# How are Alternatives Computed?

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**Summary**

It is widely assumed that focusing a phrase indicates that alternatives to the phrase are considered. The question is, how are alternatives to a given phrase determined? There are a number of proposed answers to this question (Rooth 1985,1992; von Stechow 1989; Jacobs 1983, among others).

These accounts, however, typically deal only with logically simple phrases; when more complex phrases are considered, they turn out to be inadequate. Current theories fail to provide a principled relation between the alternatives induced by a complex phrase and those induced by its component parts; moreover, they predict incorrect truth conditions in some cases. The heart of the problem with these accounts lies in the assumption that the same combinatory rules used in determining the meanings of expressions, also apply in determining the alternatives induced by them.

Instead, I argue that alternatives are induced by presupposition, and that focus induces alternatives only to the extent that it gives rise to presuppositions. The problem of determining the alternatives is thereby reduced to the problem of determining presupposition in context: the rules for computing alternatives are the same rules which govern the derivation of presupposition. These rules are different from the combinatory rules used to compute the ordinary meaning, and thus avoid the problems which plague previous approaches.

# How are Alternatives Computed?

## 1 The Interpretation of Focus

### 1.1 Focus and Alternatives

In his dissertation and subsequent work, Rooth (1985;1992) proposes that focus indicates a set of alternatives under discussion. Rooth suggests that every phrase $\phi$ has, in addition to the Montagovian *ordinary semantic value*, $[\![\phi]\!]^o$, also a *focus semantic value*, $[\![\phi]\!]^f$. The focus semantic value is the set of all terms derived from $\phi$ by substituting objects of appropriate types for the focused constituents of $\phi$.

More precisely, $[\![\phi]\!]^f$ is defined by Rooth as follows:

**Definition 1 (Focus semantic value)**

1. *If $\phi$ is a non-focused simple phrase, $[\![\phi]\!]^f = \{[\![\phi]\!]^o\}$.*
   *For example, $[\![Mary]\!]^f = \{\mathbf{m}\}$.*

2. *If $\phi$ is a focused simple phrase, $[\![[\phi]_F]\!]^f$ is the set of objects matching $[\![\phi]\!]^o$ in type.*
   *For example, $[\![[John]_F]\!]^f = E$, where $E$ is the set of individuals.*

3. *If $\phi$ is a complex phrase, with components $\phi_1, \ldots \phi_n$, the definition of the focus semantic value is applied recursively to each component. Then each member of $[\![\phi]\!]^f$ is produced by picking one element of each of $[\![\phi_1]\!]^f, \ldots, [\![\phi_n]\!]^f$, and combining them using the ordinary semantic rule for $\phi$.*
   *For example, if*
   *$[\![Mary\ takes\ John\ to\ the\ movies]\!]^o = \mathbf{take\text{-}to\text{-}movies}(\mathbf{m}, \mathbf{j}, s)$,*
   *where $s$ is a situation variable, then*
   *$[\![Mary\ takes\ [John]_F\ to\ the\ movies]\!]^f = \{\mathbf{take\text{-}to\text{-}movies}(\mathbf{m}, x, s) | x \in E\}$.*

Note that the definition of the focus semantic value is compositional; the focus semantic value of $\phi$ is a function of the focus semantic values of the parts of $\phi$. Moreover, the combinatory rules used to compute the focus semantic value are the same rules used in the computation of the ordinary semantic value. For example, if the ordinary semantic value of "$S_1$ or $S_2$" is a disjunction of $[\![S1]\!]^o$ and $[\![S_2]\!]^o$, the focus semantic value of "$S_1$ or $S_2$" is a set of disjunctions of an element from $[\![S_1]\!]^f$ and an element from $[\![S_2]\!]^f$:

(1) a. $[\![\text{S}_1 \text{ or } \text{S}_2]\!]^o = [\![\text{S}_1]\!]^o \vee [\![\text{S}_2]\!]^o$

b. $[\![\text{S}_1 \text{ or } \text{S}_2]\!]^f = \{\phi_1 \vee \phi_2 | \phi_1 \in [\![\text{S}_1]\!]^f \ \& \ \phi_2 \in [\![\text{S}_2]\!]^f\}$

Rooth (1985) proposes that for any expression $\phi$, the set of alternatives to $\phi$ is provided by the focus semantic value of $\phi$. Let ALT($\phi$) indicate the set of alternatives to $\phi$; then Rooth's definition is simply the following:

**Definition 2 (Alternatives, Rooth 1985)** $ALT(\phi) = [\![\phi]\!]^f$.

There are cases when the set of alternatives affects truth conditions. For example, Rooth points out that (2.a) and (2.b) have different truth conditions:

(2) a. I only introduced $[\text{Bill}]_F$ to Sue.

b. I only introduced Bill to $[\text{Sue}]_F$.

If the speaker introduced Bill and Tom to Sue, and performed no other introductions, (2.a) is false and (2.b) is true. The reason is, according to Rooth, that the speaker who utters (2.a) considers alternative individuals who could be introduced to Sue, and asserts that only one of them, Bill, was in fact introduced to her. In contrast, the speaker who utters (2.b) considers alternative individuals to whom Bill could have been introduced, and asserts that Bill was, in fact, introduced only to one of them, Sue.

Another function of the set of alternatives, according to Rooth, is to restrict the domain of adverbs of quantification. For example, (3.a) and (3.b) have different truth conditions:

(3) a. Mary always takes $[\text{John}]_F$ to the movies.

b. $[\text{Mary}]_F$ always takes John to the movies.

If Mary goes to the movies often, with all sorts of people, but John sits at home and never goes out unless Mary takes him, (3.a) would be false, but (3.b) would be true. Rooth explains that the domain of quantification is restricted by the disjunction of the alternatives. Since (3.a) and (3.b) have different focus structures, they introduce different sets of alternatives, hence their respective domains of quantification are different, and consequently they have different truth conditions.

Partee (1991) has formulated this claim in the framework of tripartite logical forms proposed by Kamp (1981) and Heim (1982).[1] She proposes that the disjunction of the alternatives is mapped onto the restrictor. For example, the restrictor of (3.a) would be (4.a), i.e. situations in which Mary takes some alternative to John to the movies. By definition 2, this is equivalent to (4.b). So the logical form of (3.a) would be (4.c), which is logically equivalent to (4.d).

(4) a. $\bigvee \mathrm{ALT}(\textbf{take-to-movies}(\mathbf{m}, [\mathbf{j}]_F, s))$

b. $\bigvee\{\textbf{take-to-movies}(\mathbf{m}, x, s) | x \in E\}$

c. $\textbf{always}_{s;}[\bigvee\{\textbf{take-to-movies}(\mathbf{m}, x, s) | x \in E\}]$
$[\textbf{take-to-movies}(\mathbf{m}, \mathbf{j}, s)]$

d. $\textbf{always}_{s;}[\exists x : \textbf{take-to-movies}(\mathbf{m}, x, s)]$
$[\textbf{take-to-movies}(\mathbf{m}, \mathbf{j}, s)]$

Thus we get the desired interpretation, namely that whenever Mary takes someone to the movies, it is always John.

The restrictor of (3.b), on the other hand, is (5.a), equivalent to (5.b). So the logical form of (3.b) is (5.c), which boils down to (5.d):

(5) a. $\bigvee \mathrm{ALT}(\textbf{take-to-movies}([\mathbf{m}]_F, \mathbf{j}, s))$

b. $\bigvee\{\textbf{take-to-movies}(x, \mathbf{j}, s) | x \in E\}$

c. $\textbf{always}_{s;}[\bigvee\{\textbf{take-to-movies}(x, \mathbf{j}, s) | x \in E\}]$
$[\textbf{take-to-movies}(\mathbf{m}, \mathbf{j}, s)]$

d. $\textbf{always}_{s;}[\exists x : \textbf{take-to-movies}(x, \mathbf{j}, s)]$
$[\textbf{take-to-movies}(\mathbf{m}, \mathbf{j}, s)]$

This is how the desired interpretation of (3.b) is derived, namely that whenever someone takes John to the movies, it is invariably Mary.

## 1.2 Restriction by Context

It is well known, and, in fact, has already been pointed out by Rooth (1985) himself, that definition 2, as it stands, is inadequate. Consider (6):

(6) John always $[\text{agrees}]_F$ with Mary.

According to definition 1,

(7) $[\![\text{John } [\text{agrees}]_F \text{ with Mary}]\!]^f = \{R(\mathbf{j}, \mathbf{m}, s)\}$,

where $s$ is a situation variable. In words, the focus semantic value is equal to the set of all possible relations between John, Mary, and a situation. If, as definition 2 maintains, the set of alternatives is equal to the focus semantic value, (6) would be true just in case whenever John satisfies some relation to Mary, he always agrees with her. But since John *always* satisfies some relation to Mary, e.g. occupying a

location in space different from Mary's, the truth of (6) would require that John agree with Mary every single second of their lives. Clearly, this is incorrect; we should only require that John agree with Mary in all suitably restricted situations, say when they have a discussion. It follows, then, that the set of alternatives must somehow be restricted by the context.

One possible way to do this would be to change the definition of the focus semantic value, so that, if $\phi$ is a focused simple phrase, $[\![[\phi]_F]\!]^f$ will not contain *all* objects matching $[\![\phi]\!]^o$ in type, but a smaller set, restricted by the context.[2] Thus, $[\![\text{agree}]\!]^f$ will not be the set of all relations between two individuals and a situation, but only the contextually relevant ones, perhaps $\{\textbf{agree}, \textbf{argue}, \textbf{ignore}\}$. In this way, we can maintain definition 2, and keep the compositional definition of the computation of alternatives.

However, this approach will not work: if the set of alternatives is identified by the focus semantic value, it is impossible to compute it compositionally. This can be demonstrated by an argument which von Stechow (1989) ascribes to Ede Zimmermann. He considers the following mini-dialogue:

(8) **Q:** Did Sir John already introduce each gentleman to his partner at table?
**A:** No, Sir John only introduced $[\text{Bill}]_F$ to $[\text{Mary}]_F$.

Suppose we restrict the focus semantic value by the context, so as to obtain something like:

(9) a. $[\![[\text{Bill}]_F]\!]^f = \{x | x \text{ is the male partner at table of a lady}\}$
b. $[\![[\text{Mary}]_F]\!]^f = \{y | y \text{ is the female partner at table of a gentleman}\}$

The sentence ought to be true iff there is exactly one pair $\langle x, y\rangle$ s.t. $x \in [\![[\text{Bill}]_F]\!]^f$, $y \in [\![[\text{Mary}]_F]\!]^f$, and Sir John introduced $x$ to $y$.

Now, suppose Mary is Bill's partner at table, and Erica is Jeffrey's partner at table. Suppose further that Sir John introduced Bill to Mary and Jeffrey to Mary, and performed no other introductions. Intuitively, (8) is true, since Sir John only made one introduction between a gentleman and his partner at table; Jeffrey and Mary are not partners at table. However, Jeffrey is the male partner of a lady, and Mary is the female partner of a gentleman, so that Jeffrey is in $[\![[\text{Bill}]_F]\!]^f$ and Mary is in $[\![[\text{Mary}]_F]\!]^f$, and the sentence is predicted to be false. Therefore, the set of alternatives to the VP cannot a function of the sets of alternatives to its parts, and compositionality fails.

Von Stechow's (1989) solution to this problem is in a different framework from Rooth's—the theory of *structured meanings* (see also Jacobs 1983). Structured meanings are defined as follows:

**Definition 3 (Structured meaning)**
*Let $P$ be an expression. Then*

$$\langle \lambda x_1 \ldots \lambda x_n . Q(x_1, \ldots, x_n), a_1, \ldots, a_n \rangle$$

*is a structured meaning for any $a_1, \ldots, a_n$ s.t.*

$$\lambda x_1 \ldots \lambda x_n . Q(a_1, \ldots, a_n) = P.$$

The idea is that focus determines the structured meaning: $a_1, \ldots, a_n$ are the focused phrases of $P$. For example, the structured meanings of (10.a) and (11.a) are (10.b) and (11.b), respectively (where the situation variable is left free):

(10) a. Mary takes [John]$_F$ to the movies.
b. $\langle \lambda x.\textbf{take-to-movies}(\mathbf{m}, x, s), \mathbf{j} \rangle$

(11) a. Mary takes [John]$_F$ to the movies.
b. $\langle \lambda x.\textbf{take-to-movies}(x, \mathbf{j}, s), \mathbf{m} \rangle$

Von Stechow's theory (1989) can easily accommodate the contextual restriction of alternatives:

**Definition 4 (Alternatives, von Stechow 1989[3])**
*The set of alternatives obtained from a structured meaning $\langle \lambda x_1 \ldots \lambda x_n . Q^n, x_1, \ldots, x_n \rangle$ is the set*

$$\{Q^n(y_1, \ldots, y_n) | R(y_1, \ldots y_n)\},$$

*where the relation $R$ is determined contextually.*

For example, the sets of alternatives induced by (10.b) and (11.b) are (12.a) and (12.b), respectively:

(12) a. $\{\textbf{take-to-movies}(\mathbf{m}, x, s) | R(x)\}$
b. $\{\textbf{take-to-movies}(x, \mathbf{j}, s) | R(x)\}$

If we take $R(x)$ to indicate simply that $x$ is an individual, these are exactly the sets of alternatives derived by Rooth's approach.

Now, the structured meaning of (13.a) is (13.b), and the set of alternatives is (13.c):

(13) a. Sir John introduced [Bill]$_F$ to [Mary]$_F$.

b. $\langle \lambda x.\lambda y.\mathbf{introduce}(\mathbf{j}, x, y), \mathbf{b}, \mathbf{m}) \rangle$

c. $\{\mathbf{introduce}(\mathbf{j}, x, y) | R(x, y)\}$

If we take $R(x, y)$ to indicate that $x$ is the male partner at table of lady $y$, we get the desired truth conditions.

In a more recent article, Rooth (1992) makes a similar proposal, but within his framework of alternative semantics. The definition of the focus semantic value remains the same as in Rooth (1985), but ALT($\phi$) is no longer equal to $[\![\phi]\!]^f$; it is further restricted by the context. Importantly, Rooth claims that the set of alternatives to $\phi$ is always a (not necessarily proper) subset of the focus semantic value of $\phi$. Instead of definition 2, Rooth (1992) proposes the following constraint:

**Definition 5 (Alternatives, Rooth 1992)** $\quad ALT(\phi) \subseteq [\![\phi]\!]^f$.

Thus, for example, $[\![[\text{agree}]_F]\!]^f$ is still the set of all relations between two individuals and a situation; but the set of alternatives will contain only a restricted subset of these relations. In the context of (6), this might be the set $\{\mathbf{agree}, \mathbf{argue}, \mathbf{ignore}\}$.

To take another relevant example, while

(14) $\quad [\![\text{introduce } [\text{Bill}]_F \text{ to } [\text{Mary}]_F]\!]^f = \{\mathbf{introduce}(x, y) | x, y \in E\}$,

the set of alternatives will be restricted by the context to

(15) $\quad \text{ALT}(\text{introduce } [\text{Bill}]_F \text{ to } [\text{Mary}]_F) =$
$\{\mathbf{introduce}(x, y) | x$ is a gentleman
& $y$ is a lady
& $x$ and $y$ are partners at table$\}$.

We thus get the same set of alternatives as that proposed by von Stechow (1989).

# 2 Problems

The combination of definitions 1 and 5 seems quite plausible; it provides a compositional definition of the focus semantic value, and allows context to restrict the resulting alternatives. Similarly, von Stechow (1989) proposes a compositional definition of structured meanings, while leaving the restriction $R$ to be determined by the context. There are, nonetheless, two difficulties with these accounts: a theoretical one and an empirical one.

The theoretical problem is that neither Rooth nor von Stechow provides a way to characterize the set of alternatives given a particular context, and the role of context remains completely unspecified. Consequently, the restriction of alternatives by the context is not defined compositionally; the context is not taken into account when the alternatives to a complex phrase are computed as a function of its parts, but only after the compositional computation (i.e. the focus semantic value or the structured meaning) has been completed. This leads to the result that, while $[\![\phi]\!]^f$ or the structured meaning of $\phi$ are defined compositionally, there is no corresponding compositional definition of ALT($\phi$).

Suppose $\phi$ is a complex phrase, with components $\phi_1$ and $\phi_2$. Then ALT($\phi$) is *not* a function of ALT($\phi_1$) and ALT($\phi_2$), but rather a function of $[\![\phi_1]\!]^f$ and $[\![\phi_2]\!]^f$, or the corresponding structured meanings (and the context). So the set of alternatives to a phrase is *not* a function of the alternatives to its parts. For example, it is not clear how the alternatives to $\neg\phi$, $\phi \wedge \psi$, and $\phi \vee \psi$ are related to the alternatives to $\phi$ and $\psi$.

Moreover, the idea that the set of alternatives to $\phi$ is a subset of $[\![\phi]\!]^f$ sometimes predicts incorrect truth conditions. According to definition 1, it is crucially the ordinary semantic combinatory rules which are used in the computation of the focus semantic value. Thus, for example,

(16) $\quad [\![\phi \vee [\psi]_F]\!]^f = \{\phi \vee \psi' | \psi' \in [\![[\psi]_F]\!]^f\}.$

The same goes for the structured meaning approach, since structured meanings are generated using the ordinary semantic rules (and then $\lambda$-abstracting over the focused phrases). Indeed, von Stechow (1989:20) explicitly states that the alternatives to a disjunction are in the form of disjunctions.[4] Now consider (17):

(17) Usually, people obey the law, or they are sentenced to [death]$_F$.

Before I discuss (17), a methodological point is in order. Crucially for (17) and other examples throughout the paper, only one element of a coordinated structure is focused. It may not be easy to produce this stress pattern felicitously; a brief pause seems to be required between the disjuncts. The reason is that conjunctions and disjunctions are represented as a parallel structure (Goodall 1987), and it is hard to focus one element in a parallel structure without also focusing its counterpart (Erteschik-Shir 1997). Goodall claims that only *and*, *or*, and *but* may (though not always) express "real" coordination, represented as a parallel structure. He distinguishes between these cases and and other ways to conjoin clauses, such as *while*, *after*, *whereas*, etc., which do not result in a parallel structure, even though

their meanings comprise a conjunction or a disjunction. Consequently, it is easier to focus only one element of the disjunction if the disjunction is expressed using the noncoordinating *or else* or *unless*, rather than *or*:

(18) a. Usually, people obey the law, or else they are sentenced to [death]$_F$.

b. Usually, people are sentenced to [death]$_F$ unless they obey the law.

For this reason, in addition to *and* and *or*, I will use a variety of particles throughout the paper to express conjunctions and disjunctions.

Let us now return to (17) and its paraphrases in (18). The focus semantic value of the VP is:

(19) {obey the law or be sentenced to $x$}.

Presumably, context restricts $x$ to range over punishments, so that the set of alternatives is:

(20) {obey the law or be sentenced to $x|x$ is some punishment}.

Consequently, Rooth's theory (and, similarly, von Stechow's) would predict that (17) expresses quantification over people who obey the law *or* are sentenced to some punishment or other, and states that the majority of those obey the law or are sentenced to death. Assuming that the majority of people do obey the law, (17) is predicted to be true, but it is, in fact, clearly false.

Sentence (17), I claim, expresses quantification over people who do *not* obey the law and are sentenced to some punishment, and states that this punishment is usually death. Since this is not the case, (17) is false. The desired set of alternatives, is, in fact, in the form of conjunctions, not disjunctions:

(21) {disobey the law and be sentenced to $x|x$ is some punishment}.

Note that the set of alternatives is not a subset of the focus semantic value of the VP, in contrast with Rooth's and von Stechow's proposals.

In this paper I will address both problems with Rooth's and von Stechow's theories: a consideration of the theoretical problem will suggest a solution to the empirical one.

# 3 Alternatives and Presupposition

When considering the definition of the set of alternatives, an important question to consider is whether the set of alternatives is dependent on the particular language used. Blok and Eberle (forthcoming) suggest that it is. They consider the following German sentence and its English translation:

(22) a. John trinkt nur [pils]$_F$.

b. John only drinks [lager]$_F$.

Blok and Eberle state:

> All our German and English informants confirmed that, even if we accept *lager* as translation of *Pils*, [(22.a)] and its possible translation [(22.b)] differ with respect to the alternatives of the focused constituent. Assuming the empty context, the alternatives *of which the native speaker is aware* in [(22.a)], are those kinds of beer that have a name in German, and correspondingly for [(22.b)]. Normally, neither is *Kölsch* an alternative of *lager*, nor is *ale* an alternative of *Pils* (p. 111, emphasis added).[5]

According to Blok and Eberle, then, alternatives are computed at the level of words, not concepts; if a concept does not have a name in a particular language, it cannot serve as a member of a set of alternatives. They base this claim on the judgments of their informants: although each word of (22.b) is a direct translation of the corresponding word in (22.a), the whole sentence is not a completely faithful translation, in that it induces different alternatives in the hearer. While this difference between the two sentences is unquestionably an important one, Blok and Eberle have not shown that the two sentences differ in their truth conditions. It may very well be true that, upon hearing a sentence in some language, one would initially imagine only those alternatives which have a name in that language. It does not follow, however, that these are, indeed, the alternatives with respect to which the sentence is evaluated when its truth value is assessed. Suppose that John drinks only Kölsch and lager, and no other kind of beer. I think it is clear that, in this case, both (22.a) and (22.b) are false. If, as Blok and Eberle claim, sentences in a given language were evaluated only with respect to sets of alternatives which correspond to words in that language, (22.b) would be judged true.

I propose, therefore, that alternatives are language independent; they depend on the meaning of a sentence, on the context and world knowledge, but not on the language used.[6] The question, then, is how the alternatives are determined in a given case.

Sometimes the solution is easy—the alternatives are explicitly stated. For example, if (6), repeated below as (23.b), is uttered in response to (23.a), the alternatives are overtly given, namely the set $\{\textbf{agree}, \textbf{argue}\}$.

(23) a. Does John agree or argue with Mary?

b. John always $[\text{agrees}]_F$ with Mary.

In most cases, however, the alternatives have to be inferred somehow. Consider, for example, the following sentence:

(24) Roses are usually $[\text{red}]_F$.

What is the set of alternatives with respect to which (24) is evaluated? Intuitively, it is the set of colors. A speaker who utters (24) is perceived to be considering all colors which roses might have, and asserting that the majority of roses are red.

But why should colors be the set of alternatives? One possible answer is that this is simply because *red* is a color—being red entails being colored. Perhaps, then, alternatives are based on entailment.

This solution will not do in general, however. *Scarlet* is a color, but it is also a shade of red. Being scarlet, then, entails being red, but it also entails being a color. Would the alternatives to *scarlet* be all colors or just shades of red? To answer this question, suppose Mary owns three hats: one blue, one green, and one scarlet. Every day she wears one of these hats. Therefore, there are times when she wears a hat that it not scarlet; but whenever she wears a red hat, it is invariably scarlet, because she does not own any other red hat. Given this scenario, (25) is false:

(25) Mary always wears a $[\text{scarlet}]_F$ hat.

If the alternatives to *scarlet* were shades of red only, (25) would have to be true; since it is false, we can conclude that all colors, and not just that shades of red, are alternatives to *scarlet*. The question is, then, why is that?

In a different context, Searle (1959) discusses this problem, and suggests considering presupposition rather than entailment. Being scarlet and being red both presuppose being colored, hence the alternatives to both are the set of colors. However, although being scarlet entails being red, it does not presuppose it, hence shades of red are not alternatives to *scarlet*.

Note that I am guilty of some abuse of language here, since, strictly speaking, semantic relations such as entailment and presupposition only hold between propositions, and not between other semantic objects, such as the property of being red

or being colored. This abuse of language, however, is harmless, since semantic relations can easily be extended to hold between arbitrary expressions, as I show in the appendix.

The proposal that alternatives are based on presupposition is, however, still inadequate. Being red presupposes being colored, but it also presupposes being a physical object. Yet other properties of physical objects, e.g. specific sizes, weights or shapes, are not alternatives to *red*. If they were, it would be impossible for (26) to be true:

(26) Mary only wears $[\text{red}]_F$ hats.

Sentence (26) says that the hats which Mary wears have none of the properties which constitute an alternative to *red*, except for *red* itself. If size, weight, shape, etc. were considered to be such alternatives, the truth of (26) would imply that Mary's hats have no sizes, weights, or shapes.

Note that being colored entails being a physical object, but not vice versa. In fact, there does not seem to be any other presupposition of being red which entails being colored. In this sense, being colored is a *minimal presupposition* of being red:

**Definition 6 (Minimal presupposition)**
*$\psi$ is a minimal presupposition of $\phi$ iff $\psi$ is a presupposition of $\phi$ and for every $\psi'$ presupposed by $\phi$, if $\psi' \Rightarrow \psi$ then $\psi' \Leftrightarrow \psi$.*

Note that a minimal presupposition need not be unique; it may be the case that an expression has two or more minimal presuppositions, none of which entails the other. For example, being a bachelor presupposes both being male and being an adult (cf. McCawley 1968). This is why the following sentences are odd:

(27) a. Mary $\left\{ \begin{array}{c} \text{is} \\ \text{isn't} \end{array} \right\}$ a bachelor.

b. The baby $\left\{ \begin{array}{c} \text{is} \\ \text{isn't} \end{array} \right\}$ a bachelor.

However, neither presupposition entails the other, nor do they entail any other presupposition of being a bachelor. Hence, they are both minimal presuppositions of *bachelor*.

I propose, then, that alternatives are determined by minimal presuppositions. More precisely, alternatives are expressions which share a minimal presupposition:

**Definition 7 (Alternatives)**
*Let $\phi$ and $\psi$ be expressions, $\phi$ minimally presupposes $\psi$. Then*

$$ALT(\phi) =_{def} \{\phi' | \phi' \textit{ minimally presupposes } \psi\}.$$

Note that the choice of a set of alternatives to $\phi$ depends on the choice of the minimal presupposition $\psi$, which, in turn, is provided by the context. For example, in the context of a discussion of acts performed in the Great Russian Circus, the alternatives to the VP in (28) would all presuppose performing some circus act (e.g. juggle, walk the tightrope, ride a unicycle, etc.). Given this context, (28) would be true, since, presumably, the majority of bears which perform in the Great Russian Circus ride unicycles.

(28) Bears usually ride unicycles.

In the context of a discussion of various animals and their forms of locomotion, however, (28) would be false, since few bears use unicycles to move about.

Consequently, it is clear that we should use a pragmatic (i.e. context dependent) definition of presupposition, rather than a semantic one. Numerous such definitions have been proposed, and they generally make use of concepts such as *felicity* (or *appropriateness*) and *mutual knowledge* (or *common ground*). The following definition, from Levinson (1983:205, original emphases), is typical:

**Definition 8 (Pragmatic presupposition)**
*An utterance A* pragmatically presupposes *a proposition B iff A is* appropriate *only if B is* mutually known *by participants.*

Such a definition is, needless to say, vague; unless the notions of appropriateness and common ground are given a precise formulation, it does not really enable us to predict, given an expression and a context, the pragmatic presuppositions of the expression in that context. Providing such a precise formulation of presupposition is a deep problem, one which this paper does not attempt to solve. What I do claim is that, as far as computing alternatives is concerned, nothing further is needed. Assuming that there is some mechanism which derives the presuppositions of a sentence in context, we do not need any additional device in order to derive the set of alternatives induced by the sentence in that context.

The common ground, then, determines the presuppositions, hence the minimal presuppositions, in a given context.[7] For example, in the context of the Great Russian Circus, predicating of an individual that it rides, or does not ride, a unicycle, presupposes that this individual performs some act in the circus. Hence

only bears performing in the circus will be considered in this context, and (28) would be judged true.

This contrasts with Searle's (1959) use of *semantic presupposition*, a definition of presupposition which is context independent. Indeed, in the right context, shades of red, and not colors, may be considered alternatives to *scarlet*. For example, in the following mini-dialogue, the answer is true even if Mary also wears blue and green hats, so long as she does not wear hats of any other shade of red:

(29) **Q:** Which shade of red does Mary like best?

**A:** Well, she always wears $[\text{scarlet}]_F$ hats.

Since sets of alternatives share a presupposition, it is reasonable to expect that a presupposition of the term inducing the alternatives would be shared by the alternatives.[8] For example, the verb *manage* is an *implicative* verb (Karttunen 1971); saying that $x$ managed $p$ normally presupposes that $x$ attempted or needed to accomplish $p$. For example, (30) presupposes that Ed tried to become friends with the prison guards, or that becoming friends with them was something that Ed needed to accomplish.

(30) Ed $\left\{ \begin{array}{c} \text{managed} \\ \text{didn't manage} \end{array} \right\}$ to become friends with the prison guards.

The alternatives induced by the property *manage* $p$, then, are plausibly possible outcomes of the attempt to accomplish $p$—success or failure. Now consider the following sentence:

(31) People usually manage to survive a week without food.

Sentence (31) is true iff people who have to survive a week with no food usually make it. Note that many people do not survive a week without food, for the simple reason that they do not have to; they are never put in this predicament. In other words, these people do not satisfy the presupposition, hence they do not satisfy any of the alternatives and, therefore, are not included in the quantification domain of the adverb.

Additional examples are not hard to find; the following are from Schubert and Pelletier (1987:440):

(32) a. Cats usually land on their feet.

b. A student always admires a fair professor.

c. Men usually notice pretty women.

Landing on one's feet presupposes that one drops to the ground; therefore, (32.a) is about cats which drop to the ground, and is true just in case they usually land on their feet. Admiring a person presupposes that one knows that person; hence (32.b) is evaluated with respect to students who know a fair professor, and states that such students always admire the professor. As for (32.c), noticing a person presupposes that one is near that person; hence (32.c) would be true just in case when a man is near a pretty woman, he usually notices her.

# 4 Focus

An idea common to many theories of focus[9] is that the focused element is "new," "informative," or "unexpected," whereas the unfocused part of the sentence is "old," "given," "known," or "in the common ground." This is reminiscent of pragmatic definitions of presupposition, where the presupposed information is considered to be part of the common ground.

Since the alternatives share a presupposition, it follows that what they differ on is the material which is not presupposed, i.e. the focus. It is for this reason that focus induces alternatives. The primary role of focus, then, is not to induce alternatives; it only induces alternatives to the extent that it gives rise to pragmatic presuppositions.

As we have seen, the domain of a quantifier may be restricted by a set of alternatives provided by the presupposition induced by focus. In such cases, focus is, in Rooth's (1985) terms, *associated* with the quantifier. However, the alternatives which restrict the domain of the quantifier may be provided in some other way, in particular, by lexical presuppositions of the verb. In such cases, focus is not associated with the quantifier, and may be associated with another operator, or remain free.[10]

For example, consider (31) when uttered with a different intonation:

(33) People usually manage to survive a week without $[\text{food}]_F$.

If the role of focus were to provide a set of alternatives which restricts the domain of *usually*, we would expect (33) to mean that people who manage to survive a week without something, usually survive a week without food. However, (33) has no such reading; rather, just like (31), it means that people who have to survive a week without food usually make it.

In this case, the set of alternatives introduced by the focus does not restrict the domain of the quantifier, but is associated with a different operator, depending

on the context. It might be associated with the illocutionary operator **assert**, (Jacobs 1988, as described by von Stechow 1991), indicating that alternatives to *food* (perhaps various basic necessities) are under discussion. Thus, (33) may be an appropriate answer to (34):

(34) What do people manage to survive a week without?

Alternatively, focus may have a *contrastive* role, perhaps by being associated with the **contrast** operator (Partee 1991). This is the plausible interpretation of the focus in a context such as the following:

(35) **A:** People manage to survive a week without water.
**B:** No! People manage to survive a week without $[\text{food}]_F$.

B is correcting A's claim by stating that it is food, rather than water, that people manage to survive a week without.

# 5 The Calculus of Alternatives

The proposal that alternatives are determined by presupposition has concrete implications for the way alternatives to complex phrases are determined as a function of their component phrases. It turns out that this way of computing alternatives avoids the problems with Rooth's and von Stechow's proposals. That is to say, it is possible to provide a principled method to compute alternatives which is empirically adequate.

This is in contrast with Blok's (1994) view that alternatives cannot be derived compositionally. He considers the set of alternatives to the VP in (36):

(36) John only $[\text{eats apples}]_F$.

Blok writes:

> The [set of alternatives] of *eat* will be something like {drink, chew...} and the [set of alternatives] of *apple* will be {banana, lime...}. But then, it may be clear that the [set of alternatives] we are looking for does not contain *drink a banana*. The relevant word may be *work* or *kiss a woman*, who knows. But it certainly has nothing to do with the subconstituents of the focused expression. As such, this problem seems unsolvable to me from a logical or linguistic point of view (p. 8).

It is not clear to me what makes Blok reach this pessimistic conclusion. Drinking a banana may just be too bizarre a property to be normally considered; but *chew a lime* is certainly an acceptable alternative. I believe Blok is, indeed, correct in pointing out that, in some contexts, the relevant alternatives to *eat apples* may include *work* or *kiss a woman*; *eat apples* may, given a suitable context, presuppose a property such as *do something in the morning* or *engage in one of John's favorite activities*, etc. Surely, however, there are contexts where decomposing *eat apples* into the alternatives of *eat* and *apples* is preferred; it certainly seems to be what we do in the null context, if the whole phrase *eat apples* is focused.

In this section I will concentrate on a test case for the computation of alternatives: the alternatives induced by logically complex phrases.

## 5.1 Negation

Since alternatives are determined by presupposition, and since, in a given context, presuppositions are unaffected by negation, I propose that the set of alternatives induced by a negated expression is equal to the the set induced by its non-negated counterpart:

**Rule 1 (Negation)** $\quad ALT(\neg[\phi]_F) \;=\; ALT([\phi]_F)$

Thus, for example, both (37.a) and (37.b) are evaluated with respect to the same set of alternatives:

(37) a. Usually, John [agrees]$_F$ with Mary.

b. Usually, John [doesn't agree]$_F$ with Mary.[11]

Since agreeing presupposes the occurrence of a discussion, both ALT([**agree**]$_F$) and ALT($\neg$[**agree**]$_F$) constitute the set of possible reactions to a discussion, e.g. {**agree**, **argue**, **ignore**}. Sentences (37.a) and (37.b), then, are about situations in which John and Mary have a discussion: (37.a) is true iff in most of these situations, John agrees with Mary; (37.b)—if he does not.

It should be emphasized that we cannot, as Rooth and von Stechow propose, use the ordinary combinatory rule for negation to derive ALT($\neg$[**agree**]$_F$). That is to say, the set of alternatives cannot be $\{\neg\mathbf{agree}, \neg\mathbf{argue}, \neg\mathbf{ignore}\}$. If this were the case, (37.b) would be evaluated with respect to *all* situations, since John and Mary *always* satisfy at least one of those alternative: when they argue, they satisfy $\neg\mathbf{agree}(\mathbf{j}, \mathbf{m}, s)$, and when they do not argue, they satisfy $\neg\mathbf{argue}(\mathbf{j}, \mathbf{m}, s)$. Hence, even if John and Mary are in complete agreement whenever they have a

discussion, (37.b) will be true, since most of the time (including times when John and Mary sleep, when they are at their respective workplaces, etc.) they do not have a discussion, and, trivially, do not agree on anything.

## 5.2 Conjunction

In the case of conjunctions, the predictions of the theory presented here coincide with those of Rooth's and von Stechow's. The alternatives to conjunctions are, straightforwardly, in the form of conjunctions:

**Rule 2 (Conjunction)** $\quad ALT([\phi]_F \wedge \psi) \;=\; \{\phi' \wedge \psi | \phi' \in ALT(\phi)\}$

For example, (38.a) is about situations in which Bill drives too fast and receives some punishment, stating that in most such situations he gets a ticket; (38.b), on the other hand, is about situations in which Bill breaks the law somehow and gets a ticket, stating that in most such situations he drives too fast:

(38) a. Bill usually drives too fast and [gets a ticket]$_F$ (but yesterday he was arrested).

b. Bill usually [drives too fast]$_F$ and gets a ticket (but yesterday he crossed a solid white line).

Since, as mentioned above, it is hard to focus only one conjunct, the effect is stronger when conjunction is expressed by (part of the meaning of) *after*:

(39) a. Bill usually [gets a ticket]$_F$ after he drives too fast (but yesterday he was arrested).

b. Bill usually gets a ticket after he [drives too fast]$_F$ (but yesterday he crossed a solid white line).

## 5.3 Disjunctions

Assuming that natural language obeys de Morgan's laws, we can apply them to rules 1 and 2 to derive the set of alternatives induced by disjunctions:

**Rule 3 (Disjunction)**

$$\begin{aligned} ALT([\phi]_F \vee \psi) \;=\; & ALT(\neg(\neg[\phi]_F \wedge \neg\psi)) \;= \\ & ALT(\neg[\phi]_F \wedge \neg\psi) \;= \\ & \{\phi' \wedge \neg\psi | \phi' \in ALT(\phi)\} \end{aligned}$$

In words, the alternatives to a disjunction take the form of conjunctions. This claim contrasts with Rooth and von Stechow, whose rules predict alternatives to a disjunction to be in the form of disjunctions. This may seem counterintuitive at first, but is, in fact, precisely what is needed to account for the truth conditions of sentences like (17) and (18), repeated below:

(40) a. Usually, people obey the law or they are sentenced to $[\text{death}]_F$.

b. Usually, people obey the law, or else they are sentenced to $[\text{death}]_F$.

c. Usually, people are sentenced to $[\text{death}]_F$ unless they obey the law.

The set of alternatives to the VP is:

(41) ALT(obey the law or be sentenced to $[\text{death}]_F$)=
$\{\text{disobey the law and be sentenced to } x | x \text{ is some punishment}\}$

Consequently, the sentences in (40) are true iff the majority of people who are punished for disobeying the law, are sentenced to death; since this is happily not the case, (40) are false, as desired.

To take another example, consider the familiar adage that all good things are either illegal, immoral or fattening. Suppose that 80% of all good things were fattening, 19% immoral and 1% illegal. Given this scenario, the sentences in (42), where *illegal* is focused, are false:

(42) a. Usually, good things are fattening, or they are $[\text{illegal}]_F$.

b. Usually, good things are fattening, or else they are $[\text{illegal}]_F$.

c. Usually, good things are $[\text{illegal}]_F$, unless they are fattening.

The alternatives to the VP are:

(43) ALT($[\text{illegal}]_F$ or fattening)=
$\{\phi \wedge \neg \mathbf{fattening} | \phi \in \{\mathbf{fattening}, \mathbf{immoral}, \mathbf{illegal}\}\}$

Hence (42) would be true just in case the majority of good things which are *not* fattening are illegal. Since only twentieth of those are illegal, the sentence is false. If, on the other hand, we followed Rooth and von Stechow in deriving disjunctions as alternatives to disjunctions, (42) would be satisfied iff the majority of good things were illegal or fattening. Since, in the scenario described, this is true of 81% of good things, we would, incorrectly, predict (42) to be true.

## 5.4 Alternatives and Presupposition Projection

In this paper I propose that alternatives are induced by presuppositions. If so, the manner in which alternatives are derived should be the same as that in which presuppositions are projected. It is well known that presuppositions of parts of a complex phrases are often inherited by the phrase as a whole, but not always. Determining the constraints guiding such inheritance is known as *the projection problem*. I will not attempt a solution to this problem here; my aim is to use this phenomenon to show that whatever principles constrain the projection of presuppositions, they also constrain the computation of alternatives. That is to say, I claim that the problem of computing alternatives is the same problem as that of determining presuppositions.

In the previous section I have proposed three rules for the computation of alternatives; it turns out there are exceptions to these rules, and these exceptions are exactly those cases where presuppositions of the parts are not inherited by the whole.

Consider conjunctions. The presupposition of a conjunction is usually the conjunction of the presuppositions of the conjuncts. However, if the first conjunct entails a presupposition of the second conjunct, this presupposition is not inherited by the conjunction, as first observed by Karttunen (1973).[12] He notes that although (44.a) presupposes that Fred has kissed Cecilia before, (44.b) does not presuppose this statement (though it does entail it). This can be seen by the fact that (44.c) may be true even if Fred has never kissed Cecilia in the actual world.

(44) a. Fred will kiss Cecilia again.

b. Fred has managed to kiss Cecilia and Fred will kiss Cecilia again.

c. It is possible that Fred has managed to kiss Cecilia and that he will kiss her again.

Now consider the following example:

(45) People usually attempt to survive a week without food and manage to do so.

The first conjunct of the verb phrase entails the presupposition of its second conjunct, namely an attempt to survive a week without food. Hence, this presupposition is not inherited by the verb phrase as a whole and, consequently, (45) is not only about people who attempt to survive a week without food, but about people in general. Therefore, unlike (31), sentence (45) is false.

This is also the case with alternatives induced by focus. We have seen above that (6), repeated below, is evaluated only with respect to situations in which John and Mary are having a discussion. Its truth requires that John agree with Mary in all these situations, but not that he agree with her 24 hours a day.

(46) John always [agrees]$_F$ with Mary.

But note that the same is not true of (47):

(47) John always has a discussion with Mary and [agrees]$_F$ with her.

This sentence can only get the bizarre interpretation that, in all situations, John has a discussion with Mary and that, furthermore, he agrees with her in all these situations.

Note that the first conjunct entails the presupposition of the second conjunct, namely that John and Mary are having a discussion; this presupposition, therefore, is not projected, and does not induce a set of alternatives to restrict the domain of quantification. Note that Rooth and von Stechow, as well the exceptionless rule 2 above, would erroneously predict that (47), just like (46), is only about situations where John and Mary are having a discussion.

A similar point can be made regarding disjunctions. Again, the relevant observation ha first been made by Karttunen (1973). He notes that a presupposition of $\psi$ will be inherited by the disjunction $\phi \vee \psi$ unless it is entailed by $\neg\phi$. For example, while (48.a) presupposes that Jack has children, (48.b) does not, since the presupposition of the second disjunct is entailed by the negation of the first disjunct:

(48) a. All of Jack's children are bald.

b. Either Jack has no children or all of Jack's children are bald.

Now consider (49):

(49) a. Usually, politicians are crooked, or they [hide]$_F$ their honesty.

b. Usually, politicians are crooked, or else they [hide]$_F$ their honesty.

c. Usually, politicians [hide]$_F$ their honesty unless they are crooked.

Rule 3 would predict that (49) quantifies over politicians who are *not* crooked; (49) ought to be true just in case the majority of honest politicians hide their honesty. However, this is incorrect; suppose the majority of politicians are crooked, but the few honest ones flaunt their honesty rather than hide it. In this scenario,

rule 3 would predict (49) to be false, but it is clearly true. Now note that the presupposition of the second disjunct of (49) is entailed by the negation of the first: hiding one's honesty presupposes being honest, and being honest is entailed by the negation of being crooked. The fact that (49) is not only about honest politicians, but about all politicians, shows that the presupposition of the second disjunct is not inherited by the disjunction, in accordance with Karttunen's observation. Hence, this phenomenon provides additional evidence that alternatives are determined by presupposition.

We may not know the exact nature of the rules which govern the derivation of presuppositions, but we do know that this behavior is not arbitrary, but is governed by *some* rules.[13] What I have attempted to show in this paper is that those rules, rather than the regular semantic combinatory rules, are those that determine the computation of alternatives. Thus, any solution to the problem of presupposition would immediately provide a principled, empirically adequate account of the computation of alternatives.

# A Semantic Relations between Arbitrary Expressions

Definitions 6 and 7 above make use of semantic relations; specifically, the definitions refer to entailment, equivalence, and presupposition. Such relations are only defined between truth carriers, i.e. propositions; however, focused expressions often denote other semantic objects, such as properties, relations, individuals, functions, etc. In order to provide an account of alternatives in terms of presupposition, semantic relations need to be formally defined for expressions which are not propositions.

Let us first deal with expressions whose type is *propositional*, i.e. a function from zero or more types to the type of propositions.[14]

**Definition 9 (Semantic relations)** *Let $\phi$ and $\psi$ be expressions of the type $\langle \mathcal{T}_1, \ldots, \mathcal{T}_n, \mathbf{t} \rangle$, where $\mathbf{t}$ is the type of propositions. Let $\bowtie$ be a semantic relation, e.g. entailment or presupposition. Then $\phi \bowtie \psi$ holds iff for every assignment of values to the variables $x_1^{\mathcal{T}_1}, \ldots, x_n^{\mathcal{T}_n}$,*

$$\phi(x_1^{\mathcal{T}_1}, \ldots, x_n^{\mathcal{T}_n}) \bowtie \psi(x_1^{\mathcal{T}_1}, \ldots, x_n^{\mathcal{T}_n}).$$

For example, we will say that the property **scarlet** entails the property **red**, just in case, for every assignment of values to the individual variable $x$, $\mathbf{scarlet}(x)$

entails **red**$(x)$. To give another example, the relation **manage** presupposes the relation **attempt** iff for every assignment of values to the individual variable $x$ and the proposition variable $y$, **manage**$(x, y)$ presupposes **attempt**$(x, y)$.

What about an expression whose type is not propositional? The type of such expressions is a function from zero or more types to the type of individuals. In order to define a semantic relation for such an expression, we first need to transform it into an expression of a propositional type. This will be accomplished by *Quining*,[15] which I define as follows:

**Definition 10 (Quining)** *Let $\phi$ be of the type $\langle \mathcal{T}_1, \ldots, \mathcal{T}_n, \mathbf{e} \rangle$, where* $\mathbf{e}$ *is the type of individuals. Quining $\phi$ results in:*

$$\lambda x^{\mathbf{e}}.\lambda x_1^{\mathcal{T}_1} \ldots \lambda x_n^{\mathcal{T}_n}.\ x^{\mathbf{e}} = \phi(x_1^{\mathcal{T}_1}, \ldots, x_n^{\mathcal{T}_n}).$$

After $\phi$ is Quined, we can use definition 9 to define semantic relations between $\phi$ and another expression. For example, the individual **Socrates** will be Quined into the property of being equal to **Socrates**: $\lambda x.x =$ **Socrates**. Thus, being Socrates presupposes being human just in case for every assignment of values to the individual variable $x$, $x =$ **Socrates** presupposes **human**$(x)$.

As another example, consider the function **father-of**. When it is Quined, a two-place relation results: $\lambda x.\lambda y.x =$ **father-of**$(y)$. Therefore, being a father entails being a parent just in case, for every assignment of values to the individual variables $x$ and $y$, $x =$ **father-of**$(y)$ entails **parent**$(x, y)$.

# Notes

[1]See also de Swart (1991), who formulates this account within a dynamic logic approach.

[2]Compare de Swart (1991), who reinterprets Rooth's definition of the focus semantic value in exactly this way.

[3]This definition does not actually appear in his paper, but it follows from it.

[4]More precisely, for von Stechow alternatives are sets of worlds; for example, ALT([Ede]$_F$ walks) is the set of worlds where some alternative to Ede walks. He states that

$$\mathrm{ALT}(\phi \vee \psi) = \mathrm{ALT}(\phi) \cup \mathrm{ALT}(\psi).$$

In words, ALT($\phi \vee \psi$) is the union of the set of worlds where some alternative to $\phi$ holds with the set of worlds where some alternative to $\psi$ holds, i.e. the set of worlds where some disjunction of the form $\phi' \vee \psi'$ holds, where $\phi'$ is an alternative to $\phi$ and $\psi'$ is an alternative to $\psi$.

[5]*Kölsch* and *Pils* are kinds of German beer. Interestingly, *lager* in German does not denote a kind of beer (its meaning is actually *camp*), although the etymology of the English word *lager* is, in fact, German.

[6]Perhaps this claim needs to be qualified a bit. If some form of linguistic determinism turns out to be true, then a language may affect the ontology of the language user, hence affect the set of alternatives. But even if such influence does exist, it can only be indirect, by affecting the world view of the language user.

[7]See also Blok and Eberle (forthcoming). They design a sort hierarchy, where alternatives are immediate daughters of "framed" nodes, and claim that context helps to determine which nodes are framed. Blok and Eberle do not, however, provide any account of what it is about the context which brings about this effect.

[8]Schubert and Pelletier (1987) also claim that "it is often *presuppositions of the verb phrase* which suggest the [set of alternatives]" (442, original emphasis). They do not, however, explain why this should be so.

[9]See Vallduví (1992) and Erteschik-Shir (1997) for overviews.

[10]Compare Schubert and Pelletier (1987), who consider how determining the restriction of the domain of the quantifier

> interacts with presuppositions based on presuppositional verbs (as opposed to presuppositions based on stress patterns). Our impression is that verb presupposition tends to 'win out' if there is a conflict (p. 443).

[11]Readers who find (37.b) odd may want to consider the second conjunct of (i) instead:

(i) John usually listens to Mary, but he [doesn't agree]$_F$ with her.

The points made here will apply equally well.

[12]Let me emphasize that I am using Karttunen's generalizations as descriptive statements only, making no comment on their explanatory adequacy.

[13]See Beaver (1997) for a thorough overview of the projection problem and the proposed solutions to it.

[14]I remain agnostic here regarding what the type of propositions actually is.

[15]Named after Quine's (1960) "reparsing" of names as properties, so that, for example, *Socrates* is reparsed into the property of being Socrates.

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