An Apple or a Pear. Free Choice Disjunction

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1 Introduction

1.1 The Problem

Disjunctions come in handy when we are not fully informed. For example, I don't know for sure that John ate an apple, and I don't know for sure that he ate a pear. But I do know that

he had at least one of these two fruits. I can use the disjunction in (1) to communicate this partial knowledge:

(1) John ate an apple or he ate a pear

What can you infer from this statement? You may infer that he didn't have both fruits. Perhaps you also infer that John didn't eat a papaya. But what you can definitely *not* infer is that John really did eat an apple, or that he really did eat a pear:

(2) John ate an apple or he ate a pear
$\not\Rightarrow$ John ate an apple
$\not\Rightarrow$ John ate a pear

(I use $\Rightarrow$ to indicate that something can be inferred, and $\not\Rightarrow$ that something can not be inferred from the previous sentence.)

What we have just illustrated is the uncontroversial empirical fact that asserting a disjunction *A or B* does not commit the speaker to the truth of either disjunct *A* or *B*. Importantly, this corresponds to the entailment pattern of the propositional logic disjunction operator $\vee$:

(3) $(A \vee B) \not\rightarrow A$
$(A \vee B) \not\rightarrow B$

Therefore, if we assume that the semantic denotation of *or* is $\vee$: $[\![\text{A or B}]\!] = A \vee B$, the observation in (2) follows immediately: We cannot infer *A* from a disjunction *A or B*.

Free Choice disjunctions are a puzzle because they seem to defy this basic fact. Let us see how. A father is having dinner with his daughter Mary and his son John. He announces:

(4) Mary may have a burger or (she may have) a steak

As for the son, the father states that

(5) John may have a burger

Which sibling did the father allow more? John will probably conclude that he can order a burger, but nothing else. As for Mary, we can conclude that

(6) Mary may have a burger or a steak
$\Rightarrow$ Mary may have a burger
$\Rightarrow$ Mary may have a steak

So when the father asserted the disjunction in (4), he intuitively committed himself to more than he did when asserting the single disjunct in (5). But that's exactly the opposite of what we observed above! Free Choice disjunctions, as opposed to standard disjunctions, seem to commit us to the truth of both of the disjuncts.

Generally, Free Choice (FC) inferences correspond to the following schema; throughout the paper, we will find this schema exemplified in different variations:[1]

(7) *OP* A or B
⇒ *OP* A and *OP* B

(8) *OP* A or *OP* B
⇒ *OP* A and *OP* B

We will see in the next sections that whether or not these FC inferences can actually be drawn in a given sentence depends on the identity of *OP*. For instance, the inference in (8) may go through only for certain *OP*s like *may* but not for others like *it is allowed*. Likewise, the inference in (7) may go through for *OP* = *sometimes* but not for *OP* = *somebody*. Furthermore, the FC inferences shown in (7) and (8) are a possible, but typically not the only interpretation of the relevant disjunctive sentences. Free Choice is thus the name of a particular interpretation of a disjunction, defined by the inferences shown in (7) and (8). FC inferences are sometimes described as a *quasi-conjunctive* interpretation of disjunction. This characterization of FC disjunctions offers an intuitive understanding of the connection to FC effects arising with indefinites like *any*: Its usual contribution is existential. Thus, *You didn't eat any dessert* can be paraphrased as an existential statement: There is no dessert which you ate. But in *You may eat any dessert*, the correct paraphrase is a universal statement — all desserts are allowed. Thus, the two kinds of FC effects in disjunction and lexical items like *any* are connected in that both of them involve a weak or existential item (*or, any*) which is suddenly interpreted much stronger, i.e., as a universal (allowing a paraphrase with *and, all*). Typically, this happens in combination with existential modals like *may*. Yet, simply replacing *or, any* with *and, all* in the relevant sentences will not yield two equivalent sentences, as we will see shortly.

1.2 Overview of the Data

The goal of this section is to introduce a wider range of data which constitute the puzzle of Free Choice disjunction, and to understand the theoretical challenge posed by these data.

As stated above, FC sentences are often described as disjunctions that are interpreted (quasi-)conjunctively (e.g. Klinedinst 2007b, van Rooij 2010). To illustrate in some more detail that FC disjunctions are not in fact *equivalent* to the corresponding conjunction, compare the two sentences below:

(9) a. You may have an apple or a pear

1 The inference pattern characterized in this schema is reminiscent of the formal definition of *anti-additive* functions: f is anti-additive iff $f(A \cup B) = f(A) \cap f(B)$. Certain natural language expressions, (e.g. *not*) are said to denote anti-additive functions (e.g. $\neg$). This allows the formulation of an important generalization: expressions that denote anti-additive functions license strong and weak NPIs in their scope. The puzzle of FC can then be thought of as follows: In FC disjunctions, operators like *may* behave anti-additive in their entailment patterns (i.e., *may (A or B) = may A and may B*), but not in their ability to license NPIs (cf. #Mary may ever have cake or ice-cream vs. ✓Mary may not ever have cake or ice-cream).

b. You may have an apple and a pear

The conjunction in (9-b) gives permission to have two fruits at the same time. By contrast, the FC disjunction in (9-a) is not as generous — it can even be interpreted as ruling out the possibility of having two fruits. But however the sentence is read, there is no interpretation of (9-a) under which two fruits are explicitly allowed. This is the crucial difference to the conjunctive version in (9-b). FC disjunctions are thus not equivalent to a sentence in which *or* has been replaced by *and*, and it is precisely this interpretative difference that the term '*quasi*-conjunctive' refers to.[2] What are the theoretical conclusions to be drawn from (9)? We learn that the FC interpretation is not simply a re-interpretation of *or* as *and*. Free Choice is a genuinely new interpretation of a disjunction, rather than a sudden synonymy of *or* and *and*.[3]

Why are FC interpretations of disjunction a challenge for semantic and pragmatic theory? Consider again an example:

(10) You may have an apple or a pear
⇒ You may have an apple
⇒ You may have a pear

The puzzle is that the indicated FC inferences cannot be derived from the basic semantic meaning of the sentence. Let us see why. First, note that there are two possible syntactic structures for a sentence like (10) (see next section for a more detailed discussion of syntactic issues):

(11) a. LF1: [may [you have an apple]$_A$] or [may [you have a pear]$_B$]
b. LF2: may [[you have an apple]$_A$ or [you have a pear]$_B$]

To introduce some terminology, we can refer to LF1 as a wide-scope disjunction – *or* has wide-scope relative to the modal *may*. LF2 is a narrow-scope disjunction – *or* has narrow scope with respect to *may*. What is the predicted semantic denotation of these LFs? The standard assumption is that *or* denotes the logical operator $\vee$. The modal *may*, on the other hand, denotes the existential modal quantifier $\Diamond$, i.e., $[\![\text{may A}]\!] = \Diamond A$. This is paraphrasable as *there is a possible world w s.t. A is true in w*. The term *(possible) world* is used in modal logic, metaphysics, and semantics, to formalize our thinking about possibilities and

2 The interpretation of the FC disjunction in (9-a) where you may not have both an apple and a pear corresponds to a standard scalar implicature of disjunction. Thus, from *A or B* we sometimes conclude that *not (A and B)*. In a parallel manner, from *may (A or B)* we can conclude that *not may (A and B)*. But this additional inference of the FC disjunction is of course not the FC interpretation, and is in fact logically independent of it. See Zimmermann (2000: 269), Simons (2005: 272), and Fox (2007: 35f.) for discussion.

3 As pointed out by Geurts (2005), when the operator *OP* in the schemata in (7), (8) is epistemic, there seems to be actual equivalence between disjunction and conjunction:

(i) a. It might be here or there
b. It might be here and there

These examples pose a puzzle over and above the basic FC effect.

necessities (): Possible worlds can be thought of as representing the hypothetical scenarios we imagine when making such claims as *I could take the subway* (formalized as *there is a possible world in which I take the subway*) or *I must eat more vegetables* (formalized as *in all possible worlds, I eat more vegetables*. Going back to *may*, just like other modals it can be interpreted deontically, referring to permissions, or epistemically, referring to our knowledge, or circumstantially, referring to given facts. Depending on the specific interpretation of the modal, we can refine the paraphrase: *There is a an allowable world w s.t. A is true in w*, or *there is a world compatible with what we know s.t. A is true in w*, etc. (Kratzer 2012a). The predicted semantic denotation for the LFs in (11) is given below:

(12) $[\![\text{LF1}]\!] = \Diamond A \vee \Diamond B$
$[\![\text{LF2}]\!] = \Diamond(A \vee B)$

Importantly, the two are equivalent, and the predicted meaning is paraphrased below:

(13) $\Diamond A \vee \Diamond B \equiv \Diamond(A \vee B)$
There is a possible world w s.t. at least one of A, B is true in w

Now, does this account for the FC inferences of the sentence, given in (10)? It does not. To see why, it suffices to find a context in which the truth conditions in (13) are satisfied, but the FC inferences are not. Here is one: Suppose you may have an apple (=A) but not a pear (=B). Importantly, the sentence is predicted to be true by virtue of its semantic denotation. This is because there is one allowable world where A is true. Therefore, there is an allowable world where at least one of A, B is true (=(13)). But the FC inferences, given in (10), are not both satisfied (you are not in fact allowed a pear). The conclusion is that FC inferences are not part of the basic semantic denotation of disjunctions like (10). To account for the FC interpretation, we need to either abandon the standard semantics or augment it with some pragmatic strengthening. Both approaches have been taken, as we will see in the next section. In the remainder of this section, we will look at more data where FC inferences are observed.

Recall the FC schema given above:

(14) *OP* A or B
$\Rightarrow$ *OP* A and *OP* B

(15) *OP* A or *OP* B
$\Rightarrow$ *OP* A and *OP* B

A natural question to ask at this point is whether FC effects arise only when *OP* corresponds to deontic (i.e., permission-giving) *may*. In fact, modals of all interpretations and syntactic categories can give rise to an FC interpretation. The reader is invited to check this for the following sentences:

(16) a. John might be in the office or in the gym *epistemic*
b. We can meet at noon or in the evening *circumstantial*
c. It's ok to want a burger or a steak *deontic*

The operators above are all existential – their meaning can be paraphrased as *there is a world compatible with what we know*, *there is a world compatible with our schedules*, etc. But in some of the literature, an inference pattern arising with universal operators is discussed under the header of Free Choice as well (e.g. Simons 2005):

(17) You must write a paper or give a presentation
⇒ You may write a paper
⇒ You may give a presentation

The inferences shown above (sometimes called *distributive inferences*) are not part of the basic semantic denotation of the sentence. According to this basic semantics, the sentence is true if (i) you have to write a paper but cannot give a presentation (ii) you have to present but cannot write a paper, and (iii) there is no obligation for one specific task, just to do (at least) one. What has also been called Free Choice effect is thus the strengthening of the meaning of (17) to only scenario (iii), in which you have a *choice*. However, as argued by Alonso-Ovalle (2006: 136ff) and Klinedinst (2007:271f.), this inference can in fact be derived as a scalar implicature, without any additional assumptions (e.g. Sauerland (2004), see Simons 2005, Aloni 2007, Crnič et al. 2015 for more discussion of cases like (17)). This distinguishes (17) from true FC inferences like the ones we saw above.[4]

As noted by Vainikka (1987), Nickel (2010), FC inferences can also arise with generic sentences, which have been argued to involve a covert, universal-like modal operator *Gen*. $Gen(A)(B)$ could be paraphrased as *A's are normally/prototypically/ B's* (Carlson & Pelletier 1995 and references therein). What would a disjunctive generic sentence look like? Nickel gives the following example:

(18) Elephants live in Africa or Asia

The intuition is that the sentence can be used to convey that elephants are typically found in Africa *and* that they are typically found in Asia — a quasi-conjunctive interpretation of the disjunction. However, the discussion in Nickel (2010) shows that this intuition is somewhat less clear than for the FC sentences we started out with. In particular, (18) might in fact be parallel to (17) in giving rise only to existential inferences, as shown in (19). This inference

4 In a nutshell, here is how the inferences in (17) can be derived as (scalar) implicatures. First, note that the stronger alternatives of the sentence include *You must write a paper* and *You must give a presentation*. In Sauerland's Neo-Gricean two-step architecture, first the weak implicature that the speaker is not certain that these two alternatives are true is derived. It is consistent with the basic assertion to strengthen these two weak uncertainty implicatures and to derive that (the speaker is certain that) you don't have to write a paper and that (the speaker is certain that) you don't have to give a presentation. Together, then, we have (where W = *you write a paper* and G = *you give a presentation*):

(i) $\Box(W \vee G) \wedge \neg\Box W \wedge \neg\Box G$
$\vDash \Diamond W \wedge \Diamond G$

From here onwards, I use $\Box$ as a universal modal operator *must, it is obligatory, have to*, etc. As indicated, the assertion in conjunction with the implicatures that neither W nor G are themselves necessary entails the existential inferences shown above in (17) — that W and G are both permissible.

could be accounted for just like that in (17), and would thus not necessarily constitute a genuine case of FC.

(19) Elephants live in Africa or Asia
⇒ There are elephants that (typically) live in Africa
⇒ There are elephants that (typically) live in Asia

By contrast, Nickel argues that the inferences of (18) are in fact stronger than (19), and constitute an instance of genuine FC inferences which cannot be accounted for by the basic semantics or standard implicatures of the sentence:[5]

(20) Elephants live in Africa or Asia
a. ⇒ Elephants (typically) live in Africa
b. ⇒ Elephants (typically) live in Asia

But not only modal or modal-like operators like *Gen* give rise to a FC interpretation when combined with disjunction. As first discussed[6] by Klinedinst (2007b), Eckardt (2007) and Fox (2007), it can also arise with individual quantifiers, as shown below:

(21) Some rooms have a bathtub or a fireplace
there is a plurality of rooms X such that: X has a bathtub ∨ *X has a fireplace*

According to its basic semantic meaning, paraphrased above, the sentence is true when there are in fact no rooms with fireplaces, but some with bathtubs. This may be a possible interpretation of the sentence, especially for a speaker who doesn't know what exactly the rooms are like. But crucially, there is another reading — the FC reading. Under this reading, (21) is understood as stating there are some rooms with bathtubs *and* that there are some rooms with fireplaces.

Interestingly, the FC reading hinges on the plural; if the indefinite is singular, the FC reading is no longer available:

(22) Some room has a bathtub or a fireplace
⇏ At least one room has a bathtub
⇏ At least one room has a fireplace

5 A similar empirical question arises with the following example:

(i) John wants a BLT or a tuna melt
a. John wants a BLT
b. John is satisfied with a BLT

The intuition that the sentence has a FC-like reading which implies that John will be content with either kind of sandwich is clear. However, it is less clear how to semantically characterize this inference. The sentence seems to imply that John is somewhat indifferent as to the choice between the two — both are good options. But this is intuitively described only by the weaker inference in (i-b) but not with the stronger one in (i-a), which seems to contradict the perceived indifference between the two options.

6 Klinedinst's paper had been available as a conference handout from *Sinn und Bedeutung* 10 since 2005.

Fox (2007) points out that an interpretational effect which looks like Free Choice can also be observed in existential sentences (see Milsark (1977), McNally (2011)):

(23) There is beer in the fridge or in the ice-bucket
⇒ There is beer in the fridge
⇒ There is beer in the ice-bucket

Again, the FC reading disappears if the pivot (the term after *there is/are*) is singular (see Fox's example (30)). Thus, *there is a beer in the fridge or in the ice-bucket* cannot mean that there is a beer in the fridge and also a beer in the ice-bucket. An even more striking example similar to (23) is reported in Lehrer (1997: 81) (s. also Huberstone 2011: 819):

(24) - What kind of pastries do you have?
- I have a sweet roll or a bagel
⇒ I have a sweet roll
⇒ I have a bagel

It is more drastic than Fox's existential example because there doesn't seem to be any (existential or other) operator present, yet both disjuncts can be inferred.

Fox (2007) argues that the FC effect can also arise when universal quantifiers (e.g. *every* or *must*) are embedded under negation, as with the following example:

(25) We didn't give every student a stipend and a tuition waiver
⇒ We didn't give every student a stipend
⇒ We didn't give every student a tuition waiver

Again, the puzzle remains the same as before: The basic semantic meaning (roughly: $\neg\forall x$: stipend(x) $\wedge$ waiver(x)) does not account for the FC inferences. Specifically, this basic meaning predicts (25) to be true in a situation where all students got a tuition waver, but not all got a stipend. But as shown, the FC interpretation rules out a situation in which everybody got a stipend.

As we will see, most accounts of the FC effect focus on data where *OP* is an existential modal; for instance, Aloni (2003, 2007) and Simons (2005) derive the FC effect from specific assumptions about the semantics of modals and the resulting interaction with disjunction. Zimmermann (2000) and Geurts (2005) also propose semantic accounts for the FC effect which are based on a new semantics for disjunction and the resulting interaction with modals. It remains an open question whether these accounts could be extended to FC inferences in non-modal environments like the ones we just saw.

We have already hinted at the fact that FC sentences also have another interpretation. Let us look at this in more detail now.

(26) John may have an apple or a pear. . . I forgot which

With this continuation we wouldn't draw the FC inferences that John can have an apple and that he can have a pear. Rather, we interpret the sentence as a report of John's food

allowances, from a speaker who doesn't know what exactly they are. Luckily, this reading is in fact the one predicted from the basic semantic meaning that we identified in (13) above:

(27) $\Diamond$ (John has an apple) $\vee$ $\Diamond$ (John has a pear)
there is an allowable world where John has an apple or there is an allowable world where John has pear

This meaning is compatible with a context in which John is not in fact allowed a pear, but just an apple. But we said that we infer from (26) that the speaker doesn't know which of the two permissions John actually has. How does this inference come about? It is in fact completely parallel to the inference we draw for *John ate an apple or a pear*, from which we likewise conclude that speaker doesn't know which fruit John actually ate. As discussed in of this volume, these *uncertainty* inferences arise through comparison of (26) with stronger sentences the speaker could have asserted, for example, *John may have an apple* and *John may have a pear*. Given certain assumptions about speaker's intentions, the only possible conclusion is that the speaker is not certain whether or not these stronger sentences are true, or else he would have asserted those instead of (26) (see Grice (1975, 1989), Gazdar (1979), Soames (1982), and Sauerland (2004), Katzir (2007) about the derivation of the alternatives that are compared). The reading defined by the semantics in (27) is very robustly associated with these uncertainty inferences, as is the case for disjunctions in general (s. Fox 2013 for an exception). This is why the reading in (27) is often called the *uncertainty reading*. In sum, then, sentences corresponding to the schemata in (7), (8) have two readings: the FC reading and the uncertainty reading we have just derived. The latter, but not the former, is accounted for by the standard semantic value of these sentences, and standard pragmatic mechanisms like Gricean reasoning. As has been noted by e.g. Kamp (1973), Zimmermann (2000), the availability of the FC reading correlates with the perceived authority or informedness of the speaker. Thus, whether or not a FC sentence is uttered by your boss or by one of your peers will influence whether you will opt for the FC or the uncertainty reading.

Is there always an ambiguity between the FC and the uncertainty reading? Vainikka (1987) points out there is a systematic exception, namely, FC sentences in which the modal is interpreted epistemically, i.e., with respect to our knowledge. To illustrate, consider the following examples:

(28) John may eat an apple or a pear. . . I don't know which
= I don't know which one he is allowed to eat

(29) John might be working or sleeping . . . I don't know which
= I don't know which of the two he is doing
≠ I don't know which of the two is possible

In the deontic case (28), the addition of the *I don't know which*-tag brings out the uncertainty reading, under which it can *not* be inferred that John is allowed to eat an apple (see Rooth & Partee 1982 for use of this tag as a diagnostic). By contrast, in the epistemic version (29) even the addition of this tag does not bring about an uncertainty interpretation: The sentence can only convey that John might be working *and* that he might be sleeping—this is the FC

interpretation. The *I don't know which*-tag in this case refers to what John is actually doing, not what he *might* be doing (see also Zimmermann (2000: 259)).[7]

Summing up the previous discussion, we found that FC disjunctions generally have two readings. The uncertainty reading is unproblematic in that it is accounted for by the basic semantic denotation of the sentence, and the standard pragmatic inferences expected for a disjunction. The FC reading, on the other hand, cannot be derived by standard semantic or pragmatic machinery. In particular, the FC reading is consistent with, but stronger than the basic semantic meaning, and the uncertainty inferences arising for the basic meaning contradict the FC inferences (see Fox (2007: section 6)). In summary (for sentences where the operator is an existential modal like *may*):

(30) Uncertainty Reading
Semantics: $\Diamond(A \vee B) \equiv \Diamond A \vee \Diamond B$
Pragmatics: The speaker is not certain whether $\Diamond A$, and not certain whether $\Diamond B$

(31) Free Choice Reading
Observed Interpretation: $\Diamond A \wedge \Diamond B$
Pragmatics (optional): The speaker is certain that not $\Diamond(A \wedge B)$

To conclude our data survey, we will now briefly look at the role of syntax for FC interpretations.

1.3 Overview of Data: Syntax

We saw in (11) above that FC disjunctions may be assigned two different syntactic structures. Generalizing these structures, we have:

(32) a. Narrow-scope LF: *OP* [A or B]
b. Wide-scope LF: *OP* A or *OP* B

Recall that the terminology reflects the relative scope of disjunction: In wide-scope LFs, *or* takes wide scope over two occurrences of *OP* (e.g. *may*). In narrow-scope LFs, by contrast, the disjunctive phrase is itself embedded under one operator. Different accounts rely on different logical forms. For example, pragmatic accounts derive the FC interpretation as a pragmatic inference, but rely for this derivation on a narrow-scope LF as in (32-a). On the

7 Though the intuition that the epistemic version only has a FC reading is very reliable, Simons (2005: 274) points out that this crucially depends on an independent feature of the examples: That the speaker and the epistemic subject of the modal (*might* in her examples) are the same. If both differ, the uncertainty reading re-appears. Her example goes like this: I hear on the news that *investigators believe that the fugitive might be in Cambridge*. But I don't know what Cambridge they are talking about. I can then say:

(i) The fugitive might be in Massachusetts or she might be in England . . . I don't know which
⇒ I don't know if she might be in Massachusetts
⇒ I don't know if she might be in England

Indeed, in this context the sentence doesn't give rise to the FC inference that the fugitive might be in Massachusetts *and* that she might be in England.

other hand, some semantic accounts derive the FC interpretation from a new semantics for disjunction, which only yields the correct result if a wide-scope LF as in (32-b) is assumed. As we will see, most accounts – whether pragmatic or semantic – assume a narrow-scope LF, while Zimmermann (2000) and Geurts (2005) are notable exceptions in assuming a wide-scope LF.

But a question arises: In (11) we saw that both LFs are equivalent when *OP* is an existential operator like *may*. So why would the choice matter?

First, the two LFs differ in what their alternatives are: If we replace *or* by its scalar alternative *and*, the resulting alternative for (32-b) will be different than that for (32-a):

(33) a. Alternative of wide-scope LF: *OP* A and *OP* B
b. Alternative of narrow-scope LF: *OP* [A and B]

Importantly, for most choices of *OP* the two alternatives will *not* be equivalent, as shown below for examples with an existential modal like *may*:

(34) a. Semantics of wide-scope alternative: $\Diamond A \wedge \Diamond B$ $\not\equiv$
b. Semantics of narrow-scope alternative: $\Diamond(A \wedge B)$

This matters because, as stated earlier, FC sentences like (35) can invite the following, additional inference even under the FC reading:

(35) You may have an apple or a pear
FC inference:
⇒ You may have an apple and you may have a pear $= \Diamond A \wedge \Diamond B$
Scalar inference:
⇒ It's not the case that you may have an apple and a pear $= \neg \Diamond (A \wedge B)$

This additional inference is not in fact inconsistent with the FC inference: The FC inference states that both fruits are allowed by themselves, while the scalar inference states that both fruits are not allowed together. The latter can be derived as a standard scalar implicature. A scalar implicature of a sentence S is just the negation of one of S's alternatives. Importantly, the scalar inference in (35) corresponds to the negation of the narrow-scope alternative, as can be seen from (34). The negation of the wide-scope alternative, on the other hand, would be $\neg(\Diamond A \wedge \Diamond B) = \neg \Diamond A \vee \neg \Diamond B$ – either you cannot have an apple, or you cannot have a pear. This is much stronger than the observed scalar inference. In fact, it plainly contradicts the FC inference that both fruits are allowed (s. (35)). In sum, if we chose the narrow-scope LF for a FC sentence, we can derive the additional scalar inference on the basis of independently needed pragmatic mechanisms for deriving scalar implicatures. This is one reason why the choice of LF is not arbitrary.

Another reason as to why the choice between the LFs in (32) matters comes from the following observation. Free Choice readings are possible with both versions in (36):

(36) a. John may have ice-cream or he may have cake +FC
b. John may have ice-cream or cake +FC

This is particularly challenging for accounts which rely on a narrow-scope LF to derive the FC effect, as it is not clear how a narrow-scope LF could be derived for the surface wide-scope version in (36-a) (see Simons 2005 for a detailed proposal). But as the following data show, it would be premature to conclude that a FC interpretation is possible for all sentences corresponding to the form in (36-a). Crucially, the possibility for a sentence of the form *OP A or OP B* to receive a FC interpretation depends on the choice of *OP*. This is illustrated by the following comparison:[8]

(37) a. John can have ice-cream or he can have cake +FC
b. It is ok for John to have ice-cream or it is ok for him to have cake -FC
c. It is allowed that John has ice-cream or it is allowed that he has cake -FC
d. John is allowed to have ice-cream or he is allowed to have cake ? FC

As these examples illustrate, the availability of the FC reading is restricted under surface wide-scope, i.e., when the operator appears in both disjuncts. Thus, modal auxiliaries like *can* allow a FC reading even when they occur embedded in the disjuncts, as in (37-a). Predicates like *it is allowed*, on the other hand, block an FC interpretation for sentences in which they are embedded under disjunction, as in (37-b)-(37-d). When these predicates are used in FC sentences which for independent reasons only admit an FC interpretation, we should expect the sentences to sound odd. The following contrast is a case at hand – recall from (28) and (29) above that epistemic operators seem to force a FC interpretation:[9]

(38) a. She might call or she might write +FC
b. ??It's conceivable that she will call or it's conceivable that she will write -FC

These contrasts have not been discussed much in previous literature. At this point, we already have enough background knowledge to go beyond a mere description. Specifically, the pattern in (37) and (38) would be predicted by the following assumptions: (i) the FC interpretation is derived from a narrow-scope LF (32-a) (i.e., *OP* [A or B]), and (ii) for the sentences marked -FC in (37) and (38), such an LF cannot be generated. The central question such an account would have to answer is why modal auxiliaries like *might*, but not predicates like *is allowed* can undergo the syntactic operations necessary to derive this narrow-scope LF from the sentences above.

A third consideration pertinent to the choice of LF is presented in Fox (2007: 37), who points out the following minimal pair:

8 As expected, a narrow-scope surface structure makes the FC interpretation available again (the reader is invited to check the contrasts for all sentences in (37) and (38) above):

(i) a. It is ok for John to have ice-cream or cake +FC
b. John is allowed to have ice-cream or cake +FC
c. It's conceivable that he will call or write +FC

9 The only other possible reading would be one pointed out by Simons (2005:274), under which the speaker and the epistemic subject evaluating the predicates *possible* and *likely* are not identical (see fn. (29) for more examples.

(39) a. John may either have ice-cream or cake +FC
b. Either John may have ice-cream or cake -FC

Larson (1985) showed that *either* marks the scope of disjunction at LF. According to Larson's well established generalization, the disjunction must have narrow scope with respect to the modal in (39-a) (LF: *OP* [A or B]), whereas in (39-b), it must take wide scope (LF: *OP* A or *OP* B). In the latter case, the Free Choice reading disappears, corroborating the assumptions above: It seems like the FC interpretation relies on a narrow-scope LF.

As these examples show, syntactic factors influence the availability of FC readings. This is important because most accounts explicitly rely on one particular LF, but base this choice on intra-theoretical arguments, rather than independent syntactic considerations like those above. For instance, Zimmermann (2000) and Geurts (2005) cite (36) as independent evidence for assuming a wide-scope LF, but face a challenge in view of the broader generalization presented in (37)-(38). On the other hand, accounts which rely on narrow-scope LFs (the majority of accounts, e.g., Kamp 1973, Vainikka 1987, Simons 2005, Aloni 2007, Alonso-Ovalle 2006, Fox 2007, Klinedinst 2007a) cannot always explain the availability of FC readings with sentences like (36-a), (37-a) and (38-a).[10] An exception is Simons (2005), who also relies on a narrow-scope LF, but offers a syntactically explicit account designed to also handle the variation in (36). Certain syntactic assumptions in this account have been argued against, although these arguments do not necessarily carry over to FC sentences (Bošković & Franks 2000).[11]

In this relation, recall Klinedinst's and Eckardt's data illustrating non-modal Free Choice sentences (see (21) above). Perhaps unsurprisingly at this point, these kind of FC sentences do not allow for FC readings under surface wide-scope either:

(40) Some students wrote a paper or some students gave a presentation -FC

But it is conceivable that independent factors interfere in (40). Indefinite noun phrases (e.g., *some men, a woman*) are thought to be subject to a novelty condition, which requires that they introduce new referents every time they are used (Kamp 1981, Heim 1982). In (40), this would mean that the set of students introduced in the second disjunct cannot be identical to that introduced in the first disjunct, thus forcing a reading which is weaker than the FC reading (and, if we take into consideration the exclusive inference that only one disjunct is true, even incompatible).

Further data which show that the FC interpretations are not limited to sentences where *OP* is a modal are discussed by Fox (2007: section 8)). Again, none of these data resemble (36-a), but rather exhibit a FC reading only when *OP* is not embedded inside the disjuncts

10 Among others, Fox (2007) acknowledges the problem and offers an *ad hoc* solution in fn.46.

11 Specifically, the controversial assumption is that in a sentence of the form S = [*OP* A or *OP* B], *OP* may move out of the two disjuncts simultaneously, as it were, to form one instance of *OP* in the resulting LF = OP_1 [t_1 A or t_1 B]. This type of movement is called Across-the-Board movement and uncontroversial for sentences like *What*$_1$ *does Bill hate* t_1 *and Mary love* t_1*?*. In these uncontroversial instances of ATB-movement, however, the movement of *OP* occurs overtly. Generally, ATB movement is thought not to apply covertly, i.e., at LF. See Williams (1978)

(example credited to Regine Eckardt, p.c. to Irene Heim):

(41) a. Sometimes John takes the bus or the train +FC
⇒ Sometimes John takes the bus
⇒ Sometimes John takes the train
b. Sometimes John takes the bus or sometimes he takes the train -FC

In sum, we saw that FC sentences can have two surface forms, as illustrated by the pair in (36). We also saw that two semantically equivalent LFs are in principle conceivable, shown in (32). We then considered some arguments in favor of the narrow-scope LF *OP* [A or B]. Among these arguments was the observation that all operators allow a FC interpretation for surface forms *OP* [A or B]. By contrast, for surface forms *OP* A or *OP* B, only modal auxiliaries like *might* and *can* allow for a FC interpretation, but not predicates like *it is allowed* or individual quantifiers like *some rooms*. Other arguments in favor of a narrow-scope LF came from the computation of scalar implicatures that FC sentences can have, and the role of the scope-marker *either* in the availability of the FC reading. The availability of FC readings for surface forms *OP* A or *OP* B remains an open puzzle, at least for accounts which derive the FC reading through an LF *OP* [A or B].

1.4 Historical Background

The study of Free Choice disjunction started in the context of modern deontic logic, i.e., the formal theory of inference rules between sentences granting permission or imposing obligations (Mally 1926, Jørgensen 1938, Ross 1941, von Wright 1951, Anderson 1966, Hilpinen 1982; s.McNamara 2006 for an overview). Of particular concern was the question how imperative sentences, to which the predicates *true* and *false* don't seem to apply, can take part in formal inferences, which concern the truth of a conclusion as predicted by the truth of premises (e.g. if *A* is true then *A or B* is true). Ross' suggestion was to separate the imperative force (*must!*) from the truth-conditional description of what is required (*you do the dishes*). The latter could then be modeled by propositional logic. However, as Ross noted, such a system would contain the following theorem ($\vdash$ indicates the theorem-status of the formula following; $\Box$ is a universal modal operator, which is paraphrasable as *in all possible worlds compatible with the rules/with what we know etc.*. Its natural language counterparts are *must, have to, it is obligatory*, etc.):

(42) Ross' Problem
$\vdash \Box p \rightarrow \Box(p \vee q)$
If it is obligatory that p, then it is obligatory that p or q

While this describes a valid inference in the deontic logic Ross describes, it doesn't seem to be valid in natural language, as he illustrates with the following example:

(43) You have to mail the letter
$\not\Rightarrow$ You have to mail the letter or burn it

The fact that (42) is no longer perceived valid when translated into natural language has become known as Ross' problem or Ross' paradox.[12] Generally speaking, the problem consists in a mismatch between language and logic. While from a logical point of view there are good reasons in favor of a system in which (42) can be proven, from a linguistic point of view we want the opposite: To be able to formally derive that (43), the natural language counterpart of (42), is *not* a valid inference.

Free Choice inferences reveal a mismatch of the same kind. Recall the schema of FC inferences: $\Diamond(A \vee B) \Rightarrow \Diamond A \wedge \Diamond B$ (see (7)). We observe that this inference is valid in natural language, but we cannot yet formally derive why (s. the discussion around (12)). The easiest way to derive its validity would be to add the schema as an axiom to the logic we use to model natural language inferences (e.g., deontic logic):

(44) Free Choice Axiom
$\Diamond(p \vee q) \rightarrow \Diamond p \wedge \Diamond q$

But as Ross (1941), von Wright (1968) and Kamp (1973) show (s. also Zimmermann 2000), if the Free Choice axiom is added to our logic, the following is predicted to be valid, too:[13]

12 As noted by Ross, the culprit is the more basic axiom in (i):

(i) Disjunction Introduction
$\vdash p \rightarrow p \vee q$

The principle is innocuous in logic, though it becomes all but a non-sequitur in natural language (s. Harman 1986, Braine et al. 1984):

(ii) The upper limit is 95db
$\not\Rightarrow$ So, the upper limit is 95db or 110db

That (ii) is not perceived valid can be accounted for in terms of the implicatures of disjunction: The conclusion implicates that the speaker isn't certain that the upper limit is 110db (ibid. for 95db). However, the premise conveys that he is sure that the upper limit is 95db, thus contradicting this implicature. As we will see in what follows, this explanation doesn't carry over to arguments involving FC sentences, as the following:

(iii) You may read my emails
$\not\Rightarrow$ So, you may read my emails or text messages

Again, by (i) this is predicted to follow, contrary to our intuitions. The explanation in terms of uncertainty implicatures doesn't go through here, however: As we have seen above, the conclusion in (iii) doesn't always implicate that the speaker isn't certain whether you may read my emails (or messages) (specifically, it's the FC reading which lacks these uncertainty implicatures). The uncertainty implicature can therefore not be what breaks the inference in (iii).

13 Here is the proof. Assume

(i) $\Diamond(p \vee q) \rightarrow \Diamond p$ FC Axiom

Then (46) can be proven:

(ii) $\Diamond(\neg p \vee \neg q) \rightarrow \Diamond \neg p$ FC Axiom
$\neg \Diamond \neg p \rightarrow \neg \Diamond (\neg p \vee \neg q)$ Modus Tollens
$\Box p \rightarrow \Box \neg (\neg p \vee \neg q)$ $\Box p \leftrightarrow \neg \Diamond \neg p$

(45) $\Box p \rightarrow \Box(p \wedge q)$
If it is obligatory that p, then it is obligatory that p and q

The problem is that the principle is quite obviously not valid in natural language:

(46) You must read this article
$\not\Rightarrow$ So, you must read this article and write a thesis about Free Choice

In sum, FC seems to be an inference pattern for which we cannot find a strictly logical solution: As a logical axiom, Free Choice is not tenable. A natural conclusion to draw from Ross' problem was therefore a linguistic turn: To find linguistic, rather than logical principles that explain why (43) is not valid, and why FC inferences are valid in natural language.

The first linguistic inquiry into FC sentences was the influential work of Hans Kamp (Kamp 1973, 1978), who proposed a novel analysis of permission sentences as non-truth functional contributions. Other foundational work on the FC phenomena and its relation to the logic of permission include Merin (1992) and Lewis (1979). After Kamp introduced the puzzle of FC into the linguistic debate, three lines of research developed, in roughly chronological order. Aside from *performative* or *logical* accounts related to Kamp's original analysis, proposals can be divided into *semantic* and *pragmatic* accounts, with analyses of the former kind mostly pre-dating the latter analyses. After Kamp's original proposal, FC disjunction had been somewhat neglected in the semantic and pragmatic literature (apart from Merin 1992, another exception to this hiatus is Vainikka 1987). Zimmermann (2000)'s influential semantic account brought the puzzle back on the agenda, leading to a lively and ongoing debate. The line of research which is more closely connected to Kamp's original proposal and the logical tradition continues to investigate FC inferences from the point of view of *non-standard logic* (e.g. Hilpinen 1982, Asher & Bonevac 2005, Barker 2010). These logical and/or performative analyses limit their proposals to permission sentences, while most of the semantic and pragmatic analyses tend to see the original puzzle about permission as part of a wider generalization concerning disjunction interacting with modals and individual quantifiers. The most recent contributions, in line with broader developments in semantics and pragmatics, have been *experimental* investigations into the processing of FC inferences. The above exceptions notwithstanding, almost all linguistic work on FC has been done in the last 15 years. As a result, FC disjunction is both a very accessible and very active research area.

2 The Meaning of Permission

In this section we will look at Kamp's original performative analysis of FC sentences, and more recent logical analyses. Common to all of these proposals is that they focus exclusively

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$\Box p \rightarrow \Box(p \wedge q)$ De Morgan's Law
QED.

on permission-giving (i.e., deontic) FC sentences and offer solutions which do not generalize to other kinds of FC sentences.

2.1 Performative Permission

Kamp's idea was that the FC effect follows from the use of FC sentences not as assertions, but as another kind of speech-act, namely, *performatives* (s. Austin 1962, Searle 1969). Specifically, in their performative use, FC sentences are used to *grant* permission (rather than to *describe* existing permissions). Certain prerequisites have to be fulfilled in context in order for FC-sentences to be be used in this way: (i) The speaker needs to have the necessary authority over the hearer, (ii) there needs to be a list of prohibitions in the context. To formally implement this, Kamp maintains that in addition to the common ground (Stalnaker 1973, 1974, Grice 1989, Stalnaker 1978, 2002), conversational contexts sometimes contain a list of prohibitions. The common ground is simply what is shared background information among discourse participants, such that all participants are aware that the information is shared (e.g., we both know that John is incompetent, but I'm not aware that you know it too. In that case, we have shared knowledge, but not common ground on the issue).[14] The prohibition list, on the other hand, can be represented as a set of propositions which express what is prohibited, e.g. *that you eat an apple* or *that Mary robs a bank*. Granting permission is a speech-act which subtracts propositions form this list of prohibitions. Thus, *You may eat an apple*, if used by an authority in a performative way, removes the proposition *that you eat an apple* from the contextually given list of prohibitions. This is illustrated below:

(47) Permission of A
may [you eat an apple]$_{\mathrm{A}}$
PR_{old} - A = PR_{new}

The new set of prohibitions, PR_{new}, no longer contains the proposition A = *you eat an apple*. If the prohibition list does not contain the proposition *that you eat an apple*, it means that eating an apple is allowed for you. Now we can ask, What is the effect of a disjunctive permission, as in *You may [eat an apple]*$_A$ *or [eat a pear]*$_B$? The answer crucially depends on the meaning of *or*. One standard view is that *or* denotes set union. According to this semantics, *A or B* denotes the union of the worlds in which A is true and those in which B is true: $A \cup B$. If we combine this standard view of *or* with Kamp's analysis of permissions as subtracting from PR, the predicted effect of a FC sentence will be this:

(48) Permission of *[A or B]*
may [[you eat an apple]$_{\mathrm{A}}$ or [you eat a pear]$_{\mathrm{B}}$]
$\mathrm{PR}_{old} - (A \cup B) = \mathrm{PR}_{new}$

14 Though Portner himself doesn't mention this connection, the analysis of imperatives in terms of To-Do lists (Lewis 1979, Portner 2007) is obviously related to Kamp's treatment of permissions: both kinds of speech acts operate on a representation of allowed/required actions, rather than (a representation of) the common ground.

Removing the big set $A \cup B$ from the list of prohibitions will normally[15] remove more than only removing A. This is because the set denoted by A is (normally) a proper subset of – and hence, smaller than – the set denoted by $A \cup B$. This simple set-theoretical fact explains the FC effect: PR_{new} in (48) contains neither A nor B. But if the list of prohibitions contains neither A nor B, this is tantamount to saying that A is permitted *and* that B is permitted. In contrast to (48), the permission of just A in (47) only removes A from the list of prohibited worlds. B may still be on there, so we cannot conclude that it is permitted.

The most important characteristic of Kamp's analysis is that it can maintain the standard semantic denotation of the disjunction *or* in terms of $\cup$. From this standard meaning, two seemingly inconsistent results can be derived: First, that *may A or B* allows more than *may A*. Secondly, that asserting a disjunction *A or B* is less informative than asserting either of its disjuncts (see discussion around (2)). This result is derived because of the different (set-theoretical) operations that permission-giving and assertion perform. While the former is modeled as subtraction from PR, the latter is standardly modeled as intersection on the common ground, i.e., the set of propositions representing our shared information as defined above (Stalnaker 1978, 2002):

(49) Assertion of A
John ate an apple
$\text{CG}_{old} \cap A = \text{CG}_{new}$

(50) Assertion of *[A or B]*
John ate an apple or he ate a pear
$\text{CG}_{old} \cap (A \cup B) = \text{CG}_{new}$

As we established above, the set A (normally) is a proper subset of the set $(A \cup B)$. Intersection with $(A \cup B)$ will therefore result in a bigger CG_{new} than intersection with A.[16] So CG_{new} in (50) contains *more* elements than CG_{new} in (49). But when it comes to common ground, less is more: the less possible worlds we have in CG, the more informed we are. Thus, if we think rain, sunshine and snow are all possible worlds for what the actual weather is like (i.e., if the corresponding propositions are all in CG), it just means that we have no idea what the current weather is like. If, on the other hand, the possible worlds are reduced to rain, this means that we know what the weather is like (it's raining). Since assertion of *A or B* leaves us with more possible worlds than assertion of A (and likewise for B), asserting a disjunction is correctly predicted to be weaker – less informative – than asserting its disjuncts.[17]

Another important feature of Kamp's account is its reliance on a narrow-scope LF for FC readings, and a wide-scope LF for non-FC sentences, like standard disjunctions as in

15 If the set of worlds in which A is true is just a subset of those in which B is true, this is no longer true. However, sentences which correspond to this logical possibility are odd in natural language, cf. *#John ate courgettes or vegetables*, *# You may eat courgettes or vegetables*. See Meyer (2013, 2014).

16 This holds so long as there are elements in B which are not in A, i.e., worlds where B is true but A is false.

17 As the reader will have noticed, this only holds if, prior to assertion of *A or B* or that of A, CG contains A-worlds and B-worlds, i.e., only if it is our shared background that A and B are at least possible. This is guaranteed by independent requirements on felicitous assertions, as discussed by Stalnaker. See also von Fintel (2008) for additional discussion and references.

(50) and FC sentences under their uncertainty reading (introduced in (26) above). That the narrow-scope LF is crucial for applying his subtraction analysis to permissions can be read off of (48) above: If modals like *may* signal that their argument is to be subtracted from the prohibition list, then subtraction of *A or B* will only be signaled by an LF of the form *may [A or B]*. The optionality of the FC reading, in Kamp's accout, thus correlates with a structural ambiguity (wide-scope vs. narrow-scope LF). Only one of the available syntactic representations allows a performative analysis under which the modal operators on a prohibition list. In sum, the FC reading is derived as a non-truth functional meaning of a sentence which in principle also has a truth-functional meaning, when used as an assertion.

Though it is fair to say that Kamp's account has been superseded by more general and/or more formally explicit theories (especially when it comes to the semantic analysis of the modal), it raised (and gave an answer to) a fundamental question which remains central to the study of FC: Whether or not the standard semantics for disjunction can be maintained in accounting for FC readings and, relatedly, whether the effect is a pragmatic inference or a semantic meaning component (see especially Kamp 1978).

A detailed discussion and criticism of Kamp (1973) can be found in Kamp (1978) and Merin (1992), who also notes that the proposal makes a wrong prediction with respect to conjunction: As the reader will be able to check, *You may take an apple and a pear* would not allow you to just take an apple, contrary to fact (just follow the standard set-theoretic analysis of *and* as $\cap$ and fill in (48)). Additional assumptions about the logical form of these conjunctive permission sentences are needed to remedy this (see van Rooy 2000, van Rooij 2006: 5).

2.2 The Logic of Permission

The accounts we will discuss now agree with Kamp that the source of the FC puzzle is the permission-giving deontic modal. They differ from Kamp in suggesting that, rather than their performative use in the discourse context, it is the semantics if these modals which gives rise to the FC interpretation.

Specifically, in the accounts of Hilpinen (1982), Asher & Bonevac (2005), Barker (2010), a permission sentence is analyzed as a conditional:

(51) You may eat an apple
If you eat an apple, it will/would be OK

The gist of the proposals thus consists in defining a semantics for this conditional from which the FC effect falls out as a side-effect, as it were. Turning to conditionals in order to derive the FC effect is in fact less far-fetched than it seems. Famously, disjunctions in conditionals can receive a quasi-conjunctive interpretation reminiscent of the FC reading (the inference schema is known as *Simplification of Disjunctive Antecedents* – SDA for short; s. Alonso-Ovalle 2006, 2008 and references therein):[18]

18 It should be noted that the problem of disjunctive antecedents was raised in the context of subjunctive conditionals (e.g. Lewis 1973, Nute 1980). However, depending on the semantic analysis of indicative conditionals, the

(52) If John eats a cupcake or drinks a beer, he will be in a better mood
⇒ If John eats a cupcake, he will be in a better mood
⇒ If John drinks a beer, he will be in a better mood

The analysis of permission sentences in terms of conditionals, as in (51), has its origins in theories of permission which distinguish between so-called *weak* and *strong* permission (von Wright 1963). For instance, if there is no obligation to refrain from eating octopus, it is said to be weakly permitted. If, on the other hand, there is explicit acknowledgment that eating octopus will be tolerated by the Authority, then eating octopus is said to be strongly permitted (OK, for short). The latter can then be further analyzed as a conditional statement, as in (51). At this point, the next step is obvious: FC sentences are strong permissions and therefore need to be analyzed as a conditional with a disjunctive antecedent:

(53) You may eat an apple or a pear
If you eat an apple or a pear, it will be OK

The conditional, in turn, will then be analyzed so as to validate both inferences shown in (52) — that it will be OK if you eat an apple (= *you may eat an apple*) and that it will be OK if you eat a pear (= *you may eat a pear*). In other words, the derivation of the FC interpretation is reduced to an independently known problem, that of disjunctive antecedents.

Asher & Bonevac (2005) and Barker (2010) differ in how this is derived. The former account analyses the conditional in terms of a defeasible (non-monotonic) logic which has been proposed in relation with generic sentences (see Asher & Morreau 1995, Asher & Pelletier 1997). Barker, on the other hand, suggest Linear Logic (Girard 1987) as the correct way to analyze the relevant *If ϕ, it will be OK* conditionals, and other logical connectives like *or, and*. Useful background about different (deontic) logics can be found in Hughes & Cresswell (1996), McNamara (2006) and Portner (2009). Some classic references on non-monotonic reasoning include McCarthy (1980), Gabbay (1985), Reiter (1980) (s. also Lascarides & Asher 1993). Its application to the semantics of generic sentences can be be found in Asher & Morreau (1991), Asher & Pelletier (1997).

3 Semantic Accounts

3.1 Disjunctions as Lists

Recall the general schema of the FC effect (repeated from (7)):

(54) *OP* A or B
⇒ *OP* A and *OP* B

Semantic accounts posit that this interpretation has to be accounted for by a non-standard semantic analysis of the operator *OP* (typically, the modal *may*), and/or the disjunctive connective.

puzzle carries over (s. von Fintel 2011 for an overview.

The first radical re-thinking of the FC effect along these lines comes from Zimmermann (2000). The basic idea is that disjunctions introduce a *conjunction of possibilities*. This is radical insofar as it is not a proposal about FC alone: It rejects the standard view that *or* can be modeled by the propositional logic operator $\vee$ or set union $\cup$, and is thus a theory about disjunction in general. The idea is illustrated below:[19]

(55) John ate an apple or he ate a pear
It is possible that John ate an apple & *It is possible that John ate a pear*
$\Diamond$ (John ate an apple) $\wedge$ $\Diamond$ (John ate a pear)

The modal existential quantifier $\Diamond$ is interpreted relative to the speaker's knowledge, i.e., epistemically: *there is a possible world w compatible with what I know s.t. John ate an apple in w* (see section 1.2). The simple disjunction in (55) would thus come to mean that it is compatible with my knowledge that John ate an apple, *and* that it is compatible with what I know that he ate a pear. This seems to capture the intuitive meaning of the sentence quite well.[20]

How does this modal semantics for disjunction carry over to FC disjunctions, which already contain a modal element like *may*? The gist of Zimmermann's proposal consists in spelling this out in detail. Recall from section 1.3 that Zimmermann (and Geurts following him) assume a wide-scope LF for FC sentences:

(56) John may have an apple or a pear
LF: [may [John have an apple]]$_{\mathrm{A}}$ or [may [John have a pear]]$_{\mathrm{B}}$

Given the new modal semantics of *A or B* as $\Diamond A \wedge \Diamond B$, the predicted meaning of (56) will be the following (in order to avoid confusion, we can follow common practice and render the deontic *may* as $\Diamond\!\!\!\cdot$ – *there is a possible world compatible with the rules*):

(57) $\Diamond$ ($\Diamond\!\!\!\cdot$ John have an apple)$_{=\mathrm{A}}$ $\wedge$ $\Diamond$ ($\Diamond\!\!\!\cdot$ John have a pear)$_{=\mathrm{B}}$
It is possible that John is allowed to have an apple & *It is possible that John is allowed to have a pear*

In case the FC sentence involves epistemic modality, as in *John might be in the office or in the gym*, the predicted meaning involves iterated epistemic operators:

(58) $\Diamond$ ($\Diamond$ John be in the office) $\wedge$ $\Diamond$ ($\Diamond$ John be in the gym)
It is possible that John might be in the office & *It is possible that John might be in the gym*

19 Zimmermann does not in fact propose that a disjunction *A or B* is represented as a conjunction [$\Diamond$ A and $\Diamond$ B] at LF, as Geurts (2005: 386) claims and assumes himself (p.391). Zimmermann only asserts that $\Diamond$ A $\wedge$ $\Diamond$ B is the meaning of *A or B*, but how this meaning is derived compositionally is an open question in both accounts.

20 As Zimmermann (2000: 270ff.) discusses in detail, further meaning components of the disjunction, e.g. that I am not in fact certain that he ate an apple, have to be accounted for as well. These issues are orthogonal to the analysis of FC effects.

Obviously, these predicted meanings do not yet capture the FC interpretation, according to which the sentences simply state that John may eat an apple and that he may eat a pear, and that he might be in the office and that he might be in the gym. To derive these interpretations from the predicted, doubly-modalized semantics in (58) and (57) above, it is necessary to systematically reduce the iterated modalities, as shown below:

(59) Deontic Simplification
$[\Diamond\Diamond\!\!\!\!\cdot\ \mathrm{A}] \wedge [\Diamond\Diamond\!\!\!\!\cdot\ \mathrm{B}] \rightsquigarrow \Diamond\!\!\!\!\cdot\ \mathrm{A} \wedge \Diamond\!\!\!\!\cdot\ \mathrm{B}$
It is possible that it is allowed that A ⇝ It is allowed that A

(60) Epistemic Simplification
$[\Diamond\Diamond\ \mathrm{A}] \wedge [\Diamond\Diamond\ \mathrm{B}] \rightsquigarrow \Diamond\ \mathrm{A} \wedge \Diamond\ \mathrm{B}$
It might be that it might be that A ⇝ It might be that A

While the left-hand side of the arrow corresponds to the predicted basic semantics of FC sentences, and the right-hand side to the observed FC interpretation. Zimmermann's idea is that there is a systematic explanation as to when and how these simplifications arise, namely, independent principles pertaining to the interpretation of epistemic and deontic modality, i.e., expressions like *may* and *might*.

The first of these principles is Zimmermann's *Authority Principle*, which explains the simplification in (59) and the FC interpretation with deontic modality in general.

The Authority principles states that an authority on the relevant permissions and obligations, e.g., John's food allowances, never simply thinks that it's possible that A is allowed; rather, either she is certain that A is allowed, or she is certain that A is not allowed (whence her authority). An equivalent, more formal way of putting it is the following:

(61) If S is an authority on $\Diamond\!\!\!\!\cdot A$, and if $\Diamond_S\Diamond\!\!\!\!\cdot\mathrm{A}$, then $\Box_S\Diamond\!\!\!\!\cdot\mathrm{A}$[21]

The principle applies to deontic FC sentences whenever the speaker is identified as an authority. However, Geurts (2005) notes that the principle doesn't quite achieve the desired simplification in (59); applying (61) to (57) rather leaves us with *The authority/speaker is*

21 Here is why the two descriptions of the principle are equivalent. The definition of authority given in prose can be rendered as follows (where the epistemic operators $\Box$ and $\Diamond$ are interpreted relative to the authority's knowledge):

(i) $\Box\Diamond\!\!\!\!\cdot A\phi \vee \Box\neg\Diamond\!\!\!\!\cdot\phi$

That S thinks it is possible that ϕ is allowed corresponds to (ii-a), which is equivalent to (ii-b):

(ii) a. $\Diamond\Diamond\!\!\!\!\cdot\phi$
b. $\leftrightarrow \neg\Box\neg\Diamond\!\!\!\!\cdot\phi$

Thus, if S thinks it possible that ϕ is allowed, then by (i) it follows she is certain that ϕ is allowed:

(iii) $\Diamond\Diamond\!\!\!\!\cdot\phi$
$\Box\Diamond\!\!\!\!\cdot A\phi \vee \Box\neg\Diamond\!\!\!\!\cdot\phi$
$\therefore \Box\Diamond\!\!\!\!\cdot\phi$

sure that John may eat an apple and she is sure that John may eat a pear (i.e. $\Box_S \Diamond A \wedge \Box_S \Diamond B$). Presumably, further pragmatic simplifications could then lead us to the FC reading in (59) (s. also section 4.2).

Turning to the desired simplification in (60), here we need to explain how the predicted *It is possible that John might be in the office* comes to be interpreted simply as *John might be in the office* in the FC sentence in (58). Again, the idea is that this comes about through an independent principle underlying the interpretation of epistemic modality. The principle Zimmermann invokes here is called *Self-Reflection*, and it states that a person has access to her own belief or knowledge state: When she knows something or considers something possible, she knows that this is so. As Geurts (2005) points out, Zimmermann's particular formalization of Self-Reflection corresponds to the conjunction of two axioms often assumed (and discussed) in epistemic logic:[22]

(62) Self-Reflection
  (i) Positive Introspection: $\Diamond \Diamond A \rightarrow \Diamond A$
  (ii) Negative Introspection. $\Diamond \Box A \rightarrow \Box \Diamond A$

As this makes clear, for the desired simplification in (60) only Positive Introspection is needed; this and other important issues with Zimmermann's two principles of simplification are discussed in Geurts (2005). Applying (62) to the predicted meaning of epistemic FC sentence in (58) indeed yields the desired simplification in (60).

In sum, the core ingredients in Zimmermann's account are (i) an LF with wide-scope disjunction, (ii) a semantics of *A or B* as $\Diamond A \wedge \Diamond B$ and (iii) language-independent principles to reduce the iterated modalities predicted for FC sentences. One advantage of (i) in particular is that it immediately accounts for a tough puzzle: Why the FC effect arises with both narrow and wide-scope disjunctions, as seen in 1.3:

(63) a. You may have an apple or a pear +FC

22 The axiom of Positive Introspection is valid in modal logic systems where the accessibility relation between worlds is transitive. Outside of epistemic/doxastic logics, the corresponding axiom is usually referred to as the 4-axiom, and stated in its equivalent form:

(i) $\Box A \rightarrow \Box\Box A$ Axiom (4)

Negative Introspection, on the other hand, is often referred to as the 5-axiom (again the two formulations in (62) and below are equivalent:

(ii) $\Diamond A \rightarrow \Box\Diamond A$ Axiom (5)

The 5-axiom is valid iff the accessibility relation is Euclidean. As Geurts shows, Negative Introspection a.k.a. (5) makes problematic predictions for disjunctions which contain a universal modal operator. Thus, for *It must be here or it must be there*, the predicted meaning $\Diamond\Box A \wedge \Diamond\Box B$ is reducible to $\Box A \wedge \Box B$, i.e., *It must be here and it must be there*. As Geurts points out, since Self-Reflection is a general epistemic principle, is not expected to be subject to contextual variation, and so this prediction is hard to avoid. It should also be noted that Schulz (2005: 360) has shown that Zimmermann' deontic *Authority* principle can be made to fall under the *Self-Reflection* principle, if the latter is stated for cases of mixed-modality (i.e., combined deontic and epistemic operators.)

b. You may have an apple or you may have a pear +FC

Since both versions are assigned the same LF, the fact that they can both receive the same FC interpretation follows straightforwardly. As we also saw above, however, not all surface wide-scope disjunctions actually allow for a FC interpretation; the observed restrictions would have to be explained independently.

As we saw in section 1.2, most FC disjunctions are in fact ambiguous between an FC interpretation and an uncertainty reading *I forgot which*. How does the account derive this? Zimmermann points out that the latter reading is in fact the one predicted to arise before the two principles apply, i.e.:

(64) John may have an apple or a pear. . . I forget which
$\Diamond\diamondplus$(John has an apple) $\wedge$ $\Diamond\diamondplus$(John has a pear)
It is possible that John is allowed an apple & it is possible that John is allowed a pear

In section 1.2 we observed a systematic exception to this ambiguity: FC sentences with epistemic modality seem to only have a FC interpretation (see (28)-(29)). In Zimmermann's system, this falls out of a conceptual asymmetry between the Authority principle and the Self-Reflection principle: While the latter may or may not apply, depending on the authority of the speaker in a given situation, Self-Reflection is not expected to vary with context, since it describes what some think are essential characteristics of knowledge and/or belief. In Zimmermann's account, then, epistemic FC sentences are not ambiguous because the Self-Reflection principle is universal, while the Authority Principle is not.

Independently of FC, Zimmermann's proposal is relevant in view of cross-linguistic observations (e.g. Mauri 2008). As Mauri notes, a significant number of languages lack a disjunctive connective corresponding to English *or*. To express the meaning of *A or B*, these languages juxtapose the two sentences, both of which must contain modal or evidential markers comparable to *may* or *perhaps*. In other words, the prototypical disjunction in these languages has the form *OP* A; *OP* B and thus transparently reflects Zimmermann's proposed semantics for English.

As mentioned, Geurts (2005) constitutes an essential addition to Zimmermann's proposal. While Geurts follows Zimmermann in defining disjunctions as modalized lists (understood as conjunctions), he departs from the latter regarding the source of the modal. To explain the basic idea, Geurts offers a helpful parallel to the so-called restrictor analysis of conditionals: While all conditionals are assumed to be of the form *If A, OP B* at LF, they differ in that *OP* is sometimes overt, sometimes not:

(65) a. If John buys a horse, he pays cash for it
b. If John buys a horse, he <u>will</u> pay cash for it
c. LF: *OP* (John buys a horse; he pays cash for it)

To maintain a uniform LF with the structure in (65-c), a covert operator *OP* is assumed in (65-a), assimilating it to (65-b). Geurts applies the same technique to disjunctions: If a

disjunction doesn't contain a modal, a covert operator is posited in both disjuncts at LF (per default, an epistemic existential $\Diamond$); when a disjunction already contains an overt modal, it is this modal which is assumed to be present in both disjuncts at LF:

(66) John ate an apple or a pear
LF: $\Diamond$(John ate an apple) $\wedge$ $\Diamond$(John ate a pear)

(67) John may eat an apple or a pear
LF: $\diamondplus$(John ate an apple) $\wedge$ $\diamondplus$(John ate a pear)

This substantial modification of Zimmermann's account allows Geurts to dispense with the principles invoked to explain the simplifications in (59)-(60) above.

3.2 Modals interacting with Disjunction

Aloni (2003, 2007) and Simons (2005) defend similar ideas: That the FC effect arises as a result of the particular way modals interact with disjunction *in their scope*. In this respect, the accounts differ from Zimmermann and Geurts and resemble most others in assuming a narrow-scope LF:

(68) *OP* [A or B]

Aloni's proposal has two core ingredients: First, the ability of disjunctions *A or B* to introduce a set of alternative propositions {A, B}, which may then be used by operators further up in the semantic derivation:

(69) Alternatives introduced by *A or B*: {A, B}

Secondly, Aloni proposes a new semantics for *may*.[23] Specifically, she assumes that modals involve quantification over the set of alternative propositions introduced by the disjunction in their scope (s. also Kratzer & Shimoyama (2002)). This differs in subtle but substantial ways from the standard view. According to this standard view, modals like *may* and *must* simply quantify over possible worlds and state that the proposition in their scope is true in some or all of those possible worlds. Whether or not this proposition has any alternatives is not visible in this standard semantics. The difference is illustrated below:

(70) Standard modal semantics
may [John eat an apple]$_A$
there is a possible world w s.t. A is true in w

(71) Aloni's modal semantics
may [John eat an apple]$_A$
for every alternative introduced by A: there is a possible world w s.t. A is true in w

23 Both Aloni's and Simons' proposal are explicitly designed to also include sentences of the form *must A and B*. Since this is not our focus (see discussion around (17)), we will only discuss their analyses of standard FC sentences *may A or B*.

Note that the two semantic denotations are equivalent if the only alternative to A is A itself. Things become more interesting when there is more than one alternative, and this is precisely what happens in disjunctions, as (69) states. Combining (69) and (71), the predicted meaning of a FC sentence will be this:

(72) may [John eat an apple or John eat a pear]
for all p ∈ {John eats an apple, John eats a pear}: there is a possible world w s.t. p is true in w

It is easy to see that this amounts to saying that there is a possible world where John eats an apple *and* a possible world in which he eats a pear. So John may eat an apple and John may eat a pear – the FC reading.

Importantly, if a disjunction *A or B* always introduces alternatives and the modal *may* always has the meaning in (71), a FC sentence like *John may eat an apple or a pear* would be predicted to always have the FC reading — a false prediction, as we have seen in section 1.2. What about the uncertainty reading then, under which it does not follow that John may really have an apple? Two moves are conceivable in principle: to make either the universal quantification over alternatives in (71), or the introduction of alternatives in (69) an optional meaning component. Aloni takes the latter route (as we will see, Klinedinst 2007b's analysis is similar to Aloni's, but takes the first). Thus, the uncertainty reading is derived whenever the disjunction does not introduce the two single disjunctions A, B as alternatives, but instead, only introduces the trivial set of alternatives – itself:

(73) John may eat an apple or a pear…I forget which
Alternatives: {*John eats an apple or John eats a pear*} (trivial)
for all p ∈ {John eats an apple or John eats a pear}: there is a possible world w s.t. p is true in w

This meaning predicts the sentence to be true in three different scenarios: (i) there is world in which John eats an apple, but none where he eats a pear (ii) there is a world where John eats a pear, but none where he eats an apple, and (iii) there are worlds of both kinds. Importantly, this is not the FC interpretation: In scenario (i), for instance, John may not in fact have an apple.

In Aloni's account, then, the ambiguity between the FC and the uncertainty reading is linked to whether or not a disjunction introduces two alternatives ({A, B}), rather than just itself ({A or B}). Technically, this move can in indeed derive both readings, as we just saw in (72) and (73). But the connection between perceived authority/informedness of the speaker and the availability of the FC reading is lost — there is no intuitive reason why a disjunction used by an authority should introduce alternatives into the semantic representation (as in (72)), while one used by an ignorant bystander will not (as in (73)). On the other hand, Aloni's account has the advantage of offering a unifying perspective on both FC disjunction and FC *any*; as she shows, the analysis of the universal reading of the latter likewise falls out of her semantics for the modal.

Simons (2005) also defends a semantic account, and her changes to the meaning of *may* are identical in effect to Aloni's outcome, the difference lying merely in the technical implementation. In essence, she adds to the standard truth-conditions in (74-a) the condition (74-b):

(74) may [A or B]

a. there is a subset of possible worlds *S* s.t. in every world in *S*, either *A* or *B* or both are true

b. *S* contains at least one world where *A* is true and at least one world where *B* is true

Ignoring the role of the subset *S* of possible worlds for now, condition (74-a) essentially corresponds to the basic semantic meaning of (74), according to which the sentence is true (i) if A is possible but B is not (ii) if B is possible but A is not and (iii) if both A and B are possible (not necessarily in the same world). Recall that the FC effect consists in a reduction of these scenarios to only (iii), i.e., the FC reading states that both A and B are true in some possible world. This reduction to scenario (iii) is achieved by condition (74-b).

Simons' account resembles Aloni's also in assuming that disjunction can make available a set of alternative propositions {A, B}. This is a technical requirement in order to state the two conditions in (74) above, which explicitly refers to the two propositions. If only the proposition A or B were 'visible' to the modals, this would not be possible.

As discussed by Alonso-Ovalle (2006: fn.11), one empirical difference between Simons' and Aloni's proposal is how well they extend to disjunctions under the scope of *must*. Since Alonso-Ovalle showed that these can be derived by means of standard scalar implicatures, however, we will ignore these cases here (as stated earlier, see (17)).

One advantage of Simon's analysis, as stated in section 1.3, is that it can deal with FC sentences in which the modal occurs in both disjuncts. As (74) shows, Simons derives the FC interpretation from a narrow-scope LF. For sentences like *John might be in the office or he might be in the gym*, this LF is derived by Across-the-Board movement, at LF, of the two modal auxiliaries (Williams 1978, **?**):

(75) Simons' covert ATB movement
John might be in the office or he might be in the gym
LF: might$_1$ [t$_1$ John be in the office or t$_1$ he be in the gym]

As discussed in section 1.3, fn. (39), the status of this kind of covert movement is somewhat controversial. (Bošković & Franks 2000)

3.3 Free Choice as a Distributivity Effect

Both Aloni's and Simons' proposal semantically incorporate the observation that the modal in FC sentences — typically, *may* — seems to assert the possibility of both disjuncts in its scope, rather than just assert the possibility of the disjunction as a whole. In this the FC effect is reminiscent of an interpretative effect that arises with plural noun phrases. To

illustrate, the sentence in (76) can be understood as saying that the predicate *write a poem* is true of each individual boy referred to by the plural DP *the boys* (Link 1983, Winter 2000, Zimmermann 2002):

(76) The boys wrote a poem
$\rightsquigarrow$ Each of the boys wrote a poem

The way this *distributive* reading can be derived is by way of a distributivity operator akin to overt *each*, which contributes the underlined meaning component below:

(77) The boys (each) wrote a poem
there is a unique plurality of boys X s.t. $\underline{\textit{for all atomic } x \in X}$*: x wrote a poem*
$\approx$ *there are several boys s.t. each of them wrote a poem*

The idea behind Klinedinst (2007a,b) is to model the meaning of *may* in a parallel fashion, as a plural indefinite, and then to combine this new plural meaning with a distributive component as in (77). Specifically, the new semantic denotation of the modal can be paraphrased as *there is a plurality of worlds W*, thus likening it to the meaning of the plural indefinite *boys* above. This allows a distributive operator – a covert *each* – to co-occur with this plural meaning of *may*, yielding the following semantics for a FC sentence:[24]

(78) Mary may eat an apple or a pear
there is a plurality of possible worlds W s.t.
$\underline{\textit{for each } w \in W}$*: Mary eats an apple in w or Mary eats a pear in w*

As it stands, this semantics predicts the sentence to be true if in all possible worlds (compatible with the rules), Mary eats an apple, but in no worlds she eats a pear. In other words, the FC sentence in (78) is predicted to be true even when Mary may not in fact eat a pear, just an apple. To derive the FC interpretation, one additional step is therefore needed. This step, as Klinedinst shows, is needed independently to derive the following inference:

(79) Each student ate an apple or a pear
$\Rightarrow$ At least one student ate an apple
$\Rightarrow$ At least one student ate a pear

These inferences can be derived as scalar implicatures, though the negation of the sentence's stronger alternatives *each student ate an apple* and *each student ate a pear* (s. fn. (17) in section 1.2).

Consider now the the embedded portion of (78): *for each* $w \in W$*: Mary eats an apple in w or Mary eats a pear in w*. We observe that this resembles (79), being of the same general schema *for each w: A(w) or B(w)*. Crucially, if the same inferences as in (79) can be derived here, the FC effect would follow: the inferences in question would state that there is at least one world in which Mary eats an apple, and at least one world in which she

24 In fact the distributive operator is thought to be obligatory in the scope of *may*, for reasons that need not concern us here; s. Klinedinst (2007:276).

eats a pear. All currently available mechanisms to derive these embedded inferences are in principle compatible with Klinedinst's account (s. section 4.3 for more detailed illustration of one such mechanism). Importantly, when these embedded inferences are added to (78), the sentence gets the following enriched meaning:

(80) *there is a plurality of possible worlds W s.t.*

a. Basic meaning: = (78)
for each $w \in W$: Mary eats an apple in w or Mary eats a pear in w

b. Embedded inferences:
for at least one $w \in W$: Mary eats an apple in w ≈ (79)
for at least one $w \in W$: Mary eats a pear in w

The sentence if predicted to be true if Mary is allowed to eat an apple, and allowed to eat a pear. Thus, the FC interpretation is derived.

Klinedinst's proposal may also be viewed as a pragmatic analysis, since the FC effect is derived by the same mechanism that embedded implicatures. But as we saw, these implicatures only yield the FC reading when combined with a new plural semantics for the modal. Klinedinst's approach has the advantage of using independently needed machinery — a distributivity operator and a mechanism for deriving (embedded) implicatures. The innovation here is to liken the meaning of the modal auxiliary to that of plural indefinites like *some girls*. In doing so, the analysis offers more generality than Aloni's and Simons' accounts, since FC effects in the scope of plural indefinites fall out immediately (see (21) in section 1.2):

(81) Some rooms have a bathtub or a fireplace
⇒ There is at least one room with a bathtub
⇒ There is at least one room with a fireplace

Combining the distributive meaning with an embedded implicature as before, the observed FC effect follows straightforwardly:

(82) *there is a plurality of rooms X s.t.*

a. *for each $x \in X$: x has a bathtub or x has a fireplace*

b. *for at least one $x \in X$: x has a bathtub*
for at least one $x \in X$: x has a fireplace

4 Pragmatic Accounts

The common theme in the analyses discussed below is the shift of the explanatory load from the semantics to the pragmatics. The FC effect is no longer derived by modifying the semantic denotation of the disjunctive connective and/or the modal operator, but rather, by invoking additional pragmatic mechanisms either specific to disjunction or the operators involved (Vainikka 1987) or general mechanisms of implicature computation (Alonso-Ovalle 2006, Fox 2007, Chemla 2009a, Geurts 2010). Pragmatic proposals are thus able to maintain

a standard semantics for both the disjunction and the modal (see (12)), while they have to add non-trivial assumptions about the pragmatic principles involved.

The pragmatic proposals which we discuss below all fall within either of the two main camps into which current pragmatic theory can be divided: the Neo-Gricean or the grammatical theory (s. Schlenker forthcoming, Meyer 2013 for an overview). By contrast, the proposal of Franke (2009, 2011) is cast into the recently developed framework of game-theoretic pragmatics. An introduction to a game-theoretic analysis of implicatures and FC inferences in particular is beyond the scope of this paper; the reader is referred to Benz et al. (2006), Franke (2013), Rothschild (2013) for background.

4.1 Disjunctive Pragmatics in FC

The first to propose that the FC effect arises as a pragmatic enrichment of the standard disjunctive meaning of FC sentences seems to have beenVainikka (1987). The basic observation behind the approach is the infelicity of a disjunction *A or B* in contexts in which *A* is already known be false. For instance, if we just checked Mary's office and saw it was empty, asserting *Mary is in her office or in the gym* will sound odd, even though it could still be true from a strictly semantic point of view, where the meaning of the disjunction would be rendered as $A \vee B$. While the intuition is very clear, there are several options on how to derive the effect formally.[25] Vainikka's suggestion can be seen as a *brute force* approach, in that it explicitly posits an appropriateness condition to this effect:

(83) A disjunction *A or B* is only felicitous in a context C if C is consistent with both *A* and *B*[26]

25 A simple Gricean account suggests itself: The disjunction *A or B* is compared to its simpler, but stronger alternatives, among them *B* (= *Mary is in the gym*). Now, the maxim of Quantity requires that the speaker assert the strongest possible sentence (favoring *B*). The maxim of Quality, by contrast, demands that the speaker be sure of what he asserts. The hearer concludes that the speaker was not sure that *B* is true, or else he would have asserted it, thus satisfying Quantity. Crucially, since he asserted the disjunction, by Quality it follows that he is sure that at least one of the disjuncts is true. If he is not sure that *B* is true, as we have just concluded, he must at least think it's possible for *A* (= *Mary is in her office*) to be true. But precisely this implicature contradicts what is already mutually known in the above context. As Chemla (2009:fn.5) points out, however, there may be a flaw in this derivation: Given that *A* is already known to be false in this context, the other disjunct *B* is contextually equivalent (and not stronger, as assumed above!) to the whole disjunction. Therefore, Quantity would not distinguish between *A or B* and *B* in this context, and the reasoning leading to the implicature that *A* must be possible doesn't get off the ground. Chemla suggests instead that a Gricean account has to capitalize on the maxim of Manner: Given that both are contextually equivalent, but one is less complex than the other, the unnecessary complexity in *A or B* should be banned (see Meyer 2013, 2014, 2015b for a recent attempt to formalize the maxim of Manner).

26 As is well known, disjunctions are equally odd when one of the disjuncts is known to be true. Vainikka's condition doesn't straightforwardly derive this fact; it allows a disjunct to be known (since epistemic possibility is entailed by and thus consistent with epistemic necessity). The only way to prevent this is to add an additional constraint that disjunctions presuppose the falsity of the corresponding conjunction. In her framework, this would be expressed as the requirement that in any $w \in C$, $A \cap B = \varnothing$. Then it would follow from her condition (83) that $C \subsetneq A$ and $C \subsetneq B$, i.e. that neither A nor B are common ground. But empirically, having disjunctions presuppose exclusivity is probably too strong. The additional constraint would thus have to be derived independently, e.g. as

In a standard disjunction without modals, the context C can be equated with the common beliefs of the interlocutors (see discussion in 2.1; Stalnaker 1974, 2002). Going back to the above example, after seeing Mary's empty office, *Mary is in her office* is no longer compatible with our common beliefs. Therefore, the disjunction *Mary is in her office or in the gym* violates (83) and is therefore predicted to be infelicitous in the described context.

But how could (83) account for the seemingly unrelated FC effect? Crucially, for FC sentences the assumption is that C can be equated with the conversational background R against which the modal in FC sentences is interpreted (Kratzer 2012c,b). Recall from above that with a deontic modal like *may*, this can be the set of rules, e.g. *John does not eat a papaya*, *John does not drink beer*, etc. Secondly, Vainikka assumes that this happens when the modal takes scope over the disjunction; in other words, she thus assumes a narrow-scope LF for FC readings:

(84) may_R [John eat an apple or John eat a pear]

Applying (83) to this LF, and identifying the context C with R will yield the following condition:

(85) *John eats an apple* is compatible with R & *John eats a pear* is compatible with R

But if John eating an apple is consistent with the rules, this just means that is allowed for John to have an apple (and likewise for John eating a pear), and so (83) derives the FC interpretation of (84).

As with other accounts (e.g. Kamp's original proposal), the uncertainty reading is derived by a wide-scope LF. Applied to this LF, C in condition (83) will be the common beliefs (or knowledge) among the interlocutors. In this case, (83) simply states that it is consistent with these beliefs that John may eat an apple, and that he may eat a pear. From this it doesn't follow that John may actually be allowed an apple.

As stated in section 1.2, Vainikka makes the important observation that an uncertainty reading is ruled out for FC sentences with epistemic modals. Recall the relevant example from (29):

(86) John might be working or sleeping
⇒ John might be working
⇒ John might be sleeping

But how can the obligatory FC interpretation with epistemic modals be derived? The idea (p.c. of Angelika Kratzer; Vainikka (p.154 1987)). is that an uncertainty reading would give rise to contradictions when epistemic modals are involved (see Dorr & Hawthorne 2013, Meyer 2015a for recent applications of this same idea). Specifically, Vainikka assumes that we are always informed about the status of epistemic claims like *might A* — we simply know what is and what isn't compatible with our knowledge (whereas we don't have this privileged access to other claims like *A's are B*: here we often are genuinely uncertain; s.

implicatures arising from Gricean maxims, keeping in mind the challenge mentioned in the previous footnote.

discussion in section 3.1).[27]

But this may conflict with uncertainty inferences which arise with disjunctions *A or B*, namely, that we are not sure that *A* is true (and likewise for *B*). The conflict arises when *A* and *B* are of the form *might p* and *might q*, as would be the case with a wide-scope LF for (86). Vainikka furthermore assumes that if an LF gives rise to odd inferences, it is filtered out and another LF must be chosen, if available.[28] Since for (86) another LF is available, namely, the narrow-scope LF, this is the one speakers will have to chose, and this LF happens to be the one which gives rise to the FC interpretation, in parallel to (85).

However, since the obligatoriness of the FC reading with epistemic modals is an essential feature of the FC puzzle, it is worth noting that Vainikka's account already contains the basics for an alternative explanation, which may carry over to other pragmatic accounts. Consider again a wide-scope LF — an LF for which Vainikka claims conflicting uncertainty inferences would arise:

(87) might$_R$ [John be working] or might$_R$ [John be sleeping]
John might$_R$ be working is compatible with common knowledge and *John might$_R$ be sleeping* is compatible with the common knowledge

As stated earlier, Vainikka assumes that the background *R* against which epistemic *might* is interpreted is simply common knowledge (see Vainikka 1987:159, Stephenson 2007, section 5, von Fintel & Gillies 2007). Thus, *might$_R$ A* can be paraphrased as *there is a world compatible with common knowledge s.t. A is true in it* or *it is compatible with common knowledge that A* for short. Paraphrasing *might* in (87) along these lines, we get:

(88) It is compatible with common beliefs that it is compatible with common beliefs that John is working
It is compatible with common beliefs that it is compatible with common beliefs that John is sleeping

But given certain natural assumptions about (common) belief and knowledge, this can be further simplified:[29]

27 For the case of *might A*, this could be linked to the axiom $\Diamond p \rightarrow \Box \Diamond p$ — *if it is compatible with the (common) knowledge that p, then it is (common) knowledge that it is compatible with (common) knowledge that p*. This is valid on frames with a reflexive, transitive, and symmetrical accessibility relation between worlds. The reflexivity in particular makes the axiom unsuitable for the logic of belief (which, for better or worse, does not validate $\Box p \rightarrow p$ — *if I believe that p, then p is true*). As a consequence, the argument only goes through if *might* can be shown to be interpreted with respect to (common) knowledge. Related logical principles that reflect a general principle of *transparency* or *luminosity* of knowledge and/or belief (*'I know when I know something'*) are the earlier discussed axioms of Positive and Negative Introspection; see discussion around fn. **??**, Hintikka (1962), Williamson (2000), von Fintel & Gillies (2007), Dokic & Egré (2009), **?** for background.

28 The idea that contradictory or otherwise problematic truth-conditions and/or implicatures can filter out an otherwise well-formed syntactic representation has been invoked in relation to diverse phenomena, e.g. Ladusaw (1986), von Fintel (1993), Heim (2001), Büring (1997), Fox & Hackl (2006), Magri (2009), Meyer (2015a).

29 As we saw in the discussion of Zimmermann's and Geurts' account above (see fn. (61)), the basis of this simplification is again the principle of Positive Introspection, which is thought to hold not just for individual belief and knowledge, but also for common belief and/or knowledge (Stalnaker 2002). Here, the principle is

(89) It is compatible with common beliefs that John is working
It is compatible with common beliefs that John is sleeping

It is easy to see that this simplification amounts to the FC reading, i.e., that John might be working and that he might be sleeping. Since the narrow-scope LF also yields this reading, its obligatoriness would follow simply because both available LFs are equivalent when epistemic modals are involved.

4.2 Implicatures from Similarity

That independent pragmatic principles can explain the FC effect is also the central idea behind Chemla (2009a). Chemla's account extends to Free Choice interpretations which occur in the scope of quantified expressions like *every student* or *some rooms* (see section 1.2). Here we will illustrate the account with the core datum, i.e., FC disjunctions with modals like *may*.

Chemla proposes that FC inferences are *implicatures*: Inferences which are added to the basic semantic meaning of a sentence, through our reasoning about *alternative sentences* the speaker could have asserted. For example, *A or B* often gives rise to the scalar implicature that the alternative, stronger sentence *A and B* is false (or that the speaker believes that it is false, s. below).

What alternative sentences are relevant for a FC disjunction? Theories of (scalar) alternatives predict the following set (s. Sauerland 2004, Katzir 2007):[30]

(90) Alternatives of may [A or B]
$\mathcal{ALT}$(may [A or B]) = {may A, may B, may [A and B]}

Having established what the alternatives of a FC disjunction are, we can now ask what implicatures these alternatives could give rise to. This is not a trivial question. For example, a standard disjunction typically comes with two kinds of implicatures (Gazdar 1979, Soames 1982, Sauerland 2004):

(91) Implicatures of *A or B*
a. $\rightsquigarrow$ Speaker is sure that not (A and B) *Scalar Implicature*
b. $\rightsquigarrow$ Speaker isn't sure that A *Uncertainty Implicature*
$\rightsquigarrow$ Speaker isn't sure that B

We observe that the implicatures come in two basic forms: Either of the form $\mathcal{B}\psi$, as in (91-a) (where ψ corresponds to $\neg(A \wedge B)$). But in addition, there are implicatures of the form $\neg\mathcal{B}\psi$, as in (91-b). The two kinds of implicatures reflect the possible epistemic attitude

applied in its equivalent, existential form: $\Diamond\Diamond p \rightarrow \Diamond p$—*if it is compatible with common beliefs that it is compatible with common beliefs that p, then it is compatible with common beliefs that p*.

30 Recall from (33) that the choice of LF for a FC sentence determines which alternatives it will have, and that only the narrow-scope LF seems to yield the correct alternative. Therefore, the following alternatives are those predicted for a narrow-scope LF *may [A or B]*.

of the speaker, as paraphrased in (91). Chemla's idea is that there is something systematic about the possible configurations of attitude and alternative: For similar alternatives, it will be a similar attitude. This is the central principle of the account:

(92) Similarity of Epistemic Attitudes
For similar alternatives ϕ, $\psi \in \mathcal{ALT}(\sigma)$:
If S is sure that ϕ then S is sure that ψ
If S is not sure that ϕ then S is not sure that ψ
Formally: $B\phi \rightarrow B\psi$ and $\neg B\phi \rightarrow \neg B\psi$[31]

What remains to be stated is which alternatives are similar to each other, and which ones aren't. Chemla ultimately has to rely on a stipulation for this. For the alternatives of FC disjunction in (90), we have:

(93) Similarity of Alternatives: may [A or B]
a. Set I: {may [A and B], may $\perp$}[32]
b. Set II: {may A, may B}

The principe of similarity now allows us to restrict the possible implicatures that can come with a FC disjunction like *Mary may have an apple or a pear*, by combining (92) and (93) above. Either the speaker is certain about all alternatives in Set I (i.e., $\mathcal{B}$(may [A and B]), $\mathcal{B}$(may $\perp$)). Or the speaker is not certain about either of them (i.e, $\neg\mathcal{B}$(may [A and B]), $\neg\mathcal{B}$(may $\perp$)). And likewise for set II. Note that one further, natural restriction governs our reasoning here: Whatever the speaker's attitudes about the different alternatives are, they all need to be consistent with the fact that she just asserted the FC disjunction *may [A or B]*, and thereby presented herself as being certain about this sentence (i.e., we always assume that $\mathcal{B}$(may [A or B])). This now predicts exactly two possible implicature-combinations. And these represent precisely the two readings we identified for FC disjunctions:[33]

(94) Possible Implicatures: FC reading
I. $\neg\mathcal{B}$ (*may [A and B]*), $\neg\mathcal{B}$ (*may* $\perp$)

32 The reason to include the alternative *may* $\perp$ ($\perp$ being the contradiction) is not empirical, but technical. For a standard disjunction *A or B*, it is needed to prevent the disjunction from implicating (that the speaker is sure that) *A and B*. Since $\perp$ is an alternative to *A or B*, *may* $\perp$ is an alternative to *may [A or B]*. In the case of FC disjunctions, this technical trick likewise prevents the implicature that the speaker is sure that *may [A and B]* is true. Arguably, this is empirically correct, even if derived by brute force.

33 An interesting aspect of Chemla's account is that the unavailability of the uncertainty reading for epistemic FC sentences can be formally derived. Here is how: Assume that the logic of belief satisfies the following principles (along with Positive Introspection, which is not relevant here):

(i) Consistency of Belief

Idea	*We do not have inconsistent beliefs*
Property of R	Serial: $\forall w \exists w'$ s.t. wRw'
Axiom	[D] $\Box p \rightarrow \Diamond p$

(ii) Negative Introspection

II. $\mathcal{B}$ (*may A*), $\mathcal{B}$ (*may B*)

(95) Possible implicatures: Uncertainty reading

I. $\neg\mathcal{B}$ (*may [A and B]*), $\neg\mathcal{B}$ (*may* $\perp$)

II. $\neg\mathcal{B}$ (*may A*), $\neg\mathcal{B}$ (*may B*)

The first thing to note about these two readings is that the implicature $\mathcal{B}$ (*may [A and B]*) is never be possible. This is empirically correct: A FC disjunction like *Mary may have an apple or a pear* cannot ever convey that Mary may have two fruits at the same time (if that were the intended message, the speaker would have used *and*). It is true for normal disjunctions too: *Mary had an apple or a pear* can never convey that the speaker is sure Mary had an apple *and* a pear. In both cases, this follows from the inclusion of the alternative *may* $\perp$, where $\perp$ is a logical contradiction. Chemla assumes that we are never sure that a contradiction is true, and we are also never sure that a contradiction is possible. Therefore, the only implicatures we can derive for the alternatives in Set I are of the form $\neg\mathcal{B}$.[34]

Note secondly that the implicatures about set I and set II that define the FC reading in (94) are not inconsistent: You might be sure that A is allowed, and that B is allowed, but still be unsure about whether they are allowed at the same time.[35]

Idea	*If we are not sure, we're sure that we aren't*
Property of R	Euclidean: $\forall w, w', w'' : (wRw' \wedge wRw'') \rightarrow w'Rw''$
Axiom	[5] $\neg\Box p \rightarrow \Box\neg\Box p$
	$\equiv \Diamond p \rightarrow \Box\Diamond p$
	$\equiv \Diamond\Box p \rightarrow \Box p$

The possible implicatures for an epistemic FC sentence according to Chemla's Similarity constraint are given below:

(iii) Epistemic Free Choice – Similarity Predictions:

1. $\neg\Box(\Diamond(A \wedge B)$, $\neg\Box(\Diamond\perp)$

2.a $\Box(\Diamond A)$, $\Box(\Diamond A)$

or

2.b $\neg\Box(\Diamond A)$, $\neg\Box(\Diamond A)$

Suppose we choose the implicatures in 2.b. Then from $\neg\Box(\Diamond(A \wedge B)$ it follows by Negative Introspection that $\neg\Diamond(A \wedge B)$, i.e., that the speaker does not think it possible that A and B are both true. From $\neg\Box(\Diamond A)$ it follows by Negative Introspection that $\neg\Diamond A$, and similarly $\neg\Diamond B$ follows from $\neg\Box(\Diamond B)$. But this is a contradiction to the assertion *may [A or B]*, i.e., $\Diamond(A \vee B)$ (assume that *may* is interpreted relative to the speaker's beliefs). Thus, we have to go for the implicatures in 2.a above and assume that $\Box(\Diamond A)$ and $\Box(\Diamond B)$. If the speaker's beliefs are assumed to be consistent, i.e., if we assume Seriality, then it follows that $\Diamond\Diamond A$ and $\Diamond\Diamond B$. By Negative Introspection this entails $\Diamond A$ and $\Diamond B$ – the speaker who said *may [A or B]* thinks A is possible *and* he thinks that B is possible. This is the FC reading. Note that because of the contradiction that could arise from the inferences in 2.b. in (iii), the inferences in 2.a become effectively obligatory. The obligatory FC interpretation with epistemic modals is explained.

34 It is not clear whether this empirical prediction is correct; some speakers report that the FC sentence can be understood without any implicature about whether or not both options are allowed together. See e.g. Zimmermann 2000, Simons 2005, Fox 2007 for discussion. As mentioned in fn. (93), Chemla's account hinges on the alternative *may* $\perp$ in order to avoid false predictions in standard disjunction.

35 It is now easy to see that Chemla's account relies on a narrow-scope LF to derive the FC effect itself (s. fn.

Intermission: Different form of implicatures But do the implicatures in (94) really represent the intuitive FC interpretation? So far, we have represented this interpretation as follows:

(96) You may have an apple or a pear — *may [A or B]*
⇒ You may have an apple — *may A*
⇒ You may have a pear — *may A*

This differs slightly from the FC reading given in (94). The latter only states *that the speaker is sure* that you may have an apple, i.e., $\mathcal{B}$ (*may A*) (and similarly for *may B*). So how do we get from (94) to (96)? Generally speaking, what is the relation between inferences of the form $\mathcal{B}\psi$ and those of the form ψ? The difference is in fact not practically significant here: In most situations, someone's (implicated or explicitly asserted) certainty about something is sufficient for us to believe it too. Thus, when I tell you *I'm sure they are still open* you will act on my expressed certainty and go there. The FC inferences in (96) and the epistemicized versions that are derived in Chemla's system are thus practically equivalent in most situations. This is also relevant for standard scalar implicatures like the one given for a normal disjunction in (91) above: There we stated the scalar implicature of *A or B* as *the speaker is certain that* $\neg(A \wedge B)$ (i.e, $\mathcal{B}\neg(A \wedge B)$). But depending on the mechanism by which scalar implicature are derived, sometimes this scalar implicature is simply given as $\neg(A \wedge B)$. According to what we just said, here again we can view the two forms $\mathcal{B}\psi$ and ψ as (practically) equivalent.

Looking now at the implicature $\neg\mathcal{B}$(may [A and B]) derived in Chemla's account, it states that the speaker is not certain that both A and B are allowed (at the same time). But there is an intuition that, especially under its FC reading, *Mary may have an apple or a pear* doesn't have to convey uncertainty of any kind: it can be used by an authority who is in fact certain that an apple *and* a pear is not an option. The general problem is thus the following: how does a predicted inference of the form $\neg\mathcal{B}\psi$ relate to an observed implicature of the form $\mathcal{B}\neg\psi$? Since the operator $\mathcal{B}$ *is sure that* is modeled as a universal quantifier (paraphrasable as *in all worlds compatible with S's beliefs*), this is not problematic. $\neg\mathcal{B}\psi$ is entailed by, and thus consistent with, $\mathcal{B}\neg\psi$. Especially in (Neo-)Gricean theories of implicature, it is standardly assumed that Thus, when x is sure that $\neg\psi$, then it follows that S is not certain that ψ (but not vice versa). the predicted inference $\neg\mathcal{B}\psi$ can sometimes be strengthened through additional contextual assumptions into the stronger inference that $\mathcal{B}\neg\psi$ (Soames 1982, van der Sandt 1988, Horn 1989). This can happen when we know that the speaker is an authority and therefore uncertainty will be unlikely. A detailed discussion of this kind of strengthening, and the restrictions that apply can be found in Sauerland (2004), where it is called *Epistemic Step* (s. also Meyer 2013 for discussion).

End of Intermission

4.2). This is because the conjunctive alternative generated for a wide-scope LF would be *may A and may B*. But the, Set II in (90) would contain the alternatives {[may A and may B], may $\perp$}. The resulting obligatory inference would be $\neg\mathcal{B}$ (*may A and may B*). Crucially, however, this implicature would be inconsistent with the FC inference $\mathcal{B}$ (*may A*) & $\mathcal{B}$ (*may B*). Since there are independent argument for a narrow-scope LF (see section 1.3), this is not problematic.

As in most other accounts, the choice between the two readings in (94)-(95) will depend on contextual assumptions about the speaker. If she is an authority, the uncertainty implicatures $\neg\mathcal{B}$ (*may A*) and $\neg\mathcal{B}$ (*may B*) in reading (95) will not be plausible (and strengthening both into the form $\mathcal{B}\neg\psi$ will be inconsistent with the assertion). Therefore, the hearer will chose to compute different implicatures, arriving at the FC reading in (94) instead. It is important to remember that the Similarity principle is a constraint on possible implicatures: It predicts the availability of both readings, but is not meant to predict when these readings will be chosen. Though as we saw some stipulations are required, the account offers considerable generality when compared with previous proposals (pragmatic or semantic). As Chemla discusses, the principle of Similarity makes correct predictions for a number of seemingly unrelated phenomena, among them standard implicatures, FC interpretations with non-modal operators, and even presuppositions and the way they project.

4.3 Recursive Pragmatic Strengthening

A standard reference for the approach discussed now is Kratzer & Shimoyama (2002), who are mostly concerned with marked indefinites like German *irgendein*. The important insight of K&S's paper for FC disjunction is that recursive pragmatic reasoning can account for the FC effect in both disjunction and these marked indefinites. Specifically, the idea is to derive FC interpretations as implicatures about implicatures (whence the term *recursive*). Two independent but closely related accounts in terms of recursive implicature computation exist: Fox (2007) and Alonso-Ovalle (2006). They differ mostly in their technical execution: whereas Fox uses a standard semantics, Alonso-Ovalle's account is cast in Alternative Semantics, which was developed for questions and focus (e.g., Hamblin 1973, Rooth 1992, Ramchand 1997). In view of their similarity, the below discussion will first introduce the basic idea common to both accounts, and then go on to highlight some technical aspects in which they differ.

Consider the assertion of the FC sentence *S* below in a context in which an apple and a pear are in principle available:

(97) Mary may have an apple or a pear *S*

Given a standard semantics for *may* and for *or*, the basic semantic meaning of *S* will be $\Diamond(A \vee B)$ — *there is a possible world in which Mary has an apple or a pear* (s. (12) in section 1.2). This weak semantic meaning can now be enriched by (scalar) implicatures. As we saw above, the computation of implicatures always starts with consideration of alternatives: What other relevant and possibly more informative sentences could the speaker have asserted? There are (at least) two such alternatives here:

(98) a. Mary may have an apple A_1
b. Mary may have a pear A_2

The second step in computing an implicature is a process of negation: To the meaning of *S*, we can add the negation of certain alternatives $A_1, A_2, \ldots$. This yields the strengthened

meaning $S^+ = S$ & $\neg A_1$ & $\neg A_2$ …. For example, to the basic meaning of S = *I ate some of the cookies* you may add the negation of *I ate all of the cookies* and end up with the strengthened meaning S^+ = *I ate some of the cookies & I didn't eat all of the cookies*.

Can we add the negation of A_1 and A_2 in (98) to the meaning of S? The resulting strengthened meaning would be $S^+ = S$ & $\neg A_1 \& \neg A_2$. But this is contradictory: If it is allowed to have at least one of the two fruits, it cannot be forbidden to have an apple and also forbidden to have a pear.[36]

It is at this point that K&S's insight becomes relevant: Hearers may actually compute another kind of implicature about the alternatives in (98): that their *strengthened* meanings A_1^+, A_2^+ are false. What are these strengthened, implicature-enriched meanings? In our context with two fruit options, (98-a) and (98-b) would give rise to the following scalar implicatures:

(99) a. Mary may have an apple A_1
b. $\rightsquigarrow \neg$ (Mary may have a pear)
c. Mary may have an apple & $\neg$ (Mary may have a pear) A_1^+

(100) a. Mary may have a pear A_2
b. $\rightsquigarrow \neg$ (Mary may have an apple)
c. Mary may have a pear & $\neg$ (Mary may have an apple) A_2^+

Now, if we add to the FC sentence in (97) the negation of these strengthened meanings, the result will be the following:

(101) Mary may have an apple or a pear S
& It is not true that Mary may have an apple but not a pear $\neg A_1^+$
& It is not true that Mary may have a pear but not an apple $\neg A_2^+$

Formally:

(102) $\Diamond(A \vee B)$ S
$\& \neg(\Diamond A \wedge \neg \Diamond B)$ $\neg A_1^+$
$\& \neg(\Diamond B \wedge \neg \Diamond A)$ $\neg A_2^+$

Together, this amounts to the following:

36 Two remarks are in order. First, it would be consistent to add the negation of just one of the alternatives to S. Such an arbitrary selection of alternatives has to be restricted for independent reasons, and the derivation of such a restriction is an important part of any theory of implicature (s. Sauerland 2004, Alonso-Ovalle 2006, Fox 2007, Fox & Katzir 2011, Schwarz 2016). Secondly, recall from the last section that there are also implicatures of the form $\neg\mathcal{B}\psi$, i.e., *the speaker is not sure whether* ψ. These would be consistent with the original assertion of the FC sentence in (97). The resulting meaning would be the familiar uncertainty reading of the sentence (ignoring any possible further implicatures about the conjunctive alternative):

(i) Uncertainty reading of *Mary may have an apple or a pear*
a. $\neg\mathcal{B}$ (Mary may have an apple)
b. $\neg\mathcal{B}$ (mary may have a pear)

(103) Mary may have an apple and Mary may have a pear
$\Diamond A \wedge \Diamond B$ $S^{++} = S + \neg A_1^+ + \neg A_2^+$

And this is the FC reading. Thus, by adding to the standard semantic meaning of a FC disjunction the negation of its pragmatically strengthened alternatives, we can derive its quasi-conjunctive interpretation.

Now the question is how the two levels of strengthened meanings S^+ and S^{++} are derived formally. In particular, we would like to understand how the implicatures of sentences that have not actually been asserted (e.g., the implicatures of the alternative *Mary may have an apple*) can be used in computing the actual implicatures of an FC sentence (e.g., *Mary may have an apple or a pear*, s. Fusco 2014).

It is primarily in this formal implementation that Alonso-Ovalle's and Fox's account differ. In Fox's account, scalar implicatures (i.e., strengthened meanings) are part of the semantic meaning $[\![S]\!]$ of a sentence, rather than an enrichment of meaning that happens pragmatically, after semantic composition is done. More specifically, scalar implicatures are derived by a syntactic *exhaustivity* operator *exh* which can be thought of as a covert version of *only* (Groenendijk & Stokhof 1984, Krifka 1995, van Rooij & Schulz 2006). So the informally sketched strengthening of (99) is formally derived by the following LF:

(104) a. *exh* [Mary may have an apple]
b. Mary may only have an apple
= *Mary may have an apple & ¬ (Mary may have a pear)* $\approx A_1^+$

Generalizing from this example, the operator *exh* takes a sentence S and its scalar alternative(s) $\mathcal{ALT}(S)$ as arguments and returns S's strengthened meaning:

(105) $[\![exh_{ALT}\ S]\!] = S\ \&\ \neg A_1\ \&\ \neg A_2 \ldots$, where $A_1, A_2, \ldots \in \mathcal{ALT}(S)$

One core ingredient of theories of implicature along these lines is to specify the semantics of *exh* so as to correctly capture which alternatives in $\mathcal{ALT}(S)$ can be negated to strengthen the meaning of S, and which ones cannot. One crucial requirement here is that the meaning of *exh S* be consistent: *exh* should not add to S the negation of scalar alternatives that are already entailed by S. For example, in *exh[Mary ate many of the cookies]* the *exh* operator may negate the alternative *Mary ate all of the cookies*, but not *Mary ate some of the cookies*. This is because the latter alternative is already entailed by the sentence that *exh* is adjoined to. Another requirement for an adequate semantics of *exh* is to rule out arbitrary negation of just some alternatives of S without considering the whole set $\mathcal{ALT}(S)$, as this might lead to unattested strengthened meanings. For example, in a disjunction *exh [A or B]*, the *exh*-operator shouldn't be allowed to add the negation of just A, because the disjunction would then be predicted to mean B, which is never possible (s. fn. 4.1). Both these issues and examples are discussed in detail in Fox (2007) (building on work by Spector 2003, Sauerland 2004, Chierchia 2004, 2006, van Rooij & Schulz 2006, among others). Many additional conceptual and empirical issues arise, as discussed e.g. in Recanati (2003), Geurts (2009), Sauerland (2011), Chierchia et al. (2012).

Let us now see how the FC interpretation can be derived in a system with *exh*. Crucially, the semantics of *exh* in (105) allows for one *exh*-operator to occur in the scope of another. This will be the case if S in (105) contains itself an *exh*-operator. This configuration corresponds to recursive implicature computation, as assumed for FC readings. The LF that derives this reading is thus the following:

(106) exh_2 [exh_1 [may [Mary have an apple or a pear]]]

To apply the general definition in (105) to (106), we will have to establish the alternatives that exh_2 takes as argument (and negates), i.e., the set $\mathcal{ALT}$(exh_1 [may [Mary have an apple or a pear]]). This is shown below:

(107) $[\![exh_2\ [exh_1\ S]]\!] = exh_1\ S\ \&\ \neg A'_1\ \&\ \neg A'_2 \ldots$
where $A'_1, A'_2, \ldots \in \mathcal{ALT}(exh_1 S)$

(108) $\mathcal{ALT}$(exh_1 [may [Mary have an apple or a pear]]) =
{exh_1 [may [Mary have an apple]], exh_1 [may [Mary have a pear]]}
≈ {*Mary may only have an apple, Mary may only have a pear*}
= {*Mary may have an apple but not a pear, Mary may have a pear but not an apple*}

It is easy to see at this point that the result of negating these two alternatives (which are themselves of the form *exh* S!) will correspond to our informal derivation in (99-a)-(101) above.

Alonso-Ovalle's implementation of the same idea resembles the system introduced by Chierchia (2004, 2006) in that it defines additional semantics values $[\![.]\!]^{+}$, $[\![.]\!]^{++}$ to represent the strengthened and recursively strengthened meanings, respectively. Apart from this important conceptual difference (there is no operator assumed in the syntax), the challenges and results remain the same: to define $[\![.]\!]^{+}$ and $[\![.]\!]^{++}$ so that only consistent and non-arbitrary strengthenings can apply. A detailed discussion can be found in Alonso-Ovalle (2006: 173ff.). One distinguishing feature of Alonso-Ovalle's alternative semantics for disjunction (cf. (69) in section 3.2) is that FC effects that arise in sentences like **??**, which have more than two disjuncts, can be derived without further stipulations, as can scalar implicatures for standard, multiple disjunctions (Alonso-Ovalle 2006: 56ff.; s. also Reichenbach 1947, McCawley 1981):

(109) Mary may eat an apple, a pear, or a papaya
⇒ Mary may eat an apple
⇒ Mary may eat a pear
⇒ Mary may eat a papaya

The advantage of the recursive pragmatic approach is its generality: As seen in (99)-(100), deriving the strengthened meanings of alternatives uses only mechanisms that are needed to derive simple (scalar) implicatures. As Aloni & van Rooy (2007), Fox (2007) discuss in some detail, the challenge is to restrict recursive implicature computation so as to avoid

over-generation. Here is one example to illustrate what's at stake. Suppose we use the strengthened meaning of the alternatives below to compute a recursive implicature for a standard disjunction. Here is the result of this process:

(110)	Mary ate an apple or a pear	S
	Mary ate an apple	A_1
	Mary ate an apple and not a pear	A_1^+
	Mary ate a pear	A_2
	Mary ate a pear and not an apple	A_2^+
	Mary ate an apple and a pear	$S^{++} = S + \neg A_1^+ + \neg A_2^+$

Recursive implicature computation predicts *A or B* to have a reading under which it means *A and B*! This is clearly a problematic result (though cf. Bowler (2014), Meyer (2015a)). But the problem has been addressed in some detail (Chierchia 2006, Alonso-Ovalle 2006, Spector 2007, Fox 2007). Though implemented in different frameworks, the general form of the solution is to make sure that recursive implicature computation can only apply once the standard implicatures have been added to S (a move that is reflected in Spector 2007's terminology of *first-* vs. *second-order* implicatures). For the case of disjunctions like (110), this would mean that first we need to compute the standard scalar implicature: That Mary didn't eat an apple and a pear. Then the recursive implicatures $\neg A_2^+$ and $\neg A_2^+$ can no longer be added consistently. Importantly, this will still allow the derivation of the FC interpretation via recursive implicatures (see esp. Fox 2007).

Accounts in terms of recursive implicature are general enough so as to cover FC effects that occur in the absence of disjunction and/or modals, e.g. in sentences like *we didn't give every student a stipend and a tuition waiver* (s. (25) in section 1.2). As Alonso-Ovalle shows in detail, the account can also be extended to disjunction in the antecedent of conditionals, where effects similar to the FC effect arise (s. section 2.2). Lastly, FC effects in indefinites like *irgendein* and even in plural morphology have been addressed with recursive implicature computation (Kratzer & Shimoyama 2002, Spector 2007, Chierchia 2006).

5 Semantics vs. Pragmatics: Empirical Evidence

In the preceding sections we have seen that analyses of the FC effect can be divided into at least two categories, depending on whether they derive the FC effect as part of the semantics or part of the pragmatically enriched meaning. The question as to whether FC interpretations should be derived as semantic or pragmatic meaning components was first raised by Kamp (1978), and remains debated.

Psycholinguistic research has begun to provide quantitative data from adults and children that point to processing differences between semantic and pragmatic components of meaning (e.g. Noveck 2001, Papafragou & Musolino 2003, Bott & Noveck 2004, Breheny et al. 2006, Huang & Snedeker 2009, Grodner et al. 2010, Bott et al. 2012, Tomlinson et al. 2013).

Experimental research may thus also help shed light on the status of FC inferences, and has started to do so (Chemla 2009b, Chemla & Bott 2014, Tieu et al. 2015). Results from

Chemla (2009b) and Chemla & Bott (2014) indicate that FC inferences do not in fact pattern with (scalar) implicatures. The central finding from Chemla (2009b) is that FC readings seem to be more robust than scalar implicatures. The way robustness is measured in this experiment is by looking at embedded contexts:[37] Speakers do not seem to strongly associate *some* with the scalar implicature *not all* in embedded positions like that shown in (112), while they do prefer this reading in matrix positions as in (111):

(111) John solved some of the puzzles
$\rightsquigarrow$ John solved some but not all of the puzzles

(112) Everybody solved some of the puzzles
$\rightsquigarrow$ Everybody solved some but not all of the puzzles

Now, if FC inferences really are just another kind of (scalar) implicature, as suggested by the accounts discussed in the last section, then the null hypothesis is that they should exhibit the same kind of behavior: The rate at which speakers agree with the relevant inferences should decline in environments like (114) when compared to (113):

(113) John is allowed to eat the cake or the ice-cream
$\rightsquigarrow$ John is allowed to eat the cake & John is allowed to eat the ice-cream

(114) Everybody is allowed to eat the cake or the ice-cream
$\rightsquigarrow$ Everybody is allowed to eat the cake & is allowed to eat the ice-cream

Surprisingly, though, Chemla finds that Free Choice inferences are more robust than regular scalar implicatures in embedded environments: Subjects agree with embedded FC inferences like (114) much more than they agree with corresponding embedded scalar implicatures like (112). Results from Chemla & Bott (2014) point to the same direction. In a series of experiments comparing basic semantic meaning, scalar implicatures, and FC readings, they find that the latter do not pattern with scalar implicatures with respect to reaction times, but tend to be processed much faster.

On the other hand, results of a recent acquisition study by Tieu et al. (2015) is consistent with the view that both kinds of inference share at least some essential features, in particular, the consideration of (scalar) alternatives (s. Singh et al. 2013 for a similar finding not involving FC sentences, but standard disjunction).

On the theoretical side, the argument most often invoked in favor of a pragmatic, implicature-like status of the FC inference is the fact that it is cancelable. This characteristic is thought to be a necessary (though not sufficient) condition for implicature-hood (s. Faller 2012: 288ff. for an unrelated phenomenon). The argument in favor of treating FC as an implicature goes back at least to Kratzer & Shimoyama (2002), and has been resumed in Alonso-Ovalle (2006: section 4.6.) and Fox (2007: section 2.1.), as we have seen above. The crucial empirical observation is that FC inferences pattern with scalar implicatures in

37 Chemla also looks at negative contexts, e.g. *John didn't read all books*, which leads to the so-called *indirect* implicature (Chierchia 2004) that it is not the case that John didn't read any books, i.e., that John read some books. The reader is referred to Chemla's paper for details.

disappearing under negation:[38]

(115) You may not have ice-cream or cake

a. Negation of basic meaning: $\neg\Diamond(A \vee B)$
You may have neither ice-cream nor cake

b. Negation of FC reading: $\neg(\Diamond A \wedge \Diamond B)$
You may not have both (but possibly one of the two)

Under the assumption that the FC effect is not part of the basic semantic meaning, (115-a) would be that basic semantic meaning of the sentence. (115-b), on the other hand, would be the meaning if the Free Choice effect could 'survive' under negation, for instance because it is already part of the semantic meaning of the negated clause *You may have ice-cream or cake*. We observe that (115-b) doesn't seem to be a possible meaning of the sentence; only (115-a) is. It has been argued that the unavailability of the FC effect under negation favors a pragmatic account, and specifically, an account in terms of scalar implicature (Chierchia 2004, Kratzer & Shimoyama 2002, Alonso-Ovalle 2006, Fox 2007). As we saw above, implicature involves the negation of alternatives whose truth-value is left open by the basic semantic meaning. Now, the basic meaning, by assumption, is (115-a). But this meaning is very strong, and does not leave open the truth-value of any scalar alternatives (e.g. *you may have ice-cream*). Therefore, no implicature like the supposed FC implicature is predicted to arise. The disappearance of the FC effect would be explained.

But semantic accounts might be able to handle the disappearance of FC under negation too. Aloni (2003, 2007), who as we saw in section 3.2 defends a semantic account, addresses the challenge explicitly. In her analysis, as well as other semantic accounts, Free Choice sentences are semantically ambiguous between a FC and an uncertainty reading. Importantly, the FC reading is stronger; therefore, under negation the relation reverses and it is the negated uncertainty reading which is stronger, as shown in (115). Aloni's explanation as to why the FC effect disappears under negation thus invokes an independent principle favoring the strongest meaning (Chierchia 2006: 25, s. also Dalrymple et al. 1994): Among the two readings in (115), the unattested negated FC reading is weaker and therefore dispreferred. Her explanation could in principle carry over to other semantic accounts. Of course, invoking

38 As already noted by Kamp (1978: 279) (s. also Alonso-Ovalle (2006: 183), other apparently downward-entailing (DE) environments do not make the FC reading disappear:

(i) a. If you may have the cake or the ice-cream, you should bloody well be pleased!
b. Everybody who may have the cake or the ice-cream should bloody well be pleased!

As has often been remarked, however, the restrictor of universal quantifiers and the antecedent of conditionals are not bona-fide cases of DE environments, but have been characterized as *Strawson-DE* (von Fintel 1999). As for negation, which creates a truly DE-environment, Fox (2007: fn.16) points out that the FC reading may survive even here, given special intonational marking which he characterizes as focus on *or*. The following sequence, to the extend that it is acceptable, would constitute an example:

(ii) You can't have the ice-cream OR the cake. . . the cake is for adults only!

a strongest-meaning principle makes predictions for positive cases too, as Aloni herself points out: Among the two available readings for non-negated FC sentences, it should be the stronger Free Choice reading which dominates. As the above-mentioned quantitative results indicate, FC inferences are indeed very robust. The fact that they are significantly more robust than scalar implicatures, however, remains an open puzzle which neither the invocation of a strongest meaning preference within a semantic framework, nor pragmatic accounts of FC have resolved so far.

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