence fee.

Ladusaw's hypothesis according to which the crucial property that NPIs are sensitive to is downward entailment has been widely adopted. This analysis, however, requires certain refinements to deal with the full range of cases where NPIs are licensed. There are a number of environments where NPIs are licensed that do not seem to be DE. One case is the scope of *only,* where NPIs are fine, as shown in (27). But intuitively (28b) does follow from (28a).

(27) Only John has ever owned a dog.

(28) a. Only John owns a dog.
b. Only John owns a poodle.

The problem is that (28b) conveys that John owns a poodle, which does not follow from (28a). Even if John is the only person owning a dog, it is not guaranteed that John's dog is a poodle. A way out of this problem suggests itself if we take into account that the relevant meaning component of (28b) is generally regarded a presupposition, i.e. it is presupposed that the sentence minus *only* is true. If presuppositions are disregarded when checking for downward entailment, the inference goes through: if we can take for granted that John's dog is a poodle, then (28b) is indeed entailed by (28a). Therefore, von Fintel (1999) proposes that the notion of downward entailment relevant for the licensing of NPIs is one where

presuppositions are assumed to be fulfilled. He calls this Strawson downward entailment (inspired by Strawson's (1952) work on presuppositions).

(29) A function *f* of type <σ,τ> is **Strawson downward entailing** iff for all *x, y* of type σ such that $x \Rightarrow y$ and *f(x)* is defined: $f(y) \Rightarrow f(x)$.

While characterizing the contexts where NPIs are acceptable as (Strawson) DE provides an important step towards understanding polarity sensitivity, it still leaves several issues unresolved. For one, the notion of entailment is only applicable to declarative sentences, and thus Ladusaw's hypothesis does not account for the licensing of NPIs in questions at all (for this see van Rooy 2003 who argues that what is at stake in questions is strength in terms of relevance). Moreover, it does not account for the fact that polarity sensitivity does not seem to be a uniform phenomenon. This issue is addressed in the next section.

3.2 Varieties of NPIs

It has been observed that there is considerable variation in the licensing requirements different kinds of NPIs exhibit, both cross-linguistically and within one language. In Modern Greek, for instance, NPIs can also occur in certain contexts that are not DE, in particular in modal contexts as in the following examples (taken from Giannakidou 1998:59).

(30) a. Prepi na episkeftis **kanenan** jatro. (Greek)
Must.3SG SUBJ visit any doctor
'You should visit a doctor.'
b. Pjene se **kanenan** jatro.
go.IMP.2SG to any doctor
'Go to a doctor.'

To account for these data, Giannakidou (1998, 1999) proposes a different licensing condition for NPIs. Following Zwarts (1995), she argues that the relevant semantic property of NPI licensors is nonveridicality, as defined in (31).

(31) A propositional operator *f* is **nonveridical** iff *f(p)* does not entail *p*, for all propositions *p*.

The sentences in (30), for instance, are nonveridical, as they do not entail that you indeed visit a doctor. The same holds for the DE contexts in (19), where NPIs in English are

licensed. Nonveridicality thus provides a weaker notion of negativity than downward entailment, and NPIs in Greek seem to be sensitive to this weaker notion.

But variation in the licensing requirements is not only observed across languages, but also within a language. Consider for instance the distribution of the expressions *in weeks* and punctual *until* in English, illustrated in (32) and (33).

(32) a. *I have seen Mary in weeks.
b. I haven't seen Mary in weeks.
c. Nobody has seen Mary in weeks.
d. *At most five people have seen Mary in weeks.

(33) a. *I will arrive until Wednesday.
b. I won't arrive until Wednesday.
c. Nobody has arrived until Wednesday.
d. *At most five people have arrived until Wednesday.

While *in weeks* and *until* are excluded from affirmative contexts, they can occur in the scope of negation and negative indefinites, but not in the scope of mere DE expressions such as quantifiers involving *at most.* They thus seem to be pickier and require a stronger kind of negative environment in order to be licensed. This led Zwarts (1996, 1998) and van der Wouden (1997) to propose a hierarchy of negative contexts, where downward entailment constitutes the weakest notion of negative strength, and the strongest corresponds to classical negation. Of intermediate negative strength are anti-additive operators, as defined in (34).

(34) A function f is **anti-additive** if and only if for all x and y in its domain:
$f(x \vee y) \Leftrightarrow f(x) \wedge f(y)$.

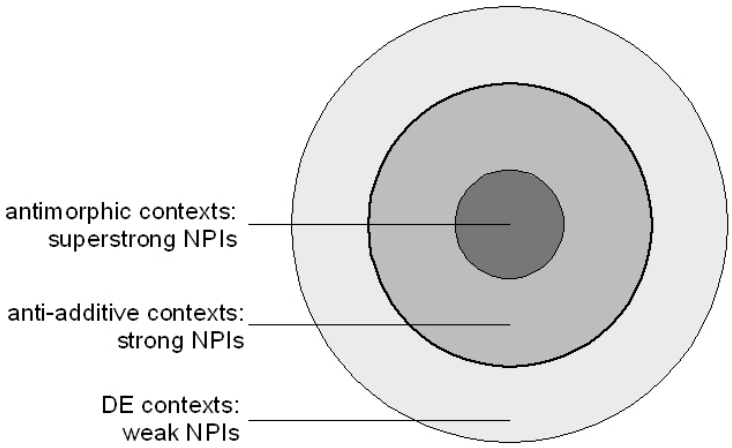
According to this definition, negative quantifiers constitute anti-additive operators. Intuitively, this can be verified by checking that (35a) entails (35b) and vice versa.

(35) a. Nobody sings or dances.
b. Nobody sings and nobody dances.

(36) a. At most five people sing or dance.
b. At most five people sing and at most five people dance.

In contrast, (36a) and (36b) are not equivalent. ((36b) is true e.g. in a situation in which four people sing and three dance, but (36a) is not.) Therefore, quantifiers involving *at most* do

not induce anti-additive contexts and are merely DE. Note that on the other hand being anti-additive entails being DE. This is so because the hierarchy of negative strength is ordered by the subset relation: negation constitutes a proper subset of anti-additive operators, which in turn are a proper subset of DE operators (see Figure 1). Corresponding to this hierarchy of negative contexts, Zwarts (1998) and van der Wouden (1997) distinguish three classes of NPIs: superstrong NPIs are licensed only in strictly negative contexts, strong NPIs require contexts which are at least anti-additive, and weak NPIs can occur in all kinds of DE contexts. Classifying *any* as a weak NPI, and *in weeks* and *until* as strong NPIs thus accounts for the observed differences in their distribution.



1

Figure 1: Hierarchy of negation and distribution of different classes of NPIs

A different perspective on the licensing requirements of strong NPIs is offered by Gajewski (2011). He argues that strong NPIs are not only sensitive to the truth-conditional content of their licensors, but also to the presuppositions and implicatures they induce. Strong NPIs are not licensed in the scope of *only*, for instance, because of the positive presupposition associated with *only*.

(37) a. *Only John has seen Mary in weeks.
b. *Only John arrived until Wednesday.

The ungrammaticality of the sentences in (37) is attributed to their giving rise to the presuppositions in (38), in which the strong NPIs *in weeks* and *until* do not occur in a DE environment.

(38) a. *John has seen Mary in weeks.
b. *John arrived until Wednesday.

Similarly, strong NPIs cannot occur in the scope of quantifiers involving *at most,* because these give rise to a positive scalar implicature. The sentences in (39), for example, lead to the scalar implicatures (40), in which the NPI is not in a DE environment.

(39) a. *At most five people have seen Mary in weeks.
*At most five people have arrived until Wednesday.

(40) a. *Some people have seen Mary in weeks.
b. *Some people have arrived until Wednesday.

Under this view, the operators that are anti-additive according to Zwarts' classification license strong NPIs because they correspond to the strong endpoint of their scale and thus do not give rise to scalar implicatures. Strong NPIs need to occur in a DE environment in the utterance itself as well as in the presuppositions and implicatures it gives rise to. Weak NPIs, in contrast, only look at the truth-conditional content and require it to be DE.

3.3 The source of polarity sensitivity

An issue we have not addressed so far but which has become central in more recent work on polarity items, is the question what makes a word or expression polarity sensitive. More recent approaches do not content themselves with describing the licensing requirements of NPIs, but strive to explain their limited distribution from their lexical semantics. Adopting the generalization that NPIs are licensed only in contexts that have the semantic property of being DE, they ask why this is so. These approaches start from the observation that a common characteristics of many NPIs cross-linguistically is that they are indefinites (e.g. *any*) or denote minimal amounts or activities (so-called minimisers e.g. *lift a finger* or *drink a drop*), and seek to flesh out the intuition that such expressions add emphasis to a negative statement.

The main idea behind such explanatory approaches has two components. First, using an NPI involves comparing relevant alternatives, i.e. other statements that might have been made instead. Second, an utterance with an NPI can only be used if it is stronger, i.e. more informative than its competitors. In this way, these approaches make sense of the fact that NPIs are licensed exactly in the contexts in which entailment is from the more general to the more specific. Assuming that NPIs denote very general properties, which hold of many entities, using an NPI will make an utterance more informative and thereby strengthen it exactly in those cases where it occurs in a DE context. The different proposals vary in the details of how these two components in the semantics of NPIs are spelled out, i.e. regarding the alternatives against which an utterance with an NPI is considered and the source of the strengthening condition.

In the seminal proposal of Kadmon and Landman (1993), *any* is analyzed as an existential determiner inducing domain widening. While the quantificational domain of a quantifier is usually restricted to contextually relevant individuals, the effect of using *any* is that such contextual restrictions are lifted. Consider for instance the difference between the sentences in (41). While (41a) states that there were no traces left by the burglar that are relevant in the context, e.g. traces that could be used as evidence by the police, (41b) denies the existence of traces of any kind whatsoever, i.e. even of traces that would not usually be under consideration such as ones which cannot be used by the police.

(41) a. The burglar didn't leave traces.
b. The burglar didn't leave any traces.

Kadmon and Landman note that domain widening results in a more informative statement precisely in DE contexts. Because entailment in DE contexts is from sets to subsets and all quantifier domains that are more restricted constitute subsets of the widened domain, an utterance where *any* occurs in a DE environment entails all other statements with a more restricted domain of quantification. It is thus in DE contexts where quantifying over a widened domain makes sense, as this will result in a stronger statement. In upward entailing contexts, in contrast, using *any* yields a less informative statement, one that is entailed by all alternative assertions with a more restricted domain of quantification.

The observation that the use of an NPI yields a stronger statement precisely in DE contexts raises the question why their occurrence is grammatically restricted in a way such that they obligatorily strengthen a statement and can never be used in non-DE contexts. Kadmon and Landman (1993) try to enforce this by stipulating a strengthening condition as

part of the lexical meaning of *any*, but this move has been criticised as being non-compositional. Lahiri (1998) derives the strengthening requirement from the conventional implicature associated with the focus particle *even*. His analysis starts from the observation that indefinite NPIs in Hindi are morphologically made up of a predicate meaning 'one' and the particle *bhii*, corresponding to *even* in English. Since *even* is associated with a conventional implicature to the effect that the proposition it applies to is the least likely (or in other words, the most noteworthy), the combination of *even* and a very general predicate leads to a contradiction in non-DE contexts. It has also been suggested that certain English NPIs, in particular minimisers, are associated with a covert *even* (Heim 1984, Guerzoni, 2004).

Krifka (1995) relates the distributional restrictions of NPIs to the mechanism that derives scalar implicatures. As in Kadmon and Landman's and Lahiri's approach, NPIs are assigned denotations that lead to strong statements in DE environments and to weak statements otherwise. According to Krifka, NPIs denote the most general properties and evoke alternatives that denote more specific properties. *Anybody* for instance, which itself means 'person', is lexically associated with more specific alternative properties such as 'man' or 'woman'. Krifka furthermore argues that by virtue of evoking alternatives, NPIs trigger the assertion operator that is also responsible for deriving scalar implicatures. The effect of this operator is to deny all logically stronger alternative propositions. If *anybody* occurs in a non-DE context, as in (42a), the assertoric content, in this case that John saw a person, contradicts the implicatures, namely that John did not see a man, a woman etc. It is simply not possible that John saw a person without also seeing someone of whom a more specific property holds.

(42) a. *John saw anybody.
b. John didn't see anybody.

In contrast, if an NPI occurs in a DE context like (42b), no implicatures arise, which would contradict what is asserted. As (42b) asserts that there is no person who John saw, which entails that there is no particular person seen by John, there are no stronger alternative propositions which the implicatures could deny.

This unified perspective on polarity sensitivity and scalar implicatures might also offer the key to solving another long-standing puzzle. Many indefinite expressions that are NPIs seem to lead a double life as so called Free Choice (FC) items, whose distribution and interpretation differ markedly from the NPI uses. In its FC use, exemplified in (43), *any*

seems to be interpreted as a universal quantifier rather than as an existential as in the NPI uses considered so far.

(43) Any student in my class can solve this problem set.

It is a long-standing question whether the FC and the NPI use of *any* correspond to separate lexical items, or whether they can be subsumed under a unified analysis. The fact that this double nature is not a peculiarity of English *any*, and is in fact shared by similar expressions in many other languages (see Haspelmath 1997), provides a strong indication that FC and NPI uses are two sides of the same coin. While earlier attempts at reducing the ambivalent NPI/FC-nature of *any* to existential and generic readings of indefinites have failed (Kadmon and Landman 1993; Lahiri, 1998), Kratzer and Shimoyama (2002) and Chierchia (2006) have paved the way for a unified analysis of polarity sensitivity and FC effects. Assuming that the central semantic property of indefinites that can be used as both NPIs and FC items is domain widening, Kratzer and Shimoyama (2002) argue that strengthening of an utterance as it happens in DE contexts is only one function of domain widening. Another function of domain widening is avoiding false exhaustivity inferences. By instructing the hearer to consider a wide domain of quantification, the speaker might want to signal that he does not want to rule out any conceivable option. The following example, involving the German indefinite *irgendein* in its FC use, for instance, conveys that any doctor whatsoever is a possible option, and thus that Maria is not choosy regarding the identity of her future husband as long as he is a doctor.

(44) Maria will irgendeinen Arzt heiraten. (German)
Maria wants irgendein doctor marry
'Maria wants to marry a doctor and any doctor whatsoever is a conceivable marriage option to her.'

Kratzer and Shimoyama (2002) derive this effect of distributing over the entire domain of quantification as a conversational implicature (a so-called anti-exhaustivity implicature). Like other implicatures, it is predicted to disappear in DE contexts. This explains why the indefinite *irgendein* seems to come in two different varieties despite being one lexical item: the FC reading of *irgendein* arises in certain contexts as an implicature, which is not available in DE contexts, where domain widening instead results in strengthening and the NPI use of *irgendein* as in (45).

(45) Niemand hat irgendeinen Arzt gesehen. (German)

Nobody has irgendein doctor seen
'Nobody saw any doctor.'

Although semantic/pragmatic theories of polarity sensitivity open up paths of investigation that have not been available before and have become very popular in recent years, they also face challenges. One concerns the question whether they can offer a unified theory of all NPIs. Analyses in the style of Kadmon and Landman (1993), Krifka (1995) and Lahiri (1998) are tailored to explain the polarity sensitivity of expressions that denote low scale elements like indefinites and minimisers. While cross-linguistically, many NPIs fall in this category, not all do, such as English *either, in ages*, *yet*, and the modal verbs *hoeven* and *brauchen* ('need') in Dutch and German, respectively.

Another problem of semantic/pragmatic analyses is that they derive the limited distribution of NPIs from semantic or pragmatic principles. While pragmatically driven conditions can usually be overridden, this does not seem to be possible in the case of unlicensed NPIs (see Giannakidou 2011). Moreover, while analyses in the style of Krika (1995) and Lahiri (1998) predict sentences with unlicensed occurrences of NPIs to be semantically or pragmatically deviant, the intuition usually reported is that they are outright ungrammatical. For these reasons, the study of polarity items has figured prominently in recent debates of where to draw the borderline between syntax, semantics and pragmatics and has subsequently led to reconsiderations of the architecture of grammar (see in particular Chierchia 2004, 2006).

4 Positive polarity items

The converse of NPIs are positive polarity items (PPIs), which are banned from negative contexts. NPIs and PPIs often come in pairs, like English *some – any* and *already – yet.* The following examples illustrate the PPI-hood of *already* and *some.* ((47) is grammatical under a reading where *some* takes scope above negation, but crucially, the reading where *some* scopes under negation is excluded).

(46) Everybody/ *nobody has already handed in the homework.

(47) John didn't read some book.
'There is some book that John didn't read.' (not: 'There is no book that John read.')

Compared to the vast body of research on NPIs, there has been rather little work on PPIs.

The null hypothesis is that PPIs have opposite licensing requirements from NPIs and are thus acceptable in the complement of the environments where NPIs can occur. But many facts have been observed in the literature that complicate the picture and have stood in the way of a uniform analysis of sensitivity to negative and positive polarity. Most importantly, PPIs and NPIs are in fact not in completely complementary distribution. Under strictly DE expressions such as *few* and *at most five,* both *some* and *any* are acceptable under the same interpretation:

(48) At most five people understood something/anything.

In light of these facts, van der Wouden (1997) proposed that there are three different types of PPIs, mirroring the hierarchy of NPIs introduced above: superstrong PPIs that must not be in the scope of a classical negation, strong PPIs that are banned from anti-additive environments, and weak PPIs that cannot occur in DE contexts.

Another curious fact about PPIs is that they can be "rescued" (Baker 1979; Szabolcsi 2004): a PPI is acceptable in the scope of negation if another DE expression outscopes it.

(49) No one thinks that John didn't call someone/anyone.

NPIs on the other hand are not generally sensitive to double negative contexts, and both *some* and *any* can be used under the same reading in (49). Arguing for symmetric licensing conditions for PPIs and NPIs, Homer (forth.) proposes that PPIs are anti-licensed in DE contexts, i.e. they can occur only in upward entailing and non-monotonic contexts. He further argues that for the licensing of a polarity item it is sufficient that there is some constituent in which it is licensed. Under this view, the NPI *anyone* in (49) is licensed within the embedded clause containing a DE expression, while the PPI *someone* is licensed by virtue of the two negative expressions cancelling each other out and rendering the matrix clause an upward entailing environment.

Further reading

Horn, Laurence R. (2001), A Natural History of Negation, CSLI Publications, Stanford. Originally published 1989 by University of Chicago Press. A comprehensive overview on research undertaken on negation since Aristotle; contains an exhaustive list of references.

Ladusaw, William A. (1997), Negation and Polarity Items, in S. Lappin, ed, 'The handbook of contemporary semantic theory', Oxford: Blackwell, 321–341. The central research

questions on polarity sensitivity are laid out in a particularly elucidative manner in this handbook article.

Giannakidou, Anastasia (2011), Negative and positive polarity items, in C. Maienborn, K. von Heusinger, and P. Portner, eds, 'Handbook of Semantics', Berlin/New York: de Gruyter, 1660– 1712. This handbook article provides a somewhat different perspective on polarity items than the one presented here.

Related Topics

Chapter 5 (Foundations of formal semantics)
Chapter 20 (Quantification)

References

Acquaviva, Paolo (1997), The Logical Form of Negation: A Study of Operator-Variable Structures in Syntax, New York/London: Garland.

Baker, Carl Lee (1970), 'Double negatives', Linguistic Inquiry 1, 169–186.

Bartsch, Renate (1973), "'Negative Transportation" gibt es nicht', Linguistische Berichte 27, 1–7.

Chierchia, Gennaro (2004), Scalar implicatures, polarity phenomena and the syntax/pragmatics interface, in A. Belletti, ed., 'Structures and Beyond', Oxford :Oxford University Press.

Chierchia, Gennaro (2006), 'Broaden your views. Implicatures of domain widening and the 'logicality' of language', Linguistic Inquiry 37(4), 535–590.

Dahl, Östen (1993), Negation, in J. Jacobs, A. von Stechow, W. Sternefeld and T. Vennemann, eds, 'Syntax: Ein internationales Handbuch zeitgenössischer Forschung.', Berlin/New York: de Gruyter, 914–923.

Fauconnier, Giles (1975), Polarity and the scale principle, in 'Chicago Linguistics Society 11', 188–199.

Fauconnier, Giles (1979), Implication reversal in natural language, in F. Guenthner and S. J. Schmidt, eds, 'Formal Semantics and Pragmatics for Natural Languages', Dordrecht: Reidel, 289–302.

Fillmore, Charles (1963), 'The position of embedding transformations in grammar', Word 19, 208–231.

von Fintel, Kai (1999), 'NPI licensing, Strawson entailment, and context dependency', Journal of Semantics 16(2), 97–148.

Gajewski, Jon (2005), Neg-Raising: Polarity and Presupposition, PhD thesis, MIT.

Gajewski, Jon (2011), 'Licensing strong NPIs', Natural Language Semantics 19, 109–148.

Geurts, Bart (1996), 'On 'No' ', Journal of Semantics 13, 67–86.

Giannakidou, Anastasia (1998), Polarity Sensitivity as (Non)Veridical Dependency, Amsterdam/Philadelphia: Benjamins.

Giannakidou, Anastasia (1999), 'Affective Dependencies', Linguistics and Philosophy 22, 367–421.

Giannakidou, Anastasia (2000), 'Negative ... concord?', Natural Language and Linguistic Theory 18, 457–523.

Giannakidou, Anastasia (2011), Negative and positive polarity items, in C. Maienborn, K. von Heusinger, and P. Portner, eds, 'Handbook of Semantics', Berlin/New York: de Gruyter, 1660– 1712.

Guerzoni, Elena (2004), 'Even-NPIs in yes/no questions', Natural Language Semantics 12, 319– 343.

Haegeman, Liliane and Raffaella Zanuttini (1996), Negative Concord in West Flemish, in A. Belletti and L. Rizzi, eds, 'Parameters and Funtional Heads. Essays in Comparative Syntax', Oxford: Oxford University Press, 117–179.

Haspelmath, Martin (1997), Indefinite Pronouns, Oxford: Oxford University Press.

Haspelmath, Martin (2005), Negative indefinite pronouns and predicate negation, in M.Haspelmath, M. S.Dryer, D.Gil and B.Comrie, eds, 'The World Atlas of Language Structures', Oxford: Oxford University Press, 466–469.

Heim, Irene (1984), A note on negative polarity and downward entailingness, in C. Jones and P. Sells, eds, 'Proceedings of NELS 14', 98–107.

Heim, Irene (2008), Decomposing antonyms?, in A. Grønn, ed., 'Proceedings of SuB12', ILOS, Oslo, 212–22.

Herburger, Elena (2001), 'The Negative Concord Puzzle Revisited', Natural Language Semantics 9, 289–333.

Hoeksema, Jack (2000), Negative polarity items: Triggering, scope, and c-command, in L. Horn and Y. Kato, eds, 'Negation and Polarity', Oxford: Oxford University Press, 115–146.

Homer, Vincent (forthcoming), 'Domains of polarity items', Journal of Semantics .

Horn, Laurence R. (1978), Remarks on neg-raising, in P. Cole, ed., 'Syntax and Semantics 9: Pragmatics', Academic Press, New York, 129–220.

Horn, Laurence R. (1985), 'Metalinguistic negation and pragmatic ambiguity', Language

61, 121–174.

Horn, Laurence R. (2001), A Natural History of Negation, CSLI Publications, Stanford. Originally published 1989 by University of Chicago Press.

Jacobs, Joachim (1980), 'Lexical decomposition in Montague grammar', Theoretical Linguistics 7, 121–136.

Jacobs, Joachim (1982), Syntax und Semantik der Negation im Deutschen, München: Fink.

Kadmon, Nirit and Fred Landman (1993), 'Any', Linguistics and Philosophy 16(4), 354–422.

Klima, Edward S. (1964), Negation in English, in J. A.Fodor and J. J.Katz, eds, 'The Structure of Language', Englewood Cliffs, NJ: Prentice-Hall, 246–323.

Kratzer, Angelika and Junko Shimoyama (2002), Indeterminate pronouns: The view from Japanese, in Y.Otso, ed., 'Proceedings of the Third Tokyo Conference on Psycholinguistics', Hituzi Syobo, Tokyo.

Krifka, Manfred (1995), 'The semantics and pragmatics of polartity items', Linguistic Analysis 25, 209–258.

Ladusaw, William A. (1979), Polarity Sensitivity as Inherent Scope Relations, PhD thesis, University of Texas at Austin. Published 1980 by Garland, New York.

Ladusaw, William A. (1992), Expressing Negation, in C. Barker and D. Dowty, eds, 'Proceedings of SALT II', Ohio State Working Papers in Linguistics 40, Ohio State University, 237–259.

Ladusaw, William A. (1997), Negation and Polarity Items, in S. Lappin, ed, 'The handbook of centemporary semantic theory', Oxford: Blackwell, 321–341.

Lahiri, Utpal (1998), 'Focus and Negative Polarity in Hindi', Natural Language Semantics 6, 57– 123.

Laka, Itziar (1990), Negation in Syntax: On the Nature of Functional Categories and Projections, PhD thesis, MIT.

Linebarger, Marcia C. (1980), The Grammar of Negative Polarity, PhD thesis, MIT.

Linebarger, Marcia C. (1987), 'Negative Polarity and Grammatical Representation', Linguistics and Philosophy 10, 325–387.

Payne, John R. (1985), Negation, in T.Shopen, ed., 'Language Typology and Syntactic Description', Cambridge: Cambridge University Press 197–242.

Penka, Doris (2011), Negative Indefinites, Oxford/NY: Oxford University Press.

Progovac, Ljiljana (1994), Negative and Positive Polarity: a Binding Approach, Cambridge: Cambridge University Press.

van Rooy, Robert (2003), 'Negative polarity items in questions: Strength as relevance',

Journal of Semantics 20, 239–274.

Strawson, P. F. (1952), Introduction to Logical Theory, London: Methuen.

de Swart, Henriette (2000), Scope ambiguities with negative quantifiers, in K. von Heusinger and U. Egli, eds, 'Reference and Anaphoric Relations', Dordrecht: Kluwer, 109–132.

de Swart, Henriette and Ivan A. Sag (2002), 'Negation and Negative Concord in Romance', Linguistics and Philosophy 25, 373–417.

Szabolcsi, Anna (2004), 'Positive polarity – negative polarity', Natural Language and Linguistic Theory 22, 409–452.

van der Wouden, Ton (1997), Negative Contexts. Collocation, Polarity and Multiple Negation, London/New York: Routledge.

Zeijlstra, Hedde (2004), Sentential Negation and Negative Concord, PhD thesis, University of Amsterdam.

Zwarts, Frans (1995), 'Nonveridical contexts', Linguistic Analysis 25, 286–312.

Zwarts, Frans (1996), A hierarchy of negative expressions, in H. Wansing, ed., 'Negation: A Notion in Focus', Berlin: de Gruyter, 169–194.

Zwarts, Frans (1998), Three types of polarity, in F. Hamm and E. Hinrichs, eds, 'Plurality and Quantification', Dordrecht: Kluwer, 177–238.