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FREE CHOICE DISJUNCTION AND EPISTEMIC POSSIBILITY*

This paper offers an explanation of the fact that sentences of the form (1) 'X may A or B' may be construed as implying (2) 'X may A and X may B', especially if they are used to grant permission. It is suggested that the effect arises because disjunctions are conjunctive lists of epistemic possibilities. Consequently, if the modal *may* is itself epistemic, (1) comes out as equivalent to (2), due to general laws of epistemic logic. On the other hand, on a deontic reading of *may*, (2) is only implied under exceptional circumstances – which usually obtain when (1) is used performatively.

INTRODUCTION

This paper offers a solution to Hans Kamp's (1973) problem of *free choice permission*: how can it be that sentences of the form '*X* may *A* or *B*' are usually understood as implying '*X* may *A* and *X* may *B*'? Unlike other approaches that locate the problem in the semantics/pragmatics interface, the solution to be presented below is purely semantic. It combines – and crucially depends on – a new, non-Boolean, modal account of disjunctions as lists of epistemic possibilities.

The paper is organized as follows. Section 1 presents the free choice problem along with some of its ramifications and ends with a first sketch of the solution. This solution makes essential use of the semantics of lists, the topic of section 2. The non-Boolean interpretation of disjunction is presented in section 3 and, in section 4, briefly compared to the standard truth-table-cum-conversational-economy approach on some phenomena

* The ideas underlying my solution to the free choice problem have first been presented as part of a talk on lists and exhaustivity at the Technische Universität Berlin in December 1994. More elaborate versions have subsequently been delivered at Rutgers (twice), UConn, Frankfurt, Stuttgart, Sinn & Bedeutung 98 (Leipzig), SALT 9 (UCSC), and the 1999 Amsterdam Colloquium. I am indebted to all these audiences for inspiring discussions. Moreover, I would like to thank the following friends and colleagues for pertinent criticism and encouraging advice, which is not to say that I have convinced them all: Rainer Bäuerle, Sigrid Beck, Maria Bittner, Cleo Condoravdi, Caroline Féry, Danny Fox, Irene Heim, Hans Kamp, Angelika Kratzer, Arthur Merin, Michael Morreau, Robert van Rooy, and an anonymous reviewer. Finally, thanks are due to Michelle Weir for checking grammar and spelling and to Christine Bartels and Elke Höhe-Kupfer for helping me with the final preparation of the manuscript.

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not involving modality. Section 5 contains the details of the solution to the free choice problem.

1. The Free Choice Problem

1.1. *The Original Problem*

An utterance of the *choice sentence* (1a), in which *may* is taken in a deontic sense (implicitly referring to the rules of the game[1]), is normally understood as implying (1b) and (1c).

(1) a. Mr. X may take a bus or a taxi.
    b. Mr. X may take a bus.
    c. Mr. X may take a taxi.

It is tempting to explain this *choice effect* by some general principle, or meaning postulate, concerning the interaction between disjunction and modality:

Choice Principle (CP)
X may A or $B \vDash X$ may A and X may B

However, as Kamp (1973) pointed out, such a general choice principle is at odds with fundamental assumptions about the semantics of disjunction and (deontic) modality. To see this, one may look at the following reasoning that crucially involves an application of (CP) and leads from a true premise to a false conclusion:

(2)	a. Detectives may go by bus.	Rule
	b. Anyone who goes by bus goes by bus or boat.	Tautology
	c. Detectives may go by bus or boat.	from (a) and (b)
	d. Detectives may go by boat.	from (c) by (CP)

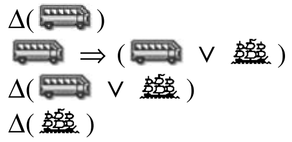
The tautology (2b) has mainly been added to make the reasoning more transparent; it is not essential and will be subject to further scrutiny in section 4.2. The step leading up to (2c) appears to be pretty innocuous in that it appeals to the principle that whenever an action of some kind is

[1] Like most examples in this paper, (1a) relates to the popular German board game *Scotland Yard*, in which a team of detectives hunts a rogue called "*Mr. X*" through central London. In order to appreciate these examples, one only needs to know that the detectives usually do not know Mr. X's exact whereabouts (although he does show himself at certain specified intervals) and that there are intricate rules regulating the choice of means of transport.

not prohibited, then actions of a more general kind are not prohibited either:[2] if detectives are allowed to take buses, they are allowed to go by surface transport, even though police cars may not be accessible to them. Since – on the truth table analysis of disjunction anyway – going by bus or boat is more general than going by bus, (2c) follows indeed. But now allowing (CP) to apply to (2c) is disastrous, inevitably leading to the false conclusion (2d).

Argument (2) corresponds to the following defective proof in modal logic, where deontic possibility is symbolized by 'Δ' and '$\Rightarrow$' expresses strict implication, that is, subsethood among propositions expressed:

(3) a.–d.



The last step of the proof makes use of a straightforward formalisation of (CP):

Formalised Choice Principle (FCP)

$\Delta(A \vee B) \vDash \Delta A \;\&\; \Delta B$

Given this formalisation, it is not implausible to dispute the correctness of (2) by pointing out that the step from (2c) to (2d) is illicit in that it does not reflect an implication between the propositions expressed by these sentences. The choice effect would then have to be explained as a pragmatic inference applying to (certain) utterances of choice sentences. This line of reasoning has been adopted by various authors, but it will not be pursued here.[3] Rather, I am going to argue that (3) is not a correct formalisation of (2) in the first place: while (3) does fail because the step from (3c) to (3d) involves the unjustified principle (FCP), the step from (2c) to (2d) is largely correct (given certain natural contextual assumptions), but the one leading up to (2c) is not. In particular then, (CP) cannot be formalised as (FCP). But before we get to matters of formalisation, let us first take a look at a few interesting observations in the vicinity of the choice problem.

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[2] As various people argued, this might not be a sound principle. But it is taken to be valid in deontic logic, evidence to the contrary being explained away by appeal to Gricean pragmatics.

[3] See, e.g., Kamp (1978), Merin (1992), van Rooy (1997: 228ff.).

1.2. *Variants*

The first observation concerns the status of the choice effect.[4] The conjecture that it is not of a semantic nature is corroborated by examples like (4):

(4) Detectives may go by bus or boat – but I forget which.

Clearly, someone who utters (4) does not mean to imply that detectives may go by boat; nor is the qualification taken to contradict or correct the preceding choice sentence – in fact, in that context the choice sentence does not seem to produce a choice effect at all. This may be taken as evidence that the choice effect is merely an implicature that gets cancelled by the qualification in (4). But then again, it may also mean that choice sentences are ambiguous between a reading with choice effect and one without. A specific proposal to this effect has been made by Kamp (1973), according to whom the consistent reading of the choice sentence in (4) is short for the (generally dispreferred) *wide disjunction* (5):

(5) Detectives may go by bus or they may go by boat.

This leads us to the second observation about the choice effect. Whatever the exact syntactic relation between choice sentences and wide disjunctions may be, it turns out that reducing the apparent cancellation of the choice effect to a hidden wide disjunction leads to a new problem.[5] For although (5) does not necessarily come with a choice effect, it may very well do so. Indeed, it seems that, given the right kind of situation – say, when someone is paraphrasing from the book of rules – (5) does express that detectives may go by bus *and* that they may go by boat. Though this phenomenon is as well known (e.g., as *conjunctive* 'or') as it is poorly understood, it has, to my knowledge, never been regarded as a variant of the choice effect.

Finally, an interesting and telling variant of choice sentences is obtained if one replaces the deontic modal by an epistemic one, as in (6):

(6) Mr. X might be in Victoria or in Brixton.

Again the choice effect – or, rather, an analogous effect (because this time there is no free choice expressed) – can be observed: the sentence is understood as implying that Mr. X might be in Victoria *and* that he might be in Brixton; again a general semantic principle on the interaction between

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[4] See Kamp (1978: 271).
[5] This is one of the reasons why Hans Kamp later rejected this explanation, cf. Kamp (1978: 273).

epistemic modals and disjunction would appear just as disastrous as (CP); and again the corresponding wide disjunction produces the analogous effect:

(7) Mr. X might be in Victoria or he might be in Brixton.

Sentence (7) is taken to imply that Mr. X might be in Victoria *and* that he might be in Brixton.

All of this may not come as a surprise. After all, the various uses of modal verbs are known to have a common semantic core.[6] Given that, the above data simply suggest that it is this common core that lies at the heart of the choice effect. So whatever the exact explanation may be, if it only refers to this common core, it should carry over to the epistemic variant.

However, there is a problem with this strategy: the explanations of the choice effect and its epistemic variant must not be too close to each other. Otherwise, whatever account we give of cancelling the choice effect would carry over to the epistemic variant where, however, the corresponding inferences simply cannot be withdrawn: like (6), (8) implies that Mr. X might be in Victoria *and* that he might be in Brixton.

(8) Mr. X might be in Victoria or in Brixton – but I don't know which.

In fact, this time the qualification seems to add little to what would have been expressed by (the epistemic variant of) the choice sentence alone. The same holds for the corresponding wide disjunction (7); here, too, the choice effect cannot be blocked:

(9) Mr. X might be in Victoria or he might be in Brixton – but I don't know which.

1.3. *A Solution in Sight*

The key to the solution of the choice problem lies in the following observation. Like the wide disjunction (5), the wide disjunction (7) is understood as a *conjunction* of its modalized disjuncts – only this time this analysis is mandatory. Hence (7) may be paraphrased by:

(10) Mr. X might be in Victoria and he might be in Brixton.

At the same time, however, (7) can also be roughly paraphrased by a simple disjunction of the corresponding non-modalized disjuncts:

(11) Mr. X is in Victoria or he is in Brixton.

[6] See Kratzer (1991) for details.

In other words, the disjunction (11) of non-modals is understood as a conjunction of modals, and both are understood in the same way as the choice sentence and the corresponding wide disjunction. This suggests the following strategy for solving the epistemic variant of the choice problem. First, analyze *all* choice sentences as wide disjunctions, thereby confining the choice problem to the latter. Second, interpret the wide disjunction of the form '*p* might be the case or *q* might be the case' as *conjoined epistemic possibilities* – just like (11) is understood as (roughly) equivalent to (10). The result will be a conjunction of doubly modalized sentences, that is, something of the form 'It might be the case that *p* might be the case and it might be the case that *q* might be the case'. The latter is obviously redundant and equivalent to '*p* might be the case and *q* might be the case', which explains the epistemic variant of the choice effect. Moreover, inasmuch as the redundancy principle applied to reduce the iterated modalities is of a semantic nature, the explanation predicts that there is no cancellation of the choice effect, as desired.

What remains to be done is to fill in the details of this sketch and develop an analysis that also applies to the original problem involving deontic modality. I will do so throughout the next three sections. In this connection I will also say something about the obligatory reduction of choice sentences to wide disjunctions, which is a syntactic *conditio sine qua non* for the present solution to the free choice problem. After that the details of the solution will fall into place rather naturally.

2. The Semantics of Lists

2.1. *Answer Lists*

According to the interpretation to be given, disjunctions are *lists* of epistemic possibilities: sentences of the form 'S_1 [or] S_2 . . . or S_n' present the propositions expressed by S_1, . . . , S_n as consistent with the speaker's knowledge.[7] In order to see how this works, it is instructive to take a brief look at the interpretation of lists as they naturally occur in answers to constituent questions: (12Q) can be answered by (12L), which is understood in a conjunctive sense [indicated by the material in brackets]; moreover,

[7] . . . or some other, contextually relevant epistemic background; cf. section 4.4. I am indebted to an anonymous reviewer for pointing out that in many cases – and in particular those involving disjunction denial – the background would have to be the common ground of the conversational participants.

the list may come with a *closure clause* (12C) to the effect that it is claimed to be *exhaustive*:

(12Q) Which tube stations are one stop from Oxford Circus?

(12L) Piccadilly Circus, Bond Street, Tottenham Court Road, Green Park, Warren Street, Regent's Park [are each one stop from Oxford Circus]

(12C) . . . and no other underground station [is one stop from Oxford Circus].

Note that if, in spoken language, (12L) is followed by (12C), the voice will not go down in (12L) but rather stay on a high level [= L*H H^- in tone sequence notation[8]]. If, on the other hand, (12L) is not followed by (12C), the same "open" intonation would express undecidedness or uncertainty as to whether the list is exhaustive. Otherwise, i.e. if the intonation at the end of (12L) does go down [= H*L L%], the list itself is taken to be exhaustive and (12C) could only be added as a redundant tag. It is therefore natural to interpret the falling pitch movement [H*L^- L%] itself as expressing *closure*, that is, an operation turning the open or undecided list into an exhaustive answer.

In order to make these ideas about answer lists precise, two major obstacles must be removed: the first one is a *compositionality* problem, the other one concerns the exact nature of *closure*.

2.2. *Compositionality*

The compositionality problem immediately arises if one takes the most straightforward interpretation of (12L) as a (logical) conjunction: if the meaning of (12L) is a proposition as represented in (13L), then closure will result in (13C).[9]

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[8] L*H and H*L are, respectively, rising and falling accents on the stressed syllable, H^- is a phrase accent functioning as a phrase-final tone, L% is a low boundary tone. I am indebted to Caroline Féry for supplying these phonological details; cf. Pierrehumbert and Beckman (1988).

[9] More precisely, closure is the result of conjoining (13L) and (13C), which is equivalent to (i):

(i) $(\forall x)$ [1STOP(oc, x) $\leftrightarrow$ [x = pc $\vee$ x = rp]]

I am indebted to an anonymous reviewer for pointing out this possible source of misunderstanding.

(13L) 1STOP(oc, pc) & 1STOP(oc, bs) & 1STOP(oc, tcr) & 1STOP(oc, gp) & 1STOP(oc, ws) & 1STOP(oc, rp)

(13C) $(\forall x)$ [1STOP(oc, x) $\rightarrow$ [x = pc $\vee \ldots \vee$ x = rp]]

The problem is how to obtain (13C) as the result of applying a general operation to (13L): such a closure operation would have to refer to the form of the individual conjuncts, which is generally impossible – at least in possible worlds semantics.[10]

There are basically three ways to overcome this difficulty. The first one[11] is to deny that the open list (12L) expresses a conjunction of propositions and interpret it as a conjunction of noun phrases instead, that is, as a quantified NP. In place of (13L) we would then have:

pc* &* bs* &* tcr* &* gp* &* ws* &* rp*

where the asterisks indicate appropriate type shifts: x* is the 'Montague lift' $[\lambda P\ P(x)]$ of the list item x, and '&*' is NP conjunction, i.e. intersection over unary quantifiers. One can then define closure under a property P as an operation Γ_P on quantifiers:

$$\Gamma_P := [\lambda \wp\ (\forall x)\ [P(x) \rightarrow \neg \wp(\lambda y\ y \neq x)]]$$

and translate (12C) by $\Gamma[\lambda x$ 1STOP(oc, x)], which is equivalent to (13C).

The second approach interprets lists as conjunctions of more finely individuated propositions. More specifically, the individual conjuncts may be analyzed as structured propositions consisting of the predicate and the respective list item. Instead of (13L) we would thus have:

$\langle \lambda x$ 1STOP(oc, x), pc$\rangle$ $\&_* \ldots \&_*$ $\langle \lambda x$ 1STOP(oc, x), rp$\rangle$

where angular brackets form tuples and conjunction on structured propositions is defined by:

$$\langle P, x\rangle \&_* \langle Q, y\rangle = \langle \lambda u\ \lambda v\ [P(u)\ \&\ Q(v)], x, y\rangle.$$

Closure under P could then operate on the structured answer meaning, yielding an unstructured proposition:

$$\Gamma_P := [\lambda\langle R, x_1, \ldots, x_n\rangle\ (\forall y)\ [P(y) \rightarrow [y = x_1 \vee \ldots \vee y = x_n]]]$$[12]

In answer lists, this particular structuring could be independently moti-

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[10] See, e.g., Rooth (1985: 85f.).

[11] See von Stechow and Zimmermann (1984) for a more general approach along these lines.

[12] I use '$\lambda \langle z_1, \ldots, z_m\rangle\ \varphi$' as short for: '$\lambda X\ (\exists z_1), \ldots, (\exists z_m)\ [X = \langle z_1, \ldots, z_m\rangle\ \&\ \varphi]$'.

vated by focus-background semantics, but other ways of structuring may be just as plausible.[13]

Finally, one could use non-Boolean conjunction '$\oplus$' instead of truth-functional '&' and interpret the list (13L) by a collection of propositions:

$$\text{1STOP(oc, pc)} \oplus \ldots \oplus \text{1STOP(oc, rp)}$$

Again the corresponding closure operation is easily found:

$$\Gamma_P := [\lambda G(\forall x)\ (\forall p)\ [[p = P(x)\ \&\ \text{True}(p)] \rightarrow p \in G]]$$

where G ranges over groups of propositions and '$\in$' denotes group membership.[14]

There is no need to decide among the above treatments of lists; each of them could be used in the semantics of disjunction to be developed below.

2.3. *Closure*

So far we have assumed that a list is closed by a statement to the effect that nothing but the list items has the property in question. However, this assumption is untenable as soon as we consider mereologically structured domains like places. In the situation depicted in the stylized map (14M), a detective may, for instance, wonder which stations can be reached by a detective within one move; if she then asks one of her 'colleagues' (14Q), she may receive (14A) as a truthful answer:

(14Q) Which parts are covered?

(14A) N and E.

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[13] Structured propositions as answer meanings have been proposed by Jacobs (1988) and von Stechow (1991). Among the other ways of structuring I would also count representationalist syntax/semantics interfaces like Discourse Representation Theory (Kamp & Reyle 1993), where the closure operation can be defined in terms of the formula determining the interpretation of the answer list.

[14] This treatment of answer lists is suggested by the semantics of questions in Pafel (1999). One could also have (13L) denote a group of *individuals*:

$$\text{pc} \oplus \text{bs} \oplus \text{tcr} \oplus \text{gp} \oplus \text{ws} \oplus \text{rp}$$

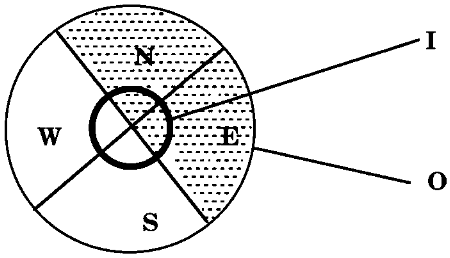
But then both the open and the closed answer would have to be obtained by operations on the list meaning:

$$\text{OPEN}_P = \lambda g\ (\forall x)\ [x \in g \rightarrow P(x)]$$

$$\text{CLOSED}_P = \lambda g\ (\forall x)\ [P(x) \rightarrow x \in g]$$

where g and x range over groups and individuals, respectively.

(14M)



In (14M) any station within the dotted area, but none outside it, can be reached by a detective within one move. It thus seems that (14A) is not only correct but also exhaustive, and should therefore be represented as a conjunction of the open list consisting of N and E with the result of applying a closure operator to it:

(15) $(\forall x)$ [COVERED(x) $\leftrightarrow$ [x = N $\vee$ x = E]]

However, this would not only correctly predict that (16) is false; it would also imply that (17) and (18) are false, where N+E is the dotted region in (14M) and EI is the common part of E and I:

(16) I is covered.

(17) N+E is covered.

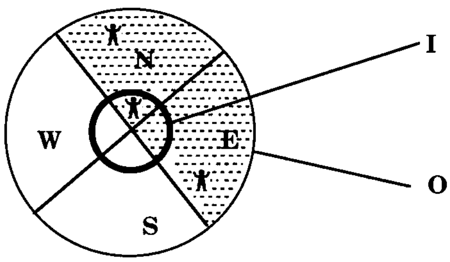
(18) EI is covered.

In order to block the unwelcome inferences, one may try and weaken the closure condition so that it does not exclude regions made up or surrounded by list members. However, as a general condition this would not be adequate: had the question been (19Q), (19A) [= (14A)] would have been as adequate an answer, on the assumption that Mr. X has shown up in precisely the places indicated in (19M):

(19Q) In which parts has Mr. X surfaced?

(19A) N and E.

(19M)



This time the closure condition should *not* entail the falseness of (20), although it would if it were defined in the way indicated.

(20) Mr. X has surfaced in N+E.

Nor should it *entail* the falseness of (21): given that Mr. X has only surfaced in N and E, he *may well* have surfaced in EI.[15]

(21) Mr. X has surfaced in EI.

The reason why closure generally does not exclude everything that has not been mentioned in the list presumably lies in general well-formedness conditions on lists. Intuitively, a list L is closed with respect to a property P if L cannot be extended to a well-formed list L' all of whose items have P, even though there may be more objects with that property. The above examples indicate when this may be the case: although an answer list like (14A) = [= (19A)] is OK, the longer list (19+) appears to be somewhat odd when used as an answer to (14Q) or (19Q):

(19+) N, E, and N+E.

(19+) is odd because the last item does not seem to be *independent* of the others. One can, however, make sense of (19+) as an answer to (19Q) by construing the first two list items as relating to the non-overlapping parts of N and E, thus *making* the list items independent. I will refer to this interpretation strategy as *forced independence*. In general, then, a well-formed list is one whose items are, or are forced to be, in some sense independent of the rest of the list. And if closure with respect to P says that a given list L cannot be extended, this means that no objects that are independent of the items on L have P.

There are various ways of making these intuitions precise. One may, for example, require that the utterance context supply a *domain* of mutually independent objects – in our case, regions – of comparable size and then restrict the universal quantifier in the closure condition to that set.[16] Alternatively (or additionally), one may define independence as a relation on the *propositions* implicitly expressed by the open list and then have closure quantify over list-independent propositions only.[17] Or one may try to find a general notion of independence that will adapt itself to any given case. Let me venture a specific proposal. If, in the closure operation of

[15] This example also shows that closure with respect to a property P does not always yield maximal information about P's extension.
[16] See Bittner (2000) for the general idea.
[17] See Kratzer (1989) for a relevant notion of independence.

the previous section, we replace identity by spatial overlap – symbolized by '$\between$' – the closure of (14A) becomes:

(14C) $(\forall x)$ [COVERED$(x) \rightarrow [x \between$ N $\vee$ $x \between$ E]]

Given certain straightfoward assumptions about spatial regions,[18] (14C) says what it should say, viz. that N+E is precisely the region covered. And it turns out that the very same trick also works on (18A), where it produces (18C), which – again under certain natural assumptions[19] – says that all places in which Mr. X has surfaced are within N+E. It thus seems that, depending on how the compositionality problem of the previous subsection is solved, one may take closure to be one of the following operations:

(22) i. $\lambda\wp\ (\forall x)\ [P(x) \rightarrow \neg\wp(\lambda y\ \neg y \between x)]$
ii. $\lambda\langle R, x_1, \ldots, x_n\rangle\ (\forall y)\ [P(y) \rightarrow [y \between x_1 \vee \ldots \vee y \between x_n]\ ]$
iii. $\lambda G\ (\forall x)\ (\forall p)\ [[p = P(x)\ \&\ \mathrm{True}(p)] \rightarrow (\exists y)\ [P(y) \in G\ \&\ y \between x]]$

According to this proposal, the relevant notion of independence is that of spatial disjointness. *Prima facie*, this would only seem to make sense if applied to a domain of spatial regions. However, the idea readily generalizes when one takes '$\between$' to be a variable whose value is the overlap relation of the (most obvious) topology on the domain under discussion. Overlap can then be thought of as a contextual parameter that collapses into identity if no obvious topology can be found. In that way the original closure operation of section 2.2 turns out to be a special case of the topological one.

3. Disjunction and Possibility

Let us now turn to the analysis of disjunctions as lists of epistemic possibilities. The idea is to interpret a disjunction of the form (23) as if it were a list answer (24A) to the (somewhat artificial) question (24Q), where *might* must be read in an epistemic sense:

(23) S_1 [or] S_2 . . . or S_n.

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[18] If one takes spatial regions to be (certain) non-empty sets of spatial points, all one needs to assume is that the intersection of any two overlapping regions contains a spatial region as a subset. Then, if COVERED is true of precisely the subregions of a given set C (of points), the universal quantifier is restricted to regions, and N and E are themselves regions, then (14C) can be shown to be equivalent to: $(\forall x)$ [COVERED $(x) \leftrightarrow [x \subseteq$ N+E]]. This equivalence holds whether or not N+E (i.e., the set-theoretic union of N and E) is itself a spatial region.

[19] If SURF is true of regions that overlap with a given set S (of points) and one takes the information provided by the open list into account, then (18C) says that $\varnothing \neq S \subseteq$ N+E.

(24Q) What might be the case?

(24A) S_1 [and] S_2 . . . [and] S_n.

As we have seen, list answers are construed as conjunctions of all propositions of the form $P(x)$, where P is the predicate whose extension is to be specified and x is a list item; moreover, under certain (rather normal) conditions, a closure condition is added, yielding a certain exhaustivity effect. Given this, (24A) may thus be paraphrased as follows:

(24O) S_1 might be the case, . . . , and S_n might be the case

(24C) . . . and nothing that is disjoint from each of S_1, . . . , S_n might be the case.

Or, in symbols:

(24ω) $\Diamond S_1$ & . . . & $\Diamond S_n$

(24κ) $(\forall S)\ [\Diamond S \rightarrow [S \between S_1 \vee \ldots \vee S \between S_n]]$

Thus, according to this analysis, there are two kinds of disjunctions: *open* disjunctions that end on a high phrase-final tone and express the possibility of each disjunct without making any claim to completeness; and *closed* disjunctions that end on a low phrase-final tone and claim to cover the space of all possibilities. And indeed, an utterance of (25r) with the intonation as indicated will be understood as saying that, for all the speaker knows, Mr. X may be in Regent's Park, that he may be in Victoria, and that he may be in the City, without implying that these are the only possibilities.

(25r) Mr. X is in Regent's Park or in Victoria or in the City, . . . [L*H H$^-$]

In other words, (25r) just says that the possibilities *include* the items on the list. If, on the other hand, the intonation is as in (25f), the speaker does seem to exclude any other possibilities, i.e. to imply that the possibilities *are* the items on the list:

(25f) Mr. X is in Regent's Park or in Victoria or in the City [H*L L%].

And, as in the case of answer lists, closure can also be expressed overtly, as in:

(26) Mr. X is in Regent's Park or in Victoria or in the City, and there are no other possibilities.

A more common way of explicitly marking closure is by adding *either*:

(26′) Mr. X is either in Regent's Park or in Victoria or in the City.

There is no way to construe (26′) as expressing an open list of possibilities; in fact, like (26), it seems to require closure intonation. This indicates that the function of *either* is to explicitly mark closure and not, as has sometimes been suggested, to indicate exclusiveness.[20]

In order to complete the picture, we still have to explain how exactly the epistemic modality $\Diamond$ and the overlap relation $\between$ in (24ω) and (24κ) are to be analyzed. It turns out that standard constructions from possible worlds semantics will do in both cases. More specifically, I take it that, in a given context of utterance *c*, the speaker's background knowledge can be modelled by a set H_c of possible worlds (to be thought of as all maximal specifications of the speaker's knowledge)[21] and that, in a context *c*, epistemic modality is a predicate of propositions that is true of a given *p* if, and only if, *p* is consistent with H_c, i.e. iff $p \cap H_c \neq \varnothing$. The relativisation to the *speaker's* knowledge is a slight oversimplification and will ultimately have to be revised (see section 4.4); but for the time being it will be appropriate. As far as the relevant notion of overlap is concerned, we have to specify a topology of the objects possibility is asserted of, i.e. propositions. The most obvious candidate is the topology of the logical space *W*, where overlap amounts to non-empty intersection. Given these assumptions, (24ω) and (24κ) respectively come out as (24ω′) and (24κ′), where the p_i are the propositions expressed by the corresponding S_i (in the utterance context *c*):

(24ω′) $p_1 \cap H_c \neq \varnothing \; \& \; \ldots \; \& \; p_n \cap H_c \neq \varnothing$

(24κ′) $(\forall q)\,[q \cap H_c \neq \varnothing \rightarrow [q \cap p_1 \neq \varnothing \vee \ldots \vee q \cap p_n \neq \varnothing]]$

It is easy to see[22] that (24κ′) is (set-theoretically) equivalent to (27):

(27) $H_c \subseteq p_1 \cup \ldots \cup p_n$

In particular, closed disjunctions of the form (23) come out as follows:

(28) $p_1 \cap H_c \neq \varnothing \; \& \; \ldots \; \& \; p_n \cap H_c \neq \varnothing \; \& \; H_c \subseteq p_1 \cup \ldots \cup p_n$

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[20] See, e.g., Gamut (1991: 32).

[21] Strictly speaking, H_c depends on both the context *c* (supplying the speaker) and an index world *w* (determining who knows what). However, since outside modal embeddings the index world coincides with the context world $W(c)$, one may take 'H_c' as short for '$H_{c,\,W(c)}$'.

[22] If ("⇒") $w \in H_c$, then $\{w\} \cap H_c \neq \varnothing$. Hence, by (24κ′), $\{w\} \cap p_1 \neq \varnothing \vee \ldots \vee \{w\} \cap p_n \neq \varnothing$, i.e.: $w \in p_1 \vee \ldots \vee w \in p_n$, i.e.: $w \in p_1 \cup \ldots \cup p_n$. – If ("⇐") $w \in q \cap H_c$, then $w \in p_1 \cup \ldots \cup p_n$, by (27), i.e.: $w \in p_1 \vee \ldots \vee w \in p_n$. Hence $q \cap p_1 \neq \varnothing \vee \ldots \vee q \cap p_n \neq \varnothing$.

According to this analysis, then, (25f) means that the speaker holds it possible that Mr. X is in Regent's Park, that he is in Victoria, and that he is in the City, but not that he is anywhere else.

If, as was suggested above, the same notion of independence features in closure and in the well-formedness of open lists and if, moreover, in the case of propositions independence boils down to incompatibility (i.e., disjointness), then the present modal analysis of 'or' predicts that well-formed disjunctions require the disjuncts to be mutually exclusive. This requirement is certainly too strong: there is nothing wrong with a disjunction like (29), even though it may be possible for Mr. X to have taken a bus without leaving Earl's Court:

(29) Mr. X took a bus, or he is still in Earl's Court.

Nevertheless there is a natural paraphrase of (29) that does involve disjointness, if we assume that *else* restricts the second alternative to the cases in which the first one is out:

(29′) Mr. X took a bus, or else he is still in Earl's Court.

If (29′) is a correct paraphrase of (29),[23] then this is another instance of forced independence and, according to the modal analysis of disjunction, (29) would mean that Mr. X may have left Earl's Court by bus and that he may still be in Earl's Court. I think that this is a straightforward interpretation of (29) indeed, but I am not prepared to defend the general view that (29) – let alone disjunctions in general – must be interpreted by forced disjointness. Moreover, the question of independence as a well-formedness criterion for open lists appears to be quite independent of the solution of the free choice problem, which is why I will leave the matter open.

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[23] Hans Kamp (p.c.; see also Kamp & Reyle 1993: 187ff.) once suggested this kind of paraphrase as part of a possible solution to the problem of nonspecific anaphors across disjunction, as in Barbara Partee's infamous bathroom sentence; see Roberts (1989: 702) for the problem and van Rooy (1997: ch. 2) for a recent and decent solution. Kamp also pointed out that, on the traditional approach to disjunction, (29) and (29′) do not differ in their truth conditions: $(p \vee q)$ is equivalent to $(p \vee (\neg p \,\&\, q))$. In particular, (29′) does not correspond to an exclusive reading of 'or'. Rather, as Kamp and Reyle (1993: 192) pointed out, speakers who utter disjunctions frequently seem to assume exclusiveness of the disjuncts, i.e. the impossibility of joint truth.

4. EXAMPLES AND COMPARISON

A new interpretation of disjunction is only of interest if it can also be applied to other uses of 'or' than just the ones featuring in the free choice problem. This section contains a mixed bag of some phenomena that a theory of disjunction should be able to deal with and that, moreover, offer an interesting perspective on how the modal approach relates to the traditional one. None of the phenomena will be analyzed down to their finest details, nor will their list be exhaustive. But I hope that the following remarks not only show that the modal analysis of disjunction can be put to work, but also that it sheds some light on otherwise obscure data. A full-fledged modal theory of disjunction is beyond the scope of the present paper and must be left to future research.

4.1. *Disjunctive Assertions*

In order to see how the above analysis of disjunction relates to the traditional one, it is instructive to take a look at *disjunctive assertions*, i.e. assertions of the form '*A* or *B*', where *A* and *B* are declarative sentences expressing propositions that I will refer to as the *alternatives*. Suppose one of the detectives, Wyman, says:

(30) Mr. X is in Regent's Park or Mr. X is in Victoria.

The communicative effects of this utterance may be seen from Zoe's, another detective's, reactions:

(30) e. I see: he is not in Hyde Park.
g. I see: he may be in Regent's Park.
i. I see: Regent's Park is not in Victoria.

In each of these reactions, Zoe reveals something she learnt from Wyman's utterance. In (30e) she deduced that, apart from the alternatives, there are no other possibilities; in (30g) she concluded that the first alternative constitutes a true possibiliity; and in (30i) she inferred that one alternative does not cover the other. The reactions thus show that – unless Wyman tried to be funny, mislead Mr. X, etc. – the alternatives are taken to be (jointly) *exhaustive*, (individually) *genuine*, and *independent* (of each other).

It should be clear what the above analysis of disjunction has to say about these three communicative effects. Exhaustivity is produced by the (usually present) closure of the list of possibilities, genuineness is the contribution of the open part, and independence should be a result of the well-formedness condition of the list. We will later see that there is reason to believe that the latter is a – presumably conventional – implicature. We thus have the following:

Division of labour according to the modal analysis of disjunction:

Explanations of . . .	in terms of
Exhaustivity	SEMANTICS
Genuineness	SEMANTICS
Independence	PRAGMATICS

On the truth-functional account of disjunction things look quite different. To be sure, the semantics of disjunction does predict exhaustivity: if Wyman knows that at least one of the alternatives is true, then there is no other possibility, i.e. their union covers his epistemic background. But genuineness is not part of the traditionally assumed literal meaning of disjunction: if Wyman knows that one of the alternatives is false and the other is true, he still knows that at least one of them is true. Of course, independence is not part of the traditionally assumed meaning of disjunction either: truth of (at least) one of the alternatives does not preclude them to be dependent on each other in some relevant way.

In order to explain the genuineness and the independence of the alternatives presented by a disjunctive assertion, the traditional analysis must therefore be augmented.[24] The standard procedure is to invoke principles of communicative economy. More specifically, it has been argued[25] that the alternatives may be construed as independent of each other in that, as far as the speaker is concerned, either might be true without the other being true; otherwise the speaker could have expressed herself more concisely by asserting that stronger disjunct. Moreover, this notion of independence happens to imply genuineness: if one alternative might be true without the other being true, then in particular it might be true, i.e., it is a genuine epistemic possibility. We thus arrive at the following picture:

[24] An anonymous reviewer reminds me of Grice's counterexamples to genuineness, which arise when the speaker deliberately and obviously hides information. (Cf. Grice 1989: 45.) A semantic approach to genuineness would have to classify these cases as abnormal utterances. Indeed, the examples that I am aware of all involve some form of pretense, which suggests that they may be analyzed as referring to a hypothetical, or fictional, epistemic background.

[25] See, e.g., Stalnaker (1975: 277f.) and Gazdar (1979: 60f.).

Division of labour according to the truth-functional analysis of disjunction:

Explanations of . . .	in terms of
Exhaustivity	SEMANTICS
Genuineness	PRAGMATICS
Independence	PRAGMATICS

A first, minor difference between the truth-functional and the modal analysis of disjunctive assertions concerns the source of exhaustivity: while both approaches agree that it is a semantic phenomenon, it is traditionally seen as the contribution of the lexical meaning of 'or', whereas on the modal account it comes out as the result of closing an otherwise open list of possibilities. In this case it is harder to find any evidence in either direction. For although we have seen that certain disjunctive statements like (31N) [= (25N)] may be analyzed as open disjunctions, it would be just as natural to regard them as *incomplete* utterances of ordinary (closed) disjunctions suggesting some contextually underspecified completion *p*, as in (31p):

(31r) Mr. X is in Regent's Park or in Victoria or in the City, . . . [L*H H⁻]

(31p) Mr. X is in Regent's Park or in Victoria or in the City, or *p* [H*L L%].

Although the details of such an analysis remain to be worked out, it seems to me that a traditional explanation of open disjunctions along these lines is not entirely implausible. In particular, then, as far as disjunctive assertions are concerned, exhaustivity does not seem to offer any ground for deciding between the two analyses.

The two interpretations of disjunction also disagree in their explanation of genuineness, that is, the understood epistemic possibility of each of the alternatives. According to the traditional view, it is a pragmatic side effect, whereas the modal interpretation treats it as part of the literal meaning of 'or'. But they agree about the status of independence as an implicature (of whatever sort), and there is some evidence that this assessment is correct. If Zoe wants to dispute the independence of the alternatives in (30), it would be odd for her to deny the disjunctive assertion, as in (32?); rather, the natural reaction would be to agree to the disjunction (32!) when all she objects to is the independence of the alternatives:

(32?) No, Regent's Park is *in* Victoria.

(32!) Yes, but then Regent's Park is *in* Victoria.

If we apply the same test to genuineness, it turns out that the modal interpretation fares better. Realizing that the detectives can eliminate the possibility that Mr. X is in Regent's Park, Zoe may contradict Wyman's claim by (33!), but this time it would be odd for her to agree while rejecting the first alternative, as in (33?).[26]

(33!) No, he can't be in Victoria.

(33?) Yes, though he can't be in Victoria.

The traditional analysis of disjunction might lead one to expect the opposite result: if genuineness is but a conversational implicature, rejecting it would not involve a denial of the assertion.[27] On the other hand, the modal analysis does predict that rejecting the genuineness of one of the alternatives is a special case of denying what has been asserted and should therefore be expressed as in (33!).

Having seen that disjunctive assertions support the idea that disjunctions can be construed as lists of possibilities, let us now look at some other uses of 'or'. In the next three sections, I will address some phenomena on which the modal approach to disjunction can shed some light, although not all of them will be true problems for the traditional analysis.

4.2. *Logical Particles*

Fiddling around with the meaning of disjunction obviously has some effect on the logic of natural language. In particular, sentences that used to

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[26] (33!) may be one of the earlier-mentioned cases of denial that require a different epistemic background than speaker's knowledge (cf. fn. 7): Zoe seems to say something about the detectives' knowledge, not just Wyman's.

[27] This is not certain, as an anonymous reviewer points out:

"There are standard cases of quantity implicatures where, when the implicature is false, a denial is appropriate, e.g.:

(i) A: John has 3 children.
B: No, he has 4.
? B: Yes, and (in fact) he actually/even has 4.

(ii) A: Some of John's children have red hair.
B: No, they all do.

(In this case, acceptance with modification is also fine: Yes, and in fact they all do.)"

Note that a reason for this asymmetry may be that (i) is not a case of implicature after all.

correspond to certain tautologies of classical logic no longer come out as valid. Here is an example:

(34) Either Mr. X is in Bloomsbury, or he is not in Bloomsbury.

According to the classical approach, (34) is an instance of the *tertium non datur* and thus void of content. One may therefore wonder why sentences like (34) are ever uttered at all. The standard answer invokes pragmatics:[28] the fact that the sentence is tautologous does not prevent standard conversational implicatures to arise. In particular, with an utterance of (34) the speaker indicates his ignorance as to whether Mr. X is in Bloomsbury; this is what the genuineness of the alternatives boils down to. The modal account arrives at the same conclusion but without taking a pragmatic detour: genuineness is part of the meaning of (34) and should therefore be communicated by any utterance of it.

If a classical tautology involves an embedded disjunction, the modal account may radically differ in its assessment:

(35) If Mr. X is going by bus, he is going by bus or boat.

Whatever the exact interpretation of indicative conditionals, it is clear that the traditional analysis of disjunction is committed to the validity of (35) – because, by the usual truth table, (36) implies (37):

(36) Mr. X is going by bus.

(37) Mr. X is going by bus or boat.

It is equally obvious that according to the modal analysis of disjunction, (36) does not seem to entail (37): if the speaker knows that Mr. X is going by bus, then (36) will be true but (37) will not be. Thus – details still depending on the semantics of conditionals – (35) is not likely to come out as valid, which I think is a welcome result: on an epistemic construal, (35) seems to say something contradictory, viz. that once we know that Mr. X is going by bus, we also know that he is going by bus *or boat*; this, I take it, is hard to swallow at least for those who are not used to logico-mathematical jargon.[29] One may object that this appearance of contradiction is a purely pragmatic effect due to the tautologous character of (35). But then one would expect a similar effect in (38); however, (38) appears to be uninformative only, and not as strange as (35):

[28] See Gazdar (1979: 51f.).

[29] Mathematically speaking, ‘If 2 is prime, then in particular 2 is odd or prime’ is just as true as ‘If 2 is an even prime number, then 2 is even’. I think this reflects a difference between the mathematical and the ordinary usage of ‘or’.

(38) If Mr. X is going by bus, he is going by bus.

One may suspect that, no matter what the exact analysis of conditionals is going to be, the modal approach is bound to meet problems with sentences like (39):

(39) If Mr. X is in Regent's Park or in Bloomsbury, he cannot take a boat.

If the truth of a disjunction depends on the speaker's epistemic background, then (39) says something about what happens given a certain condition of the speaker's information state – viz. one that is consistent both with Mr. X's being in Regent's Park and with his being in Bloomsbury – and implies that he is in one of these places. This seems odd: doesn't (39) just mean that the conditionals under (40) are both true?

(40) If Mr. X is in Regent's Park, he cannot take a boat; and
if Mr. X is Bloomsbury, he cannot take a boat.

However, the example at hand is somewhat misleading. For in some cases, disjunctions in *if*-clauses do not boil down to conjunctions of conditionals:

(41) If Mr. X is in either Regent's Park or in Bloomsbury, we may as well give up.

Sentence (41) could be the right thing for Wyman to say because it may be impossible to cover two areas as far apart as Regent's Park and Bloomsbury, which the detectives would have to do given their limited knowledge. It is clear that, in this case, (41) does not imply that the detectives may give up if Mr. X is in Regent's Park. Given this observation it is natural to look for an analysis of indicative conditionals that has (40) imply (39), though not vice versa. It turns out that a simple epistemic account, according to which a conditional 'If A then B' says that the speaker's present knowledge can only be extended to establish A under circumstances in which B is the case, does just that. More specifically, if we attribute the truth conditions given under (42) to indicative conditionals and assume the above analysis of (closed) disjunctions, which boils down to (43), then (44) will hold for any utterance context *c*:[30]

(42) $[\![\text{If } A \text{ then } B]\!]^c = \{w \mid (\forall w') [\mathrm{H}_{c,w'} \subseteq \mathrm{H}_{c,w} \cap [\![A]\!]^c \Rightarrow w' \in [\![B]\!]^c]\}$

[30] If $w \in [\![\text{if } A_1 \text{ then } B]\!]^c \cap [\![\text{if } A_2 \text{ then } B]\!]^c$ and $\mathrm{H}_{c,w'} \subseteq \mathrm{H}_{c,w} \cap [\![A_1 \text{ or } A_2]\!]^c$, then $w' \in [\![B]\!]^c$ if, for arbitrary $w'' \in \mathrm{H}_{c,w'}$: (a) $w'' \in \mathrm{H}_{c,w}$; and (b) $w'' \in [\![A_1]\!]^c \cup [\![A_2]\!]^c$. (*a*) follows from the second assumption, which also implies that $w'' \in [\![A_1 \text{ or } A_2]\!]^c$ and thus: $\mathrm{H}_{c,w''} \subseteq [\![A_1]\!]^c \cup [\![A_2]\!]^c$. But $w'' \in \mathrm{H}_{c,w''}$ – knowledge implies truth – and thus (b) follows.

(43) $[\![A_1 \text{ or } B_2]\!]^c =$
$\{w \mid \mathrm{H}_{c,w} \cap [\![A_1]\!]^c \neq \emptyset \neq \mathrm{H}_{c,w} \cap [\![A_2]\!]^c \ \& \ \mathrm{H}_{c,w} \subseteq [\![A_1]\!]^c \cup [\![A_2]\!]^c\}$

(44) $[\![\text{If } A_1 \text{ then } B]\!]^c \cap [\![\text{if } A_2 \text{ then } B]\!]^c \subseteq [\![\text{if } A_1 \text{ or } A_2 \text{ then } B]\!]^c$

I suspect that a similar, epistemic treatment can be given to quantified disjunctions that otherwise appear to be straight counterexamples to the modal approach:

(45) Every detective is either in Bloomsbury or in Regent's Park.

According to the traditional analysis, (45) is analyzed by applying the quantifier expressed by *every detective* to the predicate expressed by *is either in Bloomsbury or in Regent's Park* and expresses the proposition that the set of detectives is a subset of the union of the set of people in Bloomsbury and the set of people in Regent's Park; in particular, (45) may be truthfully (and appropriately) uttered by a speaker who knows the exact location of each detective. On the modal approach, this is not so. Rather, the sentence is predicted to express the proposition that the set of detectives is a subset of the set of persons who, as far as the speaker is concerned, may be in Bloomsbury and in Regent's Park, but nowhere else; in particular, (45) cannot be truthfully uttered by a speaker who knows some detective's exact location. This is certainly wrong.

That things are not that simple can be seen by comparing (45) to a case which, according to the traditional account, ought to be perfectly parallel:

(46) Both detectives are either in Bloomsbury or in Regent's Park.

Ignoring its obvious presupposition, (46) should be equivalent to (45); in particular, it should be possible for Mr. X to truthfully utter (46) if he knows that Zoe is in Bloomsbury but is uncertain about Wyman's present position. However, given these circumstances, (46) would not be the right thing to say; and I do not see how this can be explained on pragmatic grounds. Rather I suspect that the modal approach works just fine on (46): for it to be truthfully uttered, the speaker must be uncertain about the position of each of the two detectives. If that is so, then (45) and (46) must not receive a parallel analysis (by whatever theory): from the modal analysis point of view, (45) must not be analyzed as a simple quantification,[31] whereas the traditional approach would have to find an alternative analysis for (46).

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[31] But, then, how else? I do not know, but I have at least a direction to offer, viz. another underlying epistemic operator – this time implicit in *every*. More specifically, (45) should be analyzed as meaning that anybody about whom nothing more is known than that he or

4.3. *Disjunction and Specificity*

Let us compare the following two sentences:[32]

(47) Mr. X either took a bus to Victoria, or he took a bus to Bloomsbury.

(48) Mr. X either took a bus to Victoria, or he took it to Bloomsbury.

While (47) is a sensible thing to say for a detective in the game, (48) is not. The intuitive reason is that (48) suggests that Mr. X took a specific bus – but there are no buses in the game, only bus stops and tickets. However, the most straightforward traditional construals of (47) and (48) predict that the two sentences are synonymous:

(47t) $(\exists y)$ [BUS(y) & TOOK(X, y, Vic)] $\vee$
$(\exists y)$ [BUS(y) & TOOK(X, y, Bloo)]

(48t) $(\exists y)$ [BUS(y) & [TOOK(X, y, Vic) $\vee$ TOOK(X, y, Bloo)]]

Under the modal interpretation we get something along the following lines:

(47m) $\Diamond(\exists y)$ [BUS(y) & TOOK(X, y, Vic)] &
$\Diamond(\exists y)$ [BUS(y) & TOOK(X, y, Bloo)]

(48m) $(\exists y)$ [BUS(y) & [$\Diamond$TOOK(X, y, Vic) & $\Diamond$TOOK(X, y, Bloo)]]

Whether or not (47m) and (48m) are equivalent is largely a question of how to interpret quantification into modal contexts. On a standard account of *de re* modality,[33] (48m) is true if the speaker stands in a certain kind of acquaintance relation – perception, say – to a specific bus and, given his or her knowledge, can neither exclude that the object so perceived took Mr. X to Victoria nor that the object so perceived took Mr. X to Bloomsbury. No such acquaintance relation must hold for (47m) to be true: the speaker must only believe that there be some-bus-or-other which Mr. X took to either Bloomsbury or Victoria. I think that this difference,

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she is a detective satisfies the (modal) disjunction; in other words, adding to the speaker's information state the information that an arbitrary person x is a detective produces an information state in which x satisfies the disjunction. (This would also predict that the sentence implies that at least one detective may be in Bloomsbury!) The same, or a similar, treatment should be given to the corresponding donkey sentence:

(i) If someone is a detective, he is either in Bloomsbury or in Regent's Park.

[32] Examples like the following have been discussed by Simons (1997), who proposes a different treatment using truth-functional disjunction and a special theory of specificity.

[33] See Kaplan (1969) and the refinement in Lewis (1979). For ease of readability I have ignored closure in (47m) and (48m); it is irrelevant for the point I want to make.

which the modal disjunction theory attributes to the truth conditions of (47) and (48), pretty much corresponds to speakers' intuitions about these sentences.[34]

Some disjunctions seem to produce *de re/de dicto* ambiguities without explicit anaphors. German TV commercials for drugs always end with a hasty advice:

(49) Zu Risiken und Nebenwirkungen fragen Sie Ihren Arzt oder Apotheker.
'Concerning risks and side effects, consult your doctor or chemist.'

(49) may be understood in a way that is clearly not intended by the speaker and can be paraphrased as: 'As to risks and side effects, consult that person who, as far as I know, might be your doctor and your chemist.' Interestingly, the following, slightly longer (and thus presumably dispreferred) variant cannot be construed in that way, although it does share with (49) its intended reading:

(50) Zu Risiken und Nebenwirkungen fragen Sie Ihren Arzt oder Ihren Apotheker.
'Concerning risks and side effects, consult your doctor or your chemist.'

From a modal perspective, it is natural to assign (at least) two readings to (49) – (49dd) vs. (49dr) – whereas (50) can only be read *de dicto*:[35]

(49dd) $\Diamond(\exists x)$ [ASK(YOU, x) & DOC(x)] &
$\Diamond(\exists x)$ [ASK(YOU, x) & CHEM(x)]

(49dr) $(\exists x)$ [ASK(YOU, x) & [$\Diamond$DOC(x) & $\Diamond$CHEM(x)]]

Although the precise source of the ambiguity in (49) is not clear to me, the modal approach provides the right kind of ingredients to analyse the difference between (49) and (50), whereas the traditional analysis again seems to be forced to predict synonymy.

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[34] Given the game situation, the speaker does not literally believe in any bus rides that Mr. X may have undertaken, but only pretends to do so. She would still prefer (47) to (48), because she has no reason to pretend that she stands in any acquaintance relation to a bus. See Simons (1997) for other, pretense-free examples of the same kind.

[35] To avoid irrelevant distractions, I have switched from the imperative mode to the indicative; and I have again ignored closure.

4.4. *Attitudes toward Disjunctions*

Let us finally see what happens when a disjunction is embedded under a propositional attitude verb:

(50) Wyman thinks that Mr. X is in South Kensington or in Knightsbridge.

According to the modal interpretation, (50) can be roughly paraphrased as (51):

(51) Wyman thinks that Mr. X *may* be in South Kensington and that he *may* be in Knightsbridge and that he *could* not be anywhere else.

Up to now we had assumed that the modality associated with disjunction is speaker-oriented. However, in order for the above paraphrase to be intuitively adequate, the italicized modal verbs must apparently be understood as relating to Wyman's state of knowledge. One explanation could be that the lexical meaning of 'or' only specifies the underlying modality to be epistemic, with the details being left to the context of utterance. The same context resolution mechanism might then be used to explain why the modalities in (50) and (51) are all understood as relative to Wyman's knowledge. This mechanism would then have to be general enough to also cover cases of bound context dependence:[36]

(52) Most detectives think that Mr. X is in South Kensington or in Knightsbridge.

However, it is unclear how this account could be generalized to factive attitudes:

(53) Wyman knows that Mr. X is in South Kensington or in Knightsbridge.

This time the explicit modalities in a corresponding paraphrase do involve speaker's knowledge:

(54) Wyman knows that Mr. X *may* be in South Kensington and that he *may* be in Knightsbridge and that he *could* not be anywhere else.

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[36] For some theories – e.g. Kaplan's (1989) – bound context dependence is a contradiction in terms; following Partee (1989), I am relying on a more liberal understanding of 'context' here.

Sentence (54) suggests that the speaker does not know whether Mr. X is in South Kensington, and that Wyman does not know that either. However, whereas a suitable context may easily block the first of these inferences, the second one is more stable, which is why (56) appears to be less coherent than (55):

(55) Mr. X is in South Kensington now, and I guess they will catch him soon. Wyman already knows that Mr. X is in South Kensington or in Knightsbridge.

(56) Wyman already knows that Mr. X is in South Kensington or in Knightsbridge, so I guess they will catch him soon. Wyman even knows that Mr. X is in South Kensington.

I think that the explanation for this asymmetry is that in (55) a presupposition (triggered by the factive verb) gets cancelled, whereas in (56) the speaker contradicts or corrects herself without indicating this (which she might have done, e.g., by inserting *Actually* before the second sentence). This explanation is obviously at odds with a generalization about unembedded presupposition triggers, viz. that their presuppositions are entailments and can therefore only be cancelled at the price of incoherence.[37] Still, somewhat surprisingly, the explanation can be made consistent with a formalisation of presupposition by a special kind # of conjunction. However, to do this one would have to give up the idea that the modality underlying disjunction is context dependent and instead treat it as *logophoric*, i.e. bound by a local *de se* perspective, which normally is the speaker's but in the case of attitude reports shifts to the attitude subject.[38] The idea, then, is to formalize (53) as:

(57) $\text{KNOW}(Y, [\Diamond_i\, SK(X)\ \&\ \Diamond_i\, KN(X)])\ \#\ [\Diamond_i\, SK(X)\ \&\ \Diamond_i\, KN(X)]$

where $\Diamond_i$ expresses compatibility with the logophoric center's knowledge and KNOW is a relation between an attitude subject and a property denoted by the result of binding the perspective variable *i*. (57) would then itself express not a proposition but the property any *x* has if, given that *x*'s knowledge is compatible with both Mr. X's being in South Kensington and his being in Knightsbridge, *x* knows that Wyman's knowledge is

[37] Cf. Gazdar (1979: 119).

[38] One would thereby also have to give up the parallel treatment of (50) and (51), because the overt modalities are indeed context dependent. Logophoricity (in this sense) plays a crucial role in Kratzer's (1997) treatment of the German impersonal pronoun *man*, which was my source of inspiration for the following sketchy remarks.

compatible with both Mr. X's being in South Kensington and his being in Knightsbridge; and the sentence would be true (in a given context) if the speaker actually has that property (in that context).

4.5. *Narrow Disjunctions and Necessity*

We have so far assumed that choice sentences must be reduced to, or analyzed as being equivalent to, wide disjunctions. However, from a syntactic point of view, this assumption is rather dubious: even though one of the structures underlying (the surface string of) choice sentences may be structurally similar to a wide disjunction, certainly they should also have a *narrow disjunction* reading with the modal taking scope over the disjunction. Thus, on the modal approach to disjunction, (58) ought to have a reading according to which it is possible that there are two possible places for Mr. X to be in, viz. Kensington and Belgravia.

(58) Mr. X might be in Kensington or in Belgravia.

However, given certain natural assumptions about epistemic possibility, this reading turns out to be equivalent to the wide disjunction reading.[39] Thus, whether or not (58) is structurally ambiguous, on the modal interpretation of disjunction it has only one meaning.

Things look different for the deontic choice sentence (59), which ought to have a reading according to which Mr. X is allowed to be such that his taking a boat and his taking a taxi are the only possibilities.

(59) Mr. X may go by boat or by taxi.

On the reading in question, (59) would be trivially true, because it is not against the rules for anyone to be uncertain as to whether Mr. X went by boat or by taxi; and it would be false had the rules contained a clause to the effect that Mr. X must never take a boat when this is his only known option. Since (59) does not have such a reading, on the present approach one must find a way to block the narrow disjunction analysis of (59). An obvious way of doing so is by imposing a *selection restriction* requiring the complement of the deontic verb to denote an *action* (as opposed to an arbitrary property) and argue that actions are not closed under disjunctions. While such a restriction may be natural, care must be taken in its exact formulation. For one thing, it presupposes a theory of action(s). For another,

[39] In particular, the Self-Reflection Principle given in section 5.1 below suffices to establish the equivalence.

the restriction should not be formulated as an ordinary presupposition; for otherwise one would expect it to be cancelled in (60):

(60) It is not true that Mr. X may go by boat or by taxi – the rules do not say anything about the detectives' state of knowledge.

So the restriction must concern the *grammaticality* – with the possible side effect of considerably raising the complexity of that concept, which may be even less attractive than a 'brute force' ban on narrow disjunctions.

In a slightly more general sense, narrow disjunctions cannot be ruled out anyway. This becomes apparent when we switch modal force:

(61) Mr. X must have taken a boat or a taxi.

Construed as a wide disjunction, (61) says that there are exactly two possibilities, viz. that Mr. X took a bus and that he took a taxi. It turns out that this is precisely the reading the modal interpretation of disjunction attributes to the narrow disjunction construal of (61) – provided that *must* is dual to $\Diamond$, i.e. it expresses epistemic necessity:[40]

(62) $[\![\Box\ A]\!]^c = \{w \mid \mathrm{H}_{c,\,w} \subseteq [\![A]\!]^c\}$.

In other words, (61) comes out as equivalent to the (closed) epistemic choice sentence:

(63) Mr. X may have taken a boat or a taxi.

This is clearly a welcome result, and the narrow disjunction construal of (61) proves to be vital for it. In fact, (61) does not seem to have a wide disjunction reading, according to which Mr. X must have taken both a

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[40] The narrow disjunction reading of (61) is of the form

$$\Box[\Diamond \mathrm{b}\ \&\ \Diamond \mathrm{t}\ \&\ (\forall p)\ [\Diamond p \rightarrow p \between (\mathrm{b} \vee \mathrm{t})]]$$

and thus true of a world w^* in context c iff all words $w \in \mathrm{H}_{c,\,w^*}$ satisfy:

(i) $\mathrm{H}_{c,\,w} \cap [\![\mathrm{b}]\!]^c \neq \varnothing$
(ii) $\mathrm{H}_{c,\,w} \cap [\![\mathrm{t}]\!]^c \neq \varnothing$
(iii) $M \cap ([\![\mathrm{b}]\!]^c \cup [\![\mathrm{t}]\!]^c) \neq \varnothing$, for any set M of worlds such that $M \cap \mathrm{H}_{c,\,w} \neq \varnothing$.

Give the factivity of knowledge – $w \in \mathrm{H}_{c,\,w}$ for any w and c – and the Self-Reflection Principle (see *Section 5.1*), (i)–(iii) boil down to:

(i′) $\mathrm{H}_{c,\,w^*} \cap [\![\mathrm{b}]\!]^c \neq \varnothing$
(ii′) $\mathrm{H}_{c,\,w^*} \cap [\![\mathrm{t}]\!]^c \neq \varnothing$
(iii′) $\mathrm{H}_{c,\,w^*} \subseteq [\![\mathrm{b}]\!]^c \cup [\![\mathrm{t}]\!]^c$.

This is precisely the modal interpretation of the (closed) epistemic variant of the corresponding choice sentence.

boat and a taxi[41] – a fact which may be explained by the independence of the disjuncts: if independence means that the propositions expressed by the two disjuncts cannot both be true, the wide disjunction of (61) violates this well-formedness condition on lists.

Finally, disjunctions involving deontic necessity present a serious difficulty to the modal approach:

(64) Mr. X must take a taxi or a bus.

The problem is that neither narrow nor wide disjunction quite captures what (64) expresses. If the above considerations about selection restrictions are on the right track, the former could be dismissed anyway. The only reading left for (64) would then be one according to which there are two possibilities, viz. that Mr. X be obliged to take a taxi and that he be obliged to take a bus. While (64) may be used to express this epistemic uncertainty, there appears to be a more straightforward construal according to which Mr. X's obligations are unspecific as to the exact means of transport. I am not sure what to say about this problem and prefer to leave it to future research.

5. Back to the Choice Problem

5.1. *Epistemic Variant*

On the modal interpretation of disjunction and after reducing it to the corresponding wide disjunction (65), the epistemic 'choice' sentence (66) comes out as expressing a proposition that implies (67):[42]

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[41] The wide disjunction reading of (61) is of the form

$$\Diamond\Box \mathrm{b} \;\&\; \Diamond\Box \mathrm{t} \;\&\; (\forall p)\, [\Diamond p \rightarrow p \between (\Box \mathrm{b} \vee \Box \mathrm{t})]$$

and thus true of a world w^* in context c iff (a)–(c) hold:

(a) $\mathrm{H}_{c,\, w^*}$ contains a world w_{b} such that $\mathrm{H}_{c,\, w_{\mathrm{b}}} \subseteq [\![\mathrm{b}]\!]^c$;
(b) $\mathrm{H}_{c,\, w^*}$ contains a world w_{t} such that $\mathrm{H}_{c,\, w_{\mathrm{t}}} \subseteq [\![\mathrm{t}]\!]^c$;
(c) for any set M of worlds such that $M \cap \mathrm{H}_{c,\, w^*} \neq \varnothing$, $M \cap ([\![\Box\mathrm{b}]\!]^c \cup [\![\Box\mathrm{t}]\!]^c) \neq \varnothing$.

Under the assumptions made in the previous footnote, (a)–(c) boil down to:

(a′) $\varnothing \neq \mathrm{H}_{c,\, w^*} \subseteq [\![\mathrm{b}]\!]^c$;
(b′) $\varnothing \neq \mathrm{H}_{c,\, w^*} \subseteq [\![\mathrm{t}]\!]^c$;
(c′) $\mathrm{H}_{c,\, w^*} \subseteq [\![\mathrm{b}]\!]^c$ [Boolean] or $\mathrm{H}_{c,\, w^*} \subseteq [\![\mathrm{t}]\!]^c$.

In other words, (61) is true as a wide disjunction iff $\mathrm{H}_{c,\, w^*} \subseteq [\![\mathrm{b}]\!]^c \cap [\![\mathrm{t}]\!]^c$.

[42] The speculation about factive attitudes was just an aside, which is why I am returning to propositions as sentence contents. I am also ignoring closure once more, because I am

(65) Mr. X might be in Regent's Park or Mr. X might be in Victoria.

(66) Mr. X might be in Regent's Park or in Victoria.

(67) $\Diamond\Diamond$IN(X, rp)

What remains to be done, in order to get the choice effect, is to 'reduce' the double modalities by explaining why, quite generally, (61ii) implies (61i):

(68) i. $\Diamond$A
ii. $\Diamond\Diamond$A

Given the epistemic construal (69) of $\Diamond$, the details of such a reduction obviously depend on our theory of knowledge:

(69) $[\![\Diamond\ A]\!]^c = \{w \mid H_{c,\,w} \cap [\![A]\!]^c \neq \varnothing\}$.

(69) only says that (68ii) is true in a context *c* iff there is some world *w* in $H_{c,\,w(c)}$ such that $H_{c,\,w}$ overlaps with $[\![A]\!]^c$, whereas the simply modalized (68i) comes out as true iff $H_{c,\,w(c)}$ itself overlaps with $[\![A]\!]^c$. However, the first condition implies the second if we accept the following principle about knowledge:

Self-Reflection Principle
Any context *c* and worlds *w* and *w** satisfy:
If $w^* \in H_{c,\,w}$, then $H_{c,\,w} = H_{c,\,w^*}$.

The principle says that in any world *w** that is compatible with the speaker's knowledge in *w*, the speaker knows what he knows in *w*; in other words, the speaker is neither ignorant nor uncertain about what he or she knows – which seems reasonable;[43] and one can easily verify that it implies the desired reduction of modalities.

Finally, being a general epistemological principle, the Self-Reflection Principle cannot simply be suspended by the speaker. This, then, also explains why the epistemic choice effect cannot be cancelled.

only interested in certain inferences that do not depend on it. However, it ought to be mentioned that in order for closure to work properly, it must operate on the list of arguments of the modal verbs.

[43] Reasonable, though not beyond reasonable doubt. But then sceptics may note that weaker principles suffice to establish the choice effect. What is important here is that such principles are not of the (CP) kind.

5.2. *Deontic Variant*

The first steps in solving the choice problem for deontic cases are completely parallel to the epistemic ones: if reduced to (70), on the modal analysis of disjunction (71) comes out as implying (72), where 'Δ' again symbolizes the relevant deontic modality, i.e., it not being against the rules of the game:

(70) Mr. X may take a bus or Mr. X may take a boat.

(71) Mr. X may take a bus or a boat.

(72) $\Diamond\Delta$Take(X, )

This time it looks as if we could do with a principle taking us from (73ii) to (73i):

(73) i. ΔA
ii. $\Diamond\Delta$A

For such a principle would give us the choice effect by having (71) imply that Mr. X may take a boat. However, such a principle seems unreasonable: why should it be that the mere epistemic possibility, the fact that – for all the speaker knows – A might be the case, already guarantees that A is indeed the case?

In general, no such guarantee exists – which is, as we shall see, why the choice effect does not always come about. However, sometimes epistemic possibility does guarantee knowledge (and hence truth), viz. if the speaker is well informed about the subject matter. For instance, if the speaker knows the London tube map by heart and it is consistent with his knowledge that Warren Street station is one stop away from Oxford Circus, then it *is* one stop away from Oxford Circus. Quite generally: if the speaker knows which objects (tube stations) have a certain property P (being one stop from Oxford Circus) and which ones do not, then it suffices for an object x (Warren Street) having P that x's having P be consistent with the speaker's knowledge. Let us make this slightly more precise and say, for any context c and property (= function from objects to propositions) P that *the speaker is an authority on P in c* iff the speaker in c knows P's extension in c; that is, for any $w \in H_{c,\,w(c)}$:[44]

(EXH) $w \in P(x)$ iff $W(c) \in P(x)$, for all objects x.

[44] This is Groenendijk and Stokhof's (1984) criterion of exhaustive knowledge about what is P.

Then the following principle holds:

> *Authority Principle*
> If the speaker is an authority on P in c, then, for any x,
> $H_{c,\,w(c)} \cap P(x) \neq \emptyset$
>
> implies
>
> $H_{c,\,w(c)} \subseteq P(x)$.

In other words: if x's being P is consistent with the authority's knowledge, then the authority knows that x is P. The Authority Principle is rather weak in that it follows without any specific assumptions about the nature and structure of knowledge.[45] And it is also rather weak in that it can only be applied in contexts in which it is clear that the speaker is an authority.

In the present context, we are interested in instances of the Authority Principle involving particular predicates Δ of deontic possibility. Who are the authorities on Δ? This obviously depends on the laws Δ is based on; but there are some general trends to be observed. For example, in many cases those who have enacted the law are, rightly, taken to be authorities on Δ – especially when not all that much time has passed since the law has been enacted and everybody involved in that process still well remembers all details.

There are a lot of contexts in which the Authority Principle may be used to explain the choice effect – such as when the speaker is a legal advisor, has just read the book of rules, etc. Still, I do not want to suggest that whenever the deontic choice effect comes about, the hearer takes the speaker to be an authority on Δ. Usually, weaker assumptions about the context should suffice to make sure that if a speaker reports an epistemic possibility, it is understood as a necessity. To find and classify further such cases is beyond the present paper.[46]

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[45] If $w^* \in H_{c,\,W(c)} \cap P(x)$, then $W(c) \in P(x)$, by the "⇒" -direction of the (*EXH*) criterion. But then any $w \in H_{c,\,W(c)}$ must be in $P(x)$, by the "⇐"-direction.

[46] An anonymous reviewer provides the following scenario:

> "Suppose a player were to say the following:
> (i) I know absolutely nothing about the rules for Mr. X's moves, except this: He can take a bus or a boat at this stage of the game.

The disjunction in (i) has a free choice reading, but the speaker has just declared herself not an authority on the property "being permissible for Mr. X"."

I am not sure what to say about this case – not even if I agree that the choice effect necessarily comes about.

Obviously, *cancellations* of the choice effect are no problem for the present approach. Indeed, by uttering a sentence like (74) the speaker explicitly reveals that she is not an authority – if not remembering is taken as indication of a lack of knowledge.[47]

(74) Mr. X may take a bus or a taxi, but I don’t remember which.

5.3. *Disjunctive Permissions*

The extreme case is a situation in which no time at all has passed. Under a “*saying-so-makes-it-so*” policy,[48] performative uses are cases in point. Thus, if I say to my son:

(75) You may have an ice cream or a burger.

chances are that he will recognize my authority and deduce that what I said is not just that it is, for all I know, *possible* that he may have an ice cream, but that I actually *know* that he may have an ice cream because I tell him that this is possible and hence the case, given that I know what he is allowed to order; the latter is the case because it is (largely) my decision what he is allowed to order and, given that he and I know that he will interpret the sentence as expressing a pair of permissions, I can even use (75) to give him these permissions.

Do I, by uttering (75) in a performative fashion, allow my son to have an ice cream *and* a hamburger? Most likely not. And, indeed, the present approach would not commit me to such generosity. For although among the worlds in which my son is having an ice cream, there are some in which he is having a burger, too, there are also many in which he takes the former but not the latter. Moreover, knowing that my son knows me, I may safely assume that he knows that permission is granted for him to have a burger, though the worlds in which he has an ice cream on top of

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[47] An anonymous reviewer points out that the assumption that the speaker is an authority is given up once he or she makes explicit use of an explicit epistemic modal: if Alain, a renowned expert on the game, says that it is conceivable for Mr. X to be allowed to take a taxi, then he will be understood to not be an authority on Mr. X’s move in my technical sense. Hence the scalar implicature of the modal verb is stronger than the background knowledge about Alain. However, according to my account of deontic choice, the modal implicit in disjunction would not come with such an implicature.

Another problem with the Authority Principle has been (independently) pointed out to me by Cleo Condoravdi and Danny Fox: ordinary disjunctive assertions are never understood as conjunctions, no matter how strong the conversationalists’ beliefs in the speaker’s expertise may be. At present, I do not know how to explain these asymmetries.

[48] Cf. Cresswell (1973: ch. 14) for the kind of semantics/speech act theory interface I have in mind here.

it are still inaccessible to him; this would have been different had I been known to be more generous, or less concerned about his health.

It has been observed that in performative uses of (deontic) choice sentences the choice effect is hard – though not impossible[49] – to cancel. If the above account is on the right track, the explanation is very simple: performatives require the speaker to be an authority (in the above sense!), thereby allowing the Authority Principle to apply.

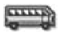
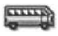
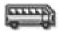
5.4. *Logic vs. Language*

We are now in a position to evaluate the proof that showed the inacceptability of a general Choice Principle. The proof came in two versions which are repeated here for the reader's convenience:

Natural Version

(2) a. Detectives may go by bus.
b. Anyone who goes by bus goes by bus or boat.
c. Detectives may go by bus or boat.
d. Detectives may go by boat.

Formal Version

(3) a. Δ()
b.  ⇒ ( ∨ )
c. Δ( ∨ )
d. Δ()

According to previous analyses the formal version breaks down in the very last line, because it appeals to the unjustified (formal version of the) Choice Principle. This part of the diagnosis I do not want to dispute; as long as we stick to the traditional, Boolean semantics of ∨, it is certainly correct. But then, according to previous analyses, the natural version would break down at the same point. This is where I disagree. For a formalization based on the modal analysis of 'or' will produce something along the following lines:

Revised Formal Version

a. Δ()
b.  ⇒ (◇()) & (◇())
c. ◇(Δ()) & ◇(Δ())
d. Δ()

[49] Cf. Kamp (1978: 271) for a nice example.

It is thus the third line that must be blamed, because neither (a) alone nor its strengthening by (b) implies (c): the latter is a conjunction, and – even in a context with an authoritative speaker, which would license the inference to (d) – the first two lines simply do not imply the second conjunct. I believe that this account, if carried over to the natural version, is quite in line with what is intuitively wrong with the free choice agrument.

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