Global Approach to Scalar Implicatures in Dynamic Semantics

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Abstract

It has been disputed whether scalar implicatures (= SIs) arise globally or locally. Basically SIs should be global because they arise by comparing strengths of whole alternative statements. On the other hand, there are a lot of examples in which local SIs are preferable. Linguists like Chierchia (2002) and Fox (2006) even claim that SIs arise by applying an operator to syntactic constituents to get their stronger meanings. In this paper, I claim that SIs are global and seemingly local implicatures are effects of contexts on global implicatures. Moreover, I will show that no syntactic analyses work.

1 Introduction

Scalar implicatures (SIs) arise on the basis of the maxim of quantity by Grice (1975):

(1) The maxim of quantity:
  a. Make your contribution as informative as is required (for the current purposes of the exchange).
  b. Do not make your contribution more informative than is required.

It is the first maxim of quantity that is relevant to SIs. When a stronger statement is relevant to the context and a speaker utters a weaker statement, it is implicated that the stronger statement is not true in the speaker's information state. Assuming that the speaker is well-informed and that he knows the stronger alternative is false, the hearer accepts the implicature as true.

Grice did not explicate the precise procedure of getting a SI. Horn (1972, 1989) suggested that a SI arises by comparing a set of alternative statements that arises by replacing a scalar term in the original statement with a stronger scalar alternative expression in the language system. Behind this idea lies the assumption that a set of scalar terms, which is called a **scalar set**, is given in the language system. Sauerland (2004) gives a more precise procedure, within the Neo-Gricean tradition that a SI arises based on a set of scalar alternatives. He assumes that SIs have an epistemic status, following Gazdar (1979), but deviates from his idea by assuming that the maxim of quantity gives rise to only uncertainty inferences, which he calls primary implicatures. Primary implicatures have the form of 'K', in which K means 'know' and is a stronger alternative sentence of the original utterance. The hearer tentatively strengthens each of the primary implicature of the form 'K'. If the stronger implicature is compatible with the meaning of the statement and all the primary implicatures, it gets the status of a SI, which he calls a secondary implicature.

His idea is illustrated in the following:

(2) John broke some glasses.

(3) a. ScalAlt(some) = {all, many, some}
  b. ScalAlt(John broke some glasses) = {John broke all glasses, John broke many glasses, John broke some glasses}
  c. (2) primarily implicates the following:
  ¬K(John broke all glasses)
  ¬K(John broke many glasses)
  d. secondary implicatures:
  K¬(John broke {all, many} glasses)

The use of *some* yields a stronger statement ϕ (= 'John broke {all, many} glasses') and the primary implicature is $\neg K\phi$, which can be strengthened into $\neg K\phi$ since it is compatible with the statement itself plus all the primary implicatures.

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Neo-Griceans naturally accepted that SIs are calculated from a whole statement. In this respect, they can be called globalists. SIs are inferences based on the maxim of quantity by Grice (1975). Implicatures are supposed to be calculated from utterances, which are always dealt with as a whole. This implies that SIs only arise from stronger statements than the original statement.

However, linguists like Chierchia (2002) claim that implicatures are included in the meaning of a statement, as part of the strengthened meaning (= the literal meaning plus its implicatures) of a CHUNK of a statement as a scope-site of a scalar expression, in the process of compositional semantic interpretation, following Krifka (1995), and the strengthened meaning of the sentence chunk is combined with the meaning of the rest of the sentence. The plain meaning of an expression α is represented as $[\![\alpha]\!]$ and the implicature is $\neg$S(α^{ALT}), where S(α^{ALT}) is the weakest alternative of α that entails α. Thus the strengthened meaning of α is the conjunction of the two meanings: $[\![\alpha]\!] \wedge \neg$S($\alpha^{ALT}$), which entails other strengthened meanings from the stronger alternatives of α. Chierchia introduces the negation operator to get a stronger meaning. For the same purpose, Fox (2006) instead introduces the exhaustivity (exh, hereafter) operator. They can be called localists.

Their analysis is illustrated in the following:

(4) Mary believes that John broke some glasses.

(5) a. LF: Mary believes that [[some glasses]$_i$ [John broke t$_i$]]

b. $[\![$[[some glasses]$_i$ [John broke t$_i$]]$]\!]$ = some'(student')(λx.broke'(j,x))

c. $[\![$[[some glasses]$_i$ [John broke t$_i$]]$]\!]^S$ = some'(student')(λx.broke'(j,x)) $\wedge$ $\neg$S([[some glasses]$_i$ [John broke t$_i$]]^{ALT}) = some'(student')(λx.broke'(j,x)) $\wedge$ $\neg$many'(student')(λx.broke'(j,x))

d. $[\![$(4)$]\!]^S$ = believes'(m, ˆ(some'(student')(λx.broke'(j,x)) $\wedge$ $\neg$many'(student')(x.broke'(j,x))))

It is assumed that the quantifier *some glasses* is Quantifier-raised witin the complement clause of the propositional attitude verb *believes*. And a SI from the use of *some* is calculated when the strengthened meaning of the complement clause is obtained in (5c). The strengthened meaning of the complement clause is the conjunction of the plain meaning and a SI of the clause, the latter of which is expressed as $\neg$S(ϕ^{ALT}), where ϕ is the complement clause *[some glasses [John broke t$_i$]]*. We are assuming that the weakest stronger alternative of *some* is *many*. The alternative meanings are derived in a similar way to the alternative semantics by Rooth (1985) for focus. The strengthened meaning of the complement clause is combined with the meaning of the rest of the sentence, as in (5d).

Localists' approaches may look more systematic, manageable and more constrained than globalists', because they are based on syntactic structures and calculation of SIs is precisely defined. However, one theoretically serious problem with localists is that, as Horn (1989) pointed out, SIs do not arise within downward entailing contexts and that SIs are based on strengths of statements as a whole. Even if they calculate SIs locally, they have to check whether an alternative involved in the calculation makes the whole sentence a stronger statement to see if it really leads to a valid SI. In this respect, SIs are inherently global.

Empirically, actual data do not take part with either of the two positions. Consider the following examples:

(6) Some students who drank beer or wine were allowed to drive.

a. Some students who drank beer or wine, but NOT both, were allowed to drive.

b. NOT[some students who drank both were allowed to drive]
(= No students who drank both were allowed to drive.)

(7) Every linguistics student at MIT has read LGB or Syntactic Structures. (Modified from Sauerland 2004, (58))

a. NOT[Every linguistics student at MIT has read LGB and Syntactic Structures]

b. Every linguistics student at MIT NOT[has read LGB and Syntactic Structures]
(= No linguistics students at MIT have read LGB and Syntactic Structures.)

In (6), it is plausible that no students who drank both beer and wine were allowed to drive, which is calculated by negating the whole stronger alternative. In (7), a linguist at MIT is likely to have read one of the two books, and the global SI is more likely. On the other hand, the following two examples show the opposite:

(8) Some students who watched TV or played games failed math.

a. Some students who watched TV or played games, but not did both, failed maths. (conveyed)

b. NOT[Some students who watched TV and played games failed maths] (global SI)

(9) Every student wrote a paper or made a classroom presentation.

a. Every student wrote a paper or made a classroom presentation but did not do both.

b. NOT(every student wrote a paper and made a classroom presentation)

In (8), it is more likely that a student who watched TV and played games failed math. For this reason the global SI that no students who watched TV and played games failed math is not acceptable. Similarly, in (9), if either of the two requirements is sufficient to get a grade, it is more plausible to assume that no students satisfied both requirements. This corresponds to the local SI. Thus we do not get the global SI that not every student did both.

Then we could take a position in which we exploit both ways of calculation of SIs. But if we cannot provide clear criteria for when we get global SIs and when we get local ones, it is not an explanation at all. Moreover, if syntactic structures are not what we directly deal with in calculating SIs, we cannot choose a localistic approach anyway. In this paper I will show that calculation of SIs needs more fine-grained structures than syntactic structures. And I will also show that local SIs are contextual effects on global SIs.

2 SIs corresponding to no syntactic constituents

2.1 SIs embedded in syntatic structures

In a syntactic analysis the operator that applies to a constituent which yields a SI is of semantic type of a proposition. In Chierchia (2002), the negation operator applies to a scope site of a scalar expression. A scope site has a semantic type of a proposition, or a clause, in more common terms. In Fox (2006), *exh* applies to a constituent that has the semantic type of a proposition and takes both the meaning of the constituent as a proposition and a set of alternative propositions to that, as its arguments. However, there are cases where we can get a SI from a NP:

(10) Some boys who read some of the books passed the test.

From the use of *some of the books* a global approach predicts the SI that no boys who read all of the books passed the test, which is implausible. A local approach predicts that the sentence conveys the meaning that some boys who read some, but not all, of the books passed the test. This does not exclude the possibility that some other boys who read all of the books passed the test. The original statement conveys the meaing that reading some of the books was sufficient to pass the test. This indicates that the local SI is not plausible, either. A more plausible SI can be one of the following:

(11) a. No boys read all of the books.

b. The boys who passed the test did not read all of the books.

The two possible SIs correspond to the following structures:

(12) a. some boys who read some of the books

b. Some boys who passed the test read some of the books.

The first SI corresponds to the NP *some boys who read some of the books*, and the second corresponds to a quite different sentence than the original. Moreover, the second SI anaphorically refers to the boys who passed the test, which does not have a corresponding constituent in the original sentence.

The two implicatures in (11) do not come from any syntactic constituent of semantic type of a proposition. This shows that SIs depend on contents, not on structures. To deal with contents of statements, we need to deal with semantic representations, instead of syntactic structures. Since SIs do not depend on syntactic structures, they are not calculated compositionally. They should be calculated after the statement is interpreted into a semantic representation.

Since we do not depend on syntactic structures, we will have to resort to a global approach. On the other hand, we have seen some SIs that could be calculated by a localistic approach. In order for a SI to be like a local SI, a SI has to have the effect of being embedded even if we calculate it after we finish interpreting the statement. One way to make such an effect is to deal with semantic representations in dynamic semantics:

(13) Mary met a doctor. He lived near Brooklyn.
$\simeq$ Mary met a doctor who lived near Brooklyn.

Even though the pronoun *he* is used in a new sentence, the whole text seems to have the meaning of a sentence in which the second sentence is embedded in a relative clause in the first sentence. A similar effect can be expected when a SI of a statement is calculated after the statement is interpreted:

(14) Some boys who read some of the books passed the test. They did not read all of the books.
$\simeq$ Some boys who read some of the books, but did not read all of them, passed the test.

In this example, the pronoun *they* refers to the boys who read some of the books and passed the test. The second sentence is added after the first statement is finished and it is taken to be a SI of the first sentence. The effect is the same as the sentence in which the SI is embedded in the relative clause of the statement.[1] This is one way of getting the effect of a local SI from a global SI. Note that this effect comes from anaphora across sentences in dynamic semantics.

2.2 SIs not based on scalar terms

Horn (1972, 1989) proposed a set of scalar terms to capture SIs. However, there are scales that are not based on scalar terms or any explicit expressions. This can be observed in examples like (6–9). Consider the pair of (6) and (8). When a student who drank beer or wine was allowed to drive, a student who drank both beer and wine is not likely to have been allowed to drive. Drinking either beer or wine is the **upper limit** for being allowed to drive. A SI that is compatible with this background knowledge survives, and a SI that is not dies. In (8), on the other hand, when a student who watched TV or played games failed math, a student who did both is more likely to fail math. Watching TV or playing games is understood as the **lower limit** for failing math. The difference between (6) and (8) lies in the opposite directionality of the scalar likelihood, independently of the semantic strengths of alternatives.

The scalarity of likelihood cannot be captured by any syntactic constituent and it is not a matter of semantics either. This can be captured by ordering possible worlds according to some knowledge about likelihood of states of affairs. SIs generally have the effect of strengthening the original statement. If the strengthening goes in the opposite direction to the scalar likelihood, the SI is rejected. In (8) the global SI is that no students who watched TV and played games failed math, which is less likely than the original sentence. Therefore it is rejected. We can get a weaker SI than this. At the moment I will call it a local SI, but I will show below that it is also a global SI. In (6), the global SI that no students who drank both beer and wine were allowed to drive is more likely than the original statement. And it is accepted. Note that this is a case where a semantic scalarity is in opposite direction to a pragmatic likelihood.

3 Global SIs with the effect of local SIs

As we have seen, sometimes we get global SIs and other times we get local SIs. It is not just that whether a global or local SI is plausible is determined by a context, but that a global SI has the effect of a local SI in a certain context. This is what I am going to show in this section.

3.1 Disjunction structures and SIs

As I said in the introduction, Saulerland (2004) assumes that the scalar alternatives of *or* is $\{$and, L, R, or$\}$. When a disjunct includes a scalar expression and the latter is replaced with a stronger alternative, the disjunct itself becomes a stronger

[1] It is sometimes pointed out that there is a subtle difference between the two sentences, but the effect is clearly what we need. And even if we admit the difference, a more intuitively correct meaning is obtained by the first one rather than the one in which the SI is embedded. When the SI is embedded in the relative clause, there is a possibility that some other boys who read all of the books passed the test. This possibility is not necessarily legitimate.

alternative and its stronger alternative is also an alternative of the whole statement, as follows:

(15) John spilt wine or broke some glasses. (= p)

(16) a. ScalAlt(p) = {John spilt wine and broke all glasses, John spilt wine and broke some glasses, John spilt wine, John broke all glasses, John broke some glasses, p}

The assumption of the operators L and R has the effect of projecting a local implicature from each disjunct into the main context. Thus the statement implicates the following:

(17) ¬(John spilt wine and broke all glasses)
¬(John spilt wine and broke some glasses)
¬(John broke all glasses)

Here the SI that John did not break all glasses arises from a stronger alternative of the second disjunct. This is a case where the disjunction structure is transparent for the projection of a SI.

However, it does not have to be the case. There are cases where a stronger alternative of a disjunct yields only a local SI:

(18) a. John broke all or some glasses.
b. John wanted hot or at least warm water.
c. John won the lottery or made some easy money.

In these examples, the use of the second disjuncts implicates that the first disjuncts do not hold. Take the first example. If the second disjunct is understood as meaning John broke some (or all) glasses, the use of the disjunction operator is infelicitous. For this reason, the second disjunct has to mean that John broke some but not all glasses, and this has to be a local implicature. Otherwise it would contradict the first disjunct:

(19) #John broke all or some glasses. He did not break all glasses.

The discourse is not inconsistent because we could conclude that John broke only some of the glasses. However, the discourse is incoherent. A speaker who can truly assert the second sentence would not utter the first sentence.[2] We can say the same thing about the other two examples.

One thing in common among the three examples is that the two disjuncts are not independent of each other. This contextual information makes the implicatures from the second disjuncts stay in the second disjuncts, making them local implicatures. However, contextual information should be put aside when we discuss the way that SIs are calculated. As I said, we can always assume global SIs and the meanings of local SIs are derived by the help of contextual information.

I propose that the meaning of a statement and its implicatures are captured by their informational effects on the current information state. Suppose that ϕ is uttered in the current information state and changes it into s′. Then a (global) SI $\neg\psi$ (, where ψ asymmetrically entails ϕ,) is added to s′ and changes it into s″. Then the net effect of ψ on s′ is the set of possible worlds eliminated by $\neg\psi$, i.e., (s′\(s′ + ψ), where "\" is a set minus). This is the actual effect of the SI on the current information state.

(20) $s + \phi = s'$
$s' + \neg\psi = s''$

(21) net effect of $\neg\psi = s' \backslash (s' + \neg\psi)$
$= s' \backslash (s' \backslash (s' + \psi)) = s' + \psi$

The composition of the set of the possible worlds determines the actual SI. Consider (15) first. With the information state s, since the two disjuncts are independent of each other, we can assume that s+(15) includes the following three sets of possible worlds:

(22) a. a set of possible worlds in which John only spilt wine
b. a set of possible worlds in which John only broke some glasses
c. a set of possible worlds in which John did both

In this context, the SI from *some* has the following effect on the information state, following (21):

(23) $(s+(15)) \backslash (s+(15)+SI_{some})$
$= s+(15) \cap \{w|$ John spilt wine or broke many/all glasses$\}$

[2]A simple way of distinguishing coherence and consistency is that a discourse is coherent if it is asserted by the same speaker, but a discourse is consistent if it does not lead to the absurd information state if uttered by different speakers. In the example at hand, if the two sentences are uttered by two different speakers, it does not lead to the absurt information state. But they cannot be uttered by the same speaeker felicitously.

= s+(15)$\cap$\{w| John broke many/all glasses\}

The net effect of the use of *some* is what we get by updating s+(15) with a stronger alternative. But (15) and the stronger alternative share the possible worlds in which the first disjunct holds. Therefore the net effect of the stronger alternative is the same as the effect of the second disjunct. Since the two disjuncts are independent of each other, the set of possible worlds eliminated by the global SI consists of those in which John only broke many/all glasses and those in which John both spilt wine and broke many/all glasses. They are possible worlds in which the second disjunct of the stronger alternative holds, regardless of whether the first disjunct holds. That is, the SI has the overall effect on the information state, regardless of whether the first disjunct holds or not. Thus the SI has the effect of a global SI, even though the net effect only comes from the second disjunct of the stronger alternative.

Next, consider (18.a), where a SI from one disjunct does not project. In a given context, the two disjuncts are not independent of each other, but there is a subset relation:

(24) a. a set of possible worlds in which John broke all glasses
b. a set of possible worlds in which John broke some glasses (and possibly all)
c. (a) $\subseteq$ (b)

In this situation, the net effect of the SI from the use of *some* is the following:

(25) s$'$ = s + "John broke all or some glasses"

(26) the net effect of "$\neg$(John broke all or many/all glasses)"
= s$'$+John broke all or many/all glasses
= s$'\cap$\{w| John broke all or many (but not some) glasses in w\}

Since the first disjunct is shared by the two alternatives, the net effect is determined by the second disjunct. Therefore the SI has the effect that John broke many (but not some) glasses. However, this does not have the overall effect on the current information state, because the two disjuncts are not independent of each other. If it did, the speaker would simply say that John broke some glasses. Then there would be no possible worlds in which John broke all glasses. There should be some possible worlds in s$'$ that John broke all glasses.[3] Then the net effect of the SI only applies to the possible worlds in which John did not break all glasses. That is, it eliminates possible worlds in which John broke not all but more than just some glasses. This is the way the global SI has the effect of a local implicature.

3.2 Other cases of local SIs

In a conditional, the antecedent clause and the consequent clause are not independent of each other. In normal cases, a SI from the consequent clause is not supposed to have the effect of a local SI. This can be explained easily:

(27) s + "if ϕ, then ψ" = s+[$\neg\phi \vee \psi$][4]

(28) For a stronger alternative ψ' of ψ, the net effect of the global SI
= s$'$+[if ϕ, then ψ']
= s+[$\neg\phi \vee \psi$] + [$\neg\phi \vee \psi'$]
= s+[[$\neg\phi \vee \psi$] $\wedge$ [$\neg\phi \vee \psi'$]]
= s+[$\neg\phi \vee [\psi \wedge \psi']$]
= s+[$\neg\phi \vee \psi'$]
= s+ [if ϕ, then ψ']

The net effect of the global SI $\neg$(if ϕ, then ψ') is limited to the possible worlds in which ϕ hold. This is the effect of restricting the SI to the consequent clause. Thus the global SI has the effect of a local SI.

On the other hand, when the antecedent clause is trivially satisfied in the current information state, a global SI has a overall effect.

(29) If you want to, you may have some apples.

In the given context, it is likely that the hearer wants to have some apples. In this context, the an-

[3]This is the effect of the felicity condition that each disjunct should make a non-trivial meaning contribution to the meaning of a whole sentence. This is beyond the scope of this paper.

[4]The way a sentence is interpreted has to be defined so that anaphoric dependency relations can be captured. For this purpose, a conditional sentence has to be interpreted as follows:

i. s + "if ϕ, then ψ" = s$\backslash$((s+ϕ)$\backslash$(s+ϕ+ψ)) = s$'$

That is, a pronoun in the antecedent clause can refer to something in the main context, and a pronoun in the consequent clause can refer to something in the main context or the antecedent clause. We can assume this rule, but it would lead to a more complex calculation. For convenience's sake, I assume a propositional logic in which a conditional is equivalent to the disjunction of the negation of the antecedent clause and the consequent clause.

tecedent clause is trivially satisfied in the current information state and thus the antecedent clause does not change the current information state. The conditional does not have the effect of a conditional but the consequent clause. Therefore the (global) SI from the use of *some* in the consequent clause affects the current information state directly and has the effect of a global SI:

(30) s + "you want to have some apples" = s
s + "If you want to, you may have some apples"
= s\((s+"you want to have some apples")\(s+ "you want to have some apples"+"you may have some apples"))
= s\(s\(s+"you may have some apples"))
= s+"you may have some apples"

As shown above, the conditional has the same meaning as the consequent clause, which makes a SI from the consequent clause a global effect on the current information state.

In Chierchia (2002), it is claimed that a scalar expression in a propositional attitude context yields a local SI. This is not explained by the mechanism I have used so far.

(31) Mary believes that John broke some glasses.
+> Mary believes that John did not broke all glasses.

(32) s + Mary believes that John broke some glasses
= {w∈s| for every w′ in Dox(m,w), John broke some glasses in w′} = s′

(33) net effect of "¬(Mary believes that John broke many/all glasses)" =
s′\(s′+"Mary believes that John broke many/all glasses")
= {w∈s| for every w′ in Dox(m,w), John broke some glasses in w′, there are some possible worlds w″ in Dox(m,w) such that John did not broke many/all glasses in w″}
= It is not the case that Mary believes John broke many/all glasses.
≠ Mary believes John did not break many/all glasses.

The SI that it is not the case that Mary believes John broke many/all glasses does not mean that Mary believes John did not break many/all glasses. But intuitively we seem to get the latter inference. However, it is not reliable to discuss belief contexts and draw a conclusion. When we talk about Mary's belief, we can think of Mary's statements the speaker heard, and they are likely to yield SIs, which are also taken to be part of Mary's belief even in the speaker's report. Another reason for not relying on discussions of belief contexts is that a belief operator is not generally accepted as a universal quantifier over doxastic alternatives. It seems to be due to the lack of an existential counterpart.

Consider an epistemic unviersal quantifier *must* and a obligation operator:

(34) John must have broken some glasses.
+> John may not have broken all glasses.
+/> John cannot have broken all glasses.

(35) John must read some of the books.
+> John does not have to read all of the book.
+/> John must not read all of the books.

Considering the fact that the deontic operator behaves just the way we expected it to, we cannot claim that SIs should be local. On the other hand, epistemic operators tend to allow stronger SIs than what is predicted by the theory. For some reason, an epistemic operator tends to have wide scope, even over the operator introduced to calculate a SI.

In this section, I have shown that the actual effect of a SI on the current information state can be captured by dealing with possible worlds, rather than expressions. It allows us to accout for how global SIs get the effects of local GIs. This allows us to dispense with local SIs. In the previous section, I also showed that SIs from syntactically embedded can have global effects and that they can be dealt with in dynamic semantics. Dynamic seantics assumes that the meaning of a sentence is a context change potential which takes an information state as an input and yields an updated information state by adding the information conveyed by the sentence to the input information state. In the next section, I will propose a new analysis reflecting the two necessary components to account for SIs and their observations.

4 SIs in dynamic semantics

4.1 Basics of dynamic semantics

In this paper, I will use a (slightly modified) DRT (discourse representation theory) in representing the meaning of a sentence for various reasons. First, it allows us to be able to manage meanings as representations. Second, it provides more fine-grained chunks of meanings than the classical predicate logic or syntactic structures, which allows us to account for some SIs which do not correspond to a syntactic constituent. Third, anaphoric relationships are easily captured, which is necessary to account for the effect of being embedded of a SI even when it is added to the DRS (discourse representation structure) after the sentence is interpreted. A variable in a SI can be free or bound by a variable in the previous DRS, and the mechanism allows us to get various SIs, depending on whether variables in a stronger alternative statement are free or bound by the variables in the original statement. Let's see how it works.

Anaphoric relations are restricted by accessibility paths given by the DRT. The accessibility paths can be restricted as follows:

(36) a. A DRS is a pair of a set of variables and a set of conditions on the variables, <var, con>.

b. A variable in (i) is accessible for a variable in (ii), but a variable in (ii) is not accessible for a variable in (iii), and not vice versa, in one of the following configurations:
<var(i), ...<var(ii),... >...>
<var(i),<var(ii),...>∨<var(iii),...>>
<var(i),...>⇒/∀<var(ii),...>

A variable newly introduced in a DRS is accessible for any variable in the conditions in it. In a disjunction structure, a variable in one disjunct is not accessible to a variable in another disjunct. In a conditional, a variable introduced in the antecedent clause is accessible for a variable in the consequent clause, but not vice versa.

On the other hand, we will assume an information state with respect to which a DRS is interpreted. This is necessary to account for cases where a global SI has the effect of a local SI.

(37) An information state is a set of pairs of a possible world w and an assignment g.

(38) A set of variables var includes a variable v for possible worlds.

(39) A DRS is interpreted with respect to a model <W, D, F, G>, where W is a set of possible worlds, D a set of individuals, F an interpretation function of constants, and G a set of assignment functions.

(40) A DRS <var, con> is supported in an information state s iff for every member <w,g> in s, {<w, g∪var>} supports every condition in con.

(41) {<w,g>} supports $P_v(x)$ iff g(v)=w and g(x) ∈ F(P)(w)

(42) {<w,g>} supports < var(i), con(i)> ∨ <var(ii), con(ii)> iff <w, g∪var(i)> supports every condition in con(i) or <w, g∪var(ii)> supports every condition in con(ii).

(43) {<w,g>} supports < var(i), con(i)> ⇒ <var(ii), con(ii)> iff <w, g∪var(i)> does not support every condition in con(i) or <w, g∪var(i)∪var(ii)> supports every condition in con(ii).

An information state is a set of pairs of a possible world and an assignment. To interpret a DRS with respect to possible worlds, I introduce a variable for possible worlds in DRSs. This is a deviation from the standard DRS, in which each DRS is interpreted with respect to a model. In this paper, possible worlds are included in a model. This makes a DRS more like a semantic representation. This would yield no problems. After a DRS is interpreted, we get an information state which supports the DRS. We only deal with information states we get after a statement is interpreted, so we do not need dynamic interpretation rules. Instead, we need support conditions. A DRS is supported by an information state iff each pair of a possible world and an assignment supports each condition in the DRS. A disjunction structure is supported by a pair of a world and an assignment iff one of the disjuncts is supported by the pair. A conditional is dealt with like a disjunction of the negation of the antecedent clause and the consequent clause.

I do not have to follow the Neo-Gricean tradition, because it is assumed that a SI arises by comparing the meanings of alternative statements. However, scalar alternatives make themselves more salient than others. In this respect it does not do any harm to assume a set of scalar alternatives. But it is not necessary to assume them.

4.2 SIs from non-clauses

Now we can deal with cases where SIs arise from some non-clause constituents. Such cases are problematic with localistic approaches. One example is given in (10), which is given here again. It is interpreted into a DRS as follows:

(10) Some boys who read some of the books passed the test.

(44)
$$\begin{array}{|l|}\hline v\ \mathrm{X\ Y\ Z\ k} \\ \hline \mathrm{boys}_v(\mathrm{X}) \\ \mathrm{books}_v(\mathrm{Z}) \\ \mathrm{Y} \subseteq \mathrm{Z} \\ \mathrm{read}_v(\mathrm{X,Y}) \\ \mathrm{test}_v(\mathrm{k}) \\ \mathrm{passed}_v(\mathrm{X,k}) \\ \hline \end{array}$$

This is just the interpretation of (10), but I will assume that it is the first sentence and constitutes the main DRS. Suppose that this is supported in an information state s. In the result information state, we calculate a SI from the use of *some of the books*. We get a global SI by negating a stronger alternative of the whole statement:

(45)
$$\neg \begin{array}{|l|}\hline v\ \mathrm{X' \ Y' \ Z' \ k'} \\ \hline \mathrm{boys}_v(\mathrm{X'}) \\ \mathrm{books}_v(\mathrm{Z'}) \\ \begin{array}{|l|}\hline \mathrm{l} \\ \hline \mathrm{l} \in \mathrm{Z'} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \ \\ \hline \mathrm{read}_v(\mathrm{X',l}) \\ \hline \end{array} \\ \mathrm{test}_v(\mathrm{k'}) \\ \mathrm{passed}_v(\mathrm{X',k'}) \\ \hline \end{array}$$

This is embedded in the main DRS and we have to see if some variables in it can be bound in the main DRS:

(46)
$$\begin{array}{|l|}\hline v\ \mathrm{X\ Y\ Z\ k} \\ \hline \mathrm{boys}_v(\mathrm{X}) \\ \mathrm{books}_v(\mathrm{Z}) \\ \mathrm{Y} \subseteq \mathrm{Z} \\ \mathrm{read}_v(\mathrm{X,Y}) \\ \mathrm{test}_v(\mathrm{k}) \\ \mathrm{passed}_v(\mathrm{X,k}) \\ \neg \begin{array}{|l|}\hline \mathrm{X' \ Y' \ Z' \ k'} \\ \hline \mathrm{boys}_v(\mathrm{X'}) \\ \mathrm{books}_v(\mathrm{Z'}) \\ \begin{array}{|l|}\hline \mathrm{l} \\ \hline \mathrm{l} \in \mathrm{Z'} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \ \\ \hline \mathrm{read}_v(\mathrm{X',l}) \\ \hline \end{array} \\ \mathrm{test}_v(\mathrm{k'}) \\ \mathrm{passed}_v(\mathrm{X',k'}) \\ \hline \end{array} \\ \hline \end{array}$$

The process is quite similar to the presupposition projection in van der Sandt (1992). Since we are talking about the same possible world, v is bound by the same variable in the matrix DRS. Variables like Z′ and k′ are introduced by presuppositions and are supposed to be bound by Z and k respectively. Therefore conditions on them are not negated:[5]

(45′)
$$\begin{array}{|l|}\hline v\ \mathrm{X\ Y\ Z\ k} \\ \hline \mathrm{boys}_v(\mathrm{X}) \\ \mathrm{books}_v(\mathrm{Z}) \\ \mathrm{Y} \subseteq \mathrm{Z} \\ \mathrm{read}_v(\mathrm{X,Y}) \\ \mathrm{test}_v(\mathrm{k}) \\ \mathrm{passed}_v(\mathrm{X,k}) \\ \neg \begin{array}{|l|}\hline \mathrm{X'} \\ \hline \mathrm{boys}_v(\mathrm{X'}) \\ \begin{array}{|l|}\hline \mathrm{l} \\ \hline \mathrm{l} \in \mathrm{Z} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \ \\ \hline \mathrm{read}_v(\mathrm{X',l}) \\ \hline \end{array} \\ \mathrm{passed}_v(\mathrm{X',k}) \\ \hline \end{array} \\ \hline \end{array}$$

This leads to the following SIs:

(47) a. No boys read all of them(= the books) and passed it(= the test).

b. No boys read all of them(= the books).

All conditions considered, we get (47a) as a SI, but intuitively it is not plausible. When some boys who read only some of the books passed the test, a boy who read all of the books is more likely to pass the test. And we already know some boys passed the test. Thus we can ignore the last condition in the DRS:

(45″)
$$\begin{array}{|l|}\hline v\ \mathrm{X\ Y\ Z\ k} \\ \hline \mathrm{boys}_v(\mathrm{X}) \\ \mathrm{books}_v(\mathrm{Z}) \\ \mathrm{Y} \subseteq \mathrm{Z} \\ \mathrm{read}_v(\mathrm{X,Y}) \\ \mathrm{test}_v(\mathrm{k}) \\ \mathrm{passed}_v(\mathrm{X,k}) \\ \neg \begin{array}{|l|}\hline \mathrm{X'} \\ \hline \mathrm{boys}_v(\mathrm{X'}) \\ \begin{array}{|l|}\hline \mathrm{l} \\ \hline \mathrm{l} \in \mathrm{Z} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \ \\ \hline \mathrm{read}_v(\mathrm{X',l}) \\ \hline \end{array} \\ \hline \end{array} \\ \hline \end{array}$$

Here comes in the more fine-grainedness of a DRS. Notice that what was in the relative clause in the sentence is not embedded in the DRS but put in the main DRS. Moreover, each condition can be

[5]We are talking about the actual world, and we do not assume a new variable for possible worlds.

freely considered or ignored in calculating SIs to get a contextually relevant SI.

In my analysis, since a SI is calculated after the sentence is interpreted, all infomation in the sentence can be considered to be presuppositions, following Stalnaker (1978, 2006). Thus even X′ can be bound by X in the main DRS.

(45‴)
$$\begin{array}{|l|}\hline v\ \mathrm{X\ Y\ Z\ k} \\ \hline \mathrm{boys}_v(\mathrm{X}) \\ \mathrm{books}_v(\mathrm{Z}) \\ \mathrm{Y} \subseteq \mathrm{Z} \\ \mathrm{read}_v(\mathrm{X,Y}) \\ \mathrm{test}_v(\mathrm{k}) \\ \mathrm{passed}_v(\mathrm{X,k}) \\ \begin{array}{|l|}\hline \\ \hline \neg \begin{array}{|l|}\hline \mathrm{l} \\ \hline \mathrm{l} \in \mathrm{Z} \\ \hline \end{array} \Rightarrow \begin{array}{|l|}\hline \\ \hline \mathrm{read}_v(\mathrm{X,l}) \\ \hline \end{array} \\ \hline \end{array} \\ \hline \end{array}$$

(They (= some boys who read some of the books) did not read all of them (= the books))

Even though the SI is calculated separately from the original sentence, it gives rise to the effect of embedding the SI in the relative clause of the original sentence as in the following:

(48) Some boys who read some of the books, but not all of them, passed the test.

It is just a coincidence that the SI goes into the relative clause. A SI can go anywhere in the main DRS, but syntactically it can be realized in a relative clause or in the restrictor or the nuclear scope of a quantifier, depending on where a relevant scalar expression occurs in the sentence.

5 Conclusion

In this paper, I claim that SIs are always global and that SIs are calculated in the framework of dynamic semantics. I used the DRT as a semantic tool, but my analyses does not rely on a particular framework. Any dynamic semantics will do. I have shown that global SIs can have the effect of local SIs in some contexts. This effect is obtained in various ways. First, a global SI can get the effect of being embedded in a purely syntactic island, and this is possible due to the dynamic binding. Another way in which a global SI can get the effect of a local is the role that a context plays. This is not a matter of structure but a matter of information contained in an information state. A third factor is background knowledge. Background knowledge determines the scalarity of likelihood of states of affairs. This is a pragmatic matter. Hence it is not captured by the semantic ordering of scalar terms.

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