A fine-grained global analysis of implicatures

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1 Introduction

According to any global approach to quantity implicatures, we start with the semantic meaning of a sentence, and then select via a pragmatic mechanism among the worlds that make the sentence true the ones where not more is true than needs to be. There are various ways such a pragmatic mechanism could be spelled out (e.g. Gazdar, 1979; Soames, 1982; Sauerland, 2004, and many others), but if spelled out in terms of exhaustive interpretation (e.g. Spector 2003; van Rooij & Schulz, 2004) the following inferences are accounted for (if all that is mentioned is relevant):

(1)	a.	$p \vee q$	$\rightsquigarrow$	not both p and q	(scalar implicature)
	b.	2 students passed	$\rightsquigarrow$	exactly 2 students passed	(scalar implicature)
	c.	$p \rightarrow q$	$\rightsquigarrow$	p if and only if q	(conditional perfection)
	d.	$p \vee q \vee r$	$\rightsquigarrow$	only one of p, q, and r is true	
	e.	$(p \vee q) \wedge (r \vee s)$	$\rightsquigarrow$	only one of $(p \wedge r), (p \wedge s), (q \wedge r)$ or $(q \wedge s)$ holds	

If the global approach towards implicatures takes semantic meaning as input, it follows immediately that two sentences with the same semantic meaning cannot give rise to different implicatures. In the above mentioned global accounts of implicatures, the semantic meaning of a sentence is modelled by a set of possible worlds. But this assumption immediately leads to the problem how to account for implicatures like (2-a) and (2-b) (on the assumption that numerals receive an 'at least'-reading) and the lack of implicature in (2-c).

(2)	a.	$p \vee q \vee (p \wedge q)$	$\rightsquigarrow$	only p, only q, or (only) $p \wedge q$
	b.	2 or 3 students passed	$\rightsquigarrow$	Exactly 2 or exactly 3 students passed
	c.	At least 2 students passed	$\not\rightsquigarrow$	Exactly 2 students passed

Confronted with the problem posed by (2-a) and (2-b), a number of researchers (e.g. Chierchia, Fox, & Spector, 2012) have concluded that what's wrong with the standard account is that implicatures are calculated *globally*.[1] Schulz & van Rooij (2006) have argued, instead, that there is an obvious other assumption that might be blamed: the assumption that semantic meanings should be modelled as coarse-grained as by sets of possible worlds. We will show in section 2 how they propose to account for the examples (2-a)-(2-c) making use of the fine-grainedness of the notion of meaning in dynamic semantics.

Kratzer (2007) suggested that one can account for many of the inferences in (1) making use of situations, or *facts*. We will take up her idea, using van Fraassen's (1969) conception of facts (or exact truth-makers), which provides a more fine-grained

[1] Gazdar (1979) accounts for example (2-a), but his mechanism was *much* richer and rather ad hoc.

notion of meaning than standard possible-world semantics does. We will show in section 3 that in terms of it, we can account for the problematic examples (2-a)-(2-c) without giving up a global approach towards implicatures. We will argue that this fact-based approach is to be preferred to the dynamic approach, because it is less dependent on the exact way the sentence is represented in logical form, and it can solve some other problems faced by the exhaustivity approach due to their reliance on predicate minimization. On the other hand, we will show in section 4 that it can still account for the exhaustivity and 'cancellation'-effects for which the exhaustivity-approach is so well-suited.

In Chierchia, Fox & Spector's (2012) non-global analysis of conversational implicatures, Hurford's constraint, according to which no disjunct may entail another, plays an important role to account for (2-a). Our global analysis doesn't need Hurford's constraint to account for the inference, but in section 5 of this paper we will discuss a closely related appropriateness condition for disjunctions to account for a phenomenon brought up by Singh (2008). Singh argued that this phenomenon shows that we need a *processing* perspective on interpretation. We will argue, instead, that a more standard appropriateness condition is able to account for the phenomenon, but that to state this condition fine-grained semantic meanings are essential.

2 Implicatures and exhaustive interpretation

2.1 Exhaustive interpretation

It is well-known that many scalar implicatures can be accounted for in terms of exhaustive interpretation, which can often be paraphrased in terms of 'only'. For example, in a context where it is relevant which students passed, (3-a) gives rise to the scalar implicature that not all students passed. This inference can also be derived from (3-b) — but now it follows from the semantic meaning of the sentence.

(3) a. Some of the students passed.
b. Only $[\text{some}]_F$ of the students passed.[2]

To account for the scalar implicatures of 'ϕ', one could assume that a sentence should pragmatically interpreted in terms of '*Prag*', which is modelled after Rooth's (1986) analysis of 'only':[3]

(4) $$Prag(\phi) \stackrel{def}{=} \{w \in [\![\phi]\!] | \neg\exists\psi \in Alt(\phi) : w \in [\![\psi]\!] \ \&\ [\![\psi]\!] \subset [\![\phi]\!]\}$$

In case the alternative of (3-a) is '*All* of the students passed', the desired scalar implicature is indeed accounted for. The reader can easily see that the same correct prediction (5-b) is made for (5-a) if $Alt(\phi \vee \phi) = \{\phi \wedge \psi\}$.

(5) a. Alice passed or Bob passed.
b. It is not the case that both Alice and Bob passed.

What is pleasing about rule (4) as well is that it seems almost immediately to be motivated by Grice's maxim of quantity 'Say as much as you can' in terms of which standard scalar implicatures like (3-a)-(3-b) and (5-a)-(5-b) are standardly accounted

[2]The notation $[\cdot]_F$ means that the relevant item receives focal stress, i.e., an H^*L prosodic contour.
[3]Krifka (1995) introduces our *Prag* under the name '*Scal.Assert*'.

for.[4]

Unfortunately, McCawley (1993) noticed that in case one scalar item is embedded under another one — as in (6),[5] — an interpretation rule like *Prag* does not give rise to the desired prediction that only one of Alice, Bob and Cindy passed if $Alt(\phi \vee \phi) = \{\phi \wedge \psi\}$.

(6) Alice passed, Bob passed, *or* Cindy passed.

Worse, *Prag* does not even give rise to the desired prediction (5-b) for (5-a) if the set of alternatives also contain 'Alice passed' and 'Bob passed'. The reason is that one cannot infer from the semantic meaning of (5-a) that any of the alternatives is true. Therefore (4) predicts that both these alternatives are false, resulting in the impossible proposition. Assuming that in these cases the alternatives are closed under disjunction (and conjuction) obviously doesn't help: the original alternatives remain alternatives when we make this shift, and the problems remain as well.

Notice that the following slight alternative of *Prag*, call it '*Prag**', is in all relevant aspects similar to *Prag*, and mispredicts in the same way for examples (5-a) and (6).

(7) $$Prag^*(\phi) \stackrel{def}{=} \{w \in [\![\phi]\!] | \forall \psi \in Alt(\phi) : w \in [\![\psi]\!] \Rightarrow [\![\phi]\!] \subseteq [\![\psi]\!]\}$$

A popular way to get rid of these problems is to account for scalar implicatures by a rule of *exhaustive interpretation*. According to it, pragmatic interpretation rules out worlds where more of the relevant alternative propositions are true than demanded to verify the sentence. This intuition is directly expressed in the following interpretation rule. In this following rule it is assumed that the set of relevant alternatives to ϕ, $Alt(\phi)$, is determined either by a question under discussion, or as the focus-alternatives, as assumed in Rooth's (2006) alternative semantics. Sentences like 'Alice passed', 'Bob passed', and 'Alice passed' are normally taken to be alternatives to sentences like (5-a) and (6).

(8) $$\begin{aligned} Exh(\phi, Alt(\phi) &\stackrel{def}{=} \{w \in [\![\phi]\!] | \neg\exists v \in [\![\phi]\!] : \{\psi \in Alt(\phi) | v \in [\![\psi]\!]\} \\ &\qquad\qquad \subset \{\psi \in Alt(\phi) | w \in [\![\psi]\!]\}\} \\ &= \{w \in [\![\phi]\!] | \neg\exists v \in [\![\phi]\!] : \forall \psi \in Alt(\phi) : v \in [\![\psi]\!] \Rightarrow w \in [\![\psi]\!]\} \end{aligned}$$

Notice that (8) doesn't give rise to any of the (potential) problems discussed above for sentences like (5-a) or (6). It correctly predicts for (6), for instance, that only one of Alice, Bob and Cindy passed.

Obviously, if we define the following (partial) ordering relation between worlds, '$<_{Alt(\phi)}$' in terms of the sets of alternative sentences that are true in those worlds, $v <_{Alt(\phi)} w$ if and only if $\{\psi \in Alt(\phi) : v \models \psi\} \subset \{\psi \in Alt(\phi) : w \models \psi\}$, we can define (8) equivalently as $Exh(\phi, Alt(\phi)) = \{w \in [\![\phi]\!] | \neg\exists v \in [\![\phi]\!] : v <_{Alt(\phi)} w\}$. Suppose now that ϕ is of the form '$P([\alpha]_F)$' and that we define $Alt(\phi)$ in terms of predicate P as follows: $Alt(\phi) =_{def} \{P(\underline{d}) | d \in D\}$, with $\underline{d}$ a name for d. In that case (8) comes down to interpretation rule (9):

(9) $$Exh(\phi, P) \stackrel{def}{=} \{w \in [\![\phi]\!] | \neg\exists v \in [\![\phi]\!] : v <_P w\}$$
$$\text{with } v <_P w \quad \text{iff}_{df} \quad P(v) \subset P(w)$$

[4]On the further assumption that the speaker is knowledgeable.

[5]Landman (2000) discusses a structurally similar example like 'Mary is either working at her paper *or* seeing *some* of her students.'

In van Rooij & Schulz (2004) and Schulz & van Rooij (2006) it is explained that if in addition we assumed a *ceteris paribus* condition for considering alternative worlds, (9) actually comes down to Groenendijk & Stokhof's (1984) principle of exhaustive interpretation, or to McCarthy's (1980) rule of predicate circumscription. In Spector (2003), van Rooij & Schulz (2004), and Schulz & van Rooij (2006) it is shown how exhaustive interpretation rules (8) and (9) can be inferred and thus motivated by Gricean maxims of quality and quantity and assumptions of (maximizing) competence.[6]

2.2 Prospects and problems of the standard exhaustivity account

Quite a number of conversational implicatures (including *scalar* ones) can be accounted for in terms of exhaustive interpretation. Except for the obvious result that from the answer 'Alice passed' to the question 'Who passed?' we derive that Alice is the only one who passed, we can also account for all of the following implicatures already mentioned in the introduction:

(10)
a. $p \vee q$ $\rightsquigarrow$ not both p and q (scalar implicature)
b. 2 students passed $\rightsquigarrow$ exactly 2 students passed (scalar implicature)
c. $p \rightarrow q$ $\rightsquigarrow$ p if and only if q (conditional perfection)
d. $p \vee q \vee r$ $\rightsquigarrow$ only one of p, q, and r is true
e. $(p \vee q) \wedge (r \vee s)$ $\rightsquigarrow$ only one of $(p \wedge r), (p \wedge s), (q \wedge r)$ or $(q \wedge s)$ holds

Moreover, we derive the implicature that not everybody passed from the answer that *most* did; and the so-called *conversion*-inference that only men passed, if the answer is 'Every man passed'.[7] Another pleasing property of an exhaustivity analysis of implicatures is that it predicts that it depends on the context, or question-predicate, whether we observe these inferences.[8] For instance, in terms of exhaustification one can immediately account for the intuition that pragmatic inferences (10-a) and (10-c) are cancelled (or better, not generated), if the statements are given as answers to yes-no questions of the form '$(p \vee q)$?' and '$(p \rightarrow q)$?', respectively.

Unfortunately, accounting for implicatures in terms of exhaustive interpretation as given in (8) or (9) also gives rise to some serious problems. The first problem — most clearly visible under formulation (9) — is due to the fact that interpreting by exhaustive interpretation adopts the strategy to only look for worlds where the extension of the relevant question-predicate under discussion is minimized. But as already seen by Groenendijk & Stokhof (1984), this gives rise to the highly unwelcome prediction

[6]For an approach based on similar ides involving Gricean maxims and maximizing competence, see Sauerland (2004).

[7]If we exchange '$\vee$' by '$\exists$' and '$\wedge$' by '$\forall$', things also work for quantified variants of e.g. (10e)' $\forall x(Px \vee Qx)$' $\rightsquigarrow \neg\exists x(Px \wedge Qx)$. In Van Rooij & Schulz (2004) it is shown, moreover, how in terms of exhaustive interpretation one can also account for the intuition that sentences represented by something like '$\Box(p \vee q)$' typically give rise to the implicatures that in all the accessible worlds only p or only q holds.

[8]Schulz & van Rooij (2006) suggest that some obvious problems of standard pragmatic interpretation rules (such as the rule given in (8) of exhaustive interpretation) can be solved when we take the minimal models into account. They propose, for instance, that to account for the context-dependence of exhaustive interpretation, the beliefs and preferences of agents are relevant to determine the ordering relation between worlds required to define the minimal models. In this way they get a better grasp of the context (and relevance) dependence of implicatures, and can account for, among others, both mention-all and mention-some readings of answers (which Groenendijk & Stokhof (1984) could not).

that nobody passed, if the following negative, or better *monotone decreasing*, answers to the question 'Who passed?' are given.

(11) a. Jo did not pass.
b. At most Jo passed.

Von Stechow & Zimmermann (1984) (in a weakened form followed by Schulz & van Rooij (2006)) proposed that in such cases we should not minimize the extension of the question-predicate 'Pass', but rather the *negation* of the question-predicate, and thus *maximize* the extension of the original question-predicate. It is disputable whether the new prediction for (11-a), i.e., everybody but Jo passed, is correct, but the prediction given for (11-b), i.e. Jo passed, is certainly wrong. Equally problematic are examples like (12-a) and (12-b) that are neither monotonic increasing, nor monotonic decreasing.

(12) a. Between two and five students passed.
b. Jo but not Bo passed.

The extension of which predicate should be minimized by pragmatic interpretation? No single answer seems appropriate. This, then, I take to be the **first problem** of exhaustive interpretation: it is not clear how to account in a systematic way for the correct predictions for downward monotone sentences like (11-b) and non-monotone sentences like (12-a) and (12-b).

The **second problem** for an analysis of implicatures in terms of exhaustive interpretation as defined by (8) and (9), and the problem that I will mostly focus on in this paper, is the fact that the following patterns also already mentioned in the introduction cannot be predicted:

(13)	a.	$p \vee q \vee (p \wedge q)$	$\rightsquigarrow$	only p, only q, or (only) $p \wedge q$
	b.	2 or 3 students passed	$\rightsquigarrow$	Exactly 2 or exactly 3 students passed
	c.	At least 2 students passed	$\not\rightsquigarrow$	Exactly 2 students passed

In Schulz & van Rooij (2006) this was called the *functionality problem.* The functionality problem follows from the fact that exhaustive interpretation works immediately on the *semantic meaning* of an expression. It follows that if two sentences have the same semantic meaning, they are predicted to give the same implicatures as well. It is, for instance, standardly assumed that 'Alice passed or Bob passed' has the same semantic meaning as 'Alice passed, Bob passed, *or both* passed', and that 'Two students passed' has the same semantic meaning as both 'Two *or three* students passed' and '*At least* two students passed'. But sentences in which the former examples occur give rise to the 'scalar' implicatures that Alice and Bob did not both pass, and that at most two students passed, respectively, while the latter do not.

Confronted with the problem posed by (27-a) and (27-b), a number of researchers (e.g. Chierchia, Fox & Spector, 2012) have concluded that what's wrong with the standard account is that implicatures are calculated *globally.* In Schulz & van Rooij (2006) it was already argued, instead, that another assumption should be blamed: the assumption that semantic meanings should be modelled as coarse-grained as by sets of possible worlds.[9] Schulz & van Rooij (2006) proposed that instead of thinking of semantic meanings as sets of *possible worlds*, we should think of them as being *more*

[9]The well-known problem of 'logical omniscience' is closely related, and adopting a more fine-grained notion of meaning has been suggested by various authors to solve this problem as well.

fine-grained as sets of *world-assignment pairs*, as is standard in *dynamic semantics*.[10]

2.3 Dynamic exhaustification

In dynamic semantics (e.g. Kamp & Reyle, 1993) it is assumed that to account for the anaphoric dependencies, we should represent (14-a), (15-a) and (16-a), respectively, by (14-b), (15-b) and (16-b) (on the simplifying assumption that the domain consists of students only).

(14) a. Two students passed.
  b. $\exists X(P(X) \wedge card(X) = 2)$

(15) a. Two or three students passed.
  b. $\exists X(P(X) \wedge (card(X) = 2 \vee card(3)))$

(16) a. At least two students passed.
  b. $\exists X(P(X) \wedge card(X) \geq 2)$

Although all three sentences are (standardly taken to be) true in exactly the same possible worlds, in dynamic semantics they give rise to different sets of dynamic meanings, thought of as sets of verifying world-assignment pairs: Each world-assignment $\langle w, g \rangle$ that is an element of the dynamic meaning of (14-b), $[\![[(14\text{-b})]\!]]$, assigns to variable X a set of exactly two students that passed. For (15-b) and (16-b) this does not have to be the case: X can also be assigned to a set of exactly three students that passed for (15-b), while any set of students that passed with a cardinality of at least 2 is possible for (16-b).

It is important to realize that the notion of meaning adopted in dynamic semantics is *finer-grained* than the notion of meaning in standard possible world semantics. Indeed, we can recover for any sentence ϕ, the standard semantic meaning, $[\![\phi]\!]$, in terms of the dynamic semantic meaning, $[\![[\phi]\!]]$, as follows:

(17) $[\![\phi]\!] \quad = \quad \{w \in W |\ \exists g : \langle w, g \rangle \in [\![[\phi]\!]]\}.$

Schulz & van Rooij (2006) propose to make use of the differences in dynamic semantic meanings between (14-a), (15-a) and (16-a) in their dynamic exhaustivity operator, $Exh_{dyn}(\phi, P)$. Recall that according to (9), exhaustive interpretation is formulated in terms of a predicate-dependent ordering relation between worlds, $v <_P w$. The definition of the order $<_P$ comparing the extensions of the question-predicate used in (9) is now extended to an ordering on world-assignment pairs simply by adding the condition that the assignments have to be identical to make possibilities comparable. Thus, $\langle w, g \rangle <_P \langle v, h \rangle$ iff$_{\text{def}}$ $g = h$ and $w <_P v$. Dynamic exhaustive interpretation is then defined as a function that selects minimal possibilities instead of worlds.

(18) $Exh_{dyn}(\phi, P) \quad \stackrel{def}{=} \quad \{i \in [\![[\phi]\!]] | \neg\exists j \in [\![[\phi]\!]] : j <_P i\}.$

This straightforward extension of standard exhaustification rule (9) to dynamic semantics accounts for the different implicatures of (14-a), (15-a) and (16-a). The reason is that the extension of variable X can no longer be varied freely when the extension of the question-predicate is minimized. Notice that although each world-assignment pair $\langle w, g \rangle$ in $[\![[(14\text{-a})]\!]]$ assigns to X a set of exactly 2 students that passed, it might still be that in the world w of that possibility more than 2 students passed. Such

[10] Sevi (2005), instead, proposed to make use of plural semantics to account for part of the functionality problem. It turns out that this bears some similarity to what I will propose here.

world-assignment pairs are eliminated, however, by means of dynamic exhaustification rule (18).[11] So far, nothing new. But for (15-a) and (16-a) things are different: a world-assignment pair $\langle w, g\rangle$ that assigns to X a set of 3 students that passed can no longer be eliminated, even though there is another pair $\langle v, h\rangle$ where in v only two students passed. The reason is that those two possibilities are now considered to be incomparable, because $g(X) \neq h(X)$. As a result, (15-a) is predicted to give rise to the implicature that exactly two or exactly three students passed, while (16-a) is predicted not to give rise to an implicature concerning the amount of students that passed at all.

Schulz & van Rooij (2006) proposed to solve the problem posed by example (27-a) in a similar vain. To do so, they propose to represent disjunctive sentences in terms of existential sentences as well. But whereas 'John or Mary passed' is represented by something like $\exists q: {}^{\vee}q \wedge (q = {}^{\wedge}P(j) \vee q = {}^{\wedge}P(m))$ (where 'q' is a propositional variable and '${}^{\vee}$' and '${}^{\wedge}$' have their usual Montagovian meanings), the senence 'John or Mary or both passed' is represented by $\exists q: {}^{\vee}q \wedge (q = {}^{\wedge}P(j) \vee q = {}^{\wedge}P(m) \vee q = {}^{\wedge}(P(j) \wedge P(m)))$. Although also on these representations they give rise to the same static semantic meanings, their dynamic meanings are predicted to be different: the latter allows for a verifying world-assignment pair where the assignment maps q to the proposition that both John and Mary passed the examination, while the former formula does not. In almost exactly the same way as for the examples (14-a) and (15-a), this difference in dynamic semantic meaning has the effect that the two formulas give rise to different exhaustive interpretations: the former, $Exh_{dyn}(\exists q: {}^{\vee}q \wedge (q = {}^{\wedge}P(j) \vee q = {}^{\wedge}P(m)), P)$, allows only for possibilities (and thus worlds) in which either only John or only Mary passed the examination; the latter, $Exh_{dyn}(\exists q: {}^{\vee}q \wedge (q = {}^{\wedge}P(j) \vee q = {}^{\wedge}P(m) \vee q = {}^{\wedge}(P(j) \wedge P(m))), P)$, allows for possibilities where both passed the examination.

Appealing as this analysis of the functionality problem is, it still gives rise to two new problems. The first problem is that in order to predict that (14-a)-(16-a), and that 'John or Mary passed' and 'John or Mary or both passed' will give rise to different implicatures, it is essential to *represent* them differently, and in particular, to represent disjunctions in terms of existential quantifiers. Although this seems very natural for (14-a)-(16-a) (cf. Kadmon, 1985; Kamp & Reyle, 1993), this seems **unnatural** for the other example. A second problem is that, at least so far, no Gricean motivation has been given for dynamic exhaustification in the same way that (8) has been motivated in the work of Spector (2003) and Van Rooij & Schulz (2004). This, together with the problem of how to account for examples like (11-b), is enough to look for an alternative.

[11] Accounting for scalar implicatures in terms of exhaustive interpretation predicts that a sentence like 'Some students passed', represented by a formula like $\exists X(P(X) \wedge card(X) > 0)$, gives rise to the implicature that *at most one* student passed. That seems too strong a prediction. Dynamic exhaustification can be used to solve this problem as well, by representing the sentence as $\exists X(P(X) \wedge card(X) > 0 \wedge card(X) \leq few)$. This formula is true in a world exactly if the earlier formula was true, and in particular in worlds in which many or even all students passed. Still, a world-assignment pair $\langle w, g\rangle$ in the dynamic meaning of the formula in which in w at least many students passed is eliminated by dynamic exhaustification. World-assignment pairs in which in the world only few students passed, however, are not eliminated.

3 Facts and implicatures

So-called 'donkey sentences' like *If a farmer owns a donkey, he beats it* poses a problem for standard possible worlds-analyses of meaning. Dynamic semantics (Kamp 1981; Heim 1982; Groenendijk & Stokhof 1990) was developed to account for it. But it soon became clear that one could solve the problem as well, making use of minimal situations (e.g. Heim, 1990). What both approaches have in common is that they both have a *finer-grained* conception of semantic meaning than standard possible worlds semantics has. We have seen in the previous section that if we want to have a global approach towards implicatures, fine-grainednes seems an essential key to the solution. This gives rise to the expectation that a situation-based approach might be able to account for some conversational implicatures as well. Indeed, this has been suggested explicitly by Kratzer (2007), who proposed, however, that these 'implicatures' follow from the semantic meaning already. In the rest of this paper I will take up Kratzer's suggestion, although work out the idea in a rather different way. First, I will not talk in terms of situations, but in terms of *facts*, or state of affairs. Nothing hangs on that, but it does reflect that where my approach is based upon. The conception of facts that I will use comes from van Fraassen (1969). What is distinctive about his conception is that there are negative and conjunctive facts, but no disjunctive ones. This is crucial if one wants to determine what the *truth-makers* are of a sentence, and it turns out that this is important for what follows.[12] In distinction with Kratzer (2007), I will also treat the inferences dealt with in this paper in terms of pragmatics, rather then semantics. Whether this is crucial or not, it does clearly point out the similarity between the (global) possible world-based analysis of implicatures discussed so-far, and the fact-based one to be developed from now on.

As van Fraassen, we will say that with every atomic sentence p there corresponds a positive and a negative state of affairs ($\mathbf{p}$ and $\overline{\mathbf{p}}$), exactly one of which holds. Facts are modelled as sets of state of affairs.[13] As positive and negative atomic facts we have e.g. $\{\mathbf{p}\}$ and $\{\overline{\mathbf{p}}\}$, and we have $\{\mathbf{p}, \overline{\mathbf{q}}\}$ as an example of a conjunctive fact (in fact, the minimal and exact one) making $p \wedge \neg q$ true. But many sentences (e.g. '$p \vee q$') have more than one exact truth-maker. For each sentence ϕ we define below its set of exact truth-makers, $T(\phi)$, and false-makers, $F(\phi)$, in a simultaneous recursion:

- $T(p) = \{\{\mathbf{p}\}\}$ $\quad F(p) = \{\{\overline{\mathbf{p}}\}\}$ for atomic p.
- $T(\neg\phi) = F(\phi)$ $\quad F(\neg\phi) = T(\phi)$.
- $T(\phi \wedge \phi) = T(\phi) \otimes T(\psi) = \{X \cup Y | X \in T(\phi), Y \in T(\psi)\}$.
  $F(\phi \wedge \phi) = F(\phi) \cup F(\psi)$.
- $T(\phi \vee \psi) = T(\phi) \cup T(\phi)$ $\quad F(\phi \vee \psi) = F(\phi) \otimes F(\psi)$.
- $T(\forall x\phi) = \bigotimes_{d \in D} T(\phi[^x/_{\underline{d}}])$ $\quad F(\forall x\phi) = \bigcup_{d \in D} F(\phi[^x/_{\underline{d}}])$.

[12] Van Fraassen uses these truth-makers to give a semantics for the notion of 'tautological entailment' introduced by Belnap & Anderson (1962). For recent work on truth-makers using this framework, see Fine (2012, to appear). For use of the same framework for quite different purposes, see van Rooij (2000, 2014). In van Rooij (to appear) and and Cobreros et al. (to appear) the framework is used to account for pragmatic inferences involving *knowability* and *vagueness*, respectively. The use of the framework to account for some of the problems that are central in this paper was first sketched in van Rooij (2013).

[13] If one doesn't like facts, one can always think of them in a purely linguistic way simply as a set of literals, where a literal is an atomic sentence, p, or its negation, $\neg p$.

- $T(\exists x\phi) \quad = \quad \bigcup_{d\in D} T(\phi[^x/_{\underline{d}}]) \qquad\qquad F(\exists x\phi) \quad = \quad \bigotimes_{d\in D} F(\phi[^x/_{\underline{d}}])$.

Notice that according to these rules, $T(p) = \{\{\mathbf{p}\}\}$, $T(\neg p) = \{\{\overline{\mathbf{p}}\}\}$, $T(p \vee q) = \{\{\mathbf{p}\},\{\mathbf{q}\}\}$ and $T(p \wedge q) = \{\{\mathbf{p},\mathbf{q}\}\}$. Important for our analysis of implicatures it will be that it also holds that $T(p \vee q \vee r) = \{\{\mathbf{p}\},\{\mathbf{q}\},\{\mathbf{r}\}\}$, $T((p \vee q) \wedge (r \vee s)) = \{\{\mathbf{p},\mathbf{r}\},\{\mathbf{p},\mathbf{s}\},\{\mathbf{q},\mathbf{r}\},\{\mathbf{q},\mathbf{s}\}\}$ and $T(p \vee q \vee (p \wedge q)) = \{\{\mathbf{p}\},\{\mathbf{q}\},\{\mathbf{p},\mathbf{q}\}\}$. We analyse conditionals like $\phi \rightarrow \psi$ as material implication, that is $p \rightarrow q \equiv \neg p \vee q$ and $\neg(p \wedge q) \equiv \neg p \vee \neg q$, and thus $T(p \rightarrow q) = \{\{\overline{\mathbf{p}}\},\{\mathbf{q}\}\}$ and $T(\neg(p \wedge q)) = \{\{\overline{\mathbf{p}}\},\{\overline{\mathbf{q}}\}\}$.[14] Observe also that $T(\forall x(Px \vee Qx)) = T(P\underline{a} \vee Q\underline{a}) \otimes T(P\underline{b} \vee Q\underline{b}) = \{\{\mathbf{Pa},\mathbf{Pb}\},\{\mathbf{Pa},\mathbf{Qb}\},\{\mathbf{Qa},\mathbf{Pb}\},\{\mathbf{Qa},\mathbf{Qb}\}\}$, if $D = \{a,b\}$.

Truth-makers of modal statements like $\Box\phi$ and $\Diamond\phi$ can be given as well. The most straightforward—though not the only—way to do so is to (i) assume that the representation of each atomic sentence ϕ has an extra world-slot, filled by distinguished world-variable i and interpreted as the actual world, and (ii) represent modal statements as formulas that explicitly quantify over worlds in the object-language, which can shift the interpretation of the world-variable. Where an atomic sentence like 'It is pouring' is now represented as Pi instead of p, the modal sentence 'It is possible that it is pouring', for instance, is now represented by $\exists j(Pj)$. On such an approach, state of affairs are world-dependent as well: they are of the form 'it is pouring at w', $\mathbf{Pw}$, instead of simply 'it is pouring', $\mathbf{p}$. On this analysis of modal statements it immediately follows that if $W = \{w,v,u\}$ is the set of worlds, $T(\exists j(Pj)) = \{\{\mathbf{Pw}\},\{\mathbf{Pv}\},\{\mathbf{Pu}\}\}$ and $T(\forall j(Pj)) = \{\{\mathbf{Pw},\mathbf{Pv},\mathbf{Pu}\}\}$. For readability, we will in this paper only occasionally think of state of affairs as being world-dependent; only in case we explicitly deal with modal statements.

It is interesting to notice that $T(\phi)$ can be thought of as a fine-grained *semantic* interpretation of ϕ. It can be used to determine its standard truth-conditional meaning, if a world is taken to be a maximally consistent conjunctive fact.[15] In that case the standard truth-conditional meaning of ϕ, $[\![\phi]\!]$, can be recovered as the set of worlds in which 'ϕ' has a truth-maker:[16]

(19) $\quad [\![\phi]\!] \quad = \quad \{w \in W | \exists f \in T(\phi) : f \subseteq w\}$.

But we did not introduce truth-makers just to recover a notion, $[\![\cdot]\!]$, we already had. Our purpose of introducing truth-makers is that in terms of them we can define a notion of pragmatic meaning in terms of which we can explain a number of pragmatic inferences. Indeed, we can use $T(\phi)$ to determine the pragmatic meaning $PRAG(\phi)$ to account for some implicatures. Our first trial is to exchange '*there is an exact truth-maker of* ϕ' ($\exists f \in T(\phi)$) in the above definition of $[\![\phi]\!]$, (19), into '*there is a unique exact truth-maker of* ϕ' ($\exists! f \in T(\phi)$):

[14]Note that the definition of $T(\phi)$ parallels the construction of the disjunctive normal form of ϕ.

[15]It is important to realize that once we talk about modal statements, world-dependent state of affairs like $\mathbf{Pw}$ don't actually have to hold in w. Just like a state of affairs $\mathbf{p}$ can hold in w or not, so it is the case for $\mathbf{Pw}$. It is only natural to assume, however, that $\mathbf{Pw}$ can *only* hold in w.

[16]More generally, we don't have to limit ourselves to worlds, but can model the meaning of a sentence as the set of facts that make it (perhaps inexactly) true. If F is the set of all facts, we can define the following semantic notion of meaning: $[\![\langle\phi\rangle]\!] \stackrel{def}{=} \{g \in F | \; \exists f \in T(\phi) : f \subseteq g\}$. It is exactly in terms of this notion of meaning that van Fraassen (1969) provides a semantics for the notion of tautological entailment: $\phi \models^{te} \psi$ iff$_{df}$ $[\![\langle\phi\rangle]\!] \subseteq [\![\langle\psi\rangle]\!]$. Notice that $[\![\langle\phi\rangle]\!]$ might be thought of as the set of (possibly non-total) situations at which ϕ is true. It is $[\![\langle\phi\rangle]\!]$ rather than $T(\phi)$ what Kratzer and others take to be the fine-grained semantic meaning of a sentence in Situation Semantics. Although $T(\phi) \subseteq [\![\langle\phi\rangle]\!]$, and all elements of $[\![\langle\phi\rangle]\!]$ make ϕ true, only those in $T(\phi)$ make ϕ *exactly* true.

(20) $$\begin{aligned} PRAG(\phi) &\stackrel{def}{=} \{w \in W \mid \exists! f \in T(\phi) : f \subseteq w\}. \\ &= \{w \in W \mid \exists f \in T(\phi) : f \subseteq w \ \&\ \forall g \in T(\phi) : g \subseteq w \rightarrow g = f\} \\ &= \{w \in W \mid \exists f \in T(\phi) : f \subseteq w \ \&\ \forall g \in T(\phi) : w \in (\!|g|\!) \rightarrow (\!|g|\!) = (\!|f|\!)\} \\ &\text{where } (\!|f|\!) \stackrel{def}{=} \{w \in W :\ f \subseteq w\} \end{aligned}$$

Our pragmatic interpretation rule immediately accounts for the standard scalar implictures (21-a) and (21-b) as well as for the examples (21-c), (21-d) and (21-e) also mentioned in the introduction.

(21) a. $p \vee q$ $\rightsquigarrow$ not both p and q (scalar implicature)
b. 2 students passed $\rightsquigarrow$ exactly 2 students passed (scalar implicature)
c. $p \rightarrow q$ $\rightsquigarrow$ p if and only if q (conditional perfection)
d. $p \vee q \vee r$ $\rightsquigarrow$ only one of p, q, and r is true
e. $(p \vee q) \wedge (r \vee s)$ $\rightsquigarrow$ only one of $(p \wedge r), (p \wedge s), (q \wedge r)$ or $(q \wedge s)$

Moreover, from 'Every boy kissed Mary or Sue' it can now be concluded that every boy kissed only Mary, or only Sue. Similarity, 'John believes that $p \vee q$', represented by a quantified formula like $\forall j(DOX(i,j) \rightarrow (Pj \vee Qj))$, is predicted to mean that in all of John's doxastic alternatives, exactly one of p or q is true. Observe that because $PRAG$ predicts implicature (22-b) from (22-a), it also predicts that (23-a) gives rise to the implicature that at most two students passed, whether (23-a) is represented by (23-b) (as is standardly assumed), or by (23-c) as discusssed in section 2.3.

(22) a. $(p \wedge q) \vee (p \wedge r) \vee (q \wedge r)$
b. only one of $(p \wedge q)$, $(p \wedge r)$ and $(q \wedge r)$

(23) a. Two students passed.
b. $\exists x, y(Px \wedge Py \wedge x \neq y)$
c. $\exists X(P(X) \wedge card(X) = 2)$

So far, the predictions are very much the same as what is predicted by standard exhaustivity approaches to implicatues discussed in sections 2.1 and 2.2.[17] Interestingly enough, our fact-based analysis immediately predicts correctly for 'monotone decreasing' statements that were problematic for the exhaustivity aproach. Consider, for instance, a sentence like (24-a), represented by (24-b) or (24-c).

(24) a. At most Jo passed.
b. $(Pj \wedge \forall x(x \neq j \rightarrow \neg Pj)) \vee \neg \exists x Cx$
c. $\forall X((P(X) \rightarrow (X = \{j\} \vee X = \emptyset))$

Recall from section 2.1 that the standard exhaustivity approach proposes to minimize the extension of the background predicate — which we assume to be 'passed' — resulting in the completely wrong prediction that (24-a) implies that nobody passed. Von Stechow & Zimmermann (1984) (followed in a weakened form by Schulz & van Rooij (2006)) propose that for 'negative' answers the to-be-minimized predicate should be the *negation* of the background predicate. But in this case this would predict that Jo passed, which is equally wrong. It is interesting to see that our fact-based analysis immediately gives rise to the correct prediction. To show this, let us assume that the domain consists of just Jo and Bo. In that case $T(\neg \exists x Px) =$

[17] Except for the fact that the exhaustivity-approach also predicts further exhaustivity- and 'cancellation'-effects.. We will discuss how our fact-based analysis can account for these predictions as well in section 4.

$F(\exists x Px) = F(Pj) \otimes F(Pb) = \{\{\overline{\mathbf{Pj}}\}\} \otimes \{\{\overline{\mathbf{Pb}}\}\} = \{\{\overline{\mathbf{Pj}}, \overline{\mathbf{Pb}}\}\}$, and thus $T((24\text{-b})) = \{\{\mathbf{Pj}, \overline{\mathbf{Pb}}\}, \{\overline{\mathbf{Pj}}, \overline{\mathbf{Pb}}\}\}$. We see that (24-b) has two incompatible truth-makers, meaning that according to the pragmatic interpretation rule (20) the pragmatic interpretation does not strengthen the semantic meaning: $PRAG((24\text{-b})) = [\![(24\text{-b})]\!]$. This is in according with intuition.

For exactly the same reason, also (25-a) does not give rise to an implicature that no student passed (as does the standard exhaustivity approach) or exactly two (as does the exhaustivity approach if the negation of the background predicate is taken to-be-minimized).

(25) a. At most two students passed.
b. $\forall X(P(X) \rightarrow card(X) \leq 2)$

What would our fact-based analysis of pragmatic interpretation do with examples (26-a) and (26-b) that are neither monotonic increasing, nor monotonic decreasing?

(26) a. Between two and five students passed.
b. Jo but not Bo passed.

It is obvious that (26-b) is accounted for immediately: according to $PRAG$ it does not give rise to any implicature because $T((26\text{-b})) = \{\{\mathbf{Pj}, \overline{\mathbf{Pb}}\}\}$. Unfortunately, the analysis does not predict correctly for an example like (26-a). It seems natural that we represent this sentence as saying that either three or four students passed. But, of course, in worlds in which four students passed their will be more than one truth-maker of the sentence. Thus, such worlds are by the current fact-based pragmatic interpretation (20) incorrectly ruled out.

In fact, the problem how to account for the pragmatic interpretation of (26-a) is really the functionality problem again, as discussed above. And indeed, also the fact-based pragmatic rule $PRAG$ cannot account for the problematic cases discussed in the introduction repeated here as (27-a), (27-b) and (27-c).

(27)	a.	$p \vee q \vee (p \wedge q)$	$\rightsquigarrow$	only p, only q, or (only) $p \wedge q$
	b.	2 or 3 students passed	$\rightsquigarrow$	Exactly 2 or exactly 3 students passed
	c.	At least 2 students passed	$\not\rightsquigarrow$	Exactly 2 students passed

Fortunately, we now have the resources available to account for such cases as well. Indeed, we propose the following slight weakening of pragmatic interpretation rule $PRAG$ defined in (20) into $PRAG^*$ defined in (28), by changing $g = f$ into $g \subseteq f$:

(28)
$$PRAG^*(\phi) \stackrel{def}{=} \{w \in W \mid \exists f \in T(\phi) : f \subseteq w \ \&\ \forall g \in T(\phi) : g \subseteq w \rightarrow g \subseteq f\}$$
$$= \{w \in W \mid \exists f \in T(\phi) : f \subseteq w \ \&\ \forall g \in T(\phi) : w \in (\!|g|\!) \rightarrow (\!|f|\!) \subseteq (\!|g|\!)\}$$

Before we are going to discuss how this new interpretation rule deals with some examples, let us first notice the similarity between this rule and the pragmatic interpretation rule $Prag^*$, (7), defined in section 2.1. Observe that $w \in [\![\phi]\!]$ iff $\exists f \in T(\phi) : f \subseteq w$ and that $(\!|f|\!)$ is the proposition that corresponds with fact f, and thus that the only difference with the earlier mentioned—and more standard—pragmatic interpretation rule $Prag^*$ is that $PRAG^*$ makes use of the facts that make ϕ true, rather than the proposition expressed by ϕ, $[\![\phi]\!]$, itself. We will see below that this makes a crucial difference.

We have seen in section 2.1 that the pragmatic interpretation rule $Prag$, (4), and thus also the almost identical $Prag^*$, (7), can almost immediately be motivated by

Grice's maxim of quantity 'Say as much as you can'. Because of the similarity between $PRAG^*$ and $Prag^*$, this motivation can be carried over to the case of $PRAG^*$, with the only difference that things should now be restated into something like 'Provide the strongest *facts* you can' instead of the strongest *proposition.* Close enough to still be 'Gricean', in my opinion.

Let us see how our new interpretation rule accounts for example (27-a). Suppose $W = \{w, v, u, x\}$ and $[\![p]\!] = \{w, v\}$ and $[\![q]\!] = \{w, u\}$. Now, the sentences $p \vee q$ and $p \vee q \vee (p \wedge q)$ give rise to the same semantic meaning: $[\![p \vee q]\!] = [\![p \vee q \vee (p \wedge q)]\!] = \{w, v, u\}$, but to different sets of minimal truth-makers: $T(p \vee q) = \{\{\mathbf{p}\}, \{\mathbf{q}\}\}$, and $T(p \vee q \vee (p \wedge q)) = \{\{\mathbf{p}\}, \{\mathbf{q}\}, \{\mathbf{p}, \mathbf{q}\}\}$. Although according to our old pragmatic interpretation rule it holds that $PRAG(p \vee q) = \{v, u\} = PRAG(p \vee q \vee (p \wedge q))$, our new pragmatic interpretation rule predics that they also give rise to different pragmatic meanings: $PRAG^*(p \vee q) = \{v, u\}$, while $PRAG^*(p \vee q \vee (p \wedge q)) = \{w, v, u\}$. This is the desired interpretation, which we now obtained without a special quantificational representation of disjunctive sentences as was required on the dynamic exhaustivity approach discussed in Schulz & van Rooij (2006).

As one might expect, our new fact-based pragmatic interpretation rule $PRAG^*$ also accounts for the intuition that from (29-a) we infer that exactly 2 or exactly 3 students passed, and that (30-a) does not give rise to the implication that at most 2 students passed. The reason it does so is the same as why our new rule accounts for (27-a) as discussed above. It is worthwhile to observe, though, that the correct prediction comes out whether we represent (29-a) as (29-b) or as (29-c), and whether we represent (30-a) as (30-b) or as an explicit disjunction (represented similarly as (29-b) but with many more disjuncts).

(29) a. Two or three students passed.
b. $\exists x, y(Px \wedge Py \wedge x \neq y) \vee \exists x, y, z(Px \wedge Py \wedge Pz \wedge x \neq y \wedge x \neq z \wedge y \neq z)$
c. $\exists X(P(X) \wedge (card(X) = 2 \vee card(X) = 3))$

(30) a. At least two students passed.
b. $\exists X(P(X) \wedge card(X) \geq 2)$

That we *can* represent (29-a) and (30-a) without making use of plural quantification is interesting, even if there is independent anaphoric evidence for such a pluralistic representation (cf. Kadmon, 1985; Kamp & Reyle, 1993). Obviously, the nonmonotonic example (26-a) is now accounted for as well

Recently, Fox & Spector (2008) and Sauerland (2012) have put forward yet another challenge for any global analysis of scalar implictures: the problem of so-called 'intermediate implicatures'. The challenge posed for global analyses is to account for the intuition that (31) gives rise to the implicature that everybody read either some but not all of the books, or all the books.[18]

(31) Everybody read some of the books or everybody read all the books.

Indeed, the standard exhaustivity approach described in section 2.1 cannot account for this intuition. To see that our current analysis can account for this intuition, let's assume that we have two individuals, Alice and Bob, and two books, 1 and 2. The facts that make (31) exactly true are then $\{\mathbf{Ra1}, \mathbf{Rb1}\}, \{\mathbf{Ra1}, \mathbf{Rb2}\}, \{\mathbf{Ra2}, \mathbf{Rb1}\}$, $\{\mathbf{Ra2}, \mathbf{Rb2}\}$, and $\{\mathbf{Ra1}, \mathbf{Ra2}, \mathbf{Rb1}, \mathbf{Rb2}\}$. It is easy to see that our new fact-based

[18] The example actually discussed by Sauerland is slightly different from (31): it uses 'most' instead of 'some'. The issue how to account for this is the same, though.

pragmatic interpretation rule $PRAG^*$ indeed accounts for the intuition that everybody read either some but not all of the books, or that everybody read all the books. Similarly, our approach correctly predict that (32) yields the implicature that Mary is allowed to read exactly three books, though she is also allowed to read more.

(32) Either Mary must read at least three of the books or she must read at least four of them.

Also (32) is discussed by Sauerland (2012) as an intermediate implicature which gives, according to him, decisive evidence in favor of a non-global approach to implicatures. But this is wrong: in terms of a more fine-grained analysis, a global approach can easily account for these data.

4 Cancellation and Exhaustivity

One of the great benefits of determining pragmatic meaning in terms of exhaustive interpretation is that one accounts not only for the fact that if a speaker says 'ϕ or ψ' that $\phi \wedge \psi$ is not the case (as does the fact-based approach), but also that this implication is cancelled (or better, does not even arise) in case the assertion was given as answer to the yes-no question whether $\phi \vee \psi$ is true. Similarly, pragmatic interpretation in terms of exhaustivity gives not only rise to the prediction that $\phi \rightarrow \psi$ is normally interpreted as $\phi \leftrightarrow \psi$ (as does the fact-based approach), it also predicts that this implication is cancelled (or better, does not arise) in case it is given as answer to the yes-no question whether $\phi \rightarrow \psi$ is true. Neither of those *cancellation-effects* are predicted so far on the fact-based approach discussed above.[19] Moreover, interpreting $\phi \vee \psi$ exhaustively has the result that we conclude not only that $\phi \wedge \psi$ is not true, but that χ is not true as well, if χ is a relevant alternative. This *exhaustivity-effect* is not accounted for by the fact-based approach discussed in the previous section either. This raises the question whether we can accommodate our fact-based approach such to account for these predictions as well. It turns out that this is rather straightforward.

Let us assume that a question gives rise to a set of alternatives, ALT. An alternative question like 'p, q, or r?' gives rise to $ALT = \{[\![p]\!], [\![q]\!], [\![r]\!]\}$, while a yes-no question like 'ϕ?' gives rise to the set of alternatives $ALT = \{[\![\phi]\!], [\![\neg\phi]\!]\}$, just as expected. Now we will define the new pragmatic interpretation rule that also takes the set of alternatives under consideration:

(33) $$PRAG^*_{ALT}(\phi) \stackrel{def}{=} \{w | \exists f \in T(\phi) : f \subseteq w \ \& \ \forall q \in ALT : w \in q : (\!| f |\!) \subseteq q\}$$ $$\text{with } (\!| f |\!) =_{df} \{w \in W : f \subseteq w\}$$

How does this new definition of pragmatic interpretation account for cancellation and exhaustive interpretation? Before explaining that, let us first observe that if $ALT = \{(\!| f |\!) : f \in T(\phi)\}$, then $PRAG^*_{ALT}(\phi) = PRAG^*(\phi)$. The reason is that (i) $w \in (\!| f |\!)$ iff $f \subseteq w$ and (ii) $g \subseteq f$ iff $(\!| f |\!) \subseteq (\!| g |\!)$. But now suppose that $ALT \supset \{(\!| f |\!) : f \in T(\phi)\}$. For instance, let us assume that $\phi = p \vee q$ was uttered, and thus that

[19] But note that in the previous section we have already seen that some 'cancellation'-effects were already predicted by the fact-based approach (just as on the dynamic exhaustivity-account): '$p \vee q \vee (p \wedge q)$' is predicted not to give rise the implicature that $\neg(p \wedge q)$, and 'At least 2 students passed' does not implicate that at most 2 students passed. Of course, on the present analysis the term 'cancellation' is not really appropriate, because we predict that the (potential) implicatures never arise. This has some interesting consequences of how implicatures are processed, but we won't delve into those issues here.

$\{(\!|f|\!) : f \in T(\phi)\} = \{(\!|\mathbf{p}|\!), (\!|\mathbf{q}|\!)\} = \{[\![p]\!], [\![q]\!]\}$, but that $ALT = \{[\![p]\!], [\![q]\!], [\![r]\!]\}$. In that case we immediately predict that the speaker implicated $\neg r$ by his or her utterance '$p \vee q$', because neither $(\!|\mathbf{p}|\!) \subseteq [\![r]\!]$ nor $(\!|\mathbf{q}|\!) \subseteq [\![r]\!]$. This explains the *exhaustivity-effect*.

To account for the *cancelation-effect*, assume that '$p \vee q$' was given as answer to the yes-no question whether $p \vee q$ is true, giving rise to $ALT = \{[\![p \vee q]\!], [\![\neg(p \vee q]\!]\}$. Notice that in this case, the alternative $[\![p \vee q]\!]$ in ALT is a proper *superset* of all the elements of $\{(\!|f|\!) : f \in T(p \vee q)\} = \{(\!|\mathbf{p}|\!), (\!|\mathbf{q}|\!)\} = \{[\![p]\!], [\![q]\!]\}$, meaning, intuitively, that the elements in the latter set are more fine-grained than required to resolve the issue under discussion. It is easy to see that according to our definition of $PRAG^*_{ALT}(\phi)$ we correctly predict that the implicature that $\neg(p \wedge q)$ is cancelled (or better, does not arise) in these circumstances, because all that is required for all worlds w such that $\mathbf{p} \subseteq w$ or $\mathbf{q} \subseteq w$ is that $(\!|\mathbf{p}|\!) \subseteq [\![p \vee q]\!]$ and $(\!|\mathbf{q}|\!) \subseteq [\![p \vee q]\!]$, respectively, if $w \in [\![p \vee q]\!]$, which is trivially the case. Similarly, we can explain why '$p \rightarrow q$' is not interpreted pragmatically as $p \leftrightarrow q$, if it is given as answer to the yes-no question whether $p \rightarrow q$ is true — giving rise to $ALT = \{[\![p \rightarrow q]\!], [\![\neg(p \rightarrow q]\!]\}$.

5 Implicatures and Hurford's constraint

Hurford (1974) proposed a constraint—known as *Hurford's constraint*—which bans disjunctions in which one of the disjuncts entails the other. This condition helps to explain the infelicity of

(34) *Jan is from (somewhere in) the Netherlands or Amsterdam.

But we have seen already some examples, repeated below, where the constraint appears to be violated, even though the sentence is appropriate:

(35) a. Either Jo passed, or Bo, or Jo and Bo passed.
b. Two or three students passed.
c. Everybody read some of the books or everybody read all the books.

To account for (35-a),[20] Gazdar (1979) claims that Hurford's constraint should be *weakened* to: '$\phi \vee \psi$ is infelicitous if ψ entails ϕ, unless ψ contradicts ϕ together with the implicatures of ϕ.' Chierchia et al (2012) argue, instead, that in contrast to (34), examples (35-a)-(35-c) do not violate Hurford's constraint, because one of the disjuncts gives rise to an *embedded scalar implicature*, and that because of that, there actually is no entailment relation between the disjuncts.

(36) a. Either only Jo passed, or only Bo, or (only) Jo and Bo.
b. Two and only two or three and only three students pased.
c. Everybody read some but not all of the books or everybody read all the books.

I agree with Chierchia et al (2012) that Gazdar's weakening of Hurford's constraint is rather *ad hoc*. Unfortunately for the purpose of this paper, however, Chierchia et al. (2012) make crucial use of a *local* , or *grammatical*, notion of implicature: They would represent a sentence like (35-a) making use of (at least) two silent 'only's: $only(p) \vee only(q) \vee (p \wedge q)$. Although this analysis accounts for the data mentioned above, the question arises whether we cannot explain the same data making use of a

[20] To account for some related data, Hurford (1974) argued that 'or' is ambiguous between an inclusive and an exclusive reading. See Gazdar (1979) for a thorough criticism of this view.

global approach to implicatures.[21] That is, to explain why, on the one hand, (34) is inappropriate, without being forced to say that, on the other hand, (35-a)-(35-c) are inappropriate as well.

In our opinion—and adopting a *global* perspective towards implicatures—, the appropriateness of examples (35-a)-(35-c) shows that Hurford's constraint is *too strong*. Even though the latter disjunct in each example entails the former one(s) (where entailment is thought of standardly), this doesn't mean that there is anything wrong with them.[22] But how, then, to account for the *in*appropriateness of (34)? We would like to claim that (34) is inappropriate, not so much because the first disjunct is *entailed* by the second, but rather because the second disjunct is *redundant*, because already mentioned as a possibility in the first disjunct. We would like to represent (34) by a formula of the form $\exists xPx \vee Pa$. Of course Pa entails $\exists xPx$, but more relevantly, we feel, is that $T(\exists xPx) = T(\exists xPx \vee Pa)$: adding the latter disjunct doesn't add a new way to make the sentence (exactly) true. Instead of claiming that $\phi \vee \psi$ is inappropriate if $[\![\psi]\!] \subseteq [\![\phi]\!]$, this suggest that one should propose the **constraint** that $\phi \vee \psi$ is inappropriate if $T(\psi) \subseteq T(\phi)$. Notice that because $T(Pa) \subset T(\exists xPx)$ (or $T(p) \subset T(p \vee q)$), but $T(p \wedge q) \not\subseteq T(p)$, this constraint correctly predicts (34) to be inappropriate, without denying that examples like (35-a) can be appropriate. Because to be able to *formulate* the new constraint it seems essential to make use of truth-makers $T(\cdot)$ rather than standard semantic meaning $[\![\cdot]\!]$, this can be seen as another motivation for using a *finer-grained* notion of meaning.[23]

Although the constraint saying that $\phi \vee \psi$ is inappropriate if $T(\psi) \subseteq T\phi)$ suggested above works for the examples discussed previously, there is reason to believe that it is not exactly what we are looking for. As observed by Singh (2008), disjunctive sentences are inappropriate sometimes also when two disjuncts are mutually consistent:

(37) *John is from (somewhere in) Russia or Asia.

This suggests that Hurford's constraint is not only too strong, it is too weak as well. In addition, however, it also suggests that our newly suggested constraint on the appropriate assertion of disjunctions is too weak: (37) is not predicted to be inappropriate because both disjuncts have a truth-maker that the other does not have. Of course, one can correctly predict (37) to be inappropriate by a constraint demanding for an assertion of '$\phi \vee \psi$' that $[\![\phi]\!] \cap [\![\psi]\!] = \emptyset$. But such a constraint is much too strong: 'Jo passed or Bo passed' is perfectly appropriate.[24] Using $T(\cdot)$, however, we can state the following much weaker demand for appropriateness of assertions with sentences of the form '$\phi \vee \psi$':

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[21] Although I prefer a traditional global approach towards implicatures to a local one as proposed by Chierchia et al. (2012), the aim of this paper is just to *show* that the global approach can be pushed further than is sometimes assumed. I prefer to leave the, sometimes, heated discussions between globalists and localists to others (e.g. Geurts, 2009).

[22] Singh (2008) observes that whereas ((35-a)). is ok, the following type of example is inappropriate: **Either Jo and Bo passed, or Jo, or Bo.* This suggests that perhaps Hurford's constraint should still be in play for left to right inferences between disjuncts.

[23] Of course, one might suggest that the new constraint just follows from Hurford's constraint, *if* Hurford's constraint would have been formulated in terms of the appropriate fine-grained notion of *semantic meaning*, $T(\cdot)$. In a sense, this is the case. Notice, however, that formulating entailment in terms of a subset-relation of truth-makers, i.e. $\phi \models^* \psi$ iff$_{df} T(\phi) \subseteq T(\psi)$, would have the (I take it) undesirable consequence that $p \wedge q \not\models^* p$.

[24] Localists might suggest that this constraint should only hold after local strengthening. But in this paper we adopt a globalist perspective.

(38) '$\phi \vee \psi$' is appropriate only if $T(\phi) \cap T(\psi) = \emptyset$.

Observe that none of the examples (35-a)-(35-c) are predicted to violate this constraint, intuitively because $T(p) \cap T(p \wedge q) = \emptyset$ (and for (35-a), $T(p) \cap T(q) = \emptyset$). Sentences like (37) of the form $(p \vee r) \vee (q \vee r)$ (or more generally of the form $\exists x_D Px \vee \exists y_{D'} Py$, with D and D' the domains of quantification of the two disjuncts and $D \cap D' \neq \emptyset$), on the other hand, are now correctly predicted to be ruled out because the two disjuncts share an exact truthmaker, i.e. r.[25] Again, to formulate this constraint, fine-grainedness seems crucial.

6 Conclusion and Outlook

I have argued in this paper that fine-grainedness is the key to account for quite a number of conversational implicatures and the statement of appropriateness conditions, if one adopts a global approach towards pragmatic inferences. In particular, I argued in favor of a fact-based analysis, making use of truth-makers. But we have seen that some of the data might also be accounted for using another fine-grained notion of meaning: the one adopted in dynamic semantics. It is noteworthy to observe that these two fine-grained notions of meaning have been used as well to account for other problems of the standard possible world-based analysis of meaning posed by disjunctive and/or existential sentences. Indeed, both types of approaches have been used to account for (i) anaphoric dependencies in donkey-sentences—as already mentioned in the beginning of section 3—, and (ii) simplification of disjunctive antecedents of counterfactual conditionals using a similarity-based semantics (van Rooij (2006) uses 'dynamic' meanings while Fine (2013) uses facts).[26]

It can hardly be a coincidence that these approaches work for these types of examples and more: both approaches are more fine-grained than the standard approach exactly if disjunctive and/or existential sentences are involved. Indeed, in terms of the dynamic meaning of a existential formula like '$\exists x Px$' one can easily recover not just its standard possible worlds-meaning ($[\![\exists x Px]\!] = \{w \in W | \ \exists g : \langle w, g\rangle \in [\![[\exists x Px]\!]]\}$), but also the (singular) propositions that correspond with its (exact) truth-makers: $\{(\!|f|\!) : f \in T(\exists x Px)\} = \{\{w \in W | \exists h : \langle w, h\rangle \in [\![[\exists x Px]\!]] \ \& \ g(x) \in I_w(P) \ \& \ g(x) = h(x)\} | g \in G\}$. The other way around seems to work similarly. The use of Roothean Alternative Semantics as the proper semantic treatment of disjunctive sentences

[25] Also a sentence of like 'Either she read at least three of the books or she read at least four of them' is predicted to be inappropriate as well. According to Sauerland (2012), this is as it should be (although he would account for it in terms of Hurford's constraint.

[26] There are other problems of the standard possible worlds-approach posed by disjunctive sentences, e.g. the problem of free-choice permissions, and one might expect that the two fine-grained approaches would work here as well. Sentences that are naturally represented as being of the form $May(\phi \vee \psi)$ seem to give rise the free-choice inference $May(\psi)$. The problem is that on the standard treatment of obligations and permission in possible worlds semantics, (i) $O(\phi) \models O(\phi \vee \psi)$ and (ii) $O(\phi) \models P(\phi)$. Accounting form free-choice permissions as a semantic inference $P(\phi \vee \psi) \models P(\psi)$ would have the absurd result that $O(\phi) \models P(\psi)$ (by transitivity of inference). There are various ways to overcome this problem. According to almost all approaches, the free-choice permission inference is not semantic, but pragmatic in nature. Some have tried to account for this motivated by Grice's first maxim of quantity, 'say as much as you can' (e.g. Schulz 2004, Fox, 2007), while others have rather eluded to Grice's second maxim of quantity, 'don't say more than you must', perhaps in conjunction with an appeal to minimal complexity (e.g. Franke, 2010). In contrast to these pragmatic approaches, van Rooij (2006) proposed a modification of the *semantic performative* approach adopted by van Rooij (2000), making crucial use of dynamic meanings. A similar move using (something as fine-grained as) facts works as well (cf. Mastop, 2005).

(Alonso-Ovalle, 2005), and the recently developed inquisitive semantics (cf. Ciardelli et al. 2013) have been used to solve some of these problems in similar ways as well (e.g. Brochhagen & Coppock, 2013). Also here, a special treatment of disjunctive sentences is crucial. Naturally, this all asks for a formal proof that the fine-grained frameworks mentioned share a common core. It would be interesting to show what exactly this common core is.

In this paper I have assumed that the inferences mentioned, for instance, in the introduction are *pragmatic* in nature, and showed that a global approach can be adopted. Instead, as mentioned already, Kratzer (2007) suggested that the inferences typically discussed under the heading 'scalar imlicatures' are really *semantic* in nature. I am not sure how much substance is behind this different terminology: both Kratzer and I (and, actually, all those who treat the inferences in terms of exhaustive interpretation) would say that none of the implicatures discussed in this paper can be *cancelled*, although the possibility of cancellation was according to Grice (1967) one of the distinctive features of pragmatic inferences. Still, in contrast to what Kratzer (2007) suggests, in my treatment the standard semantic possible worlds-meanings play a role. Indeed, I believe that although the exact truth-makers are crucial to account for implicatures, I don't think it would be appropriate to define entailment *immediately* in terms of them: as already noted above, if one would demand for entailment, $\phi \models^* \psi$, that $T(\phi) \subseteq T(\psi)$, a conjunctive sentence of the form $p \wedge q$ would not entail p, which seems absurd. More interestingly, perhaps: semantic and pragmatic approaches to account for the same data might suggest different processing loads (cf. Chemla & Singh, in press). Whether this speaks in favor of the pragmatic approach adopted here remains to be seen.

References

[1] Alonso-Ovalle, L. (2005), 'Distributing the disjuncts over the modal space'. In: L. Bateman and C. Ussery (ds.), *NELS*, **35**, Amherst.

[2] Anderson, A.R. and N.D. Belnap (1962), 'Tautological entailments', *Philosophical Studies*, **13**, 9-24.

[3] Brochhagen, T. & E. Coppock (2013), 'Raising and resolving issues with scalar modifiers', *Semantics and Pragmatics*, **6**: 1-57.

[4] Chemla, E. & R. Singh (in press), 'Remarks on the experimental turn in the study of scalar implicatures', *Language and Linguistic Compass.*

[5] Chierchia, G., D. Fox, and B. Spector (2012), 'The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics', In *An International Handbook of Natural Language Meaning Semantics*, eds. P. Portner, C. Maienborn and K. von Heusinger, Mouton de Gruyter.

[6] Chierchia, G., D. Fox & B. Spector (ms), 'Hurford's constraint and the theory of scalar implicature: evidence for embedded implicatures'.

[7] Ciardelli, I., J. Groenendijk & F. Roelofsen (2013), 'Inquisitive semantics: a new notion of meaning', *Language and Linguistic Compass*, **7**, 9, 459-476.

[8] Cobreros, P., P. Egré, D. Ripley & R. van Rooij (to appear). 'Pragmatic interpretations of vague expressions: strongest meaning and nonmonotonic consequence', *Journal of Philosophical Logic.*

[9] Fine, K. (1212), 'A difficulty for the possible worlds analysis of counterfactuals, *Synthese*, **189**: 29-57.

[10] Fine, K. (to appear), 'Truth-Maker semantics for intuitionistic logic', *Journal of Philosophical Logic.*

[11] Fox, D. (2007), 'Free choice and the theory of scalar implicatures', in U. Sauerland & P. Stateva (eds.), *Presupposition and Implicature in Compositional Semantics*, Basingstake: Palgrave Macmillan, pp. 71-120.

[12] Fox, D. & B. Spector (2008), 'Economy & embedded exhaustification.

[13] Fraassen, B. van (1969), 'Facts and tautological entailments', *Journal of Philosophy*, **66**: 477-487.

[14] Franke, M. (2011), 'Quantity implicatures, exhaustive interpretation, and rational conversation', in *Semantics and Pragmatics*, **4**, 1-82.

[15] Gazdar, G. (1979), *Pragmatics: Implicature, Presupposition and Logical Form*, New York: Academic Press.

[16] Geurts, B. (2009), 'Scalar implicatures and local pragmatics', *Mind and Language*, **24**: 51-79.

[17] Grice, H.P. (1967), 'Logic and conversation', *William James Lectures*, Harvard University, reprinted in *Studies in the Way of Words*, 1989, Harvard University Press, Cambridge, Massachusetts.

[18] Groenendijk, J. and M. Stokhof (1984), *Studies in the Semantics of Questions and the Pragmatics of Answers*, Ph.D. thesis, University of Amsterdam.

[19] Groenendijk, J. and M. Stokhof (1991), 'Dynamic predicate logic', *Linguistics and Philosophy*, 14, pp. 39-100.

[20] Heim, I. (1982), *The Semantics of Definite and Indefinite Noun Phrases*, Ph.D. dissertation, University of Massachusetts, Amherst.

[21] Heim, I. (1990), 'E-type pronouns and donkey anaphora', *Linguistics and Philosophy*, 13, pp. 137-178.

[22] Hurford, J. R. (1974), 'Exclusive or inclusive disjunction', *Foundations of Language*, **11**: 3, 409-411.

[47] Kadmon, N. (1985), 'The discourse representation of NPs with numeral determiners', In: S. Berman et al. (eds.), *Proceedings of NELS 15*, GLSA, Linguistics Dept. University of Massachusetts, Amherst, pp. 207-19.

[24] Kamp, H. (1981), 'A theory of truth and semantic representation', In: J. Groenendijk et al. (eds), *Formal Methods in the Study of Language*, Amsterdam, pp. 277-322.

[47] Kamp, H. and U. Reyle (1993), *From Discourse to Logic*, Kluwer, Dordrecht.

[26] Kratzer, A. (2007), 'Situations in natural language semantics', *Stanford Encyclopedia of Philosophy*, E. N. Zalta (ed.).

[27] Krifka, M. (1995), 'The semantics and pragmatics of polarity items', *linguistic Analysis*, **25**: 209-258.

[28] Mastop, R. (2005), *What can you do?*, PhD-dissertation, Universiteit van Amsterdam.

[29] McCarthy, J. (1980), 'Circumscription - a form of non-monotonic reasoning', *Artificial Intelligence*, **13**: 27-39.

[30] McCawley, J. (1993), *Everything that linguists always wanted to know about Logic**, The University of Chicago Press, Chicago.

[31] Landman, F. (2000), *Events and Plurality*, Kluwer, Dordrecht.

[32] Rooij, R. van (2000), 'Permission to change', *Journal of Semantics*, **17**: 119-145.

[33] Rooij, R. van (2006), 'Free choice counterfactual donkeys', *Journal of Semantics*, **23**: 383-402.

[34] Rooij, R. van (2013), 'Vagueness. Insights from Martin, Jeroen and Frank', in Roelofsen et al (eds), *Festschrifft for Stokhof, Groenendijk, and Veltman*, Amsterdam, pp.

[37] Rooij, R. van (2014), 'Leibnizian intensional semantics for syllogistic reasoning', in R. Ciuni et al (eds.), *Recent Trends in Philosophical Logic*, Trends in Logic, Volume 41, Springer, Heidelberg, pp. 179-194.

[36] Rooij, R. van (to appear), 'Nonmonotonicity and Knowability: As Knowable as Possible', in C. Baskent, L. Moss and R. Ramanujum (eds.), *Festschrifft in honor of Rohit Parikh*, Springer Verlag.

[37] Rooij, R. van and K. Schulz (2004), 'Exhaustive interpretation of complex sentences', *Journal of Logic, Language, and Information*, **13**: 491-519.

[47] Rooth, M. (1996), 'Focus', In: S. Lappin (ed.), *The Handbook of Contemporary Semantic Theory*, Blackwell Publishers, Malden Massachusetts, pp. 271-297.

[47] Sauerland, U. (2004), 'Scalar implicatures of complex sentences', *Linguistics and Philosophy*, **27**, 367-391.

[40] Sauerland, U. (2012), 'The computation of scalar implicatures: pragmatic, lexical or grammatical?', *Language and Linguistic Compass*, **6**: pp. 36-49.

[41] Schulz, K. (2005), 'A pragmatic solution for the paradox of free choice permission', *Synthese: Knowledge, Rationality and Action*, **147**: 343-377.

[42] Schulz, K. & R. van Rooij (2006), 'Pragmatic meaning and non-monotonic reasoning: The case of exhaustive interpretation', *Linguistics and Philosophy*, 2006, **29**: 205-250.

[43] Sevi, A. (2006), *Exhaustivity. A Semantic Account of 'Quantity' Implicatures*, PhD-dissertation, Tel Aviv University, Tel Aviv.

[44] Singh, R. (2008), 'On the interpretation of disjunction: asymmetric, incremental, and eager for inconsistency', *Linguistics and Philosophy*, **31**: 245-260.

[47] Soames, S. (1982), 'How presuppositions are inherited: A solution to the projection problem', *Linguistic Inquiry*, **13**: 483-545.

[47] Spector, B. (2003), 'Scalar implicatures: Exhaustivity and Gricean reasoning?', In: B. ten Cate (ed.), *Proceedings of the ESSLLI 2003 Student session*, Vienna.

[47] Stechow, A. von and T.E. Zimmermann (1984), 'Term answers and contextual change', *Linguistics*, **22**: 3-40.