Conditionals as Definite Descriptions (A Referential Analysis)

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0 Introduction

After developing his logic of counterfactuals, Lewis 1973 noted (almost in passing) that a weakened form of his system could be applied to definite descriptions. The crucial observation ('Lewis's generalization') was that the non-monotonic behavior that motivated modern theories of conditionals can be replicated with definite descriptions, in a way which is not predicted by standard treatments, whether Strawsonian or Russellian. Lewis's observation has gone largely unnoticed, maybe because his theory is rather unintuitive when applied to definite descriptions, which he takes not to refer in any sense of the word.

In this paper we develop Lewis's initial observation. We suggest that *if* should be seen as the form taken by the word *the* when it is applied to a description of worlds. Unlike Lewis, however, we claim that *both* definite descriptions and *if*-clauses refer. Following von Heusinger's recent work, we analyze definites in terms of Choice functions, and show that the latter are a simple variant of Stalnaker's Selection functions, which were originally designed to handle conditionals. By treating *if*-clauses as *plural* definite descriptions (following Schein 2001), we obtain a generalization of Stalnaker's system (analogous to 'class selection function' analyses of conditionals [Nute 1980], or to Lewis's Logic *with* the 'Limit Assumption'). We then use this analysis to revisit the syntax and semantics of conditionals: being definites, *if*-clauses can be topicalized (cf. e.g. Bhatt & Pancheva 2001); the word 'then' can be analyzed as a pronoun which doubles the referential term (Iatridou 1993, Izvorski 1996); the syntactician's Binding Theory constrains possible anaphoric relations between the *if* clause and the word 'then'; and general systems of referential classification can be applied to situate the denotation of the term, yielding a distinction between indicative, subjunctive and 'double subjunctive' conditionals.

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1 Lewis's Generalization

1.1 Basic Idea

Lewis 1973 observed a curious similarity between the logical properties of *if*-clauses and definite descriptions. The observation arose from a critique of traditional analyses of both constructions, which predicted 'monotonic' patterns of reasoning. For instance if a conditional is analyzed as a material or as a strict implication, it is predicted that *If p, q* should entail: *If p & p', q* ('Strengthening of the Antecedent'). But a standard observation in the modern theory of conditionals is that *if*-clauses in natural language do *not* obey this pattern of inference. As a result, it is no contradiction to assert (1)a (Lewis 1973 p. 10), which is roughly of the form in (1)b:

(1) a. If Otto had come, it would have been a lively party; but if both Otto and Anna had come it would have been a dreary party; but if Waldo had come as well, it would have been lively; but...
b. If O, L; but if O & A, ¬L; but if O & A & W, L; but ...

By the same token, it appears that the following argument is not valid:

(2) If John came, Mary would be happy. Therefore, if John came and he was drunk, Mary would be happy.

Lewis 1973, 1979 makes an entirely similar observation about definite descriptions. While he starts from a Russellian analysis (which he criticizes), I will introduce the problem as it appears for a Strawsonian theory (the Russellian variant is discussed below). The problem is that the same pattern of strengthening is predicted to hold *whenever all descriptions can be used felicitously*: from *[the P] Q,* one may infer *[the (P & P')] Q* (for if *the P* and *the (P & P') can be uttered felicitously in a given context, they must denote the same individual, hence the entailment)[2]. But such patterns fail in natural language, as shown by the following, uttered in a piggery (Lewis 1973):

(3) a. The pig is grunting; but the pig with floppy ears is not grunting; but the spotted pig with floppy ears is grunting; but ...
b. [The P] G; but [the (P& F)] ¬G; but [the (P & F & S)] G; but ...

For the same reason, it appears that the following reasoning is invalid:

(4) The pig is grunting, therefore the pig with floppy ears is grunting.

We may also ascertain, for future reference, that the problem arises with plural descriptions as well:

[2] This is von Fintel's notion of 'Strawson-entailment'. See von Fintel 1999.

(5) [Uttered in Los Angeles]

a. The students are happy, but the students in Kabul aren't *(non-contradictory)*

b. The students are happy, therefore the students in Kabul are happy *(invalid)*

The logical patterns appear to be similar in the two cases, in the (relatively weak) sense that a monotonic behavior that one might expect systematically fails. Interestingly, the same kind of analysis has been given to both cases, although under different names. In order to handle the non-monotonicity of conditionals, Stalnaker 1968 introduced the device of *selection functions*. Intuitively, the expression *if p* evaluated in a world w was to select among the worlds that satisfy *p* the one that is most similar to w. This presupposed that worlds could always be completely ordered according to their degree of similarity to a given world of reference. Interestingly, a weakened version of the same device has been used under a different name to handle definite descriptions. This tradition has been developed in great detail in von Heusinger's recent work. It posits that *the P* uttered in a context c selects among the things that satisfy *P* the most salient one. Thus the notion of salience in the domain of reference to individuals plays a role analogous to the notion of similarity in the domain of possible worlds.

The connection between these two traditions lies in David Lewis's work (Lewis 1973 was primarily concerned with conditionals, while Lewis 1979 only mentioned definite descriptions). The paradox, however, is that Lewis himself did *not* resort to Choice functions or to Selection functions to handle the non-monotonicity of *if*-clauses and of definite descriptions. Rather, he designed a more general and more complicated system in order to address some alleged weaknesses in Stalnaker's original analysis of conditionals. The result, was that on Lewis's final analysis definite descriptions and *if*-clauses are taken *not* to refer. This may not be a serious problem in the analysis of *if*-clauses, for which speakers do not have clear intuitions of reference. But for definite descriptions the conclusion is rather implausible, since speakers *do* have strong intuitions about which objects fall under a definite description[3]. In case no object (or too many objects) satisfy the restrictor of the description, I will assume that referential failure occurs, as is argued on Strawsonian analyses.

I now set out to do the obvious thing, i.e. develop a system that gives a unified account of *if*-clauses and definite descriptions. By analyzing *if*-clauses as *plural* definite descriptions (following Schein 2001), we will reduce the analysis of conditionals to the theory of plurals and definiteness. The result is a strengthened version of Lewis's system which is discussed but dismissed in Lewis 1973 (we will see that Lewis's counterargument is not cogent).

[3]In fairness, the discussion in Lewis 1973 was presented more as an exercise in analogy than as an empirical claim about natural language. The issue was revisited in Lewis 1979, but the connection with conditionals was then lost.

1.2 Non-Monotonicity

1.2.1 If-*clauses*

Let us remind ourselves of the problem faced by standard ('monotonic') theories in the analysis of conditionals. Both in traditional modal logic and in theories based on generalized quantification over possible worlds (e.g. Kratzer 1991), *if*-clauses are analyzed in terms of universal quantification over possible worlds, as in b. (modal analysis) and in c. (generalized quantification):

(6) a. If I strike this match, it will light
b. $\Box$(I-strike-this-match $\Rightarrow$it-will-light)
c. [$\forall$w: wRw* & I-strike-this-match(w)] (it-will-light(w))

Both representations give rise to the same truth-conditions, and predict patterns of monotonic reasoning which are also shared by material implications. Here are three major properties, which simply derive from the logic of universal quantification, as in: 'every accessible ϕ-world is a ψ-world':

(7) a. Strengthening of the Antecedent: If *If* ϕ, ψ, then *If* ϕ & ϕ', ψ
b. Contraposition: If *If* ϕ, ψ, then *If* $\neg\psi$, $\neg\phi$
c. Transitivity: If *If* ϕ, ψ and *If* ψ, χ, then *If* ϕ, χ

But these properties do not hold of natural language conditionals, which appear to be 'non-monotonic'.

Consider the following examples, each of which refutes one of the properties mentioned in (7):

(8) a. Failure of Strengthening of the Antecedent:
If this match were struck, it would light, but if this match had been soaked in water overnight and it were struck, it wouldn't light [modified from Stalnaker 1968]
b. Failure of Contraposition
(Even) if Goethe had survived the year 1832, he would be dead by now
$\not\Rightarrow$If G. were not dead by now, he would not have survived the year 1832 (Kratzer)
b. Failure of Transitivity
If B. wins the election, S. will retire to private life. If S. dies tomorrow, B. will win the election $\not\Rightarrow$ If S. dies tomorrow, S. will retire to private life.

These facts have led to the development of special, 'non-monotonic' logics for conditionals. We now argue that these properties hold of definite descriptions as well.

1.2.2 Definite descriptions

A Strawsonian account predicts that the patterns in (7) should hold of definite descriptions when *if* is replaced with *the*, at least when all the definite description(s) involved can be used felicitously (i.e. when their presuppositions are satisfied):

(9) a. If *The* ϕ, ψ, then *The* ϕ & ϕ'$,\psi$
b. If *The* ϕ, ψ, then *The* $\neg\psi$, $\neg\phi$
c. If *The* ϕ, ψ and *The* ψ, χ, then *The* ϕ, χ

Let us first consider (9)a. If *The* ϕ can be used felicitously, there is exactly one ϕ-individual in the domain of discourse. Hence if *The* ϕ & ϕ' can also be used felicitously, it must denote the same individual, and therefore the entailment should hold. The same reasoning applies to (9)b.: If both *The* ϕ and *The* $\neg\psi$ can be used felicitously, there is exactly one ϕ-individual and one $\neg\psi$-individual in the domain of discourse. If the former has property ψ, then it must be distinct from the second, which thus couldn't have property ϕ (or else there would be two ϕ-individuals in the domain, contrary to assumption). Third, turning to (9)c., if *The* ϕ and *The* ψ can both be used felicitously, then there is there is exactly one ϕ-individual and one ψ-individual in the domain of discourse. Thus if the first one has property ψ, it must be identical to the second one, hence the entailment. Let us note, finally, that the same predictions are made for plural descriptions if these are analyzed in terms of maximality operators. For if *The* ϕ denotes the maximal ϕ-set in the domain of discourse, and it is included in a ψ-set, then: (i) *a fortiori* the same holds for the maximal ϕ&ϕ'-set, which derives (9)a; (ii) the maximal $\neg\psi$-set cannot contain any ϕ-elements (or else the maximal ϕ-set would contain these elements too, and would thus fail to be included in a ψ-set); this, in turn, derives (9)b. (9)c is derived in similar fashion: if the maximal ϕ-set s_1 is included in a ψ-set s_2 and the maximal ψ-set (which must include s_2) is contained in a χ-set s_3, then of course s_1 must be included in s_3.

In natural language, however, all of these patterns fail, just as they do with conditionals. Thus the following inferences are not valid (note that both singular and plural descriptions can be used to make this point):

(10) Invalid inferences
a. The dog is barking, therefore the neighbors' dog is barking.
a'. The pig is grunting, therefore the pig with floppy ears is grunting
a''. The students are happy, therefore the students in Kabul are happy
b. The professor is not Dean, therefore the Dean is not a professor
c. The students are vocal. The undergraduates in Beijing are students. Therefore the undergraduates in Beijing are vocal.

For the same reason, the following are non-contradictory:

(11) Non-contradictory statements
a. The dog is barking, but the neighbors' dog is not barking.
a'. The pig is grunting, but the pig with floppy ears is not grunting [Lewis 1973]
b. The professor is not Dean, but of course the Dean is a professor.
c. The students are vocal, and of course the undergraduates in Beijing are students, but the undergraduates in Beijing are certainly not vocal at the moment.

Why should that be? Intuitively, Lewis's suggestion is that 'the pig' doesn't mean 'the one and only pig in the domain of discourse', but rather: 'the most salient pig in the domain of discourse'. Thus the most salient *pig* need not be the same individual as the most salient *pig with floppy ears*, hence the consistency of (7)a'. By the same reasoning, we could add that 'the students' need not denote the maximal set of students in the domain of discourse, but may denote the most salient students only, hence the consistency of (10)a".

If one is worried about our special use of entailment ('entailment... *when the sentences can be uttered felicitously*'), the argument against Strawson can be simplified. We may simply ask whether (10)a', b', c' could ever be *true* (as opposed to false or truth-value-less) on a Strawsonian account. Each time the answer is negative: the truth of the first clause (in the case of (10)c': of the first two clauses) automatically makes the last clause false or truth-value-less. This is an undesirable result, since these sentences could all be uttered truly (and felicitously) in the right context.

Superficially it would seem that Russell fares slightly better than Strawson, since on a Russellian analysis (9)a and (9)b do *not* come out as valid. This is because one of Strawson's definedness conditions could be violated in the consequent, which on Russell's analysis leads to falsity rather than undefinedness. Here are the relevant abstract examples:

(12) a. Refutation of (9)a: Suppose that $[[\phi]]=[[\psi]]=\{d\}$, $[[\phi\ \&\ \phi']]=\emptyset$
b. Refutation of (9)b: Suppose that $[[\phi]]=[[\psi]]=\{d\}$, $[[\neg\psi]]=\emptyset$

By contrast, the pattern in (9)c *is* predicted to be valid by Russell, and in this respect he fares no better than Strawson:

(13) Proof of (9)c: From *The* ϕ, ψ, we obtain: $|[[\phi]]|=1$ and $[[\phi]]\subseteq[[\psi]]$. From *The* ψ, χ, we obtain: $|[[\psi]]|=1$ and $[[\psi]]\subseteq[[\chi]]$. Taken together, these conditions entail: $|[[\phi]]|=1$ and $[[\phi]]\subseteq[[\chi]]$

But even for (10)a' and (10)b', where it would superficially appear to work, Russell's analysis is utterly implausible because it saves the coherence of the sentences only by giving the negation *wide* scope in the clause where it appears, as in (14)b and (15)b. By contrast, giving the negation *narrow* scope would immediately yield falsehoods, as in (14)c and (15)c:

(14) <u>Situation</u>: there is one (salient) pig without floppy ears and one (less salient) pig with floppy ears in the domain of discourse.
a. The pig is grunting, but the pig with floppy ears is not grunting [Lewis 1973]
b. [The P] G & ¬[the (P& F)] G (can be true in this situation)
c. [The P] G & [the (P& F)] ¬G (cannot be true in this situation)

(15) <u>Situation</u>: there is one (salient) professor who isn't a Dean and one (less salient) professor who is Dean in the domain of discourse.
a. The professor is not Dean, but of course the Dean is a professor.
b. ¬[the P] D & [the D] P (can be true in this situation)
c. [The P] G & [the (P& F)] ¬G (cannot be true in this situation)

Unfortunately for the Russellian, these sentences may remain intuitively true even when negation has clearly narrow scope:

(16) a. The pig is grunting, but the pig with floppy ears is doing something other than grunting

b. The professor is something other than Dean, but of course the Dean is a professor

I conclude that the Russellian's advantage is only apparent, and that on closer inspection Lewis's examples are as problematic for Russell as they are for Strawson.

The similarity between *if*-clauses and definite descriptions suggests that a uniform analysis is called for: the same semantic operator, call it ι, should be used to handle both phenomena[4]. We will see that this can be done by interpreting the ι-operator as a Choice function, which selects the most similar world(s) when it is spelled-out as *if*, and the most salient individual(s) in the domain of discourse when it is spelled-out as (plural) *the*.

1.3 Controls

1.3.1 The Problem

Before we develop the analysis, however, we should address one important empirical worry. So far we have assumed, following Lewis, that non-monotonicity is a specific property of *if*-clauses and definite descriptions. But there is another possible line of analysis, which is to suggest that natural language quantification displays a non-monotonic behavior *quite generally*. The argument would go like this: quantification is sensitive to contextual restrictions on quantifier domains; but contexts can change. If so, the predicate 'student' could denote students *in L.A.* in one sentence, and students *in the entire world* in the next (if we've enlarged the domain of quantification). But then none of the patterns in (7) are expected to hold! Consider for instance 'strengthening of the antecedent', applied to universal quantification over individuals:

(17) The situation in our department has deteriorated. Every student is depressed. This isn't the case in competing departments. For instance, many Harvard students are perfectly happy. Competition will be tough.

If quantification displayed a monotonic behavior, it should be inferred from 'Every student is depressed' that 'Every Harvard student is depressed'. But if so (17) should be a contradiction, contrary to fact. The data are explained by positing that the implicit restriction on the quantifier 'every student' can change throughout discourse..

Assuming that (bare) conditionals are analyzed as instances of universal quantification, as in (6), we have no reason to expect that they should be any more monotonic

[4] And possibly *when*-clauses as well. Lewis 1973 doesn't consider these directly, but he does study a formal language that includes 'when-next' and 'when-last', which are future and past versions of a temporal non-monotonic operator.

than universal quantifiers over individuals. The issue of non-monotonicity would thus be reduced to that of (changing) domain restriction, and there would be no argument left to suggest that 'if' and 'the' should be given the same abstract treatment. There would also be no argument left for a non-uniform treatment of *if*-clauses to begin with, since everything could be done in terms of universal quantification and context-sensitive domain restriction.

Lewis 1973 explicitly considers this possibility, but he rejects it[5]. Commenting on examples such as (8)a, he writes that 'our problem is not a conflict between counterfactuals in different contexts, but rather between counterfactuals in a single context. It is for this reason that I put my examples in the form of a single run-on sentence, with the counterfactuals of different stages conjoined by semicolons and 'but'' '(Lewis 1973 p. 13). This now excludes the examples in (17) as irrelevant (since the *if*-clause appears in different sentences, and thus in different contexts), and suggests that the behavior of conditionals leaves something to be explained above and beyond the context-dependency of domain restrictions.

Unfortunately when it comes to restrictions on quantifier domains, context-dependency appears to be less constrained than is presupposed by Lewis's remark. He assumes that within the confines of a single sentence the restriction C on a given predicate of worlds should not change. If this condition is met, (8)a is of the form $[\forall w{:}C(w)\&\phi]\,\psi$ *but* $[\forall w{:}C(w)\&\phi'\&\phi]\neg\psi$, which should come out as a contradiction on a monotonic analysis ('Strengthening of the antecedent' fails); this, in turn, provides an argument in favor of the non-monotonic analysis. By contrast, if the domain restriction *can* change, the LF becomes $[\forall w{:}C(w)\&\phi]\,\psi$ *but* $[\forall w{:}C'(w)\&\phi'\&\phi]\neg\psi$, where C and C' are distinct domain restrictions. But if C and C' are properly chosen this need not result in a contradiction. As A. Szabolcsi (p.c.) points out, it *is* in fact known that domain restriction on quantifiers can change within a single sentence, as shown by the following type of examples, due originally to Westerstahl:

(18) [*Situation:* A committee must select some applicants. Some of the applicants are Italian, and there are also Italians on the committee, though of course they are not the same.]
Every Italian voted for every Italian

The intended reading is that every Italian *on the committee* voted for every Italian *among the applicants.* This means that the domain restriction isn't the same for the first and the last noun phrases. But if domain restriction is so unconstrained when it comes to quantification over individuals, there is no reason it should be any more constrained in the case of quantification over worlds. As a result, the second logical form mentioned above ($[\forall w{:}C(w)\&\phi]\,\psi$ *but* $[\forall w{:}C'(w)\&\phi'\&\phi]\neg\psi$) should be available, and the sentence should not come out as a contradiction *even* if no special story is told about conditionals. Thus Lewis's argument cannot go through as it stands.

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[5] His (short) discussion centered around the hypothesis that conditionals are strict implications with a *vague* accessibility relation and a context-sensitive mechanism of resolution. But his argument carries over to the hypothesis that the quantifier restriction rather than the accessibility relation is context sensitive.

1.3.2 Attempt at a solution

There does appear to be an argument that Lewis was right, however. For there is an empirical difference between the inferences in (10), which are invalid, and similar patterns with garden-variety universal quantifiers, which seem valid:

(19) a. Every dog is barking, therefore the neighbors' dog is barking
(similarly for: '... therefore every dog that the neighbors have is barking')
b. Every pig is grunting, therefore the pig with floppy ears is grunting
(similarly for: '... therefore every pig with floppy ears is grunting')
c. Every student is happy, therefore every student in Kabul is happy.

If the invalidity of the patterns in (10) were due to changing domain restrictions, it would be a mystery why with other quantifiers the domain restriction is allowed to remain constant. The non-monotonic analysis can handle these facts in a simpler fashion: a charitable hearer should try to fix the domain restriction so as to make the pattern of inference valid; this explains why despite the facts in (18) the patterns in (19) are convincing. But this means that domain restriction cannot be the culprit in the invalid patterns of (10). Something else must be responsible for the invalidity - on Lewis's analysis, the non-monotonic behavior of 'the' and 'if'[6].

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[6] There might be another argument for the same conclusion. Ellipsis of a Noun Phrase appears to make it harder to change the domain restriction. Thus some speakers that accept a. as non-contradictory still dislike b. (with ellipsis of 'student'). This suggests that the elided noun gets its domain restriction from its antecedent.

(1) [Uttered in Los Angeles]
a. ? Every student reads Chomsky. But some students in Beijing don't.
a'. $[\forall x:\mathbf{C}(x)\&\ S(x)](RC(x))$ *but* $[\forall w:\mathbf{C}'(w)\&\ S(x)]\neg(RC(x))$
b. #Every student reads Chomsky. But some ~~students~~ in Beijing don't.
b'. $\#[\forall x:\mathbf{C}(x)\&\ S(x)](RC(x))$ *but* $[\forall w:\mathbf{C}(w)\&S(x)\&B(x)]\neg(RC(x))$ (contradictory)

If this analysis is correct (which isn't obvious), ellipsis can be used to force the domain restriction to remain constant. The predictions are as follows:
-If Lewis is right and non-monotonicity is a phenomenon above and beyond domain-restriction, the non-monotonic patterns observed above should exist just as well with elision as without it.
-If Lewis is wrong and non-monotonicity is nothing but context-dependent domain restriction, the non-monotonic patterns should disappear when ellipsis used.
Preliminary evidence suggests that the second hypothesis is correct (the facts are not very sharp, however):

(2) [Uttered in Los Angeles]
a. The students read Chomsky. But some ~~students~~ in Beijing don't.
b. #Every student reads Chomsky. But some ~~students~~ in Beijing don't.

2 A Choice Function Analysis

2.1 Choice Functions across domains (the singular case)

Stalnaker 1968, who assumed that there *was* something to explain about non-monotonicity above and beyond domain-restriction, introduced the device of *Selection functions* to handle the problem. Intuitively, *if* ϕ is taken to 'select' the world most similar to the actual world which satisfies ϕ (if there is no such world we will assume that a presupposition failure occurs, although this isn't Stalnaker's analysis; see below). *If* ϕ, ψ is then taken to be true just in case the world selected by *if* ϕ satisfies ψ (this is simply a case of predication). This formulation is analogous to the device introduced on independent grounds to handle the non-monotonicity of definite descriptions. 'Selection functions' are then called 'Choice functions', but they are simply a weakened version of the same mechanism (cf. e.g. von Heusinger 1996). Instead of selecting the closest world from a particular set, Choice functions select the most salient individual in a set. Both traditions are heirs to Lewis's work, but they haven't been brought together. By taking literally the suggestion that *if* is *the* applied to worlds, we obtain either Stalnaker's analysis (singular definite descriptions) or a strengthened version of Lewis's system (plural definite descriptions; this gives rise to a version of Lewis's system that incorporates with he calls the *Limit Assumption*). We start our discussion with Stalnaker's Selection Function analysis, which we apply to *if*-clauses and definite descriptions alike. We then extend Stalnaker's system by introducing functions that select a plurality of individuals.

2.1.1 General Format

We write 'the' and 'if' as ι. When ι is followed by an individual variable, it represents *the*; when it is followed by a world variable, it represents *if*. ι always selects the element that is closest to a given element under some pre-established linear ordering. What is this 'given element'? If we didn't have to worry about embeddings, we could simply assume that, both for definite descriptions and for conditionals, it is the context of utterance. But this won't do in the general case for conditionals, which can be recursively embedded:

(20) If John were here, if Mary were here as well, the party would be a lot of fun.

Clearly the context of utterance is the same throughout the discourse. However the second *if*-clause should not be evaluated from the standpoint of the actual world w*, but rather from the world selected by f(w*, [[John is here]]). In the general case, then, Stalnaker's Selection functions must take two arguments: a world of evaluation and a set of worlds[7].

Turning now to definite descriptions, it would seem that there is no reason to provide the Choice function with two arguments (an individual and a set of individuals) rather than just one (a set of individuals/a predicate). This is because on a superficial analysis 'the P'

[7] The second argument could just as well be taken to be a sentence rather than a set of worlds (=a proposition).

might be taken to denote an element which is salient *in the context of discourse*. However when more complex examples are taken into account, this treatment is seen to be too crude:

(21) a. No class was so bad that the teacher resigned in despair.
b. #[No x: class(x)] resigned([ιy teacher(y)])
c. [No x: class(x)] resigned([ι_xy teacher(y)])

Clearly the analysis in (21)b won't do, since the quantifier does not bind any variable. From the present perspective a simple solution is to endow the *ι*-operator with an additional argument, written in the object language as a subscript, which represents the individual with respect to which salience is computed. In this way (21)a can be interpreted as: exactly one class was so bad that *the most salient teacher* for that class resigned in despair. This yields the right truth-conditions, on the assumption that the most salient teacher from the standpoint of a given class is the teacher who happened to teach that class[8].

2.1.2 Stalnaker's first three conditions

Let us now consider Stalnaker's Selection Functions and see whether and how they may be used to model the behavior of definite descriptions as well. Stalnaker 1968 imposed four conditions on his selection functions, which we discuss in turn.

<u>Condition 1</u> (=Stalnaker's Condition (1)): For each element d and each set E of elements of a given sortal domain, f(d, E)∈ E. For definite descriptions, this means that the individual denoted by *the* ϕ must satisfy the predicate ϕ. For conditionals, this means that the world denoted by *if* ϕ must satisfy the sentence ϕ. Both conditions are uncontroversial.

<u>Condition 2</u> (equivalent to Stalnaker's Condition (4) when Condition 1 holds): For each element d, if E'⊆E and f(d, E)∈ E', then f(d, E')=f(d, E). When applied to individuals under a measure of salience, this can be paraphrased as: if some element is the most salient among all the members of E, then it is also the most salient among some subset of E that includes it. Although this condition has not (to my knowledge) been discussed in the Choice Function literature, it is necessary to ensure that the Choice Function indeed models a notion of *maximal* salience. More generally, this condition must apply whenever a function is supposed

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[8] This solution will not extend to other cases of quantifier domain selection discussed (for instance) in Heim's 'Articles and Definites'. A case in point is the following example:

(3) Only one class was so bad that no student passed the exam (Heim's (91))

The device introduced above will provide a treatment for the definite description 'the exam', but not for the quantifier 'no student', which on the present analysis is monotonic (the problem is that the students that are quantified over must relativized to the choice of a particular class). See Heim 1991 for a discussion.

to select from a set the element(s) with the greatest degree of a property P. (On Stalnaker's analysis, P is the degree of similarity to the world of evaluation.)

The foregoing discussion was a slight distortion of the history, however. Stalnaker 1968 discusses in fact a different version of the condition, but it turns out to be equivalent to the present version given Condition 1. Stalnaker's condition is:

<u>Condition 2'</u> (=Stalnaker's Condition (4)): For each element d and any sets E and E', if f(d, E')$\in$E and f(d, E)$\in$E', then f(d, E)=f(d, E').

Claim: Condition 2 and Condition 2' are equivalent given Condition 1.

Proof: (i) Condition 2 $\Rightarrow$ Condition 2'. Suppose f(d, E')$\in$E and f(d, E)$\in$E'. By Condition 1, f(d, E')$\in$E$\cap$E' and f(d, E)$\in$E$\cap$E'. By Condition 2, f(d, E)=f(d, E$\cap$E')=f(d, E'). (ii) Condition 2' $\Rightarrow$ Condition 2. Suppose E'$\subseteq$E and f(d, E)$\in$E'. By Condition 1, f(d, E')$\in$E' and hence f(d, E')$\in$E since E'$\subseteq$E. By (i), f(d, E)=f(d, E').

<u>Condition 3</u> (=Stalnaker's Condition (2)): For each element and each set E of elements, f(d, E)=# iff E=Ø.

Here I will interpret # as symbolizing referential failure, as is natural for definite descriptions on a Strawsonian or on a Fregean view. Stalnaker, who was interested in conditionals, did not allow for referential failure. Rather, he interpreted # (which he wrote *λ) as* 'the *absurd world* - the world in which contradictions and all their consequences are true'.[9] In Stalnaker's system any proposition is true of the absurd world. As a result, a conditional with an impossible antecedent is deemed true no matter what the consequent is (this is because in that case *if φ, ψ* is true just in case the world selected by *if φ*, i.e. λ, satisfies ψ; but λ satisfies every proposition). By contrast, on the present view a conditional with a *clearly* impossible antecedent is deemed infelicitous. *The φ* fails to refer just in case there is no individual whatsoever, even a particularly non-salient one, which satisfies *φ*. This is a natural implementation of the idea of referential failure within Lewis's or von Heusinger's salience-based system. Similarly *if φ* fails to refer just in case there is no world whatsoever, even a particular distant one, which satisfies *φ*. This condition does not appear to be too far-fetched given the infelicity of sentences such as: *#If John were and weren't here, Mary would be happy*[10].

2.1.3 Stalnaker's last condition: Centering

Stalnaker's Selection Functions were defined by a fourth condition, which does not appear to be plausible for definite descriptions:

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[9] Stalnaker further stipulates that λ 'is an isolated element under [the accessibility relation] R; that is, no other world is possible with respect to it, and it is not possible with respect to any other world'.

[10] What about other cases? 'If round square existed, you might get the job' - no infelicity here, except for the applicant. I would suggest that the speaker who utters this presents himself as assuming that there *is* a possible world in which round squares exist, although this is a very remote one.

<u>Condition 4</u> (=Stalnaker's Condition (3)): For each element d and each set E, if $d \in E$, then f(d, E)=d.

Applied to possible worlds, this condition states that *if* φ always selects the world of evaluation if φ is true in that world. For instance, in an unembedded environment, this means that the *if*-clause must always select the actual world if it happens to satisfy the antecedent. This condition is entirely natural when the ordering of two elements is defined by their similarity to the actual world, as is the case for *if*-clauses. The condition seems less plausible for definite descriptions, where elements are ordered by their relative salience from the standpoint of a particular individual. If Condition 4 were applied in this domain, it would require that an unembedded definite description should always pick out the speaker if she happens to satisfy the restrictor of the description. Clearly, this is an overly egocentric view of communication. I may certainly use the description 'the guy in the white shirt' to refer to John even if I myself happen to be wearing a white shirt. But if Condition 4 held of descriptions of individuals, 'the guy in the white shirt' would, of necessity, denote *me.*

This, however, is a problem only so long as it is assumed that the speaker necessarily serves as the default point of evaluation for the Choice/Selection Function used to model salience. But this might be too strong. In fact, when I utter a sentence I typically take for granted some perceptual situation which I might not be a part of (this should be clear if the perceptual situation is my own visual field, since I don’t typically see myself, at least not entirely). Obviously no such perceptual condition holds in the domain of worlds (because these can’t be perceived). As a result, the world of evaluation in a standard speech situation c is the one which is most relevant to c, i.e. the world of c. If this analysis is correct, the reason ‘the man in the white shirt’ may fail to refer to me even if I happen to be wearing a white shirt myself is *not* that the centering condition fails; rather, it is that the point of reference in that situation isn’t the speaker himself but whatever is at the center of the speaker’s perceptual field[11].

Interestingly, there appears to be an argument that the Centering condition *does* hold when the point of reference is not left to some element of the context but is determined by the linguistic context. Consider a modification of an example discussed earlier (in (21)):

(22) a. No class was so bad that the teacher abandoned the class .
b. [No x: class(x)] (abandoned([ι_xy teacher(y)], ([ι_xz class(z)]))

Here it certainly is the case that under an assignment s *[ι_xz class(z)]* must denote s(x), i.e. the value of the point of reference, which is itself a class. I leave it for further research to determine whether this condition is *always* met.

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[11] There is also another confound. In normal communication, if I can refer to myself using the word ‘I’, then I *must* do so. This presumably follows from general principles of rational communication (‘I’ is normally briefer and more informative than any definite description, etc.). But one way or another it makes the centering condition very hard to test.

One final point is in order. Although in standard cases the world of utterance provides a default value for the world argument of an unembedded *if*-clause, this needn't always be the case. Consider the following example:

(23) Suppose I didn't exist. If you were the same person that you actually are, you would be much happier

It is clear in this case that the actual world w* satisfies the antecedent of the conditional. Yet the *if*-clause certainly does not select the actual world, for if this were the case the sentence would be trivially false (it couldn't be that you are happier in w* than you are in w*). The natural interpretation is not that Condition 4 is suspended; rather, it is that the point of evaluation is not w* but one of the worlds in which the initial assumption ('Suppose I didn't exist') is met. This is of course parallel to the reasoning we just made for definite descriptions.

To summarize this part of the discussion, let us see how the system works in the example of 'Strengthening of the Antecedent'. The logical forms are now as follows (I use a cross-sortal ι and overt variables for each sort; w* represents the world of evaluation - typically the world of the context, and x* represents the individual of evaluation, which will often be different from the speaker. For simplicity, I omit time/world variables in a'. and time/individual variables in b'.):

(24) a. The pig is grunting, but the pig with floppy ears isn't grunting.
a'. grunting($[\iota_{x*}$x: pig(x)]) but $\neg$grunting($[\iota_{x*}$x: pig(x) & floppy-ears(x)])
b. If this match were struck, it would light, but if this match had been soaked in water overnight and it were struck, it wouldn't light
b'. light($[\iota_{w*}$w: strike(w)]) but $\neg$light($[\iota_{w*}$w: strike(x) & soak(w)])

Since the most salient *pig with floppy ears* need not be the most salient *pig*, a'. is not contradiction. For the same reason the closest (most similar) world in which the match is soaked in water and struck might not be the closest world in which it is struck, and thus b'. is also predicted to be consistent.

2.2 Adding Plurality

Stalnaker's analysis has a major defect: it does not allow for quantification over possible worlds. This is problematic in view of examples such as 'Necessarily, if John comes, Mary will be happy' or 'Probably, if John comes, Mary will be happy'. A major insight in the recent history of conditionals was that in these examples *if*-clauses restrict generalized world or event quantifiers [Lewis 1975, Kratzer 1991]. However if *if*-clauses are construed as *singular* descriptions, there is no way this can be done. The solution is to treat *if*-clauses as *plural* definite descriptions, and to analyze generalized world quantification by analogy with partitives [see also Stone 1997, Schein 2001 for uses of plurality in the analysis of mood and conditionals]:

(25) a. Most of the students are happy.
a'. As for the students, most of them are happy.
b. Probably, if Mary comes, John will be happy.
b'. If Mary comes, John will probably be happy.

The resulting theory will be analogous to a strengthened version of Lewis's Logic, one which is discussed at some length by Lewis himself in *Counterfactuals* (see also Nute 1980).

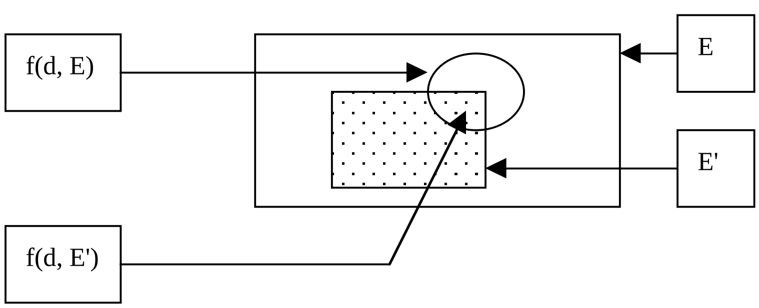
2.2.1 Modifying Stalnaker's Conditions

What happens, then, when plurality is incorporated to the theory of *the* and *if* based on cross-sortal Choice Functions? Plural Choice functions are just another name for what Nute 1980 calls 'Class selection functions'. The literature on conditionals is rife with constraints that can be imposed on these to yield various logics. I do not aim to do justice to these suggestions, but only to point out (i) that the same constraints might in principle be imposed onsalience-based theories of plural definite descriptions, and (ii) that it might be heuristically interesting to explore the possibility (which is our working assumption) that exactly the same constraints are at work for plural Choice functions as they apply to *if*-clauses and to plural definite descriptions. If we wish to preserve as much as possible of Stalnaker's original intuitions in this weaker framework, we may impose (tentatively) the following conditions:

Condition 1*: For each element d and each set E of elements, f(d, E)$\subseteq$E (this is just Condition 1, repeated)

Condition 2*: For each element d, each set E and each set E', if E'$\subseteq$E and f(d, E)$\cap$E'$\neq\emptyset$, then f(d, E')=f(d, E)$\cap$E'.

This modification of Condition 2 is natural given our that our Choice functions are supposed to select the *most salient* individuals and the *most similar* worlds in a given context. Consider the following, which represents a situation in which f(d, E)$\cap$E'$\neq\emptyset$:



-Clearly, if some elements of E' are the most highly ranked (with respect to salience or similarity) in the superset E, they should count as the most highly ranked among the elements of E'. This yields the inclusion: f(d, E)$\cap$E' $\subseteq$f(d, E').

-Conversely, the elements of f(d, E) are more highly ranked than any other element of E, hence also more highly ranked than any other element of the subset E'. Since f(d, E)$\cap$E'$\neq\emptyset$, any element of E'-f(d, E) must be less highly ranked than the elements of E'$\cap$f(d, E), and hence couldn't belong to f(d, E'). This yields the inclusion: f(d, E')$\subseteq$E'$\cap$f(d, E)

For convenience, I repeat Condition 3, which may be retained without change, and I adapt Condition 4, which will be useful for conditionals:
Condition 3* (=Condition 3): For each context c and each set E of elements of a given sortal domain, f(c, E)=# iff E=Ø.
Condition 4*: For each context c and each set E of elements of a given sortal domain, if world(c)∈E, then world(c)∈f(c, E).

2.2.2 An independent argument for plurality: Schein 2001

Schein 2001 has offered an independent argument that *if*-clauses should be treated as plural descriptions. In the case of simple sentences, introducing a plural definite description as the restrictor of a generalized quantifier would seem to be harmless, as shown in the following:

(26) a. Each student is happy
a'. [∀x: student(x)] (happy(x))
b. Each of the students is happy
b'. [∀x: [ιX: STUDENT(X)] Xx)] (happy(x))

The first analysis is standard. The analysis in b'. is more indirect, since the restrictor of 'every' is obtained by first singling out a plural object (capital letters are used for 2nd order predicates and variables). In this example the final truth-conditions appear to be the same in both cases. In more complicated examples, however, an important difference does arise. With an eye to what is to come, I illustrate it with preposed definite descriptions in French, which will be seen to be similar to preposed *if*-clauses:

(27) a. Les Français, ceux que je connais sont pour la plupart sympathique.
The French, thoswe that I know are for the most part nice
'As for the French, those I know are mostly nice'
b. [ιX': FRENCH(X')] [ιX: X⊆X' & I-KNOW(X)] [Most x: Xx] (nice(x))
c. [Most x: French(x) & I-know(x)] (nice(x))
'Most Frenchmen I know are nice'

Here two definite descriptions have been stacked at the beginning of the sentence. The truth-conditions should come out as in c., which only involves first-order quantification. But the representation in c. is implausible because 'mostly' had to be moved to the beginning of the sentence, while the two restrictors had to be conjoined. The solution is simply to offer a plural analysis as in b., which derives the correct truth-conditions in a compositional fashion. In fact a first-order analysis wouldn't be appealing to begin with, since explicit plural markers appear in the sentence to be analyzed.

However, when the problem is transposed to quantification over possible worlds the solution becomes less obvious because English does not have overt markers of plurality for worlds. The problem is Barker's puzzle about iterated *if*-clauses (Barker 1997), and the solution is Schein's, who resorts to plural quantification over events rather than possible worlds, as is done here (Schein 2001). Here is a simplified version of the crucial examples:

(28) a. If John comes, if Mary comes as well, the party will probably be a disaster.
b. [ιW': JOHN-COMES(W')] [ιW: W⊆W' & Mary-comes(W)] [Most w:Ww] (disaster(w))
c. [Most w: John-comes(w) & Mary-comes(w)](disaster(w))

As in the preceding case, the final truth-conditions should be those of c. (at least as a first approximation). But the logical form in c. is implausible because it involves a drastic re-arrangement of various parts of the sentence. By contrast, the analysis in b., which crucially relies on plural definite descriptions of worlds, is syntactically natural. This suggests that *if*-clauses should, at least in some cases, be analyzed as plural rather than as singular descriptions of possible worlds (or events).

2.2.3 Comparisons

The comparison with Stalnaker's system is easy. We may now leave out the requirement that similarity or salience are always so fine-grained as to yield a single 'most salient' or 'most similar' individual. We also weaken the resulting logic. In Stalnaker's initial system *because if ϕ* denotes a single possible world, for any proposition you care to mention either that world is in that proposition or it isn't. As a result, '[if ϕ ψ]$\vee$ [if ϕ $\neg\psi$]' comes out as a logical truth. But this principle, called 'Conditional Excluded Middle', fails when plural choice functions are used. If some of the worlds denoted by 'if ϕ' satisfy ψ while others don't, it will neither be the case that [if ϕ ψ] nor that [if ϕ $\neg\psi$][12].

Lewis 1973 considered a system related to the analysis of *if*-clauses as plural definite descriptions given above. But he dismissed it as too strong. In our terms, the problem is that the analysis predicts referential failure whenever it is not possible to select a set of worlds that are 'the closest' among those that satisfy the antecedent. How could this situation ever arise? Consider the following example:

> Suppose we entertain the counterfactual supposition that at this point ________ there appears a line more than an inch long. (Actually it is just under an inch.) there are worlds with a line 2" long; worlds presumably closer to ours with a line 11/2" long; worlds presumably still closer to ours with a line 11/4" long; worlds presumably still closer .... But how long is the line in the *closest* worlds with a line more than an inch long? If it is 1+x" for any x however small, why are there no other worlds still closer to ours in

[12] Stalnaker (p.c.) has made the suggestion that a treatment of if-clauses as plural definite descriptions might allow us to have our cake and eat it too when it comes to the Conditional Excluded Middle. For apparently plural definite descriptions have conditions of *use* that differ from those of other quantifiers. It might simply not be felicitous to utter 'The children are happy' if some of the children are and some of the children aren't. If such a condition is real, there will be the appearance of a Conditional Excluded Middle despite the fact that the semantics does not make this a valid pattern. On the assumption that 'if ϕ, ψ' can be used only if *all* closest ϕ-worlds satisfy ψ,or else *none* of them do, the Conditional Excluded Middle would be true whenever a conditional can be uttered felicitously. This suggestion is still speculative as it stands, and I leave its development to future research.

which it is 1+1/2x", a length still closer to its actual length? (...) Just as there is no shortest possible length above 1", so there is no closests world to ours among the worlds with lines more than an inch long (...)". [Lewis 1973 p. 20]

It isn't clear that Lewis's example is cogent; nor does his solution to the problem seem satifactory. As pointed out by Stalnaker and others (see Harper 1981, Nute 1980), if such a fine-grained measure of similarity were *ever* available it would according to Lewis make the following sentence true for any value of ε (e.g. ε=0.1", 0.01", 0.001", etc.): ⌜If this line were longer than 1" long, it would be smaller than (1+ε)" long⌝.[13] But there doesn't seem to be any context in which all of these sentences are true. In order to address this kind of objection, Lewis has apparently suggested that the *coarseness* of the similarity measure may vary, so that in the example at hand all worlds in which, say, the length is between 1” and 5” count as equally similar to one another [Nute 1980 cites conversations with Lewis on a different but structually similar example]. But if so the same device can be used to save the plural Choice function analysis (i.e. the class function analysis) from Lewis’s purported counterexample: we may simply stipulate that the similarity measure is never as fine-grained as the difference between the length of the line at w and at w*. Coarseness may save Lewis from trouble, but it also saves the class selection function analysis from Lewis.

Let us also note, more tentatively, that it is highly unclear how Lewis's system can be extended to cases of generalized quantification, in which some value must be given to the *if*-clause to serve as restrictor of the generalized world quantifier (e.g. ‘probably’, ‘there 30% chance’, etc.). This difficulty might be circumvented on the class selection function analysis, since a plural definite description of worlds may restrict a generalized world quantifier, just as ‘the students’ may restrict ‘most’ in ‘Most of the students came’[14].

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[13] Here is why. In Lewis's sphere-based system, the truth-conditions a conditional If ϕ, ψ are as follows:

If ϕ, ψ is true at world i (according to the system of spheres \$) if and only if either

(1) No ϕ-world belongs to any sphere S in $\$_i$, or

(2) Some sphere S in $\$_i$ does contain at least one ϕ-world, and $\phi\Rightarrow\psi$ holds at every world in S

Take ϕ=⌜this line is longer than 1"⌝, ψ_ε=⌜this line is longer than (1+ε)"⌝(note that ε is a parameter, to be replaced by its value, not quoted; hence the use of Quine's quasi-quotation marks).

Let $\$_\varepsilon$ be the sphere than contains all the worlds in which the size of the line is smaller than (1+ε)" (by assumption such a sphere exists since the similarity measure in the context of speech orders worlds by the value of ε at those worlds). Clearly there are ϕ-world in $\$_\varepsilon$ if $\varepsilon>0$. In these worlds $\phi\Rightarrow\psi$ is true. Hence the conditional should be true.

[14] There is a glitch, however. The current analysis predicts that from *Necessarily, if p, q* it is *not* possible to infer: *Necessarily, if p & p’, q*. This is because some of the worlds selected by *if p & p’* might not belong to be in the set selected by *if p* - an undesirable result. The conceptual problem is to put together within a compositional analysis the non-monotonicity of *if p, q* with the monotonicity of *necessarily, if p, q.* A simple but disappointing solution is to resort to the context-dependency of the similarity measure. The assumption would be that whenever generalized world quantifiers are used, the similarity measure is trivial, so that *all* the worlds satisfying the antecedent are selected by the *if*-clause. The next question would be to determine whether a similar argument can be made for definite descriptions. I am pessimistic about the outcome].

3 Consequences of the referential analysis (I): topic, focus and ‘then’.

3.1 Topicalization of the *if*-clause, focalization of ‘then’

The referential analysis of *if*-clauses can now be used to derive a number of interesting syntactic and semantic facts. First, it has been observed that *if*-clauses can appear in the position of sentence topics, in a left-dislocated position. This should now come as no surprise, since referential elements can quite generally be dislocated in this fashion. By contrast, quantifiers or simple restrictors may not not be:

(29) a. *Every man, he is happy
b. *Man, every is happy

Second, as other referential expressions an *if*-clause may be doubled by a pronoun. Following van Benthem, Cresswell 1990, Iatridou 1993 and Izvorski 1996, I assume that ‘then’ is simply a world pronoun. Iatridou 1993 made this suggestion in order to derive the semantic/pragmatic restrictions on the distribution of ‘then’:

(30) a. If Peter runs for President, the Republicans will lose.
b. If Pete runs for President, then the Republicans will lose.

(31) a. If John is dead or seriously ill, Mary will collect the money.
b. If John is dead or seriously ill, then Mary will collect the money.
a'. If John is dead or alive, Bill will find him.
b'. #If John is dead or alive, then Bill will find him.

Although superficially there is no difference between a sentence with and without ‘then’ (e.g.(30)a-b), on closer inspection some subtle contrasts do arise, as illustrated by the deviance of (31)b’. Iatridou’s suggestion is that the presence of ‘then’ triggers a presupposition or an implicature which she analyzes as follows, where O is a generalized quantifier over worlds (e.g. ‘necessarily’, ‘possibly’, etc.), ‘[p]’ is its restrictor, and ‘q’ its nuclear scope:

(32) Iatridou’s analysis of *O, if p, then q*
a. Assertion: O[p] q
b. Presupposition/Implicature: ¬O[¬p] q

A bare *if*-clause is analyzed (*à la* Kratzer) as restricting a covert universal quantifier. The presupposition/implicature in (31)b’ is thus that there is a possible world in which John is neither dead nor alive and in which we find him. But there are certainly no such worlds (John is either dead or alive), which accounts for the deviance of this example.

Iatridou further attempts to relate this effect to the presupposition/implicature found in constructions that involve left-dislocation and doubling in German. The following typically implicates that someone other than Hans failed to understand:

(33) Hans$_i$, der$_i$ hat es verstanden. [German; Iatridou 1993]
Hans, he has it understood
a. Assertion: P(i)
b. Presupposition/Implicature: $[\exists j: j \neq i] \neg P(j)$

Iatridou suggests that the doubled pronoun plays the same role as 'then' in the preceding examples. Although these suggestions are illuminating, Iatridou doesn't really explain how *if*-clauses and dislocated noun phrases may be treated in a unified framework. Part of the problem is that on her analysis an *if*-clause is a restrictor rather than a referential element. This makes the comparison with left dislocated referential noun phrases harder to make. On the present approach, the difficulty disappears since *if*-clauses are treated as referential elements.

Iatridou further observes, however, that unfortunately the analogy between 'then' and 'der' in German breaks down in the following example, due to I. Heim:

(34) Alle haben die Vorlesung verstanden. Hans hat sie verstanden. Maria hat sie verstanden. Und unser Freund Peter, der hat sie auch verstanden. [German]
'Everybody understood the lecture. John understood it. Mary understood it. And our friend Bill, he understood it too.'

Iatridou's prediction is that (34) should be infelicitous because the implicature contradicts the assertion. But this is not the case. Iatridou leaves the problem open. The difficulty can be solved by suggesting that 'then' isn't any type of pronoun, but rather a *strong* pronoun. In languages that distinguish between weak and strong pronouns, Heim's facts can be replicated with the former but not with the latter. Strong pronouns thus pattern in the way predicted by Iatridou's analysis, as illustrated by the following contrasts in French:

(35) Everybody understood. The professors understood, the staff understood, and...
a. #[Les étudiants]$_i$, eux$_i$ ont compris aussi
[The students]$_i$, them$_i$-strong$_F$ have understood too
b. [Les étudiants]$_i$, ils$_i$ ont compris aussi
[The students]$_i$, they$_i$-weak$_F$ have understood too

The facts now appear similar in the case of 'eux' and of 'then'. With 'eux', the implicature is that some non-students didn't understand, hence the infelicity of the above example (since everybody understood). In the case of 'then' in *if p, then q* it is that some non-*p* worlds are non-*q* worlds, which accounts for (31)b'

Izvorski 1996 has explored a a different line of reasoning to overcome this problem. Izvorski suggests that the reasons (34) is grammatical is that the focus-particle 'too' has been added. Adding the same particle to Iatridou's 'then' examples makes them felicitous under the same conditions:

(36) We will definitely play soccer. If the sun shines we will. If it is cloudy and cold we will. And if it rains (#then) we will / And <also> if it rains *then* too we will.

As it happens, this observation meshes well with the suggestion that 'then' is a *strong* world pronoun. For in Izvorski's example 'too' is added right after the word 'then'. If 'aussi' is placed right after 'eux' in (35)a, the example improves. And if 'too' is placed lower down in the structure in Izvorski's example, it becomes worse:

(37) Everybody understood. The professors understood, the staff understood, and...

a. [Les étudiants]$_i$, eux$_i$ aussi ont compris

[The students]$_i$, them$_i$-strong$_F$ too have understood

b. We will definitely play soccer. If the sun shines we will. If it is cloudy and cold we will. #And if it rains *then* we will too.

Let us now see whether Iatridou's and Izvorski's observations can be derived (in both categorial domains) from an independently motivated mechanism. In order to achieve this, I simplify the problem and consider only the case of a focused pronoun, disregarding the left-dislocated element. Given the referential analysis of *if*-clauses, the semantic value of 'then' should be precisely that of its antecedent, which makes the simplification relatively harmless.

Let us first consider a standard example. Rooth 1996 briefly discusses the following sentence:

(38) Situation: Steve, Paul and I took a calculus quiz (which was graded on the spot). George asked me how it went.

a. Well, I$_F$ passed. [Rooth 1996 (11)b]

b. Implicature: Steve and Paul didn't pass

Briefly, Rooth's suggestion is that a focused element introduces a set of alternatives, so that if the subject is focused in 'I passed', a set of alternatives will be triggered, of the form: {'I passed', 'Steve passed', 'Paul passed', 'Steve and I passed', 'Paul and I passed', 'Steve, Paul and I passed', etc.}. This, in turn, triggers an implicature that the sentence that was in fact asserted was the most informative true sentence among the set of alternatives. Note that the alternatives may involve plural subjects, which is crucial to derive the correct results. Rooth analyzes the alternatives as a set of propositions (i.e. as a set of sets of possible worlds). In order to simplify the treatment of focused world pronouns, I use sets of sentences instead. Rooth's analysis may then be reconstructed as follows, where 'w' is a variable that denotes the actual world ('$\ulcorner$' and '$\urcorner$' are Quine's quasi-quotation marks):

(39) Situation: Steve, Paul and I took a calculus quiz (which was graded on the spot). George asked me how it went.

a. Well, I$_F$ passed. [Rooth 1996 (11)b]

b. Ordinary value: passed(w, I)

[Ordinary value: 'I passed']

c. Focus value: F={S: for some contextually given denoting (possibly plural) expression E, S=$\ulcorner$passed(w,E)$\urcorner$}

[Focus value: {'I passed', 'Steve passed', 'Paul passed', 'Steve and I passed', 'Paul and

I passed', 'Steve, Paul and I passed', etc.}]
d. Implicature: no sentence in F both (i) entails (a) and (ii) is true.
[Implicature: No one but me passed among the relevant alternatives]

Since the alternatives to 'I' in Rooth's example involve plural subjects, if someone other than me, X, had passed, I could have uttered: 'X and I passed' (or: 'we passed'), which would have been both true and more informative than what I in fact uttered. Since I did not utter this more informative sentence, I implicated that only I passed.

This analysis can be extended without difficulty to a case involving focalization of a plural pronoun (I use a French example because the morphological distinction between weak and strong pronouns entails that in the following example the strong pronoun *must* be focused):

(40) a. ([Les étudiants]$_i$,) [eux$_i$]$_F$ ont compris [French; 'eux' is the strong pronoun]
([The students]$_i$,)[them$_i$-strong]$_F$ have understood
b. Ordinary value: understood(w, they$_i$)
[Ordinary value: 'they$_i$ understood']
c. Focus value:Focus value: F={S: for some contextually given denoting (possibly plural) expression E, S=$\ulcorner$understood(w,E)$\urcorner$}
[Focus value: {'they$_i$ understood', 'I and they$_i$ understood', 'Paul, Steven and they$_i$ understood', etc}]
d. Implicature: no sentence in F both (i) entails (a) and (ii) is true.
[Implicature: No one except them$_i$ understood among the relevant alternatives]

The implicature is that none of the contextual alternatives to the plural individual denoted by 'the students' did in fact understand, for otherwise a more informative sentence could have been asserted (namely: 'The students *and X* understood'). There are now two ways in which the implicature could lead to infelicity:
-If there are other (salient) people and they also understood, the implicature will simply be false.
-If there is no one else in the domain discourse, the focus value will only contain sentences which are entailed by the sentence that was in fact asserted. This makes the implicature idle, in a way that appears to lead to deviance. Thus if there were only students in the audience of a particularly complicated thriller, it won't do to say: 'Les étudiants, eux ils ont compris' (*the students, them-strong they understood*). For this would imply that other members of the audience, non-students, didn't understand. But there are no non-students in the audience. This leads to the following condition:

(41) Non triviality condition: some element in the Focus value should not be entailed by the asserted sentence.

Applied to conditionals, this appears to account for the deviance of (31)b', repeated as (42) and analyzed as in (43) [W is a variable over pluralities of worlds]:

(42) #If John is dead or alive, $then_F$ Bill will find him.

(43) a. ([If $p]_i$,) $[then_i]_F$ q
b. Ordinary value: $q(then_i)$
[Ordinary value: q holds in the worlds denoted by '$then_i$']
c. Focus value: F={S: for some contextually given denoting expression E, S=$\ulcorner$will-find-him(E)$\urcorner$}
[Focus value: {'if John is dead, Bill will find him', 'if John is alive, Bill will find him', etc}]
d. Implicature: no sentence in F both (i) entails (a) and (ii) is true.

Because the antecedent is a tautology, the condition of non-triviality is violated, hence the deviance of the example. (Note that on this analysis this sentence is not exactly parallel to the 'Hans' example given above, as was suggested by Iatridou; rather, the correct point of comparison is the thriller example we discussed above.)

3.2 Condition C effects

The referential analysis allowed us to explain why *if*-clauses can be dislocated and doubled by the word 'then', construed as a world pronoun. But if this theory is on the right track we would expect world pronouns and world descriptions to share other formal properties of pronominal and referential expressions. In the domain of reference to individuals, there are well-known constraints on the syntactic distribution of such elements, summarized in Chomsky's 'Binding Theory'. We now attempt to show that one these conditions (the strong form of 'Condition C') applies to world expressions as well. This can be seen as an extension of a question raised by Percus 2000, who suggested that some world variables must satisfy other syntactic constraints (Percus suggested that some world variables must be bound locally).

Condition C of the Binding Theory states that a referential expression ('R-expression') may not be bound. Typically violations of the constraint are relatively mild (and cross-linguistically unstable) when an R-expression is co-indexed with another c-commanding R-expression. By contrast, the violations are very strong (and cross-linguistically rigid) when an R-expression is c-commanded by a co-referring pronoun. The latter case is illustrated by the examples in (44), whose structures are given in (46):

(44) a. $John_i$ likes [people who admire him_i]
b. *He_i likes [people who admire $John_i$]
c. [His_i mother] likes [people who admire $John_i$]

(45) a. [R-expression$_i$ [$_{VP}$ [$_{NP}$ ... pronoun$_i$ ...]]]
b. * [pronoun$_i$ [$_{VP}$ [$_{NP}$ ... R-expression$_i$ ...]]]
c. [[... pronoun$_i$ ...] [$_{VP}$ [$_{NP}$ ... R-expression$_i$ ...]]]

As is shown in (44)-(45)c, a pronoun may in some cases be coindexed with a referential expression that follows it ('backwards anaphora'). However this is impossible if the referential expression is in the scope of ('c-commanded by') the pronoun, as in (44)b. Exactly the same pattern can be replicated with *if*-clauses, construed as referential terms, and the word 'then', analyzed as a world pronoun:

(46) a. [if it were sunny right now]$_i$ I would see [people who would then$_i$ be getting sunburned].
b. *I would then$_i$ see [people who would be getting sunburned [if it were sunny right now]$_i$].
c. Because I would then$_i$ hear lots of people playing on the beach, I would be unhappy [if it were sunny right now]$_i$

All the examples make reference only to the time of utterance, which ensures that *then* is interpreted modally, not temporally (this is because the word *now* rather than *then* must be used to refer to the time of utterance). It is plausible that *then* and an *if*-clause are adjoined somewhere below IP and above VP. This yields exactly the same schematic structures as in (45). The natural conclusion is that *if*-clauses, as other referential expressions, are subject to Condition C of Chomsky's Binding Theory.

4 Consequences of the referential analysis (II): referential classification

Referential expressions may appear with features that indicate how their denotation is situated with respect to the context of speech ('context-relative classification') or with respect to some other salient entity ('object-relative classification'). The first case is illustrated by the contrast between 'I', which must denote the speaker, and 'he', which normally may not do so. Similarly, the word 'this' must denote an entity which is close to the speaker, while the word 'that' must normally denote an entity which is further away. The second case ('object-relative classification') requires that we consider more exotic languages. In Algonquian, two sorts of 3rd person agreement markers are distinguished. A 'proximate' expression must denote a salient entity which is the center of reference in a stretch of discourse. By contrast, an 'obviative' expression denotes some other entity, which is less salient than the referent of the proximate term. In English an object-relative system appears to be used in the temporal domain, where a time variable with pluperfect features must denote a moment which is prior to some other salient past moment.

In this section I suggest that the distinction between indicative and subjunctive conditionals should be analyzed by analogy with that between 'this' and that'. To simplify the analysis I assume that descriptions of worlds are always singular, although as was said above plural descriptions should probably be countenanced as well. I suggest in this simplified framework that an indicative *if*-clause must denote a world which is in the Common Ground, and thus counts as 'close enough' to the context of utterance. A subjunctive *if*-clause normally denotes a world which is further away. This is almost *exactly* the analysis offered in Stalnaker 1975, except that now the theory is embedded within a general system of referential classification which applies to individuals and worlds alike (similar suggestions with respect to the tense/mood analogy are made in Iatridou 1994). I then extend this theory to examples involving two layers of subjunctive morphology ('double subjunctives'), which are analyzed as an instance of object-relative classification in the domain of worlds.

4.1 'This' vs. 'that'

Consider first the difference between 'this' and 'that'. It appears that 'this' incorporates a presupposition that its denotation should count as close to the speaker. We may be tempted to define the opposite presupposition for 'that', i.e. that 'that' may *not* denote an entity which is close to the speaker. This would be overly strong, however. Watching a scene in the mirror, I may find out that a table I was observing is in fact the table standing right next to me. I could then utter without presupposition failure: 'That is this!'. The same point carries over to other cases. If David observes throught a mirror someone whose pants are on fire, he may at some point exclaim: 'He is me!'. Although it was presupposed all along that 'I' referred to the speaker, it was *not* presupposed that 'he' referred to a non-speaker (or else David's utterance would have resulted in presupposition failure, contrary to fact).

In order to analyze these facts, I resort to a device inspired by Dekker 2000. Dekker observes that there can be uncertainty as to whom I am referring to through a use of the word 'he' (consider for instance the mirror example discussed in the last paragraph). For instance I may be unsure whether I am referring to John or to Sam, although I know that I am not referring to Peter. This fact can be formally captured by evaluating the sentence with respect to a set of assignments $S=\{s_1, s_{2,} ...\}$ rather than with respect to a single assignment. If I know who I am referring to, all elements of S will assign the same value to the pronoun I used. If I am not entirely sure who I am referring to, S will contain some assignments which, say, assign John to 'he', while others assign Sam to the same pronoun (though no element of S assigns Peter to it, since I know that I am *not* referring to Peter.)

We can then use this system to give an asymmetric definition of the semantics of 'this_x' and 'that_y', where x and y are variables whose value is contextually supplied (by a demonstration, encoded in the assignment function with respect to which the sentence is evaluated). In the case of 'this_x', the presupposition is that 'x' refers to an object near the speaker. To put it more formally, for every member s of S, it must be the case that s(x) is near the speaker. For 'that_y', by contrast, the presupposition is simply that there is a *possibility* that the denotation of z isn't close to the speaker. This just requires that for some s in S, s(z) far from the speaker. Thus no presupposition failure need arise when I utter something like: 'That is this'. This analysis is naturally cast within a dynamic semantics, as is done in the Appendix (again following Dekker's ideas). The set of assignments with respect to which the sentence is evaluated is modified in discourse, so that in uttering 'That$_y$ is this$_x$' I eliminate from S those assignments in which s(y)≠s(x).

4.2 Indicative vs. Subjunctive

On Stalnaker's standard analysis (Stalnaker 1975), indicative mood incorporates the (default) assumption that the Selection function must pick a world within the Common Ground. From the present perspective, this is just to say that indicative mood expresses a presupposition similar to that of the word 'this', but in the domain of worlds rather than of individuals. The notion 'close to the context of utterance' is rendered, following Stalnaker, as: 'within the Common Ground'. The Common Ground also plays a second role, which is to model the speaker's uncertainty about what the actual world is. Thus when we compute the reference of a definite description of worlds $[\iota_{w*}w{:}\ \varphi]$, we may not know with precision what the value of the point of reference w* is (in other words, there are assignments compatible with the speaker's state of knowledge which assign different values to w*). As a result, there will be uncertainty on the value of $[\iota_{w*}w{:}\ \varphi]$, which by definition the closest φ-world(s) to w*. Given our very weak semantics for 'that', we expect that sujunctive marking should only indicate that there is a *possibility* that $[\iota_{w*}w{:}\ \varphi]$ denotes a world outside the Common Ground. To quote Stalnaker 1975, subjunctive marking indicates that 'the selection function is one that may reach out' of the Common Ground. This 'may' is now analyzed as: one of the assignments s with respect to which the sentence is evaluated is such that the value of $[\iota_{w*}w{:}\ \varphi]$ under s is not in the Common Ground.

This analysis, like Stalnaker's original theory, does *not* predict that subjunctive conditionals are counterfactual. This is a welcome result in view of the following example, due to Anderson (cited in von Fintel 1997 and also by Stalnaker):

(47) If Jones had taken arsenic, he would have shown just exactly those symptoms which he does in fact show. [So, it is likely that he took arsenic]

The speaker wants to argue that Jones took arsenic in the actual world. If so, by Centering the *if*-clause must pick out the actual world, which is in the Common Ground. This need not cause any problem on the present theory. All the subjunctive marking indicates is that *some* of the assignments with respect to which the sentence is evaluated gives the *if*-clause a value that lies outside the Common Ground. Within a dynamic framework the assertion indicates that these assignments should be thrown out of the initial information state; but this need not cause any presupposition failure.

A final point is in order. The Common Ground constantly evolves in a discourse, since each assertion reduces the set of assignments (and possible worlds) which are compatible with the speaker's beliefs/assertion. But since the Common Ground serves to define which worlds count as ‘close’ to the context of utterance, the notion of closeness itself must change throughout a discourse. This is modeled in some detail in the Appendix.

4.3 ‘Double Subjunctives’

The indicative/subjunctive distinction has now been analyzed in terms of a context-dependent system of classification. As was mentioned earlier, however, there are also *object*-dependent systems of classification in natural language. We cited without much discussion the proximate/obviative distinction in Algonquian, or simply with the pluperfect in English. As one would expect, such systems also exist in the domain of reference to worlds. The relevant facts are discussed, among others, in Dahl 1997 and Jespersen 1965. The latter observes that the pluperfect may, in colloquial speech, be used ‘of the present time, simply to intensify the unreality irrespective of time’[15]. He gives the following example:

(48) If I had had money enough (at the present moment), I would have paid you.

The facts might be clearer in other languages. French displays the following minimal pairs:

(49) [John, a professional tennis player, had a terrible injury and is now sitting at the hospital. He definitely cannot participate in the competition which is to take place tomorrow. Talking to him, I say:]
a. Si tu avais joué demain, tu aurais gagné.
If you had played tomorrow, you would-have won
‘If you had played tomorrow, you would have won’
b. #Si tu jouais demain, tu gagnerais/aurais gagné
If you played tomorrow, you would win/would-have won
‘If you played tomorrow, you would win/would have won’

In this situation, John's participation in the event is not only counterfactual (it is presupposed that it won’t happen), but it is particularly remote. *Not* using the pluperfect (interpreted as a double subjunctive) would in fact come across as insensitive, as it would disregard John’s unfortunate situation.

From the present perspective an account suggests itself: in its modal uses just as in its temporal uses, the pluperfect is a device of object-relative classification. In the case at hand it indicates that the worlds picked out by the *if*-clause are more remote that some worlds which are themselves outside the Common Ground. The latter are presumably worlds in which John did not have an accident. The implementation offered in the appendix simply involves a dyadic predicate ‘<’ (which applies across domains, i.e. to individuals, times and worlds alike). In the world domain, $\ulcorner\alpha<\beta\urcorner$ indicates that the value of α is more remote than the value of β (this, in turn, can be defined in terms of Stalnaker’s Selection function).

[15] Thanks to Frank Veltman for bringing these examples to my attention.

5 Conclusion

If the present theory is on the right track, a large part of the semantics of conditionals can be derived from independent grammatical mechanisms. *If* is simply the form taken by *the* when it applies to a description of worlds. The non-monotonicity of conditionals can thus be seen as a special case of the non-monotonicity of definite descriptions. *If*-clause can be topicalized because they are referring expression. A precise notion of co-reference between ‘then’ and an *if*-clause can thus be developed, which accounts for Iatridou’s and Izvorski’s insights concerning the analogy between if/then and correlative constructions, and also predicts - correctly - Binding Theoretic effects with world-denoting expressions (as anticipated in Percus 2000). Finally, the distinction between indicative, subjunctive and double subjunctive conditionals can be analyzed in terms of a general system of referential classification which situates the value of the word(s) denoted by the *if*-clause with respect to the context or with respect to some salient world. If successful, this analysis may play a part in a general attempt to reduce the semantics of natural language to a few abstract semantic modules which apply in identical fashion to different sortal domains.

Appendix

We provide a formal implementation of some of the main ideas presented in the paper. For simplicity, this system is restricted to singular descriptions, and thus adheres strictly to Stalnaker's original definition of Selection functions. The theory is stated as much as possible in a sortally-neutral fashion, i.e. whenever possible a single symbol applies to individuals, to times and to worlds [in this article no use is made of generalization to time of the relevant notions].

- *Vocabulary*

Logical Vocabulary
-Non-sortal vocabulary:
$\&, \neg, \iota, \forall, =$
-Sortal vocabulary:
for each $\xi \in$ {'x', 't', 'w'}, for each i $\in$ |N, a first-order variable ξ_i.
We say that the sortal domain of 'x' is D, the sortal domain of 't' is T and the sortal domain of 'w' is W. By extension, ξ_i is said to have the sortal domain of ξ. We write: sort('x')=D, sort('t')=T, sort('w')=W. And by extension: sort(ξ_i)=sort(ξ)

Non-logical vocabulary
For each m, n, p in |N, the non-logical vocabulary contains an infinite set $R^{<x:\ m,\ t:\ n,\ w:\ p>}$ of predicates taking m individual variables, n time variables and p world variables.
Proper names (individual sort): *John, Mary, Wisahkechahk , Fox* (proper names are sometimes abbreviated in what follows with their first letter only)

Features
local, <local, LOCAL, <LOCAL, <

Note: 'local' indicates that an expression must denote a coordinate of the context (speaker, time, or world of utterance). '<local' indicates that an expression must denote an entity which is distant from the context on some measure. 'LOCAL' indicates that the value of an expression must lie in the neighborhood of the context. '<LOCAL' forces the value of an expression *not* to lie in the neighborhood of the context. Finally, '<' is a dyadic predicate that indicates for $\ulcorner\alpha<\beta\urcorner$ that the value of α is more remote than the value of β (from the standpoint of the context).

Parentheses and brackets: (,), [,], {, }

Note: (,) are used to indicate constituency; [,] are used to symbolize quantifiers. {, } indicate presuppositions.

- *Terms and Formulas*

-Each variable and each constant of sort s is a term of sort s.
-If $\tau_1, ..., \tau_m, \tau'_1, ..., \tau'_n, \tau''_1, ..., \tau''_p$ are respectively m, n and p terms of sorts D, T, W, if $R \in R^{<x: m, t: n, w: p>}$, if φ_1 and φ_2 are formulas, and if $i \in |N$ and $\xi \in \{$'x', 't', 'w'$\}$, the following are formulas:
$R(\tau_1, ..., \tau_m, \tau'_1, ..., \tau'_n, \tau''_1, ..., \tau''_p) | \neg\varphi \mid (\varphi_1 \& \varphi_2) \mid \forall\xi_i\varphi | \tau_1=\tau_2 | \tau'_1=\tau'_2 | \tau''_1=\tau''_2$
-If φ is a formula, if $\xi \in \{$'x', 't', 'w'$\}$ and if $i \in |N$, $[\iota_{\xi_k} \xi_i \varphi]$ is a term of the same sort as ξ
-If τ, τ' are terms of sort s, the following are terms of sort s: $\tau\{local\} \mid \tau\{<local\} \mid \tau\{LOCAL\} \mid \tau\{<LOCAL\} \mid \tau\{<\tau'\}$

- *Models*

A model M=<D, T, W, I, f> consists of:
(i) three non-empty, non-intersecting sets: D, T and W (=the sortal domains or simply the 'sorts' of 'x', 't' and 'w', in the terminology introduced above)
(ii) an interpretation function I which assigns
-a subset I(R) of $D^m \times T^n \times W^p$ to each letter R of $R^{<x: m, t: n, w: p>}$
-an element I(c) in the sortal domain of c to each constant c
(iii) a selection function from $(D\times\mathcal{P}(D))\cup(T\times\mathcal{P}(T))\cup(W\times\mathcal{P}(W))$ into $D\cup T\cup W$ which satisfies Stalnaker's Conditions (generalized across domains):
-Condition 1 (minimum condition on Choice Functions)
$\forall S\in\{D, T, W\}\ \forall a\in S\ \ \forall A\subseteq S\ \ (f(a, A)=\#$ or $(f(a, A)\in A))$
-Condition 2 (condition for a Choice Function to select the 'closest' element on some measure)
$\forall S\in\{D, T, W\}\ \forall a\in S\ \ \forall A\subseteq S\ \forall A'\subseteq S\ (A'\subseteq A\ \&\ f(a, A)\in A') \rightarrow f(a, A)=f(a, A')$
-Condition 3: Referential failure
$\forall S\in\{D, T, W\}\ \forall a\in S\ \ \forall A\subseteq S\ (f(a, A)=\#\ \leftrightarrow A=\varnothing)$
-Condition 4: Centering
$\forall S\in\{D, T, W\}\ \forall a\in S\ \ \forall A\subseteq S\ (a\in A \rightarrow f(a, A)=a)$

<u>Note 1</u>: We can define the derived notions '$<_a$' '$\leq_a$'for each a in some sortal domain:
$\forall S\in\{D, T, W\}\ \forall a, a', a''\in S\ (a''\leq_a a' \leftrightarrow_{def} f(a, \{a', a''\})=a')$.
$\forall S\in\{D, T, W\}\ \forall a, a', a''\in S\ (a''<_a a' \leftrightarrow_{def} (a'\neq a''\ \&\ f(a, \{a', a''\})=a')$.

<u>Note 2</u>: < is taken to represent salience for individuals, temporal remoteness in the past for times, and modal remoteness for worlds.

<u>Note 3</u>: Stalnaker's conditions on f induce implausibly strong conditions on <, esp. for times and worlds.

- *Information States*

-An information state is a set S of triples of the form:
$s=<<d, t, w>, g>$, with $<d, t, w>\in D\times T\times W$, and g an assignment function which assigns to each variable ξ_i for $\xi\in\{$‘x’, ‘t’, ‘w’$\}$, $i\in$ |N a value from its sortal domain.

Note: Intuitively, an information state represents what the speaker knows about his context of speech (here identified to a triple $<d, t, w>$), as well as about objects he might be referring to with demonstrative terms.

Terminology: With s defined as above, we write: context(s)=: $<d, t, w>$ and local(D)(s)=: d, local(T)(s)=: t, local(W)(s)=: w. If ξ is a variable, we write $s(\xi)=:g(\xi)$.

-We also need to determine what a speaker in a given information state considers to be the objects that count as ‘close’ to the context of speech. We assume that a function LOCAL is given which associates to each element s of an information state S a triple of the form
$<d^+, t^+, w^+>\in \mathcal{P}(D)\times\mathcal{P}(T)\times\mathcal{P}(W)$
with the stipulation that (with the notation used above) $d\in d^+$, $t\in t^+$, $w\in w^+$.

Notation: For LOCAL(s, S) defined as above, we write LOCAL(D)(s, S)=:d^+, LOCAL(T)(s, S)=: t^+, LOCAL(W)(s, S)=: w^+

Stipulation: Stalnaker’s notion of Common Ground
For each information state S, we stipulate that:
$\forall s\in S$ LOCAL(W)(s, S)={local(W)(s): $s\in S$}
Let us think of S as representing the speaker’s state of belief. The Stipulation has the effect of forcing LOCAL(W)(s, S) to represent Stalnaker’s notion of ‘Common Ground’ (or ‘Context Set’): these are the worlds which, for all the speaker knows, could be the world he lives in.

- *Reference and truth relative to an assignment and to an information state*

The definition is in two steps. First, we define reference and satisfaction under an assignment s *in an information state S.* The assignment s is not enough because S serves indirectly to determine which worlds count as ‘close’, which in turn determines which descriptions of worlds fail to refer (this occurs for instance when the presupposition introduced by LOCAL is violated). In a second step, we define updates on information states.

Let s be an element of an information state S.
-If ξ is a constant, $[[\xi]]^{s, S}=I(\xi)$
-If ξ is a variable, $[[\xi]]^{s, S}=s(\xi)$

-$[[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]]^{s, S}\neq\#$ iff each of $[[\tau_1]]^{s, S}, ..., [[\tau''_p]]^{s, S}$ is $\neq\#$.
If $\neq\#$, $[[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]]^{s, S}=1$ iff $<[[\tau_1]]^{s, S}, ..., [[\tau''_p]]^{s, S}>\in I(R)$
-$[[\neg\varphi]]^{s, S}\neq\#$ iff $[[\varphi]]^{s, S}\neq\#$. If $\neq\#$, $[[\neg\varphi]]^{s, S}=1$ iff $[[\varphi]]^{s, S}=0$
-$[[(\varphi_1\&\varphi_2)]]^{s, S}\neq\#$ iff $[[\varphi_1]]^{s, S}\neq\#$ and for $S'=\{s'\in S: [[\varphi_1]]^{s', S}=1\}$, $[[\varphi_2]]^{s, S'}\neq\#$.
If $\neq\#$, $[[(\varphi_1\&\varphi_2)]]^{s, S}=1$ iff $[[\varphi_1]]^{s, S}=1$ and $[[\varphi_2]]^{s, S}=1$.
-$[[[\iota_{\xi_k}\xi_i\varphi]]]^{s, S}\neq\#$ iff
(a) $\forall e\in sort(\xi)$: $[[\varphi]]^{s[\xi i\to e], S}\neq\#$, and
(b) $f(s(\xi_k), \{e\in sort(\xi): [[\varphi]]^{s[\xi i\to e],S}=1\})\neq\#$, i.e. (given Condition 3) $\{e\in sort(\xi): [[\varphi]]^{s[\xi i\to e], S}=1\}\neq\emptyset$
If $\neq\#$, $[[[\iota_{\xi_k}\xi_i\varphi]]]^{s, S}=f(s(\xi_k), \{e\in sort(\xi): [[\varphi]]^{s[\xi i\to e], S}=1\})$
-If τ is a term:
$[[\tau\{local\}]]^{s,S}\neq\#$ iff $\forall s'\in S[[\tau]]^{s',S}\neq\#$ and $\forall s'\in S$ $[[\tau]]^{s',S}=local(sort(\tau))(s')$. If $\neq\#$, $[[\tau\{local\}]]^{s,S}=[[\tau]]^{s,S}$
$[[\tau\{<local\}]]^{s,S}\neq\#$ iff $\forall s'\in S$ $[[\tau]]^{s', S}\neq\#$ and $\exists s'\in S$ $[[\tau]]^{s', S}\neq local(sort(\tau))(s')$. If $\neq\#$, $[[\tau\{<local\}]]^{s,S}=[[\tau]]^{s,S}$
$[[\tau\{LOCAL\}]]^{s,S}\neq\#$ iff $\forall s'\in S[[\tau]]^{s', S}\neq\#$ and $\forall s'\in S$ $[[\tau]]^{s',S}\in LOCAL(sort(\tau))(s, S)$. If $\neq\#$, $[[\tau\{LOCAL\}]]^{s, S}=[[\tau]]^{s, S}$
$[[\tau\{<LOCAL\}]]^{s,S}\neq\#$ iff $\forall s'\in S$ $[[\tau]]^{s', S}\neq\#$ and $\exists s'\in S$ $[[\tau]]^{s, S}\notin LOCAL(sort(\tau))(s, S)$. If $\neq\#$, $[[\tau\{LOCAL\}]]^{s, S}=[[\tau]]^{s, S}$
$[[\tau\{<\tau'\}]]^{s,S}\neq\#$ iff $\forall s'\in S$ $[[\tau]]^{s',S}\neq\#$ and $[[\tau']]^{s',S}\neq\#$ and $\forall s'\in S$ $[[\tau]]^{s',S} <_{local(sort(\tau))(s')}[[\tau']]^{s',S}$. If $\neq\#$, $[[\tau\{<\tau'\}]]^{s,S}=[[\tau]]^{s,S}$
-$[[\forall\xi_i\varphi]]]^{s, S}\neq\#$ iff $\forall e\in sort(\xi)$: $[[\varphi]]^{s[\xi i\to e], S}\neq\#$.
If $\neq\#$, $[[\forall\xi_i\varphi]]]^{s, S}=1$ iff for all $e\in sort(\xi)$: $[[\varphi]]^{s[\xi i\to e], S}=1$.
-$[[\tau=\tau']]]^{s, S}\neq\#$ iff $[[\tau]]]^{s, S}\neq\#$ and $[[\tau']]]^{s, S}\neq\#$. If $\neq\#$, $[[\tau=\tau']]]^{s, S}=1$ iff $[[\tau]]]^{s, S}=[[\tau']]]^{s, S}$

- *Updates*

This is a standard update semantics, in which $S[\varphi]$ is the result of updating information state S with the formula φ
Let S be an information state. Then:
-$S[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]\neq\#$ iff $\forall s\in S$ $[[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]]^{s, S}\neq\#$.
If $\neq\#$, $S[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]=\{s\in S: [[R(\tau_1, ..., \tau_{m}, \tau'_1, ..., \tau'_{n}, \tau''_1, ..., \tau''_p)]]^{s, S}=1\}$
-$S[\neg\varphi]\neq\#$ iff $S[\varphi]\neq\#$. If $\neq\#$, $S[\neg\varphi]=S-S[\varphi]$
-$S[(\varphi_1\&\varphi_2)]\neq\#$ iff $S[\varphi_1]\neq\#$ and $S[\varphi_1][\varphi_2]\neq\#$. If $\neq\#$, $S[(\varphi_1\&\varphi_2)]=S[\varphi_1][\varphi_2]$
-$S[\forall\xi_i\varphi]\neq\#$ iff $\forall s\in S$ $\forall e\in sort(\xi)$: $[[\varphi]]^{s[\xi i\to e], S}\neq\#$. If $\neq\#$, $S[\forall\xi_i\varphi]=\{s\in S: \forall e\in sort(\xi)\ [[\varphi]]^{s[\xi i\to e], S}=1\}$
-$S[\tau=\tau']\neq\#$ iff $\forall s\in S$ $[[\tau=\tau']]]^{s, S}\neq\#$. If $\neq\#$, $S[\tau=\tau']=\{s\in S: [[\tau]]]^{s, S}=[[\tau']]]^{s, S}\}$

- *Truth*

φ is true with respect to s iff $\{s\}[\varphi]=\{s\}$ (in other words, the singleton $\{s\}$ updated with φ is $\{s\}$ itself).

- *Examples*

(I depart from the 'official' notation for predicates, for which I use English words.)

(50) a. He_i is me_k (*is not a presupposition failure*)
b. $x_i\{<\text{local}\}=x_k\{\text{local}\}$
c. $S[b]\neq\#$ iff $\forall s\in S\ [[x_i\{<\text{local}\}=x_k\{\text{local}\}]]^{s,\,S}\neq\#$
iff $\forall s\in S(\exists s'\in S\ [[x_i]]^{s',\,S}\neq \text{local}(D)(s')\ \ \&\ \ \forall s'\in S\ [[x_k]]^{s',\,S}=\text{local}(D)(s'))$
iff $\exists s'\in S\ s'(x_i)\neq \text{local}(D)(s')\ \&\ \ \forall s'\in S\ s'(x_k)=\text{local}(D)(s'))$
If $\neq\#$,
$S[b]=\{s\in S: [[x_i\{<\text{local}\}]]^{s,\,S}=[[x_k\{\text{local}\}]]^{s,\,S}\}=\{s\in S: s(x_i)=s(x_k)\}$

<u>Note</u>: Intuitively, the definedness condition indicates that (i) there must be a possibility that 'he_i' doesn't refer to the speaker, i.e. it must *not* be presupposed that 'he_i' refers to the speaker, and (ii) it must be presupposed that 'me_k' refers to the speaker.

(51) a. That_i is this_k (*is not a presupposition failure*)
b. $x_i\{<\text{LOCAL}\}=x_k\{\text{LOCAL}\}$
c. $S[b]\neq\#$ iff $\forall s\in S\ [[x_i\{<\text{LOCAL}\}=x_k\{\text{LOCAL}\}]]^{s,\,S}\neq\#$
iff $\forall s\in S(\exists s'\in S\ [[x_i]]^{s',\,S}\notin \text{LOCAL}(D)(s',S)\ \&\ \forall s'\in S\ [[x_k]]^{s',\,S}\in \text{LOCAL}(D)(s',S)$
iff $\exists s'\in S\ s'(x_i)\notin \text{LOCAL}(D)(s',S)\ \&\ \ \forall s'\in S\ s'(x_k)\in \text{LOCAL}(D)(s',S)$
If $\neq\#$,
$S[b]=\{s\in S: [[\ x_i\{<\text{LOCAL}\}]]^{s,\,S}=[[x_k\{\text{LOCAL}\}]]^{s,\,S}\}=\{s\in S: s(i)=s(k)\}$

(52) a. $\text{Wisahkechahk}^{\text{PROX}}$leave-behind $\text{Fox}^{\textbf{OBV}}$ *(proximate vs. obviative in Algonquian)*
b. $\text{leave}(W\{<\text{local}\},\ F\{<W\{<\text{local}\}\},\ t_0,w_0))$
c. $S[b]\neq\#$ iff $\forall s\in S\ [[\text{leave}(W\{<\text{local}\},\ F\{<W\{<\text{local}\}\},\ t_0,w_0)]]]^{s,\,S}\neq\#$
iff $\exists s\in S\ I(W)\neq \text{local}(D)(s)\ \&\ \forall s\in S\ I(F)<_{\text{local}(D)(s)}I(W)$
If $\neq\#$,
$S[b]=\{s\in S: <I(W), I(F), s(t_0), s(w_0)>\in I(\text{leave})\}$

<u>Note:</u> Proximate marking is analyzed as simple 3rd person features in English. Obviative marking on 'Fox' is analyzed as a presupposition that Fox is less salient than another individual which is denoted using a proximate expression (in this case, 'Wisahkechahk').

(53) a. The man is coughing *(need not refer to the speaker even if the speaker is male)*

b. $\mathrm{cough}([\iota_{x_k} x_i\, \mathrm{man}(x_i, t_0, w_0)], t_0, w_0)$

c. $S[b]\neq\#$ iff $\forall s\in S\ \{e\in D: [[\mathrm{man}(x_i, t_0, w_0)]]^{s[x_i\to e], S}=1\}\neq\varnothing$, iff $\forall s\in S\ \{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{man})\}\neq\varnothing$

If $\neq\#$,

$S[b]=\{s\in S: \langle f(s(x_k), \{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{man})\}), s(t_0), s(w_0)\rangle\in I(\mathrm{coughing})\}$

<u>Note</u>: If the point of reference $s(x_k)$ is a man, then by Centering 'the man' must refer to $s(x_k)$. In particular, if $s(x_k)$ is the speaker and the speaker is a man, then 'the man' must refer to the speaker. However nothing forces x_k to denote the speaker, and thus in general 'the man' could refer to someone other than the speaker even if the latter is a man.

(54) a. The pig is grunting, but the pig with floppy ears isn't grunting *(need not be a contradiction)*

b. $[\iota_{x_k} x_i\ \mathrm{pig}(x_i,t_0,w_0)]\ \mathrm{grunting}(x_i,t_0,w_0)\ \&\ [\iota_{x_k} x_i((\mathrm{pig}(x_i,t_0,w_0)\ \&$
$\mathrm{floppy}(x_i,t_0,w_0))]\neg\mathrm{grunting}(x_i,t_0,w_0)$

c. $S[b]\neq\#$ iff $\forall s\in S\ \{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{pig})\}\neq\varnothing$ and $\forall s\in S$ s.t. $\langle f(s(x_k), \{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{pig})\}), s(t_0), s(w_0)\rangle\in I(\mathrm{grunting})\}$, $\{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{pig})\ \&\ \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{floppy})\}\neq\varnothing$

If $\neq\#$,

$S[b]=\{s\in S: \langle f(s(x_k), \{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{pig})\}), s(t_0), s(w_0)\rangle\in I(\mathrm{grunting})\ \&$
$\{e\in D: \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{pig})\ \&\ \langle e, s(t_0), s(w_0)\rangle\in I(\mathrm{floppy}), s(t_0), s(w_0)\rangle\notin I(\mathrm{grunting})\}$

<u>Note:</u> If the closest pig doesn't have floppy ears, the selection function f will not select the same individual for the two descriptions 'the pig' and 'the pig with floppy ears', which explains that the sentence isn't contradictory.

(55) a. If John came, Mary would be happy, but if John came and he was drunk, Mary wouldn't be happy *(need not be a contradiction)*

b. $[\iota_{w_0} w_i\ \mathrm{came}(J,t_0,w_i)]\mathrm{happy}(M,t_0,w_i)\ \&\ [\iota_{w_0} w_i\ \mathrm{came}(J,t_0,w_i)\ \&\ \mathrm{drunk}(J,t_0,w_i)]$
$\neg\mathrm{happy}(M,t_0,w_i)$

c. $S[b]\neq\#$ iff $\forall s\in S\ \{e\in W: \langle I(J), s(t_0), e\rangle\in I(\mathrm{came})\}\neq\varnothing$ and $\forall s\in S$ s.t. $\langle I(M), s(t_0), f(s(w_0), \{e\in W: \langle I(J), s(t_0), e\rangle\in I(\mathrm{came})\})\rangle\in I(\mathrm{happy})\}$: $\{e\in W: \langle I(J), s(t_0), e\rangle\in I(\mathrm{came})\ \&\ \langle I(J), s(t_0), e\rangle\in I(\mathrm{drunk})\}\neq\varnothing$

If $\neq\#$,

$S[b]=\{s\in S: \langle I(M), s(t_0), f(s(w_0), \{e\in W: \langle I(J), s(t_0), e\rangle\in I(\mathrm{came})\})\rangle\in I(\mathrm{happy})\ \&\ \langle I(M),$

$s(t_0), f(s(w_0), \{e\in W: \{e\in W: <I(J), s(t_0), e>\in I(came)\ \&\ <I(J), s(t_0),$
$e>\in I(drunk)\})>\notin I(happy)\}$

[For simplicity I have disregarded mood in this example. See below]
Note: If the closest world in which John comes is one in which he isn't drunk, the selection function f will not select the same world for the two descriptions 'if John comes' 'if John comes and is drunk', which explains that the sentence isn't contradictory.

(56) a. If John is sick, Mary is unhappy *(indicative conditional)*
b. $unhappy(Mary, t_0\{local\}, [\iota_{w_0} w_i\, sick(J,t_0\{local\},w_i)]\{LOCAL\})$
c. $S[b]\neq\#$ iff $\forall s\in S\ (\{e\in W: <I(J), s(t_0), e>\in I(sick)\}\neq\emptyset\ \&\ s(t_0)=local(T)(s)\&\ f(s(w_0),$
$\{e\in W: <I(J), s(t_0), e>\in I(sick)\})\in LOCAL(W)(s, S)$, with $LOCAL(W)(s,$
$S)=\{local(W)(s): s\in S\}$ (=the Common Ground), by the Stipulation introduced above.)
If $\neq\#$,
$S[b]=\{s\in S: <I(M), s(t_0),f(s(w_0), \{e\in W:<I(J),s(t_0), e>\in I(sick)\})>\in I(unhappy)\}$

[Present tense and mood are treated in terms of the features 'local' and 'LOCAL']

(57) a. If John were sick, Mary would be unhappy *(subjunctive conditional)*
b. $unhappy(Mary, t_0\{local\}, [\iota_{w_0} w_i\, sick(J,t_0\{local\},w_i)]\{<LOCAL\})$
c. $S[b]\neq\#$ iff $\forall s\in S\ (\{e\in W: <I(J), s(t_0), e>\in I(sick)\}\neq\emptyset\ \&\ s(t_0)=local(T)(s))\&\ \exists s\in S$
$(f(s(w_0), \{e\in W: <I(J), s(t_0), e>\in I(sick)\})\notin LOCAL(W)(s, S))$, with $LOCAL(W)(s,$
$S)=\{local(W)(s): s\in S\}$ (=the Common Ground), by the Stipulation introduced above.
If $\neq\#$,
$S[b]=\{s\in S: <I(M), s(t_0),f(s(w_0), \{e\in W:<I(J),s(t_0), e>\in I(sick)\})>\in I(unhappy)\}$

(58) a. If John had been sick (now), Mary would have been unhappy *(double subjunctive conditional)*
b. $unhappy(Mary, t_0\{local\}, [\iota_{w_0} w_i\, sick(J,t_0\{local\},w_i)]\{<w_1\{<LOCAL\}\}))$
c. $S[b]\neq\#$ iff
(i) $\exists s\in S\ s(w_1)\notin LOCAL(W)(s, S)$, with $LOCAL(W)(s, S)=\{local(W)(s): s\in S\}$ (=the Common Ground), by the Stipulation introduced above.
[this is the presupposition introduced by $w_1\{<LOCAL\}$)
(ii) $\forall s\in S\ s(t_0)=local(T)(s)$ [presupposition introduced by $t_0\{local\}$]
(iii) $\forall s\in S\ \{e\in W: <I(J), s(t_0), e>\in I(sick)\}\neq\emptyset$ [presupposition introduced by the *if*-clause]
(iv) $\forall s\in S\ f(s(w_0), \{e\in W:<I(J),s(t_0), e>\in I(sick)\}) <_{local(W)(s)} s(w_1)$
If $\neq\#$,
$S[b]=\{s\in S: <I(M), s(t_0),f(s(w_0), \{e\in W:<I(J),s(t_0), e>\in I(sick)\})>\in I(unhappy)\}$

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