Some constraints on the derivation of alternatives

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Abstract

A prevalent view in alternative semantics is that symmetry can only be broken formally, i.e. that exhaustification of a sentence S implies $\neg S'$ only if S' is a formal alternative of S and no other formal alternative of S implies $\neg S'$. We present some data which contradict this view. Taking Fox and Katzir (2011) as the basis, we develop a definition of F(S), the set of formal alternatives of sentence S, and propose a constraint on possible restrictions of F(S) which together derive the empirically correct inferences.

1 Introduction

Exhaustification of a sentence S negates certain "alternatives" of S.[1]

(1) a. John (only) did some of the homework
Inference: $\neg$[John did all of the homework]
$\rightarrow$ A = {John did Q of the homework | Q $\in$ {some, all}}
b. John (only) has three chairs
Inference: $\neg$[John has four chairs]
$\rightarrow$ A = {John has n chairs | n $\in$ {one, two, three, four, ...}}

(2) $\text{EXH}(A)(S) \Leftrightarrow S \wedge \bigwedge\{\neg S' \mid S' \,\varepsilon\, N_S(A)\}$

One way to describe the "strengthened meaning" of a sentence S, i.e. the conjunction of its literal meaning and its "implicature," is to say that S can be parsed as **exh**(A)(S) (cf. Krifka 1995, Fox 2007a, Chierchia et al. 2012, Magri 2009, 2011, among others).[2]

(3) EXH(S)(A) is true iff S is true and each S' in $N_S(A)$ is false

(4) a. John did some of the homework
Inference: $\neg$[John did all of the homework]
$\rightarrow$ A = {John did Q of the homework | Q $\in$ {some, all}}
b. John has three chairs
Inference: $\neg$[John has four chairs]
$\rightarrow$ A = {John has n chairs | n $\in$ {one, two, three, four, ...}}

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[1] For arguments that implicatures are computed in the grammar by way of a silent exhaustifying operator, see (cf. Krifka 1995, Fox 2007a, Chierchia et al. 2012, Magri 2009, 2011, among others).

[2] Following Fox (2007b,a), we assume N(S,A) in (3) to be the set of "innocently excludable alternatives in A given S," defined as in (i).

(i) $N(S,A) = \cap \{A' \mid A'$ is a maximal subset of A such that $\{S\} \cup \{\neg S' \mid S' \,\varepsilon\, A'\}$ is consistent$\}$

Informally, then, N(S,A) is the intersection of all maximal subsets of A whose elements can be consistently negated in conjunction with S.

This approach to implicature amounts to assimilating it to association with focus (cf. Fox 2007b, Fox and Katzir 2011). The definition of **exh** is essentially that of the exhaustifying operator **only**, modulo the fact that **only**(A)(S) presupposes the prejacent instead of asserting it.

(5) only(A)(S) ⇔ exh(A)(S) if $\models_c$ S, undefined otherwise

For present purposes, we can ignore the difference between presupposition and assertion and regard **only** simply as the overt counterpart of **exh**.

(6) exh(A)(S) = only(A)(S) = EXH(A)(S)

Goal of the talk: to proposed a characterization of A which derives inferences of EXH(A)(S) that pose a challenge for the theory of alternatives advanced in Fox and Katzir (2011).

(7) a. Bill went for a run and didn't smoke. John (only) went for a run.
Inference: ¬[John went for a run and didn't smoke]
b. Bill fathered some children but no twins. John (only) fathered some children.
*Inference: ¬[John fathered some children but no twins]

(8) The committee didn't pass all of my students
Inference: ¬[The committee didn't pass some of my students]

(9) Some of my students did all of the readings
*Inference: ¬[All of my students did some of the readings]

1.1 Relevance and symmetry

Rooth (1992) notes that EXH(A)(S) licences different inferences depending on which constituent of S is focused and what is relevant.

(10) Rooth (1992)
a. A = F(S) ∩ C
b. F(S) = {S′ | S′ is derivable from S by replacement of F-marked constituents with expressions of the same semantic type}
c. C = {S′ | S′ is relevant}

It seems natural to assume that relevance is closed under negation and conjunction.[3]

(11) a. If p ε C, then ¬p ε C
b. If p ε C and q ε C, then p∧q ε C

But these conditions lead to the so-called "symmetry problem."[4]

(12) John (only) [has three chairs]$_F$
F(S) = {S′ = John has four chairs, S″ = John has exactly three chairs,...}
Inference: ¬S′

(13) John (only) [did some of the homework]$_F$
F(S) = {S′ = John did all of the homework, S″ = John did some but not all of the homework,...}
Inference: ¬S′

[3]A more formal way to motivate (11) is to assume that conversation is guided by a "question under discussion," and to be relevant is to distinguish only between answers to this question. More explicitly, let Q be the question under discussion and Ans(Q)(w) be the set of answers to Q that are true in w. For a proposition p to be relevant, it must hold that p makes no distinction between any two worlds w and w′ if there is no distinction between Ans(Q)(w) and Ans(Q)(w′), i.e. it must hold that for all w, w′, p(w) = p(w′) if Ans(Q)(w) = Ans(Q)(w′). The conditions in (11) follow from this assumption (cf. also Groenendijk and Stokhof 1984, Lewis 1988, von Fintel and Heim 1997).

[4]The symmetry problem was first formulated in the context of the discussion on scalar implicatures (Kroch 1972, von Fintel and Heim 1997). However, it generalizes to association with focus, as shown in Fox and Katzir (2011).

(14) John (only) [talked to Mary or Sue]$_F$
F(S) = {S' = John talked to Mary and Sue, S'' = John talked to Mary or Sue but not both,...}
Inference: $\neg S'$

(15) John (only) [read a book]$_F$
F(S) = {S' = John watched a movie, S'' = John didn't watch a movie,...}
Inference: $\neg S'$

We will call such pairs of alternatives as S' and S'' in the examples above "symmetric alternatives" and the problem they create for the theory of exhaustification the "symmetry problem."

(16) S' and S'' are "symmetric alternatives" of S iff
(i) $S' \wedge S''$ is a contradiction, and
(ii) either $S' \vee S''$ is equivalent to S or $S' \vee S''$ is the tautology

The symmetry problem: the theory imlies that A either contains both S' and S'' or none of these alternatives, while the facts imply that A contains S' but not S''.

1.2 The complexity metric and exhaustive relevance

The attempt to break symmetry which we find most adequate to date is that made in Fox and Katzir (2011), which builds on Katzir (2007, 2008).

(17) Fox and Katzir (2011)
$F(S) = F_{Rooth}(S) \cap \{S' \mid S' \preceq_c S\}$

The relation '$x \preceq_c y$' holds between linguistic expressions and is to be understood as 'x is no more complex than y in discourse context c.'

(18) Complexity metric (Fox & Katzir)
a. $E' \preceq_c E$ if $E' = T_n(...T_1(E)...)$, where every $T_i(x)$ is the result of replacing a constituent of x with an element of SS_c, the substitution source in c
b. $SS_c = \{x \mid x \text{ is a lexical item}\} \cup \{x \mid x \text{ is a constituent uttered in c}\}$

Basically, E' is no more complex than E if E' can be derived from E by a series of substitution transformations, each of which applies to an input x and replaces one constituent of x with a lexical item or a constituent uttered in the context.

(19) John (only) [has three chairs]$_F$
F(S) = {John has four chairs, ~~John has exactly three chairs~~,...}

(20) John (only) [did some of the homework]$_F$
F(S) = {John did all of the homework, ~~John did some but not all of the homework~~,...}

(21) John (only) [talked to Mary or Sue]$_F$
F(S) = {John talked to Mary and Sue, ~~John talked to Mary or Sue but not both~~,...}

(22) John (only) [read a book]$_F$
F(S) = {John watched a movie, ~~John didn't watch a movie~~,...}

F&K's metric accounts for facts beyond those we have considered.

(23) Yesterday it was (only) warm. Today it is warm and sunny with gusts of wind.
Inference: ¬Yesterday it was hot
Inference: ¬Yesterday it was warm and sunny with gusts of wind

(24) Yesterday it was (only) warm
Inference: ¬Yesterday it was hot
*Inference: ¬Yesterday it was warm and sunny with gusts of wind

(25) Detective A concluded that the robbers stole the book and not the jewelry. Detective B (only) concluded that they stole the book.
Inference: ¬Detective B concluded that the robbers stole the book and not the jewelry
Inference: ¬Detective B concluded that the robbers stole the book and the jewelry

F&K's theory derives the right alternatives for disjunction in the same manner as other alternatives are derived, i.e. by substitution.

(26) John is (only) required to read the book or do the homework
Inference: ¬John is required to read the book
Inference: ¬John is required to do the homework

But there is a little problem with disjunction:

(27) Bill talked to Mary. John (only) talked to Mary or Sue.
*Inference: ¬John talked to Mary

The conditions on C do not rule out C = {Mary∨Sue, Mary, Mary∧Sue}, which induces the unattested inference. In light of this problem, F&K propose that A should not be regarded as F(S) ∩ C but instead as an "allowable restriction of F(S)," defined as follows.

(28) Allowable restriction (Fox and Katzir)
a. A is an allowable restriction of F(S) if (i) A contains S and (ii) no member of F(S)\A is exhaustively relevant given A
b. A proposition p is exhaustively relevant given A if EXH(A)(p) is in the Boolean closure of A

The definition in (28) guarantees that A = {Mary∨Sue, Mary, Mary∧Sue} is not an allowable restriction of F(Mary∨Sue). The reason is that F(Mary∨Sue)\A contains "Sue," which is exhaustively relevant given A, since EXH(A)(Sue), being equivalent to Mary∨Sue ∧ ¬Mary, is in the Boolean closure of A.

2 Identifying a problem

Although F&K's definition of A as an "allowable restriction" of F(S) deviates slightly from the definition of A as F(S) ∩ C, it crucially shares with the latter the prediction that symmetry cannot be broken by restriction of F(S): if F(S) contains two symmetric alternatives then no restriction of F(S) can eliminate one without also eliminating the other.[5]This consequence of F&K's proposal reflects a conviction underlying most analyses in alternative semantics.

(29) Standard view on symmetry
Symmetry can only be broken formally

Let us, at this point, introduce the main empirical puzzle that this paper sets out to resolve. Consider the sentences in (30).

(30) a. Bill went for a run and didn't smoke. John (only) went for a run.
F(S) Inference: ¬[John went for a run and didn't smoke]
b. Bill works hard and doesn't watch TV. John (only) works hard.
Inference: ¬[John works hard and doesn't watch TV]
c. Bill is tall and not bald. John is (only) tall.
Inference: ¬[John is tall and not bald]

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[5]Proof: Let F(S) contain an alternative S′ as well as its symmetric counterpart S″, and let A contain S′ but not S″. It follows from the definition of EXH that EXH(A)(S″) ⇔ S″ ∧ φ, where φ is in the Boolean closure of A. This means that EXH(A)(S″) is in the Boolean closure of A if S″ is. Given that A contains S and S′ and that S″ is either equivalent to S ∧ ¬S′ or equivalent to ¬S′, it follows that S″ is in the Boolean closure of A, hence that EXH(A)(S″) is in the Boolean closure of A, hence that A is not an allowable restriction of F(S). QED.

These sentences all license the inference that what is true of Bill is not true of John. This inference requires A to be a symmetry-breaking restriction of F(S). Thus, (30) is evidence that the standard view on symmetry is false. Now consider the sentences in (31).

(31) a. Bill ate exactly three cookies. John (only) ate three cookies.
*Inference: ¬John ate exactly three cookies
b. Bill fathered some children and no twins. John (only) fathered some children.
*Inference: ¬John fathered some children and no twins
c. Bill passed some of the fitness tests and failed some. John (only) passed some of the fitness tests.
*Inference: ¬[John passed some of the fitness tests and failed some]

These sentences do not license the inference that what is true of Bill is not true of John. Thus, (31) is evidence that the standard view on symmetry is correct.

The task, therefore, is to redefine A in such a way that symmetry can be broken in the first set of cases but not in the second.

3 Solving the problem

3.1 First attempt: pragmatic scales

One strategy that readily comes to mind in light of the observations presented in the last section is the following. First, we relax the definition of A as an allowable restriction of F(S) from (28) to (32), thereby permitting symmetry to be broken by contextual restriction of F(S).[6]

(32) Allowable restriction (first revision)
A is an allowable restriction of F(S) if A contains S

Second, we explain the absence of inferences which depend on contextual symmetry breaking as being due to those inferences coming into conflict with other constraints. Pursuing this idea, let us consider (33a) and (33b), as representatives of cases where symmetry can and cannot be broken by contextual restriction of F(S), respectively.

(33) a. Bill went for a run and didn't smoke. John only went for a run.
Inference: ¬[John went for a run and didn't smoke]
b. Bill passed some of the fitness tests and failed some. John only passed some of the fitness tests.
*Inference: ¬[John passed some of the fitness tests and failed some]

Given common knowledge, it seems much easier to construct a "pragmatic scale" on which running and smoking is ranked lower than running and not smoking than it is to construct one on which passing all of the tests ranks lower than passing some but not all of the tests. Let us, then, impose the following constraint on **only** (cf. Klinedinst 2004).

(34) **only**(A)(S) licences $\neg S'$ as an inference only if $S \wedge \neg S'$ is ranked lower than $S \wedge S'$ on some pragmatic scale

The contrast in (35) gives further supporting evidence for (34).

(35) a. Bill went for a run and didn't smoke. John only went for a run.
b. #Bill went for a run but didn't lift weights. John only went for a run.

[6] This revision will require us to say something about disjunction in order to ensure that if S' is an alternative of (S' **or** S'') then S'' must also be one. Let us ignore this problem for now.

However, it turns out that the constraint on **only** in (35) is not enough to explain the contrast in (33): the contrast persists even in contexts where passing some but not all of the tests is ranked higher than passing all of the tests.

Situation: Everyone has to go through military fitness tests and those who passed all of these tests must join the army and go to the front to be slaughtered by the enemy while those who failed some of the tests can stay home and go to college.

(36) Bill has once again been dealt a better hand than John. He passed some of the military fitness tests and failed some, while John only passed some of the tests.
*Inference: ¬[John passed some of the tests and failed some]

And similarly for all other examples in (31).

Situation: "gluttony rehab center" where eating less cookies means making more progress.

(37) Bill is making more progress at the gluttony rehab center than John. Today he ate exactly three cookies, while John only ate three cookies.
*Inference: ¬[John ate exactly three cookies]

Situation: "genetic lab" where scientists try to engineer the most "representative" male homo sapiens, i.e. one which can father children but which does not have the biological defect of always fathering (identical) twins.[7]

(38) Bill turned out to be a better specimen than John. He fathered some children and no twins, while John only fathered some children.
*Inference: ¬[John fathered some children and no twins]

3.2 Second and final attempt

We will begin with the cases in which symmetry cannot be broken, again using (39) as the starting point.

(39) Bill passed some of the military fitness tests and failed some. John only passed some of the tests.
*Inference: ¬[John passed some and failed some of the test]

What we have to do is to prevent A from eliminating **pass all** from F(S) = {**pass some**, **pass some and fail some**, **pass all**, ...}. We propose to do this by way of the following revised definition of "allowable restriction."[8]

(40) Allowable restriction (final version)
A is an allowable restriction of F(S) if (i) A contains S and (ii) no member of F(S)\A logically entails a member of A

Because **pass all** logically implies **pass some** which by definition is in A, **pass all** must be in A. The definition works for the other examples in (31) as well.

(41) a. Bill ate exactly three cookies. John only ate three cookies.
F(S) = {three, exactly three, four, ...}
b. Bill fathered some children and no twins. John only fathered some children.
F(S) = {some children, some children and no twins, some twins,...}

What about cases in which symmetry can be broken? Let us take (30a), repeated in (42) below, as a representative of these.

(42) Bill went for a run and didn't smoke. John (only) went for a run.
Inference: ¬[John went for a run and didn't smoke]

[7] Let us, for argument's sake, assume that the male partner can be responsible for monozygotic twinning.

[8] Note that this definition achieves for disjunction what F&K's definition was intended to achieve: each disjunct is logically stronger than the disjunction, so both must be in A.

It turns out that the definition of A in (40) does not deliver the empirically correct result. By hypothesis, the set of formal alternatives of S = **John went for a run**, i.e. F(S), includes S' = **John smoked** and S'' = **John went for a run and didn't smoke**, generated by replacing **went for a run** in S with **smoked** and **went for a run and didn't smoke**, respectively. The problem is that F(S) also includes S''' = **John went for a run and smoked**, generated by replacing **didn't smoke** in S'' with **smoked**. And here is why this is a problem. The attested inference of EXH(A)(S) is $\neg S''$. This inference, given the definition of EXH, requires that A contain S and S'' but not S' or S''', as the reader can verify. However, the definition of A in (40) rules out this possibility: although it allows S' to be pruned from F(S), it does not allow the elimination of S''', since S''' logically implies S which by assumption is in A.

One way out of this dilemma, it would seem, is to revise the definition of A so that A can eliminate S''' from F(S). However, we are not clever enough to see how a solution along this line can harmonize with cases where symmetry cannot be broken, i.e. those which we used to motivate (40). Fortunately, there is another way to address the problem: we can revise the definition of F(S) in such a way that it never contains S''' in the first place. This will be the direction we take. First, note that S''' is distinguished from S' and S'' by the fact that its derivation involves two steps, not one, as shown in (43). By definition, constituents in the relevant substitution source include α = **went for a run and didn't smoke** and β = **smoked**, as both have been uttered in the context.

(43)	S	= John went for a run	the prejacent
	S''	= John went for a run and didn't smoke	replacing **went for a run** with α
	S'''	= John went for a run and smoked	replacing **didn't smoke** with β

We could therefore impose on F(S) the condition that its elements be derived in at most one step. However, this move would cost us an elegant solution to the notorious problem of multiple disjunctions, i.e. sentences of the form (A **or** (B **or** C)), which by default license the inference that exactly one disjunct is true. This inference turns out to follow straightforwardly from the current definition of F(S), which implies that (A **and** B), (A **and** C) and (B **and** C) are all formal alternatives of (A **or** (B **or** C)). The reader is invited to do the computation herself. What is crucial here is that none of these formal alternatives can be generated in one step: each of them requires a step which replaces **or** with **and** and another step which reduces the ternary coordination to a binary one, in either order. For example, (A **and** B) is derived from (A **or** (B **or** C)) by first replacing (B **or** C) with B and then replacing **or** in the result with **and**.

We believe this is good reason for not imposing on F(S) the condition that its elements be derived in at most one step. The question, then, is what makes S''' in (43) special other than the plurality of steps its derivation involves. The answer we are going to give requires the introduction of a new concept, that of a "syntactically atomic expression," which in turn requires a brief discussion of what we have been calling the "substitution source."

The substitution source can be naturally thought of as a set of expressions provided by the discourse context for the contruction of formal alternatives. Thus, the syntactic derivation of alternatives "begins" with the selection of a substitution source in much the same way as the syntactic derivation of sentences begins with the selection of a numeration (cf. Chomsky 1995). One manifest difference between these two contructs, of course, is that whereas the numeration contains only lexical items, the substitution source contains both lexical items and complex phrases. Interestingly, the core of our solution to the problem at hand will be the hypothesis that this difference is only phonological, not syntactic. Specifically, we propose the following.

(44) Syntactic Atomicity Constraint (SAC)
Expressions in the substitution source are treated syntactically as a lexical items

A simple way to implement this idea is to say that every expression in the substitution source is formally marked with a feature, AT, which makes its internal structure invisible and thus inaccessible to syntactic rules. Call lexical items and AT-marked expressions "atomic expressions." We now have a concept which unites the numeration and the substitution source: both contain only syntactically atomic expressions.[9] To see how this works, consider (30a) again, repeated in (45) below.

[9]Note that being a lexical item does not preclude being AT-marked: lexical items in the substitution source are AT-marked.

(45) Bill went for a run and didn't smoke. John (only) went for a run.

The substitution source of S = **John went for a run**, which is the prejacent of EXH, includes every constituent uttered in the discourse context. By assumption, every one of these will be marked with "AT." Thus, the substitution source includes α = **[$_{AT}$ went for a run and didn't smoke]** and β = **[$_{AT}$ smoked]**. Crucially, it does not include **went for a run and smoked**, as this is not a constituent uttered in the context. Let us now see what the derivation of the problematic S‴ = **John went for a run and smoked** would have to look like.

(46)

S	= John went for a run	the prejacent
S″	= John [$_{AT}$ went for a run and didn't smoke]	replacing **went for a run** with α
S‴	= John [$_{AT}$ went for a run and [$_{AT}$ smoked]]	*replacing **didn't smoke** with β

As we can see, the step from S″ to S‴ violates the constraint in (44): it replaces a proper part of a syntactically atomic expression with another expression. This means that S‴ cannot be derived, i.e. that it is not a formal alternative of S, which is the result we aimed for. Let us consider the other examples in (30), repeated in (47) below, to convince ourselves that the theory works for these cases as well.

(47) a. Bill works hard and doesn't watch TV. John (only) works hard.
b. Bill is tall and not bald. John is (only) tall.

The inference licensed by (47a) is that it is not the case that John works hard and doesn't watch TV, i.e, that he does watch TV. This inference is possible only if **John works hard and watches TV** is not among the formal alternatives of **John works hard**, which is in fact what we predict, as the derivation of this alternative would have to involve replacing a proper part of a syntactically atomic expression with another, as evident in (48), where α = **[$_{AT}$ works hard and doesn't watch TV]** and β = **[$_{AT}$ watches TV]**.

(48)

John works hard	the prejacent
John [$_{AT}$ works hard and doesn't watch TV]	replacing **works hard** with α
John [$_{AT}$ works hard and [$_{AT}$ watches TV]]	*replacing **doesn't watch TV** with β

Similarly, the inference licensed by (47b) is that it is not the case that John is tall and not bald, i.e. that he is bald. This inference is possible only if **John is tall and bald** is not a formal alternative of **John is tall**. Again, this is what we predict, as the derivation of **John is tall and bald** would have to involve replacing a proper part of a syntactically atomic expression with another, as shown in (49). Here α = **[$_{AT}$ is tall and not bald]** and β = **[$_{AT}$ bald]**.

(49)

John is tall	the prejacent
John [$_{AT}$ is tall and not bald]	replacing **tall** with α
John [$_{AT}$ is tall and [$_{AT}$ bald]]	*replacing **not bald** with β

It remains to show that (25), repeated in (50) below, is captured by our theory as well. This is the case which motivates our intepretation of F&K's notion of "successive replacement" as one which allows the kind of syntactic operations that we just argued should not be allowed.

(50) Detective A concluded that the robbers stole the book and not the jewelry. Detective B (only) concluded that they stole the book.
Inference: ¬Detective B concluded that the robbers stole the book and not the jewelry
Inference: ¬Detective B concluded that the robbers stole the book and the jewelry

F&K derive the second inference from the claim that the formal alternatives of S = **detective B concluded that they stole the book**, which is the prejacent, include S′ = **detective B concluded that they stole the book and the jewelry**. This claim is not compatible with what we have just said, as the derivation of S′ would have to involve first replacing **stole the book** in S with α = **[$_{AT}$ stole the book and not the jewelry]** and then replacing **not the jewelry** in the result with β = **[$_{AT}$ the jewelry]**, with the second step violating the SAC. However, what we can claim is that S″ = **detective B concluded that they stole the jewelry** is a formal alternative of S, as S″ can be generated by replacing **the book** in S with γ = **[$_{AT}$ the jewelry]**. The negation of S'' entailed by EXH(A)(S) will effectively yield F&K's result: if B did not conclude that the robbers stole the jewelry, then B did not conclude that they stole the book and the jewelry.[10]

4 Extending the proposal

In this section we will consider how the proposal we just made can be extended in some natural fashion to derive a number of observations that have posed problems, specifically overgeneration problems, for Neo-Gricean theories of scalar implicature. But first we should note that the system, as it is, can already account for a puzzle, presented in Romoli (2012a), which relates to the well-known observation that **[not[all]]**, by default, implicates ¬**[not[some]]** (Atlas and Levinson 1981, Horn 1989, Sauerland 2004), as exemplified in (51).[11]

(51) The committee didn't pass all of my students
Inference: ¬[The committee didn't pass some of my students]

Romoli points out, correctly, that given F&K's structural characterization of alternatives and the assumption, motivated by established facts and built into the definition of EXH in (3), that the computation of scalar implicatures involve the negation of not only logically stronger but also logically independent alternatives (Spector 2006), the attested inference of (51) is predicted to be non-existent. Thus, suppose the relevant analysis of the prejacent S = **the committee didn't pass all of my students** is (52).

(52) $[_{XP}$ not $[_{YP}$ the committee passed all of my students]]

F&K's theory predicts both S' = **the committee didn't pass some of my students** and S'' = **the committee passed some of my students** to be formal alternatives of (52): the first derived by replacing **all** with **some** and the second derived by replacing XP with YP followed by replacing **all** in the output with **some**. The problem is that S' and S'' are symmetric alternatives, which means that F&K would have find a way to say that utterance of (51), by default, makes S' relevant but not S''. Obviously, an explanation along this line looks rather hopeless. On the contrary, the facts follow straightforwardly from our theory, which simply rules out S'' as a formal alternative of S, as its derivation involves replacing a subpart of an atomic expression, namely **$[_{AT}$ the committee passed all of my students]**, with another.[12] Thus, our account circumvents the overgeneration problem that F&K's faces in this case.

Romoli (2012b) discusses another case of overgeneration which manifests itself in two related facts, the first of which is (53).[13]

(53) Some of my students did all of the readings
*Inference: ¬[all of my students did some of the readings]

Intuitively, (53) does not have the implicature that it is not the case that all of my students did some of the readings, i.e. that some of my students did none of the readings. This is a problem for F&K as well as for us, as we both predict that S' = **all of my students did some of the readings** to be a formal alternative of S = **some of my students did all of the readings**, and since S' is logically independent of S, we predict ¬S' to be an implicature of (53), which it is not. The second fact is (54).

(54) None of my students did all of the readings
Inference: all of my students did some of the readings

[10] Under the standard assumption that propositional attitude verbs such as **conclude** are universal quantifiers over worlds and thus distribute over conjunction (cf. Hintikka 1969).

[11] In what follows we will write "[α[β]]" to represent a sentence in which α scopes over β, with α and β ranging over logical constants such as **not**, **some** and **all**.

[12] The expression is atomic by virtue of being in the substitution source.

[13] In the same work, Romoli proposes a solution to the problem he identifies which has some resemblance to the solution we are going to propose below. We will not be able to discuss Romoli's account in this paper. The reader is invited to consult Chapter 6 in Romoli (2012b) for details.

This fact is related to the first through Romoli's assumption about the word **none**, which we will adopt. Specifically, Romoli takes **none** to be the morphological reflection of **some** embedded under negation. Thus, the analysis of (54) is (55).

(55) [not [some of my students did all of the readings]]

The generalization, then, is that **[not[some[all]]]** implicates ¬**[not[all[some]]]** but **[some[all]]** does not implicate ¬**[all[some]]**, even though in both cases the relevant alternative is logically independent of the prejacent and should be, given the system as it is, syntactically derivable from it. The task, therefore, is to fine-tune the system in such a way that **[all[some]]** can be derived from **[some[all]]** but **[not[all[some]]]** cannot be derived from **[not[some[all]]]**. In other word, the system should allow **some** and **all** to switch places only when both are embedded under negation. We propose to do this by way of the following three constraints on the replacement rule which is the only rule that applies in the derivation of formal alternatives. Let us give this rule a technical name, "F-replacement," to highlight the fact that it is not generic replacement but such as is subject to specific formal constraints.[14]

(56) F-replacement of constituent C only applies under the following conditions:
   a. C is not AT-marked
   b. C is not asymmetrically c-commanded by an AT-marked constituent
   c. The result is not logically weaker than the prejacent

Before showing how these contraints derive the facts, let us briefly discuss their content. The first, (56a), basically says that an expression which replaces another cannot itself be replaced, which makes sense from an economy standpoint, as replacing X with Y and Y with Z is just a cubersome way to replace X with Z. The second condition requires F-replacement to proceed "from bottom up," so to speak: it excludes the possibility of replacing X before replacing Y if X is structurally higher than Y. The last condition says that alternatives which are entailed by the prejacent, i.e. which cannot be negated by EXH, should not be generated. Moreover, it says that F-replacement is "myopic" in the sense that it does not look beyond its output: it compares its output to the prejacent, not what can be derived from its output.

Let us now see how these constraints work. First, consider **[not[some[all]]]** being the prejacent. We predict that the following derivation is possible.

(57)	[not[some[all]]]	the prejacent
	[not[some[some$_{\mathrm{AT}}$]]]	replacing **all** with **some**$_{\mathrm{AT}}$
	[not[all$_{\mathrm{AT}}$[some$_{\mathrm{AT}}$]]]	replacing **some** with **all**$_{\mathrm{AT}}$

Each step replaces an expression which is neither AT-marked nor asymmetrically c-commanded by an AT-marked constituent, and no step results in a sentence logically weaker than the prejacent. Thus, all replacements in (57) are F-replacements, which means **[not[all[some]]]** is a formal alternative of **[not[some[all]]]**. Now consider the case where the prejacent is **[some[all]]**. Logically, there are two ways to derive the problematic **[all[some]]** from it, either as in (58) or as in (59).

(58)	[some[all]]	the prejacent
	[some[some$_{\mathrm{AT}}$]]	*replacing **all** with **some**$_{\mathrm{AT}}$
	[all$_{\mathrm{AT}}$[some$_{\mathrm{AT}}$]]	replacing **some** with **all**$_{\mathrm{AT}}$

(59)	[some[all]]	the prejacent
	[all$_{\mathrm{AT}}$[all]]	*replacing **some** with **all**$_{\mathrm{AT}}$
	[all$_{\mathrm{AT}}$[some$_{\mathrm{AT}}$]]	replacing **all** with **some**$_{\mathrm{AT}}$

It turns out that both derivations are excluded by the constraints in (56). In (58), the second step yields a sentence which is logically weaker than the prejacent, and in (59), the second step replaces an expression which is asymmetrically c-commanded by an AT-marked constituent. It follows that **[all[some]]** is not a formal alternative of **[some[all]]**, which is the result we want.

[14]This means that we should now interpret the word "replacing" in the definition of F(S) in (18) as meaning 'F-replacing.'

We thus have a solution to the second overgeneration problem as well. It can be verified that the addition of the constraints in (56) to our proposal does not affect how it accounts for the facts discussed in the previous sections. But we will leave this task to the reader.

5 Conclusion

Exhaustification of a sentence makes reference to a set of alternatives. We have proposed a characterization of this set from which observations follow that either have not been made in the literature or have posed difficulties for other theories. Our proposal suggests that far more formal conditions need to be imposed on the syntactic derivation of alternatives than have been previously assumed. Specifically, we argue (i) that the derivation starts with a set of expressions to be used, each considered syntactically atomic in the sense that their internal structure is inaccessible to manipulation, (ii) that the derivation proceeds from bottom up, applying the relevant rule to more embedded expressions before less embedded ones, and (iii) that the derivation is myopic, each step being legitimized only by its output and not by what can be generated from that output. We also proposed a relatively simple constraint on how the set of syntactically generated alternatives can be restricted. Our system makes the prediction, generally considered false, that symmetry can be broken non-formally. We have shown that this prediction is born out by facts, and have shown that the conditions under which it is are expected in our account.

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