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RESEARCH ARTICLE

Structurally-defined alternatives

Roni Katzir

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Abstract Scalar implicatures depend on alternatives in order to avoid the symmetry problem. I argue for a structure-sensitive characterization of these alternatives: the alternatives for a structure are all those structures that are at most as complex as the original one. There have been claims in the literature that complexity is irrelevant for implicatures and that the relevant condition is the semantic notion of monotonicity. I provide new data that pose a challenge to the use of monotonicity and that support the structure-sensitive definition. I show that what appeared to be a problem for the complexity approach is overcome once an appropriate notion of complexity is adopted, and that upon closer inspection, the argument in favor of monotonicity turns out to be an argument against it and in favor of the complexity approach.

Keywords Scalar implicature · Horn scales · Complexity · Alternatives

Computing the scalar implicatures of a linguistic object involves reference to alternative objects that were not used. This paper argues for a structure-sensitive characterization of these alternative objects. For any structure ϕ, the alternatives will be all those structures that are at most as complex as ϕ, under a particular notion of complexity:

(1) $A_{str}(\phi) = \{\phi' \mid \phi' \lesssim \phi\}$

R. Katzir (✉)
Linguistics and Philosophy, MIT, 77 Mass. Ave., Bldg. 32-D808,
Cambridge, MA 02139, USA
e-mail: trifilij@mit.edu

Complexity is not a new notion in the domain of conversational reasoning. It is present in Grice's Maxim of Manner and elsewhere. However, there has also been skepticism about the relevance of complexity for scalar implicatures.[1] One reason for skepticism is the scarcity of instances where an inference about ϕ seems to require reasoning about a strictly simpler ϕ'. In most cases, ϕ and ϕ' are of roughly the same complexity. This is surprising under (1). On the other hand, under the widely assumed characterization of alternatives in terms of *scales* (Horn 1972; Gazdar 1979), the scarcity of complexity-related implicatures makes much more sense. And there have been other objections. Perhaps the most serious objection to the use of complexity is an argument by Matsumoto (1995), who observes that in certain cases an inference about an utterance ϕ requires reference to an alternative that appears to be strictly more complex than ϕ. Matsumoto's conclusion is that complexity does not play a role in the computation of implicatures. Instead, he follows Horn (1989) in adopting a semantic constraint on scale-mates that makes use of the notion of *monotonicity*. We will review these arguments in Sect. 1.

Section 2 presents an empirical observation that will suggest that complexity might be the right way to go after all. The observation is this: in certain contexts, a complex, non-monotonic expression can give rise to an implicature that requires a comparison with a simpler alternative. This goes against the monotonicity condition, and indirectly also against the notion of scale, while supporting the complexity approach.

To turn the complexity approach into an actual proposal, we will need an explicit definition of structural complexity. We will also have to address Matsumoto's objection, as well as the concern about the scarcity of comparisons with strictly simpler alternatives. Section 3 offers a definition of complexity, based on the idea that we can transform ϕ into a structure that is no more complex if we restrict ourselves to (a) *deleting* elements in ϕ, and (b) *substituting* elements in ϕ with other elements from an appropriately defined source. In Sect. 4 we will see that a large family of conversational inferences is correctly predicted, including certain disjunction puzzles analyzed by Sauerland (2004), as well as some new cases. Along the way we will see why inferences that refer to simpler alternatives are rare: usually, simpler structures result in weaker assertions, so no inference arises. Once this is observed, the problem can be avoided by embedding complex structures in downward-entailing contexts, where entailment relations are reversed. As predicted, we will find that in such contexts the relevant inferences arise. In Sect. 5 we turn to Matsumoto's argument against complexity. Addressing the argument will force us to be more careful about our notion of substitution source. This, in turn, will lead to certain new predictions.

The primary goal of this paper is to argue for a structure-sensitive characterization of the alternatives. The secondary goals are to argue against a monotonicity constraint on alternatives, as well as against the intermediate step of scales. Before we start, I would like to mention what this paper is *not* about. I will have very little to say about the question of whether implicatures are computed locally (as in

[1] From here on I will simply write *implicatures* rather than *scalar implicatures*, hoping that no confusion will arise.

Landman 2000; Chierchia 2004; Fox 2006, and others) or globally (as in the traditional accounts, as well as in recent proposals by Sauerland 2004; Russell 2006). Much of the discussion will be framed in terms of global, neo-Gricean reasoning, but this is done for ease of presentation only. As far as I can tell very little of the current discussion depends on this choice. Secondly, I will avoid talking about the relation of implicatures to exhaustivity in answers, as in the proposals of van Rooij and Schulz (2004), Sevi (2005), Spector (2007), and others. Finally, I will have nothing to say about implicatures that depend on context and world knowledge, of the kind discussed by Hirschberg (1985/1991).

1 Background

1.1 Conversational reasoning

Informally speaking, a cooperative speaker can be assumed to make maximally helpful contributions to the conversation. If ϕ and ϕ' are potential contributions, and if ϕ' is strictly better than ϕ (i.e., ϕ' is at least as good as ϕ in every relevant respect, and strictly better than it in at least one relevant respect), then a cooperative speaker will prefer using ϕ' when possible. Consider, for example, a situation in which (2) and (3) are both potential contributions to the conversation.

(2) John ate some of the cake

(3) John ate all of the cake

(3) is more informative than (2), but in all other respects the two sentences seem equally good. A cooperative speaker, then, will prefer using (3) to (2). If despite this preference the speaker has uttered (2), the hearer can conclude that there were considerations other than those mentioned above that prevented the speaker from using (3). Depending on what else can be assumed, the hearer may take this inference to license further conclusions. For example, they can conclude that the speaker does not have an opinion about (3), or that the speaker believes (3) to be false. Still in loose terms, the preference can be stated like this:

(4) Conversational principle (informal version): do not use a linguistic object ϕ if there is another object ϕ' such that both
   a. ϕ' is better than ϕ, and
   b. ϕ' could have been used

Several aspects of (4) must be specified if we want to be able to apply it at all. First, one has to decide what kinds of objects ϕ and its alternatives are. Then one has to provide concrete content to the term *use* (in fact, we will soon see that it is common to provide different content to each of the two occurrences of *use*), as well as to the term *better*. Once this is done, (4) can license the following kind of inference: if a cooperative speaker has used ϕ, then for all better alternatives ϕ' it is not the case that the speaker could have used ϕ' instead of ϕ. In our example, since (3) is better

than (2), the use of (2) licenses the inference that it is not the case that the speaker could have used (3).

Depending on what else is assumed, these inferences can sometimes license further inferences about why it is that the better ϕ' could not be used. For example, if the speaker can be assumed to be in a position to use either ϕ' or $\neg\phi'$, the weak inference *it is not the case that the speaker could have used* ϕ' can be strengthened into *it is the case that the speaker could have used* $\neg\phi'$. If such an assumption can be made about the speaker of (2), and if using an alternative implies believing that it is true, the hearer will conclude that the speaker believes that (3) is false, and that John ate some but not all of the cake.

The general 2-step architecture we just went through follows the proposals of Soames (1982), Hirschberg (1985/1991), Horn (1989), and more recently Sauerland (2004), and I will make extensive use of it in discussing possible choices for the definition of alternatives. The first step derives weak, or, using Sauerland's terminology, *primary* implicatures using a conversational principle. The second step strengthens these to *secondary* implicatures under certain conditions (see Fox 2006 for important modifications of this part). In terms of this architecture, the present paper focuses entirely on the first step.

1.2 The symmetry problem

As an attempt to turn (4) into a working definition, we can first try the following idea, based on an over-simplification of Grice, and more directly on the formulation in Gamut (1991). The linguistic objects, ϕ and its alternatives, are full sentences. Using them, in the sense of the first occurrence of *use*, means asserting them in discourse. *Better* means more informative, understood in terms of semantic entailment. And using an alternative ϕ', in the sense of the second occurrence of *use*, means that it is believed to be true, relevant, and supported by evidence. This last condition means, roughly, that ϕ' would be assertable in the absence of any other alternative. It will be convenient to have a shorter way to say this. I will do this by defining a notion of *weak assertability*[2]:

(5) Weak Assertability:
A structure ϕ will be said to be *weakly assertable* by a speaker S if S believes that ϕ is true, relevant, and supported by the evidence.

Our version of the conversational principle will now look like this:

(6) Conversational principle (naïve version): do not assert ϕ if there is another sentence ϕ' such that both
a. $[\![\phi']\!] \subset [\![\phi]\!]$, and
b. ϕ' is weakly assertable

[2] The definition of weak assertability makes reference to a speaker S. Most of the time, however, no confusion is likely to arise, and I will usually suppress this parameter.

We now have what looks like a concrete version of the conversational principle in (4), which we could use to reason about examples like (2) above. As noted by Kroch (1972), however, (6) does not work. The problem, dubbed the *symmetry problem* in class notes by Kai von Fintel and Irene Heim (see also Horn 2000; von Fintel and Fox 2002), has to do with the fact that (6) allows us to reason about too many alternatives: for any ϕ' that is stronger than ϕ, and that we would like to reason about, there is another alternative, $\phi'' = \phi \wedge \neg\phi'$, which is also stronger than ϕ, and which would license an inference in the opposite direction. Combined, ϕ' and ϕ'' license only ignorance inferences, contrary to fact.

To see how the symmetry problem arises in a simple example, let us return to (2) above, repeated here:

(7) John ate some of the cake

Assuming that the speaker obeys (6), the hearer can conclude that there was no sentence that is strictly more informative than (7) that the speaker could have (weakly) asserted instead. In particular, the speaker could not have asserted this (repeated from (3)):

(8) John ate all of the cake

(8) is more informative than (7). Assuming that (8) is relevant, the hearer may conclude that either (8) is not supported by the evidence that the speaker had or that the speaker believes it to be false. If (8) were the only sentence to consider in the context of (7), and if it is plausible that the speaker has access to the relevant evidence, the hearer could conclude that the speaker believes (8) to be false. However, (6) does not restrict us to (8) alone. Consider (9), for example:

(9) John ate some but not all of the cake

Like (8), (9) is also strictly more informative than (7), and the same reasoning as above would lead the hearer to conclude that either (9) is not supported by the evidence that the speaker has, or that the speaker believes it to be false. Again, if (9) were the only sentence to consider, and if it is plausible that the speaker is well-informed, the hearer could conclude that the speaker believes that (9) is false, and that John ate all of the cake. And here is the problem: given that (7) is true, the two alternatives (8) and (9) cannot be simultaneously false. Either John ate all of the cake or he didn't.[3] The speaker cannot believe that (8) and (9) are both false (unless the speaker is entertaining contradictory beliefs), and the hearer can reason that the speaker is not opinionated with respect to at least one of the two alternatives. But for a speaker who believes that (7) is true, being opinionated about one of the two alternatives means being opinionated about the other, and the hearer can conclude that the speaker is not opinionated about either. In other words, the speaker did not

[3] Assuming that all presuppositions are satisfied.

have access to the relevant evidence after all, and so was not in a position to believe either (8) or (9). The speaker is simply ignorant of the relevant facts.

Ignorance inferences of this kind often conflict with other beliefs of the hearer. For example, the hearer might be quite confident that the speaker was watching John throughout the cake-eating event. And yet there is nothing deviant in (7) even in this context. The assertion implies neither that the speaker has lost her recollection of whether or not John ate all of the cake nor that the speaker is non-cooperative. In fact, the standard inference in this situation is that the speaker believes that John did not eat all of the cake. That is, actual hearers reason as if only (8) were an alternative to (7) for purposes of conversational reasoning. Fixing (6), then, will require excluding (9) from the reasoning process.

1.3 Restricting the alternatives

1.3.1 The neo-Gricean approach

(6) said that when ϕ is uttered, every alternative ϕ' should be considered. The symmetry problem arose from the fact that for each such ϕ', a symmetric ϕ'' was available. A widely accepted solution involves being more careful about the alternatives that are being referred to. Each sentence ϕ can be thought of as being associated with a set of alternatives, $A(\phi)$, and it is only those alternatives that are considered for purposes of deriving implicatures. If $A(\phi)$ is chosen appropriately, it will consist of those alternatives that correspond to the actual inferences that are made. Symmetric alternatives of the kind that gives rise to unattested ignorance inferences will be excluded. Here is a minimally revised version of (6) that can refer to alternatives.

(10) Conversational principle (alternative-sensitive): do not assert ϕ if there is another sentence $\phi' \in A(\phi)$ such that both
   a. $[\![\phi']\!] \subset [\![\phi]\!]$, and
   b. ϕ' is weakly assertable

For (7) above, for example, the goal would now be to find a set of alternatives that will include (8) but not (9). Of course, one would like to have a principled way to arrive at $A(\phi)$ for any given ϕ. If we had to associate each sentence with an arbitrary set of alternatives, the theory would hardly be predictive.

1.3.2 Scales

Scales, introduced by Horn (1972) and developed further by Gazdar (1979), Atlas and Levinson (1981), and others, offer a partial solution to the problem of deriving $A(\phi)$. The intuition is this: to determine that (8) is a good alternative for (7) while (9) is not, all we have to know is that *all* is an alternative expression to *some* while *some but not all* is not. Determining whether sentences containing these expressions are alternatives to each other is done mechanically, by substitution. The idea, then, is to break down the task of deriving A, the relation between full sentences and

their alternatives, into two components. The first component is a new relation, S (for `scale-mate-of`), defined over a proper subset of linguistic objects, sometimes referred to as *scalar items* (the set of scalar items is typically finite, and is often taken to be a subset of the lexicon). The second component uses S to derive A by substitution: if $\langle \alpha, \alpha' \rangle \in S$, and if ϕ is a sentence that has an occurrence of α, then $\langle \phi, \phi[\alpha'/\alpha] \rangle \in A$, where $\phi[\alpha'/\alpha]$ is obtained from ϕ by replacing that occurrence of α with α'.[4] In our example, it would suffice to specify that $\langle$*some, all*$\rangle \in S$ while $\langle$*some, some but not all*$\rangle \notin S$.[5]

The scalar approach offers a way to avoid stating separately for every sentence what its alternatives are. However, if we don't know how scales are derived, their usefulness will be limited. For any two expressions we would need to know in advance whether they are scale-mates or not; otherwise, no predictions can be made. Perhaps we can do no better than that. Gazdar (1979, p. 58), for example, concluded that scales are ''... in some sense, 'given to us'''. I will try to show that we can do better than that, and that structural complexity provides an adequate characterization of alternatives. This direction, though, will eventually lead us to abandon the notion of scales.

1.3.3 Complexity and its problems

The role of complexity in communication was explored by Zipf (1949), Grice (1989), McCawley (1978), Atlas and Levinson (1981), and Horn (1984), among others (for more recent work, see Blutner 2000; Parikh 2000; van Rooij 2004). For our example (7) we can state the reasoning as follows. (7) and (8) are of roughly the same complexity, in some sense, and so they can be compared for purposes of computing implicatures. (9), on the other hand, is more complex than (7), and is consequently ignored. I stated the informal reasoning process in terms of comparing whole utterances. It is easy to do the same in terms of scales: *some* and *all* are of the same complexity, and can therefore be on the same scale, while *some but not all* is more complex than *some* and cannot be on the same scale with it.[6]

Within the Gricean framework, complexity has often been related to the Maxim of Manner. The status of this maxim, however, has remained unclear. For example, one

[4] As Sauerland demonstrates, the replacement of elements by their scale-mates should not be restricted to one-step substitutions. Rather, any sequence of replacements of elements with their scale-mates that can take us from ϕ to ϕ' will license using ϕ' as an alternative.

[5] A further point that Sauerland makes is that `scale-mate-of` must be a symmetric relation: what matters is the entailment relation between the whole sentences ϕ and $\phi[\alpha'/\alpha]$ and not between the scalar items α and α' within them. This is important for dealing with the phenomenon of scale reversal in downward-entailing contexts. The order in which the items are listed on the scales here, then, should not be taken as significant.

[6] In the literature, one often finds attempts to characterize alternatives in terms of *degree of lexicalization*, as distinct from brevity. Thus, Atlas and Levinson (1981, p. 44) write that ''... to constitute a genuine scale for the production of scalar implicatures, each item must be lexicalized to the same degree.'' As discussed by Matsumoto (1995), it is not always clear how one should distinguish between brevity and lexicalization (Matsumoto himself argues that neither of these is relevant for implicature). See Horn (2000) for further discussion on this matter, as well as for reasons to reject Atlas and Levinson (1981)'s symmetric condition in favor of a formulation that allows using alternatives that are strictly more lexicalized than what was uttered, much in the spirit of the current proposal.

wonders whether a cooperative speaker should avoid providing relevant information, as in the excluded *some but not all*, just in order to maintain simplicity. It is also somewhat surprising that the supposed effects of Manner are manifest almost exclusively in licensing alternatives of the same complexity, as with (7) and (8). Shouldn't we also expect to find a complex sentence having implicatures that are based on negating simpler alternatives? As mentioned in the introduction, however, candidates for such implicatures appear to be few and far between.

More serious concerns about the Maxim of Manner have to do with the precise notion of complexity that is used. Certain definitions, such as syllable count and phonetic effort, seem to yield incorrect results (see Poser 1992 for discussion). Worse, as argued by Matsumoto (1995), some implicatures require alternatives that are strictly more complex than the actual utterance under any reasonable definition of complexity. If this is correct, complexity cannot be the way to go.

The argument is based on the results of asserting (11a):

(11) a. It was warm yesterday, and it is a little bit more than warm today (Matsumoto 1995, ex. 39, p. 44)
b. It was a little bit more than warm yesterday, and it is a little bit more than warm today

As Matsumoto notes, uttering (11a) gives rise to the inference that it was only warm yesterday, and not a little bit more than warm. Intuitively, this inference seems to rely on considering the stronger alternative (11b) and concluding that it was false. The problem, of course, is that (11b) is more complex than (11a).

1.3.4 Monotonicity

Complexity, then, appears to be on the wrong track. A more promising approach, Matsumoto suggests, is the one that was outlined in Horn (1989), and in which the semantic notion of *monotonicity* (or *scalarity*) plays a role.

(12) ''Positive and negative quantifiers, modals, and related operators must be represented on distinct, though related scales. There can be no single scale on which operators like *some* and *not all*, or *possible* and *unlikely*, can be plotted. Rather, there is one scale defined by the positive operators and one by their negative counterparts.'' (Horn 1989, p. 235)

(13) ''Scalarity Condition: Expressions that form a Horn scale must be either 1) all positively scalar (e.g., ⟨*all, some*⟩) or 2) all negatively scalar (e.g., ⟨*no, few*⟩).'' (Matsumoto 1995, p. 46)

Condition (13) licenses the alternatives that we have seen so far.[7] It also prevents expressions such as *some but not all* from being on the same scale as *some*, or indeed on any scale.

[7] Though see Sevi (2005) for complications with applying the notion correctly.

In fact, one could try to further strengthen the argument for monotonicity and against complexity, as was pointed out to me by Danny Fox (p.c.). Imagine a complexity-based theory that would somehow allow (11b) to be used as an alternative for (11a). Such a theory, it seems, will also allow (14b) to be used as an alternative to (14a):

(14) a. John talked to some of the girls yesterday, and he talked to some but not all of the girls today
b. John talked to some but not all of the girls yesterday, and he talked to some but not all of the girls today

However, uttering (14a) does not give rise to the inference that (14b) is false. In fact, (14a) does not seem to give rise to any inference at all. It is just an odd sentence. For a monotonicity-based account, this is not a problem. The non-scalar *some but not all* is ruled out as an alternative on semantic grounds. It seems, then, that a complexity-based approach would have to include both a special mechanism that would license *a little bit more than warm* as an alternative for *warm* in sentences such as (11a), and a monotonicity condition to rule out *some but not all* as an alternative to *some* in the otherwise analogous (14a). This looks like a fairly direct argument against the complexity approach.

2 A puzzle

Having convinced ourselves that monotonicity works and that complexity does not, let us now look at the following sentences. In each example, uttering the (a) sentence seems to imply that the (b) sentence is unassertable.

(15) a. I doubt that exactly three semanticists will sit in the audience
b. I doubt that three semanticists will sit in the audience

(16) a. If we meet John but not Mary it will be strange
b. If we meet John it will be strange

(17) (Danny Fox, p.c.)
a. Everyone who loves John but not Mary is an idiot
b. Everyone who loves John is an idiot

By uttering (15a), for example, the speaker asserts that they find it unlikely that the number of semanticists in the audience will be exactly three, but they also suggest that they do not find it unlikely that the number would be at least three. Similarly, (16a) asserts that all situations in which we meet John but not Mary will be strange, while implying that, for all the speaker knows, there can be situations in which we meet John and in which there is no strangeness (in those situations we would necessarily also meet Mary, though it is conceivable that there would also be some strange situations in which we meet both John and Mary). And (17a) suggests that, as far as the speaker is concerned, it is possible to love John without being an idiot

(again, as long as one also loves Mary). In each example, the (b) sentence is stronger than the (a) one, so if we could use the (b) sentences as alternatives, we would be able to derive the implication that the (b) sentence is not assertable as an implicature of the (a) sentence.[8] The problem is that both *exactly three semanticists* and *John but not Mary* are non-scalar, and so the monotonicity approach predicts that they would not be used. On the other hand, the complexity approach makes the correct predictions here.

I will try to argue that the situation in (15)–(17) is not an accident, and that complexity, under the right formulation, provides a correct characterization of the alternatives, while monotonicity is wrong. To be able to make this claim I will have to provide a concrete definition of complexity-based alternatives, and I will also have to explain why it is that in some cases complexity appears to be wrong and monotonicity appears to be right.

3 Proposal

3.1 Structural complexity

Certain operations simplify a structure. Viewing syntactic structures as trees (or directed graphs, more generally, with edges representing motherhood), simplifying operations may involve *deletion* (removing edges and nodes) and *contraction* (removing an edge and identifying its end nodes). Other operations do not simplify but also do not add complexity. *Substitution* of one terminal element for another terminal element of the same category is an example, and more generally, substitutions of structures for other structures given an appropriately defined substitution source. For the moment we can think of the substitution source as the lexicon of the language, though we will revise this once we get back to Matsumoto's sentences in Sect. 5.[9]

(18) Substitution Source (first version, to be revised in 41):
Let ϕ be a parse tree. The *substitution source* for ϕ, written as $L(\phi)$, is the lexicon of the language.

We can now say that a structure ψ is no more complex than ϕ if ψ can be obtained from ϕ by a finite number of operations of the kind discussed above. Here are the definitions.

[8] That these are indeed implicatures can be seen by their cancelability. For example, the suggestion that it is possible to love John without being an idiot disappears if we continue (17a) with ''In fact, everyone who loves John [period] is an idiot.'' I thank an anonymous reviewer for pointing this out to me.

[9] The existence of a lexicon is a contentious issue (see Marantz 1997 for discussion), and in non-lexicalist approaches such as Distributed Morphology (DM, Halle and Marantz 1993) there is no place where words are listed to the exclusion of non-words. The use of the lexicon under the current proposal is done only for obtaining a set of easily accessible constituents for substitution. These do not have to be words, and the revision that will be needed to deal with Matsumoto's examples will bring in things that are strictly non-words. It might therefore be better to use something like the DM notion of *vocabulary* in the definition of $L(\phi)$, though for presentation purposes I will stick to the term *lexicon*.

(19) Structural Complexity:
Let ϕ, ψ be parse trees. If we can transform ϕ into ψ by a finite series of deletions, contractions, and replacements of constituents in ϕ with constituents of the same category taken from $L(\phi)$, we will write $\psi \lesssim \phi$. If $\psi \lesssim \phi$ and $\phi \lesssim \psi$ we will write $\phi \sim \psi$. If $\psi \lesssim \phi$ but not $\phi \lesssim \psi$ we will write $\psi < \phi$.

Using the structural relation $\lesssim$ we can now provide a complexity-based definition of the set of alternatives.

(20) Structural Alternatives:
Let ϕ be a parse tree. The set of *structural alternatives* for ϕ, written as $A_{str}(\phi)$, is defined as $A_{str}(\phi) := \{\phi' : \phi' \lesssim \phi\}$.

3.2 Using the alternatives

Having a set of alternatives is one thing. Using them is another. In the informal discussion above I have assumed a global comparison of alternatives. This is the traditional (neo-)Gricean approach (see Horn 1972; Gazdar 1979; Atlas and Levinson 1981; as well as Sauerland 2004; Russell 2006; Spector 2007; Geurts 2007 for a recent defense of the global approach). Over the past few years it has been recognized that the global approach faces non-trivial difficulties, and a localist approach to implicatures has been developed by Landman (2000), Chierchia (2004), and Fox (2006). It is not the goal of this paper to decide between these two approaches. Both make crucial use of alternatives, and both are compatible with the definition of structural alternatives in (20). I will keep discussing implicatures using the globalist perspective of Sauerland's 2-step architecture, outlined above, but this is done for ease of exposition only.[10]

Obtaining the primary implicatures is done through the neo-Gricean principle (10) above, where $A(\phi)$ is now specified to be $A_{str}(\phi)$, the structural alternatives of ϕ defined in (20).

(21) Conversational principle (with structural alternatives): do not use ϕ if there is another sentence $\phi' \in A_{str}(\phi)$ such that both
a. $[\![\phi']\!] \subset [\![\phi]\!]$, and
b. ϕ' is weakly assertable

[10] Here is a brief sketch of how the current discussion could be recast in a localist system, along the lines of Fox (2006). Implicatures, in Fox's system, are derived using an exhaustive operator, *Exh*, roughly a non-presuppositional counterpart of *only*. When *Exh* attaches to a clause ϕ, the result is an assertion that $p = [\![\phi]\!]$, the proposition denoted by ϕ, is true, and that all the alternatives to p in a set of alternatives A that can be safely negated (Fox's *innocently excludable* alternatives, here written as $IE(A, p)$) are false:

$$[\![[Exh\phi]]\!] = \lambda w_s \cdot [\![\phi]\!](w) \,\&\, \forall q \in IE(A,p) \cdot \neg q(w)$$

On an account that derives implicatures using such an operator, the current proposal would translate into restricting the set A to be a subset of the set of denotations of the structural alternatives to ϕ. That is, $A = \{[\![\phi']\!] \mid \phi' \in A_{str}(\phi)\}$.

3.3 Aside: A_{str} and the Maxim of Manner

Notice that (21) expresses an indirect preference for simple sentences: if ϕ' is strictly simpler than ϕ then ϕ' will be taken into account in computing the implicatures for ϕ, but ϕ will not be relevant for the implicatures of ϕ'. On the other hand, there is no direct pressure to minimize structure: the fact that ϕ' is strictly simpler than ϕ does not on its own mean that ϕ' is preferable to ϕ if the two are truth-conditionally equivalent. In other words, we are using complexity as a neo-Gricean filter on structures and not as a preference that might correspond to the Gricean Maxim of Manner. Let us look at what a Gricean formulation would look like. Here again is the conversational principle we started with:

(22) Conversational principle (informal version, repeated from (4)): do not use a linguistic object ϕ if there is another object ϕ' such that both
   a. ϕ' is better than ϕ, and
   b. ϕ' could have been used

The choice of interpreting *better* in terms of semantic entailment in (22) was a simplification, based on one part of Grice's Maxim of Quantity. To incorporate Manner, we could combine semantic entailment $\subseteq$ with our notion of structural complexity $\lesssim$. Using $\precsim$ for `at-least-as-good-as`, we could write this as follows:

(23) $$\precsim := \{(\phi, \psi) \mid \phi \lesssim \psi \ \wedge \ [\![\phi]\!] \subseteq [\![\psi]\!]\}$$

We could then take *better* to mean the irreflexive $\prec$ (defined as $\precsim \setminus \precsim^{-1}$), changing our neo-Gricean (21) into a Gricean principle[11]:

(24) Conversational principle (Gricean): do not assert ϕ if there is an alternative ϕ' such that
   a. $\phi' \prec \phi$
   b. ϕ' is weakly assertable

Treating complexity as part of the comparison, as in (24), is perhaps more natural from a globalist, pragmatic perspective than using it as part of the filtering mechanism, as in (21).[12] More significantly, the two approaches make distinct predictions. If $[\![\phi]\!] = [\![\phi']\!]$ then under (21) the weak assertability of ϕ' will never affect the assertability of ϕ. Under (24), if ϕ' is strictly less complex than ϕ, the weak assertability of ϕ' will prevent ϕ from being assertable. Following these predictions will take us beyond the scope of the current paper, as does the evaluation of other

[11] More generally, we could start with any set of pre-orders over the domain of structures Φ (that is, reflexive, transitive relations over $\Phi \times \Phi$), $\{\leq_\alpha\}_{\alpha \in I}$. In addition to semantic entailment and structural complexity, one can use pre-orders that correspond to obscurity, appropriateness, politeness, and so on. The relation of `at-least-as-good-as` can then be defined as the intersection of these pre-orders: $\precsim := \bigcap_\alpha \leq_\alpha$. The rest proceeds as above.

[12] See Fox (2006) and Russell (2006) for considerations regarding the role of formal alternatives in conversational reasoning.

choices that could have been made in the formulation of the conversational principle. For the examples that we will discuss below, the differences between the two formulations will not matter. I will keep using the neo-Gricean (21), mostly in order to facilitate the comparison with other proposals.

4 Examples

4.1 Some, all, some but not all

Let us start by verifying that our definitions can handle the simple (7) with which we started, repeated here.

(25) a. ϕ = John ate some of the cake
b. ϕ' = John ate all of the cake
c. ϕ'' = John ate some but not all of the cake

Assuming that *all* and *some* are of the same syntactic category, and assuming that both are in the lexicon, we can substitute one for the other and get from ϕ to ϕ' (or from ϕ' to ϕ) without adding complexity. That is, $\phi' \sim \phi$, and by definition, $\phi' \in A_{str}(\phi)$. Consequently, when ϕ is uttered, ϕ' is evaluated by (21), which tells us that ϕ should not be uttered if (i) $[\![\phi']\!] \subset [\![\phi]\!]$, and (ii) ϕ' is weakly assertable. Assuming that the speaker obeys (21), then, the utterance of ϕ means that at least one of (i) and (ii) does not hold. (i) is true, so (ii) must be false. That is, ϕ' is believed to be not true, not relevant, or not supported by the evidence.

ϕ'' is also stronger than ϕ, and we saw that if it is not excluded from being an alternative it gives rise to the symmetry problem. Under the current definitions, ϕ'' is successfully excluded. The alternatives of ϕ are only structures that are at most as complex as ϕ, and ϕ'' is not such a structure: there is no way in which we can transform ϕ into ϕ'' by the operations relevant for structural complexity listed in (19). In fact, ϕ'' is strictly more complex than ϕ. (21) does not consider ϕ'', and so no inference is made.

Summing up, uttering ϕ gives rise to the inference that it is not the case that ϕ' is weakly assertable, and it does not give rise to any inference with respect to ϕ''. Assuming that no other alternatives are available, the only primary implicature of ϕ is that ϕ' is not weakly assertable. This now feeds the second process in which the primary implicatures are strengthened. Under the appropriate assumptions, the secondary implicature is that ϕ' is false. In total, we obtain the desired inference that John ate some but not all of the cake.

4.2 'or', 'and', L, R

Disjunction gives rise to two main inferences: that only one of the disjuncts is true (*exclusiveness*), and that the speaker does not know which one it is (*ignorance*). We start with exclusiveness. Uttering ϕ, for example, usually implies that it is not the case that John ate both the apple and the pear. That is, ϕ implies that ϕ' is false.

(26) a. ϕ = John ate the apple or the pear
b. ϕ' = John ate the apple and the pear
c. ϕ'' = John ate the apple or the pear but not both

To obtain the exclusive reading of ϕ we must make sure that ϕ' is an alternative, but the symmetric ϕ'' is not. Under the current approach, this is the result of the same structural consideration that prevented the symmetry problem elsewhere: ϕ' is at most as complex as ϕ, while ϕ'' is strictly more complex. So far, nothing special.

Turning to the ignorance inference, it was observed by Grice (1989) (see also Gazdar 1979, among others) that disjunction usually implies that the speaker does not know which of the disjuncts holds. In ϕ above, the speaker can be taken not to be in a position to say which of the two fruits John ate. A proposal for deriving the ignorance inference has been developed by Sauerland (2004), and I will adopt the proposal in its essentials. I will show, however, that one particular aspect of the proposal can be simplified: the effects of a seemingly stipulative definition of scales are directly predicted from our complexity-sensitive alternatives.

As Sauerland notes, the ignorance inference for disjunction can be obtained if ϕ has ψ' and ψ'' as alternatives.

(27) a. ψ' = John ate the apple
b. ψ'' = John ate the pear

Semantically, ψ' and ψ'' are both strictly stronger than ϕ. If ψ' and ψ'' are alternatives to ϕ, we may conclude that neither of them was weakly assertable. Since both seem to be relevant in situations in which ϕ is, as was ϕ' above, we obtain the following primary inferences:

(28) a. It is not the case that the speaker believes that ϕ'
b. It is not the case that the speaker believes that ψ'
c. It is not the case that the speaker believes that ψ''

As before, these primary inferences now feed the process of strengthening, resulting in secondary implicatures. For (28a) strengthening is straightforward, yielding the inference that the speaker believes that ϕ' is false. For (28b) and (28c), on the other hand, no strengthening takes place, since it is impossible to strengthen both inferences simultaneously without contradicting the original assertion ϕ. See Sauerland (2004) and Fox (2006) for details and discussion.

The key to obtaining the correct inferences for ϕ is the alternatives. Specifically, we need ϕ', ψ', and ψ'' to be alternatives, while ϕ'' must be excluded. Structurally defined alternatives, using $\lesssim$, derives precisely these alternatives. Notice, however, that there was something new in this example. So far, the good alternatives were always of the same complexity as the original utterances. The excluded structures were strictly more complex. Here, for the first time, we needed to use alternatives that were strictly less complex than the original structure. Relatedly, this is also the first example in which our proposal behaves differently from a scale-based approach. For a scale-based approach, including ϕ' and excluding ϕ'' is fairly

straightforward: *or* and *and* are standardly assumed to be scale-mates, and there is no scale which allows us to get to ϕ''. Deriving ψ' and ψ'', on the other hand, is less simple. The problem, discussed by Sauerland (2004), is this: for any disjunction $p \vee q$ we would like to have both p and q as alternatives. The relation `scale-mate-of`, however, is really an equivalence relation. This would mean that for any p and any q we would have $p \vee q$ as an alternative, which in turn would mean that p and q are scale-mates of each other, regardless of what they are. But if every sentence is an alternative to any sentence, all we would get is ignorance inferences, and no real (secondary) implicatures would ever arise.

Sauerland's solution is to posit two binary connectives, `L`(eft) and `R`(ight), which are scale-mates to $\vee$ and $\wedge$. `L` returns its left argument, and `R` returns its right argument: $[\![\phi L \psi]\!] = [\![\phi]\!] = [\![\psi R \phi]\!]$. With these new scale-mates, $\phi \vee \psi$ will always have both $\phi L \psi$ and $\phi R \psi$ as alternatives, simulating the effect of using each disjunct as an alternative. Importantly, this does not actually turn the disjuncts into alternatives: ϕ is not the same as $\phi L \psi$ (or $\psi R \phi$); consequently, the problem of arbitrary sentences becoming alternatives of each other disappears.[13]

The introduction of `L` and `R` and the conditions on them are somewhat stipulative. Our structural alternatives derive the effect of these connectives using nothing more than what was needed to obviate the symmetry problem with *some*, *all*, and *some but not all*.

4.3 Strictly simpler alternatives

Under the current proposal, we should expect to find effects similar to those of `L` and `R` but in other domains. That is, whenever we have a complex structure ϕ, we predict that any simplification of ϕ will be an alternative to it. For example, a structure that contains a modified noun phrase should have as an alternative the same structure but without modification. Normally, however, we see no such effects, which is one of the reasons for skepticism towards complexity-based theories. But there is a reason why such inferences are rare. In most cases, a sentence with a modified noun phrase will (asymmetrically) entail the variant with no modification:

(29) a. ϕ = A tall man came to the party
b. ϕ' = A man came to the party

Since ϕ is stronger than ϕ', we cannot negate ϕ' without contradicting the assertion. To test for complexity effects in implicatures we need to reverse the entailment relations. Under downward-entailing operators, then, we will expect to find implicatures that are based on complexity. In fact, we already saw some such cases in (15) above. Here are some further examples. In each case, the (a) sentence implies that the (b) sentence is not assertable.

[13] Or, at least, it disappears if we assume that uttering ϕ can never be mis-parsed as $\phi L \psi$ or as $\psi R \phi$. Sauerland addresses this concern by a prohibition against using `L` and `R` in speech, an effect that he attributes to the Maxim of Manner.

(30) a. ϕ = If any tall man comes to the party, he will be disappointed
b. ϕ' = If any man comes to the party, he will be disappointed

(31) a. ψ = Every candidate who sang was elected
b. ψ' = Every candidate was elected

(32) a. ξ = John doubts that many dogs with long tails will be sold
b. ξ' = John doubts that many dogs will be sold

As with disjunction, these inferences pose a challenge to scale-based approaches. If we wanted to capture the implicatures above in terms of scales, we would probably say that *tall man* is a scale-mate of *man*, *candidate who sang* is a scale-mate of *candidate*, and *dogs with long tails* is a scale-mate of *dogs* (and perhaps more generally that any noun phrase that contains a modifier is a scale-mate of the same noun phrase but without the modifier). But this would predict that in upward-entailing contexts we would get implicatures in the opposite direction, from the simple structure to the complex one. This prediction is not borne out: in none of the examples below does the (a) sentence imply that the (b) sentence is false.[14]

(33) a. ϕ = A man came to every party
b. ϕ' = A tall man came to every party

(34) a. ψ = Each reporter talked to a candidate
b. ψ' = Each reporter talked to a candidate who sang

(35) a. ξ = John is sure that many dogs will be sold
b. ξ' = John is sure that many dogs with long tails will be sold

The (a) sentences suggest nothing about their (b) counterparts. Under the direct approach, using structural alternatives, the absence of inferences about more complex structures, as in (33), is predicted.

As we saw in Sect. 2 above, the same pattern holds also for non-monotonic noun phrases. Here are the examples again.

(36) a. I doubt that exactly three semanticists will sit in the audience
b. I doubt that three semanticists will sit in the audience

(37) a. If we meet John but not Mary it will be strange
b. If we meet John it will be strange

(38) (Danny Fox, p.c.)
a. Everyone who loves John but not Mary is an idiot
b. Everyone who loves John is an idiot

[14] The use of universal operators in these examples guards against the possibility that inferences would be blocked because of symmetry. See Sect. 5.2 for discussion.

In (36) the triggering elements, *exactly three semanticists* and *John but not Mary*, were not monotonic, though their alternatives were. It is just as easy for the alternatives themselves to be non-monotonic:

(39) a. I doubt that exactly three semanticists and exactly two syntacticians will sit in the audience
b. I doubt that exactly three semanticists will sit in the audience

In total, then, we have a system that dispenses with the notion of scale, derives the effect of L and R for disjunction, and makes new (and correct) predictions about a family of inferences that arise in downward-entailing contexts, inferences that pose a challenge for the monotonicity-based approach and for the very notion of scale.

5 Complex alternatives: redefining the substitution source

It is now time to go back to Matsumoto's argument against the use of complexity in implicatures. The argument was based on example (11a) above, repeated here:

(40) a. ϕ = It was warm yesterday, and it is a little bit more than warm today
b. ϕ' = It was a little bit more than warm yesterday, and it is a little bit more than warm today

Our task is to allow ϕ' to be an alternative for ϕ even though it is strictly more complex. I would like to suggest that what licenses ϕ' as an alternative is the fact that, in some sense, its building blocks are already present in ϕ. To obtain ϕ' from ϕ what we need is to substitute *a little bit more than warm* for *warm* in ϕ. The structure for *a little bit more than warm* is not in the lexicon, which prevented us from performing the relevant substitution so far, but it is there as part of the right conjunct of ϕ. If we could enrich the substitution source with the subtrees of the current utterance, we would get what we want. Here is the definition[15]:

(41) Substitution Source (final version):
Let ϕ be a parse tree. The substitution source for ϕ, written as $L(\phi)$ is the union of the lexicon of the language with the set of all subtrees of ϕ

With our revised definition for $L(\phi)$ in place we can now derive the desired implicature. Since *a little bit more than warm* is a subtree of ϕ, we can use it for

[15] Not all speakers share Matsumoto's intuitions about (40a). Among those who do, some seem to require a special prosodic marking of *warm* and *a little bit more than warm*, similar perhaps to the marking discussed by Geurts (2007) in the context of Levinson (2000)'s examples. I have nothing interesting to say about the source of this inter-speaker variation. For now I will assume that speakers differ in whether they use only the lexicon as their substitution source, as in our original definition, or whether they allow also substitutions outside the lexicon, as in (41), possibly subject to the requirement that substitutions outside the lexicon be prosodically marked in the relevant way.

substitution and obtain ϕ', which means that $\phi' \lesssim \phi$, appearances to the contrary notwithstanding. Semantically, we may assume that $[\![$a little bit more than warm$]\!] \subset [\![$warm$]\!]$. A speaker who obeys (21) will therefore not assert ϕ if ϕ' is weakly assertable. Assuming that there are no symmetric alternatives to consider, strengthening may now proceed, giving rise to the inference that it was warm but not a little bit more than warm yesterday, and it is a little bit more than warm today.

5.1 Concern I: arbitrariness

We have thus derived the inferences which Matsumoto used against complexity-based approaches. Though the change to our original system was not big, it does look like a hack, added to simulate Matsumoto's results without giving up on structural comparisons. We could, perhaps, justify our move by saying that the substitution source is the collection of objects that are available for further syntactic operations. Those include the lexicon, used as a source for the terminal elements in the derivation, but they also include any constituent of the current structure (and maybe nearby structures as well)[16] that could be used for movement, pronominalization, the satisfaction of anaphoricity requirements on focus and ellipsis, and so on. Perhaps. Fortunately, we do not have to rely on such considerations. As it happens, the two proposals are not equivalent. They make different predictions, and it is the predictions of the current one that are borne out.

Under the current proposal the inference in cases like (40a) depends on the presence of the more complex alternative somewhere within the structure. If it is not there, no implicature will be generated. Under a scale-based approach, on the other hand, once a scale-mate always a scale-mate. (40a) would teach us that *warm* and *a little bit more than warm* are scale-mates; after that we would expect to find similar inferences elsewhere, regardless of whether *a little bit more than warm* is present or not. The facts seem to support the complexity approach. When *a little bit more than warm* is absent, no inference about yesterday's temperature is made:

(42) It was warm yesterday, and it is cold today

(43) It was warm yesterday, and it is hot today

[16] That nearby structures are also available for substitution can be seen from the possibility of replicating Matsumoto's results across discourse. An anonymous reviewer, for example, offers the following exchange, to be imagined as part of a long-distance phone call:

A: I love late spring. It's warm here.
B: It's a little bit more than warm here. I'm inside with the air conditioning.

As in Matsumoto's example, B's utterance implies that it is warm, but not a little bit more than warm on A's side. A similar point can be made using the following exchange, from Gazdar (1979), where B's answer is taken to imply that B's mother is not well:

A: Is your mother well and back?
B: Well, she's back, yes.
A: She's not well then.

It is also worth noting that the current approach, differently from the scale-based one, predicts that more or less any other inference can be triggered if the relevant material is already part of the structure.[17] This, too, seems to be correct: uttering (44) implies that yesterday it was just warm, not warm and sunny with gusts of wind.

(44) It was warm yesterday and it is warm and sunny with gusts of wind today

5.2 Concern II: non-scalar items

Matsumoto's example was meant as an argument against using complexity in the computation of implicatures. Upon closer inspection, as we just saw, this example turned out to teach us about the exact notion of complexity that is involved. It also constitutes another argument against the notion of scale. But should the definition of alternatives ignore any non-structural considerations? The patterns that we discussed suggest two conflicting conclusions. On the one hand, we observed that non-monotonic elements can trigger implicatures (as in (15) above), and that the alternatives themselves can be non-monotonic (as in (39)). Those implicatures are often difficult to find, since the simpler alternatives are usually weaker, but in downward-entailing contexts the implicatures surfaced. On the other hand, we have encountered other data that seem to suggest the opposite: when Matsumoto's example is modified to involve non-monotonic elements instead of the original monotonic ones, no inference arises. The relevant example was (14a) above, repeated here.

(45) a. John talked to some of the girls yesterday, and he talked to some but not all of the girls today
b. John talked to some but not all of the girls yesterday, and he talked to some but not all of the girls today

Uttering the distinctly odd (45a) does not give rise to any inference about (45b), as we saw. Should we then find a way to incorporate monotonicity as a condition in cases like (45a)? I think not. The problem is one of symmetry. Notice that (45b) is not the only alternative to (45a). The following is also a stronger alternative:

(46) John talked to all of the girls yesterday, and he talked to some but not all of the girls today

Combining (45b) and (46), all we get for (45a) is an ignorance inference.[18] In this case, then, monotonicity and brevity make similar predictions. It is possible to tease these predictions apart, though. If monotonicity holds, it should hold in all cases. If the problem is one of symmetry, embedding the structure in a context where the two

[17] Subject to considerations of symmetry, as we discuss immediately below.

[18] Though I do not know why the result is odd.

symmetric alternatives do not exhaust the space of possibilities will solve the problem, and an implicature is predicted to arise. What we should do, then, is modify (45a) using a universal operator, as in (47). The two symmetric alternatives, no longer exhausting the possibilities, are listed in (48).

(47) Yesterday, every boy talked to some of the girls, and today every boy talked to some but not all of the girls

(48) a. Yesterday, every boy talked to all of the girls, and today every boy talked to some but not all of the girls
b. Yesterday, every boy talked to some but not all of the girls, and today every boy talked to some but not all of the girls

Judgments about (47) are far from clear. To the extent that the sentence is at all acceptable, though, it seems to imply that yesterday at least one boy talked to all of the girls and that at least one boy didn't. Similar effects arise with other non-scalar items. For example, (49) suggests that yesterday John was required to talk to at least three girls, and that he could have satisfied this requirement by talking to exactly three girls or by talking to more.[19]

(49) Yesterday, John was required to talk to three girls, and today John was required to talk to exactly three girls

(50) a. Yesterday, John was required to talk to four girls, and today John was required to talk to exactly three girls
b. Yesterday, John was required to talk to exactly three girls, and today John was required to talk to exactly three girls

It appears, then, that monotonicity plays no role at all in implicatures. It restricts neither the triggers nor the alternatives, as we discussed in the context of strictly simpler alternatives in Sect. 4.3, and now we just saw further evidence that it does not restrict the alternatives. The only relevant factor, it seems, is structure.

6 Summary

We started with the symmetry problem, which arises when every stronger alternative can be negated, as in the naïve conversational principle (6), repeated here.

(51) Conversational principle (naïve version, repeated from (6)): do not assert ϕ if there is another sentence ϕ' such that both
a. ϕ' is more informative than ϕ, and
b. ϕ' is weakly assertable

[19] I use a modal rather than a quantifier over individuals as the universal operator in (49) following a suggestion by Danny Fox, p.c., who points out that modals help sharpen the judgments about the inferences in these sentences. I have no account for the difference between the operators.

We followed the neo-Gricean idea of restricting the set of alternatives, though we saw evidence against the more familiar implementations in terms of scales and monotonicity. Instead, a structural condition on alternatives seemed to work: the alternatives of ϕ are all the structures that are at most as complex as ϕ. We noticed that in many cases, simpler alternatives are also weaker, and hence irrelevant for the computation of implicatures. When the simpler alternatives are stronger, as with disjunction or with weak alternatives in downward-entailing contexts, the predicted inferences arise. Moreover, we found inferences of this kind that arise with respect to non-monotonic expressions. Our definitions made no reference to the notion of scales, and in fact we noticed that deriving the alternatives directly helped us avoid some of the challenges that are faced by accounts that use that notion. Finally, in addressing Matsumoto's argument against complexity, we had to revise our definition of substitution source. This revision led to certain predictions that were different from those made by Matsumoto's account. As it turned out, the correct predictions were the ones of the current account, providing an additional argument in favor of the complexity-based approach and against the use of scales and monotonicity.

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