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Becker, Ramsey, and Hi-world Semantics. Toward a Unified Account of Conditionals

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In Lowe (1995), instead of endorsing a Stalnaker/Lewis-style account of counterfactuals, E. J. Lowe claims that a variation of C. I. Lewis's strict implication alone captures the essence of everyday conditionals and avoids the paradoxes of strict implication. However, Lowe's approach fails to account for the validity of simple and straightforward arguments such as 'if 2=3 then 2+1=3+1', and Heylen & Horsten (2006) even claims that no variation of strict implication can successfully describe the logical behavior of natural language conditionals. By incorporating the German logician O. Becker's modal intuition with the insight of Ramsey's Test, we show that there does exist a unified, strict-conditional based account of everyday conditionals, which withstands all attacks previously raised against truth-conditional accounts of conditionals. Furthermore, a subtle distinction between autistic and realistic readings of the indexical 'I' involved in a conditional helps us resolve a recent debate concerning the Thomason conditionals.

Keywords: Becker's Semantics, Ramsey's Test, Hi-world Semantics, Moore's Principles, Thomason conditionals.

1. *Introduction*

In Lowe (1995: 57), E. J. Lowe reckons

> Conditionals in general present an extremely perplexing set of linguistic phenomena which often seem to defy a simple, uniform treatment of them for logical purpose.

Nevertheless, what he actually did was to try the seemingly impossible, namely, to defend a relatively simple core theory for them. Heylen

& Horsten (2006) defied Lowe's attempt and proved in general that no future attempts along the line of variation of strict implication would ever succeed. I think Lowe's attempt was indeed problematic, but Heylen and Horsten's analysis was problematic as well, because it was misled by an unwarranted assumption concerning possible worlds, which we shall explain in more detail later.

In Lowe (1983), Lowe expresses his general uneasiness towards the possible-world based account of conditional that were developed in the works of Stalnaker and Lewis.[1] As he wrote at that time,

> At no time, however, shall I argue for my position by appeal to considerations involving 'possible worlds', because I find this notion so fraught with epistemological and ontological difficulties that to explicate conditional in terms of possible worlds must in my view, be to explain the obscure by the still more obscure. (Lowe 1983: 358)

Stalnaker and Lewis do employ possible worlds in their accounts of conditionals, but it is possible that what makes Lowe uneasy about possible worlds is not that the notion of possible worlds in itself is problematic, but rather that in order to cope with the phenomenon of conditionals, Stalnaker and Lewis have resorted to some additional structures imposed upon possible worlds, such as "worlds closest to ours", and "constantly varying spheres of possible worlds", etc. This partly explains the fact that twelve years later, in Lowe (1995), Lowe himself adopts a possible-world interpretation for counterfactuals as well—apparently, what he finds unacceptable are some miscellaneous notions associated with possible worlds, rather than possible worlds themselves.

As is remarked in Copeland (2002), in the early days of possible worlds, a Beckerean notion of possible worlds—or case-classes (Becker 1952)—is a strong contender along with the familiar notion of Kripkean possible worlds. In this paper, I shall adopt the hierarchical possible world semantics, i.e. the so-called 'hi-world semantics', developed in Tsai (2012) and try to provide a unified treatment of the logic of conditionals which, to a greater extent, catches the essence of everyday conditionals, indicative and subjunctive alike. Such semantics of conditionals not only is simpler than that of Stalnaker and Lewis but also sticks to Lowe's insight of using strict conditional as the backbone of a conditional. This in effect shows that Heylen and Horsten's negative result has not been conclusive. As a matter of fact, their analysis fails right at the beginning when they assume that

> … it would scarcely be imaginable that the correct interpretation of conditionals essentially involves nested modalities. The resulting readings would be just too complicated for humans to use in ordinary reasoning. (Heylen and Horsten 2006: 540)

As we shall see soon, the hierarchical structure of a hi-world, consisting of different levels of case-classes, can play an essential role in our understanding of modality and conditionals.

[1] See, for instance, Stalnaker (1968) and Lewis (1973).

Two simple yet insightful ideas, due to O. Becker and F. P. Ramsey respectively, shall be the two pillars of our unified semantics for a language that contains conditionals. With Becker's insight, one can, through recognizing worlds of different levels, avoid the paradoxes of material implication, and with Ramsey's Test, we would not fall easy prey of the paradoxes of strict implication.

In the next section, we shall sketch the basics of Becker's semantics and the hi-world semantics, regarded as an alternative to the Kripkean semantics, and use it as the default semantics for our subsequent interpretation of modal operators. This by no means suggests that Kripke's semantics is in any way inferior to the Beckerian semantics. It is just that the account of conditionals that we will to proposing can be more straightforwardly discussed in Beckerian terms.

2. *Becker's Semantics and the Hi-world Semantics*

In Becker (1952), a "statistical interpretation of modal logic" was formulated in terms of cases and case-classes in such a way that a non-modal sentence P was to be evaluated against a case, while a primitive modal sentence (such as $\Box P$ and $\Diamond P$) and an iterated modal sentence (such as $\Box\Box P$ and $\Diamond\Box P$) were to be evaluated against a first level *case-class*[2] (i.e. a set of cases) and a second level case-class (i.e. a set of first level case-classes) respectively to yield a truth value. And the semantics is set up in such a way that $\Diamond\Box P$ is true with respect to a set U^2 of case-classes provided that among case-classes of U^2, there is at least one case-class U^1 such that P is fulfilled in all cases contained in it. Higher degree situations can be worked out in the same spirit through induction: degree n modal sentences, i.e. iterated modal sentences with n modal operators, are to be evaluated against a level n case-class, where a level k case-class is a set of level k-1 case-classes, and a level 0 case-class is simply a case. A level 0 case can be seen, if one prefers, as a possible world, or, more properly, a plain world. A possible interpretation of the set U^1 is that it consists of all possible worlds consistent with one's present knowledge about the actual world. And, contrary to what some possible-world theorists would have said, this interpretation suggests that *counterfactual* possible worlds might not reside in U^1, but rather reside in some subsets of U^2. This in effect introduces a stratification into the realm of possibility.

A sentence of the form '*p* or *q*' can be concerned with two different kinds of entities. It may be saying something about a plain world w, claiming that the world is in the state prescribed by the sentence, or it may be saying something about a set U of possible worlds—claiming that each of those possible worlds is in the state prescribed in the earlier sense. So, the disjunction '*p or q*' can be translated either into $p \vee q$ or $p \surd q$, which abbreviates $\Box(p \vee q)$, and be evaluated against w and U

[2] Copeland's translation of *Fallklasse* is adopted here. See Copeland (2002).

respectively. The fact that no one would think 'I live on Earth or I shall be assassinated by a Martian' is true, while everyone would accept that 'I live on Earth or I live on Mars' is true does suggest that there is some subtle mechanism that drives us to take the U-reading for the former and the w-reading for the latter. So far as the semantics of a formal language is concerned, however, we do not need to know exactly how that mechanism works—we only need to acknowledge the existence of these two readings and know that they can be expressed in terms of connectives $\vee$ and $\surd$ respectively.

Let us illustrate this phenomenon further with the *direct argument* discussed in Stalnaker (1975: 269).

(P) *Either the butler or the gardener did it.*

∴(C) *If the butler didn't do it, the gardener did.*

Stalnaker elaborates on his pragmatic account and claims that the argument is indeed a *reasonable inference* but it is *invalid* nonetheless, so the validity of the following argument

(P1) *The butler did it.*

∴ (C) *If the butler didn't do it, the gardener did.*

would not follow from the apparent validity of 'P1/∴P'. But, for us, it is only a matter of what reading—w-reading or U-reading—a speaker tends to have in mind for each of the sentences involved in the argument. The following are some of the possibilities, where $p \to q$ here abbreviates $\Box(p \supset q)$.

1. [P1–w; P–w; C–w]
   $B / \therefore B \vee G$ valid, $B \vee G / \therefore \neg B \supset G$ valid, and $B / \therefore \neg B \supset G$ valid;
2. [P1–w; P–w; C–U]
   $B / \therefore B \vee G$ valid, $B \vee G / \therefore \neg B \to G$ invalid, and $B / \therefore \neg B \to G$ invalid;
3. [P1–w; P–U; C–U]
   $B / \therefore B \surd G$ invalid, $B \surd G / \therefore \neg B \to G$ valid, and $B / \therefore \neg B \to G$ invalid;
4. [P1–w; P–w; P–U ; C–U]
   $B / \therefore B \vee G$ valid, $B \surd G / \therefore \neg B \to G$ valid, and $B / \therefore \neg B \to G$ invalid;

Clearly, only Case 4 captures the intuition of Stalnaker's reader—before the notion of "reasonable inference" were made available—but it involves a subtle shift in the interpretation of the disjunction 'either the butler or the gardener did it' from one argument to another.

This is a promising result for Becker's semantics, but Becker's semantics actually faces a serious challenge that partly explains its poor reception in the early days of possible world semantics. This is the inconsistency in the process of evaluating sentences: sometimes you call for a world w, and sometimes you call for a set U of possible worlds. On the face of it, this separates the set of sentences into two subsets, w-sentences and U-sentences. But, the problem lies deeper—Becker's semantics cannot cope with sentences such as $\Box P \wedge P$, which apparently is neither talking merely about w nor merely about U. Fortunately, this problem can be solved with the introduction of hi-worlds. As the hi-world semantics will play an essential role in this paper, we shall sketch it here for easy reference and the reader is referred to Tsai (2012) for more details.

Let the language $\mathcal{L}$ of propositional modal logic be defined by the following BNF:

$$\varphi := p_i \mid \neg\varphi \mid (\varphi\wedge\varphi) \mid (\varphi\vee\varphi) \mid (\varphi\supset\varphi) \mid (\varphi\equiv\varphi) \mid \Box\varphi \mid \Diamond\varphi$$

where p_i is any atomic formula. A model M for $\mathcal{L}$ consists of a non-empty domain set D, together with an interpretation function I which assigns a subset $I(p_i)$ of D to each atomic formula p_i. Intuitively, one can think of an element w of D as a Kripkean possible world, but to avoid confusion, we shall refer to it merely as a *plain-world*. Now, a *hi-world* s is of the form $(U^0, U^1, U^2, \ldots)$, where U^0 is a plain-world w, and U^i is a level i world, i.e. an element of $(\mathscr{P}^*)^i(D)$, where $\mathscr{P}$ is the power set operator and $\mathscr{P}^*(A)=\mathscr{P}(A)\setminus\{\varnothing\}$. In short, a hi-world s is an element of $\prod_{i=0}^{\infty}(\mathscr{P}^*)^i(D)$. A hi-world t is a *sub-hi-world* of s provided that $\pi_i(t)\in \pi_{i+1}(s)$ for all $i \geq 0$, where π_i is the projection into the i-th component. The interpretation $\|\alpha\|_M$ of a formula α with respect to M is given by $\|\alpha\|_M=\prod_{i=1}^{\infty}U^i$, where $U^1=I(\alpha)$ and $U^i=(\mathscr{P}^*)^i(D)$ for $i > 1$.

The hi-world semantics can then be given by

i) If α is a formula, then

$\|\neg\alpha\|_M=\prod_{i=0}^{\infty}(\mathscr{P}^*)^i(D)\setminus\|\alpha\|_M$

$\|\Box\alpha\|_M=\{s\in \prod_{i=0}^{\infty}(\mathscr{P}^*)^i(D) \mid t\in \|\alpha\|_M$ for all sub-hi-worlds t of $s\}$

$\|\Diamond\alpha\|_M=\{s\in \prod_{i=0}^{\infty}(\mathscr{P}^*)^i(D) \mid$ there is a sub-hi-worlds t of s such that $t\in \|\alpha\|_M\}$

ii) If α and β are formulas, then

$\|\alpha\wedge\beta\|_M = \|\alpha\|_M \cap \|\beta\|_M$
$\|\alpha\vee\beta\|_M = \|\alpha\|_M \cup \|\beta\|_M$
$\|\alpha \supset \beta\|_M = \|\neg\alpha\vee\beta\|_M$
$\|\alpha \equiv \beta\|_M = \|\alpha \supset \beta\|_M \cap \|\beta \supset \alpha\|_M$

Interestingly, we can introduce $\alpha\sqrt{}\beta \equiv \Box(\alpha\vee\beta)$ and $\alpha\rightarrow\beta \equiv \Box(\alpha \supset \beta)$ to force the usual U-readings of disjunctions and conditionals that we discussed earlier.

3. *Ramsey's Test—Imposing the Antecedent*

In a footnote to his paper 'General propositions and causality', Ramsey famously says the following about conditionals,

> If two people are arguing 'If p will q?' and are both in doubt as to p, they are adding p hypothetically to their stock of knowledge and arguing on that basis about q; so that in a sense 'If p, q' and 'If p, $-q$' are contradictories.
> (Ramsey 1990: 155, footnote 1)

This passage is usually referred to as 'Ramsey's Test' in the literature. However, to my knowledge, Ramsey did not call it a *test* himself, and it is indeed not merely a test. It can provide us with a general truth condition for conditionals, and captures some central features of conditionals that have been ignored by many theorists and hence caused many unnecessary conceptual difficulties concerning conditionals.

In this passage, Ramsey imagines that two people are disputing about the truth of a conditional "If *p* then *q*" and then explains to us what these people actually do: they are adding *p* hypothetically to their stock of knowledge and arguing on that basis about *q*. In other words, Ramsey, in effect, outlines a truth condition for the conditional, and the truth condition roughly takes this form: a conditional 'If *p*, *q*' is true for *S* provided that *S* adds *p* hypothetically to her stock of knowledge and on that basis accepts *q*.[3] Therefore, if we stick to the framework of a truth-conditional semantics—that the meaning of a sentence is exhausted by its truth condition—then Ramsey's Test, in short RT, amounts to the core of a theory of conditionals.

Now, if we are indeed concerned with the truth of a conditional of the form 'If *p*, *q*', and are *unsure* about how the truth is to be determined—or we would not need RT in the first place—then we should take every care to ensure that in the process of carrying out RT, no other conditionals are employed. For otherwise RT would become a circular process that leads us nowhere—it invites a conditional to explain the conditional, while the meaning of the conditional introduced remains unexplained. Before spelling out what Ramsey really suggests, let us first look at a recent debate concerning RT so as to know how easily RT can be misinterpreted.

In Chalmers and Hájek (2007), the authors claim that 'Ramseyan and Moorean principles entail that rational subjects should accept that they have the epistemic powers of a god', in short, Ramsey + Moore = God. Barnett (2008) on the other hand claims that Chalmers and Hájek have interpreted Ramsey's Test incorrectly, and that, when suitably interpreted, Ramsey + Moore ≠ God. I shall show that both accounts involve circular explanation of conditionals, so that their arguments in support of their respective results can simply be discarded.

The positions of Chalmers and Hájek (2007) and Barnett (2008) can be summed up as follows. According to Chalmers and Hájek, Ramsey's Test amounts to the following.

(0) [C&H's Ramsey] 'if *p* then *q*' is acceptable to a subject *S* iff, were *S* to accept *p* and consider *q*, S would accept *q*.

C&H's Ramsey together with Moore's rationality principles would yield that, for a rational subject,

[3] Apparently, such a truth condition suggests that people could disagree upon the truth of a conditional. However, this is not a drawback of the account. Rather, it reflects the true nature of real-life conditionals.

[Moore #1] If p, then I believe p,

and

[Moore #2] If I believe p, then p,

are acceptable and thus we get

Ramsey + Moore = God. — (※)

On the other hand, after introducing a notion of General Acceptability to account for the difference between acceptance and acceptability, Barnett arrives at the conclusion that Ramsey's Test should rather be interpreted as

(0′) [Barnett's Ramsey] 'if p then q' is acceptable to a subject S iff, were S to hypothetically accept p and, on that basis, consider q, S would, on that basis, accept q.

According to Barnett, with this interpretation of the Ramsey Test, Moore #1 and Moore #2 are no longer acceptable, and we need not be bothered by the absurd result (※).[4]

Now, the true spirit of RT is to pin down the evaluation process of a conditional in terms of no other conditionals, yet while (0) introduces 'were S to' into its description of the process, (0′) complicates the matter even further by coming up with the phrase 'were S to hypothetically'. Note that, generally, 'were S to' in itself starts a counterfactual conditional, which can be roughly paraphrased as 'if S…'[5] If RT is supposed to explain for us what 'if … then …' means, how can the very notion itself be employed to do the job? These authors have indeed gone along the opposite direction that Ramsey suggests us to go. They make RT entirely dispensable: if we can understand conditionals perfectly well, then what is the point of inviting RT into play in the first place? The absurdity of C&H program (Barnett's is even more awkward) can be illustrated through the ironic equivalency of the following statements—it leads us to an infinite regression without explaining what 'if … then…' actually means.

"'**if** p **then** q' is acceptable to S_1' is acceptable to S_2' is acceptable to S_3.

⇔ "**if** S_1 accepts p and considers q, **then** S_1 would accept q' is acceptable to S_2' is acceptable to S_3.

⇔ '**if** S_2 accepts 'S_1 accepts p and considers q' and considers 'S_1 accepts q', **then** S_2 would accepts 'S_1 accepts q'' is acceptable to S_3.

⇔ **If** S_3 accepts 'S_2 accepts 'S_1 accepts p and considers q' and considers 'S_1 accepts q'' and considers 'S_2 accepts 'S_1 accepts q'', **then** S_3 would accepts 'S_2 accepts 'S_1 accepts q''.

[4] Barnett's position is further stressed in Willer (2010: 292), where Willer tries to draw the reader's attention to the fact that Ramsey "suggested that the antecedent is not accepted but only *hypothetically* added to what the agent believes to be true".

[5] Note that 'were S to' and 'if S' behave differently so far as grammar is concerned. But we ignore this issue.

Alas, there is no way to get rid of the 'if, then'. The reader, S_4 say, of the last of these sentences still has to figure out whether the conditional '**If…then…**' is acceptable. Evidently, this is unlikely what Ramsey had in mind when he wrote down his famous footnote in question.

RT as a truth-condition for conditionals

One remarkable feature of RT is that Ramsey himself does *not* commit this fallacy of circularity. He uses the word 'hypothetically' so carefully that, on the one hand, one smells the flavor of a conditional through the employment of the term, and on the other hand, the evaluation process outlined in RT remains a declarative statement of the form 'they are … and …', the grasping of which does not presuppose the grasping of 'if … then ….' Moreover, this allows us to have a truth-conditional semantics that can handle sentences with/without conditionals in a unified way.

To decide whether someone, S say, would assert 'if p then q', Ramsey suggests that[6]

(R) S asserts 'if p then q' iff S hypothetically adds p into her stock of knowledge and considers q and, on that basis, asserts q.[7]

Note that there is nothing conditional on the right hand of 'iff', and Ramsey has succeeded in providing us with a criterion for S's assertion of 'if p then q'. The nasty problem of 'whether if p then q?' has now been turned into one concerning the mental reality of S, and the latter then provides us with a definite yes-no answer to the assertion of q given p.[8] This is the key point of Ramsey's proposal—shifting one's focus from an entailment relationship between *world affairs* to an entailment relationship between *beliefs* of a person. Furthermore, we only need to know that there exists such a mental mechanism that would produce a yes-no answer to the conditional, not having to worry about what the detailed reasoning process of S actually is.

However, what do we mean by '*hypothetically* adding a belief p into one's stock of knowledge'? Is it the same as 'adding a belief p into one's stock of knowledge'? Apparently not, because otherwise the term 'hypothetically' would be redundant. Nevertheless, the difference is subtler than we expect, and it will take me some time to explain it here.

Recall that in elementary logic, to prove the argument $r / \therefore p \supset (p \wedge r)$, our friend S often use Conditional Proof as follows,

[6] Note that on the left hand side of 'iff' we are using the word 'accepts', in contrast to the word 'acceptable' used on the left hand side of 'iff' in (0).

[7] Some might object that in (R), I have used the term 'iff' which involves the notion of 'if' that I set out to explain, so I myself fall prey of the circularity problem. To this my reply is: i) 'iff' need not involve 'if' just as '=' need not involves '≥', ii) even if 'iff' involves 'if', so long as it is not used, as a meta-concept, in the definien—the Right Hand Side of 'iff', that is—the definition is not guilty of circularity.

[8] Some might object that asserting 'if p then q' and asserting q are different things, so (R) cannot be right. However, it will be shown later that the one that asserts q is not, strictly speaking, the one that asserts 'if p then q' in the first place.

1. r	Premise
2. p	Premise*
3. $p \wedge r$	1, 2, Conjunction
4. $p \supset (p \wedge r)$	2–3, Conditional Proof

Now S has a premise r in her stock of premises to begin with, which makes her stock of premises consisting of only one premise. Then at step 2, she *hypothetically* introduces another premise p into her stock of premises. A key question to ask here is 'how many premises does S have now?' If the answer is 'one', then S is not entitled to use the second premise p in step 3. If the answer is 'two', then it contradicts the fact that S has only one premise. Furthermore, S has no right to introduce a new premise into her stock as she wishes. What happens?

The fact is that when S gets past step 2, she is posing herself as some other agent $\hat{S}$ who has, in addition to all the beliefs that S has, in her stock of knowledge the belief p, and it is this $\hat{S}$ who does the reasoning at steps 2 and 3, instead of S.[9] And only when we get to step 4 does $\hat{S}$ get the sack and S goes on alone to deal with things to come. In sum, *throughout* the proof, S has only one premise (and $\hat{S}$ has two). It is just that at steps 2 and 3, we find the recruiting of $\hat{S}$ helpful. One thing important to note here is that this individual $\hat{S}$ has the belief p *intrinsically* rather than *hypothetically*. To be more explicit, at step 2 and 3, there are two individuals S and $\hat{S}$ hanging around, and while the real S has the belief p hypothetically, the hypothetical $\hat{S}$ has p intrinsically.

Now, back to (R), with the help of this individual $\hat{S}$, it is clear that the clause on the right hand side of 'iff' in (R) should be read as '$\hat{S}$ has p in her stock of knowledge and $\hat{S}$ considers q and $\hat{S}$ asserts q'.[10] Indeed we have a textual support from Ramsey (1990: p155) to hypothesize such an individual $\hat{S}$ who has p in her stock of knowledge. The passage in question is this

> So that in a sense 'If p, q' and 'If p, $-q$' are contradictories.

Recall that S is by assumption in doubt as to p, so there is no reason why she would find $p \wedge q$ and $p \wedge -q$ contradictory—they may well be both false because p is a contradiction in itself. On the other hand, for an $\hat{S}$ who has p in her stock of knowledge, $p \wedge q$ and $p \wedge -q$ are clearly contradictory. So the fact that Ramsey thinks 'If p, q' and 'If p, $-q$' are contradictories suggests that he reasons as if there is such an $\hat{S}$ who simply *has p*.

[9] The introduction of $\hat{S}$ turns the notion of hypothetical thinking into a concrete one. One can readily imagine that such $\hat{S}$'s can be designed with the help of Artificial Intelligence.

[10] The original qualification 'on that basis' in (R) serves to remind us that the assertion is made by the resulting $\hat{S}$ rather than the S.

In the end, we can spell (R) out as follows

($\mathfrak{R}$) S asserts 'if p then q' iff S poses herself as an $\hat{S}$ that is like S in every aspect except that $\hat{S}$ has p in her stock of knowledge, and $\hat{S}$ considers q, and $\hat{S}$ asserts q.

On the face of it, ($\mathfrak{R}$) is easy to understand and has great explanatory power, but the adding of p into one's stock of knowledge alone will inevitably generate some nasty problem concerning one's personal identity. We will defer the treatment of this complication until Section 5.

Alternatively, we can adopt the language of hi-world semantics and spell (R) out more explicitly as the following truth condition:

($\mathfrak{R}$*) The conditional 'if p then q' is true for a hi-world s iff there is a sub-hi-world s' of s such that p holds, and for any such s', q holds as well.

The set $\check{s}_p$ of all such sub-hi-worlds of s can be associated with the $\hat{S}$ in ($\mathfrak{R}$) in the following sense. Let $\check{s}$ denote the set of all sub-hi-worlds of s, then $\check{s}_p$ is simply $\check{s}\cap\|p\|_M$.[11] For a non-modal p, this amounts to modifying the U^1 of s into its intersection with the interpretation $I(p)$, that is $U^1\cap I(p)$, and obtaining a new hi-world $\hat{s}$. Thus s and $\hat{s}$ correspond to S and $\hat{S}$ of ($\mathfrak{R}$) perfectly. This correspondence, however, may not hold for an antecedent p that involves modality of different levels. When p is a sentence that mixes modality of different levels together, for instance, $p=(A\vee\Diamond B)$, then there may not exist an $\hat{s}$ such that $\check{s}_p$ corresponds to the set of all sub-hi-worlds of $\hat{s}$. In such cases, $\|p\|_M$ is not necessarily a product set, thus its intersection with the product set $\check{s}$, is not necessarily a product set. Therefore, the $\hat{S}$ in ($\mathfrak{R}$) can only be thought of as a hypothetical individual who possesses the mindset $\check{s}_p$, which is concretely specified as a set of hi-worlds.

As a consequence, in terms of the language of propositional modal logic, Ramsey's conditional 'if p then q' can be translated as $\Diamond p \wedge\Box(p\supset q)$. I shall call this the *default* of a conditional. The $\Diamond p$ part plays a key role in the understanding of Ramsey's conditional and it corresponds to the phrase 'adding p hypothetically to their stock of knowledge' in the Ramsey Test. In effect, $\Diamond p$ forces us to consider the possibility of p, while the $\Box(p\supset q)$ part requires us to restrict our attention to all those worlds such that p holds, and then we set our mind on q to see whether for all those worlds, q holds.

Recall that the paradoxes of strict implication take the following form. Were 'if p then q' interpreted as the strict conditional $\Box(p\supset q)$, then

S1 *not* $\Diamond p$ / $\therefore$ *if p then q*
S2 $\Box q$ / $\therefore$ *if p then q*

[11] The reader is referred to Section 2 for the meaning of a sub-hi-world and the definition of $\|p\|_M$.

are both valid argument forms, yet the following typical instances of them are clearly invalid,

Ex1 / ∴ *If 1=2 then I am happy.*
Ex2 / ∴ *If I am happy then 1<2.*

Now let us see how our candidate $\Diamond p \wedge \Box(p \supset q)$ fares on these matters. One interesting fact to note first is that this candidate was actually bypassed by Lowe in Lowe (1995). It can avoid the first paradox of strict implication right away, but its alleged failure to cope with the second paradox of strict implication has led Lowe to turn to another candidate. It is not difficult to see that with this interpretation, S2 is indeed valid provided that *p* is possible. However, for S2 to be a non-trivial argument, the conclusion 'if *p* then *q*' will have to be understood differently, namely in a subjunctive mode, and S2 then becomes invalid. As we need to resort to hi-worlds to have a better grasp of the subjunctive mode, we will postpone the detailed treatment to the next section.

However, for the moment, we can at least observe that Ex2 is not an instance of S2 at all. In other words, the utterer of Ex2 may not reckon *1<2* as a necessary truth. So the absurdity of Ex2 may not entail the invalidity of S2. Hitchcock (1998) suggests that '*p* entails *q*' can be interpreted as $\Box(p \supset q) \wedge (\Diamond p \vee \Diamond \sim q)$ to avoid both PSI1 and PSI2, but it does not work for the cases exemplified by Ex 1 and Ex 2. Another candidate $\Box(p \supset q) \wedge \Diamond p \wedge \Diamond \sim q$ would render both S1 and S2 invalid as desired, however, the adding of $\Diamond \sim q$ is too strong a requirement, because it would make the truism 'if 1=1 then 1=1' false.

In addition to the PSI, Lowe is also worried about the fact that the interpretation $\Diamond p \wedge \Box(p \supset q)$ would have deemed the following statement invalid, while it is surely a mathematical truism.

(#) If *n* were the greatest natural number, then there would be a natural number greater than *n*.

This, in the end, leads Lowe to propose interpreting 'if *p* then *q*' as $\Box(p \supset q) \wedge (\Diamond p \vee \Box q)$.

Indeed, (#) belongs to a category of conditionals that deserve more of our attention[12] but Lowe's approach solves it at the price of accepting the second paradox of strict implication. The introduction of the condition $\Box q$ for cases where *p* is not possible does avoid the problem of (#), but it runs against the direction suggested by the second paradox of strict implication. On the other hand, the fact that (#) should be deemed valid can indeed be dealt with naturally and beautifully by the hi-world semantics as will be discussed in the next section. More specifically, when $\sim \Diamond p$ is true or $\Box q$ holds, we need not concede right away that 'if *p* then *q*' is true, hence Ex1 and Ex2 can be invalid while (#) is valid. Ramsey's idea and Tsai's hierarchy together allows us to deal with these situations in a unified way which is consistent with our intuition.

[12] The reader is referred to Heylen & Horsten (2005) for a revised version of it.

4. *Conditionals and hi-worlds*

If $\Diamond p \wedge \Box(p \supset q)$ in itself would not account for the validity of (#), how are we to cope with this situation?

The central idea of the hi-world semantics is that a hi-world s consists of worlds U^i of different levels. Now, the Default of a conditional $\Diamond p \wedge \Box(p \supset q)$ is clearly to be evaluated against a level–1 world U^1. However, if we have $\sim\Diamond p$, then no plain world w in U^1 is such that p holds, thus seemingly an essential step in Ramsey's Test, namely that of 'adding p', cannot be carried out. In this case, do we simply say that the conditional 'if p then q' is false? Surely not! Re-examining Ramsey's Test more closely, we would find that Ramsey simply assumes that 'adding p' is always a possible action. In other words, if we are to be true to Ramsey's spirit, then we need to be prepared to give truth values to a conditional 'if p then q' even for cases where p is not possible.

So, we are challenged with a Mission Impossible, are we not? Certainly not. Recall that a hi-world s can be thought of as a string of worlds of all levels (U^0, U^1, U^2, ...). Now, $\sim\Diamond p$ says that there is no level–0 world w in the level–1 world U^1 such that p holds.[13] However, that does not mean we have no way to conceive of a plain world w in the entire hierarchy of s such that p holds. As a matter of fact, beside the most natural place to look for such worlds, namely U^1, the next candidate that comes to our mind is certainly U^2. So, when we are given $\sim\Diamond p$, and prompted by Ramsey's command to "add p to our stock of knowledge", what we need to do is simply imposing $\Diamond\Diamond p$, which claims that there is a level–1 world U^1 in the level–2 world U^2 such that there exists a plain world w in U^1 such that p holds.[14]

This insight leads us to the following unified account: a conditional 'if p then q' in a natural language can be translated into one of the following sentences in the language of propositional modal logic,

Unified $(p \supset q)$ or $[\Diamond p \wedge \Box(p \supset q)]$ or $\{\sim\Diamond p \wedge [\Diamond^2 p \wedge \Box^2(p \supset q)]\}$

where $\Diamond^2$ and $\Box^2$ are the shorthand for $\Diamond\Diamond$ and $\Box\Box$ respectively. Note that, as we have seen in Section 2, the w-reading $p \supset q$ is seldom what we have in mind when we utter a conditional. Furthermore, recall that, in Tsai (2012), under the mild assumption that $U^i \in U^{i+1}$, for $i \geq 0$, we have that $\Box\alpha$ entails α, for any α, and for most people this is a quite natural assumption—if something happens in all possible worlds then it certainly would happen in this world as well. It is not difficult to see that if we adopt this assumption and disregard the primitive w-reading $p \supset q$, then **Unified** simply reduces to

[13] Recall that U^1 is determined by one's stock of knowledge in such a way that if you *know* that α, then your U^1 can only consist of plain worlds such that α.

[14] Gauker (2005) has introduced similar concepts, such as plain contexts and multi-contexts, into his account of conditionals. But unlike Gauker's account, our account here is more robust, not assuming any notion similar to Lewis' sequence of centered spheres.

Core $\{\Diamond p \wedge \Box(p \supset q)\}$ or $\{\Diamond^2 p \wedge \Box^2(p \supset q)\}$

One might wonder what happens to the truth of a conditional 'if p then q' if its antecedent p is not only such that $\sim\Diamond p$ holds but also $\sim\Diamond^2 p$ holds. Should **Core** render the conditional false then? As a matter of fact this is not an option at all, because, as suggested by Ramsey, when we employ conditionals to convey our thoughts, the state of affair described by the antecedent has to be conceivable for us. If an antecedent is not only impossible but also necessarily impossible,[15] then in practice it amounts to inconceivability for any utterer of the conditional, and we should regard it as *meaningless*—the predicate 'true' is simply inapplicable to such a conditional—rather than regard it as false. For instance, if you can conceive of the existence of a round square in your U^2 then the conditional 'if there is a round square then geometry has to be rewritten' is meaningful and can be either true or false; but if you cannot, then the conditional is simply meaningless for you. This issue can be further illustrated by how we answer a query raised by an anonymous reviewer for an earlier version of this paper. According to the reviewer, while 'if $\Box A \wedge \sim A$ then $A \wedge \sim A$' is seemingly true, the present account rules it as false because we have $\sim\Diamond\Diamond(\Box A \wedge \sim A)$. The point that I would stress here is that, given the mild assumption that $U^i \in U^{i+1}$, for $i \geq 0$, we indeed have $\sim\Diamond(\Box A \wedge \sim A)$. But, to make sense of the conditional in question, we *have to* impose $\Diamond\Diamond(\Box A \wedge \sim A)$ anyway. And while it seems, at least for the reviewer, that $\sim\Diamond\Diamond(\Box A \wedge \sim A)$ holds naturally, it is not necessarily the case. While $\Diamond p$ concerns possibility, $\Diamond\Diamond p$ concerns the *possibility of possibility*, and to impose $\Diamond\Diamond p$ we would naturally drop, if necessary, the possibility scheme at the lower, that is $\Diamond p$, level, and this is how the present scheme works.[16]

Now, **Core** offers two possible reading for a conditional. In a real life discourse, a glimpse at a conditional 'if p then q' usually suffices to make us opt for one of them,

Default $\Diamond p \wedge \Box(p \supset q)$ when p is deemed possible,
Subjunctive $\Diamond^2 p \wedge \Box^2(p \supset q)$ with p is deemed impossible.

Interested readers can check for themselves that the famous pair of Oswald-Kennedy conditionals can be explained in terms of these two readings. In the indicative mood, due to the *known* fact that the assassination has indeed happened, our U^1 does not contain any plain world in which Kennedy has not been assassinated; while in the subjunctive mood, our U^1 consists only of plain worlds in which Kennedy was assassinated by Oswald, so in order to impose the antecedent we are forced to resort to some plain worlds in some $U^{1\prime}$ of U^2 in which Oswald did

[15] Theoretically one might consider pushing the possibility to still higher levels, for instance, taking into account $\Diamond^3 p$. But in practice, reaching $\Diamond^2 p$ suffices for our everyday purposes.

[16] In this example, drop the condition that all sub-hi-worlds should satisfy the condition $U^i \in U^{i+1}$, for $i \geq 0$ as well.

not assassinate Kennedy and to see whether in those plain worlds Kennedy would still be assassinated at all—by others, of course.

We have seen previously that the Default reading renders (#) false while our intuition deems it true. With the Subjunctive reading at hand, however, we can easily see that (#) can now be true if we could imagine the existence of a *pseudo*-mathematical system in which there is a greatest natural number n, and for such pseudo-mathematical systems we can always find a natural number greater than n.[17]

With this, the truth of the following two conditionals would agree with a layman's intuition that (a) is false while (b) is true

(a) *If* $3^8=2187$ *then* $3^8=2187\times3$.
(b) *If* $3^8=2187$ *then* $3^9=2187\times3$.

According to proponents of strict implication, the mathematical truth that $3^8=2187\times3=6561$ makes the antecedent $3^8=2187$ necessarily false, so both (a) and (b) are true. But an evaluator of these conditionals may not be aware of $3^8=6561$, so her U^1 may indeed contain worlds in which $3^8=2187$ holds, so that the conditionals are not deemed true automatically. Even if the evaluator happens to be an expert in numbers who knows that $3^8=2187$ is necessarily false, according to Ramsey's requirement of forcing the antecedent, he still has to force himself to accept $\Diamond^2 p$, and the truth values of (a) and (b) are still to be decided pending on whether $\Box^2(p \supset q)$. As a result, we obtain the following interesting table.

	Strict implication $\Box(p \supset q)$	Lowe $\Box(p \supset q) \wedge(\Diamond p \vee \Box q)$	Hitchcock $\Box(p \supset q) \wedge(\Diamond p \vee \Diamond{\sim}q)$	Default $\Box(p \supset q) \wedge\Diamond p$	**Core**	Intuition
a)	T	T	T	F	F	F
b)	T	F	F	F	T	T

Note that **Core** differs from the other candidates in that it allows us to resort to second order modalities. To further appreciate the power of **Core**, let us consider the following example of iterated strengthening of the antecedent

1) *If John wins the race then Jane will be happy.*
2) *If John wins the race and dies of a heart attack immediately afterward, then Jane will be happy.*

[17] It may contain results that are inconsistent with present day mathematics. The lesson one learns from (#) may be this: given that such pseudo mathematical systems are all inconsistent—the antecedent is inconsistent with present day mathematic—we conclude that it is impossible for the antecedent of (#) to be true, hence the Subjunctive reading is justified.

It takes the following form

1′) If A then D,
2′) If A and B then D.

According to the MI and SI accounts of conditionals, they should be translated as $A \supset D$, $(A \wedge B) \supset D$, and $\Box(A \supset D)$, $\Box((A \wedge B) \supset D)$, respectively. And for both accounts, the truth of 1′) guarantees that of 2′). But in practice, it is very likely that one would assert 1) and deny 2). So we need new interpretations of 1′) and 2′). According to the account outlined earlier, they can be translated as

1) $\Diamond A \wedge \Box(A \supset D)$ w.r.t. $s=(U^0, U^1, U^2, \ldots)$
2) $\Diamond^2(A \wedge B) \wedge \Box^2((A \wedge B) \supset D)$ w.r.t. $s=(U^0, U^1, U^2, \ldots)$

The fact that 2) is thought to be false comes in two steps. First, the Default reading of 2′), namely $\Diamond(A \wedge B) \wedge \Box((A \wedge B) \supset D)$, is inapplicable because in one's mind, no world in U^1 is such that $A \wedge B$—otherwise he or she would not assert 1) in the first place—so the first conjunct is false right away. Second, the Subjunctive reading $\Diamond^2(A \wedge B) \wedge \Box^2((A \wedge B) \supset D)$ of 2′) asks us to search in U^2 for some U^1 such that it contains a plain worlds w for which $A \wedge B$ holds, and then see whether all such worlds w's in all such U^1's are such that D. As it is usually not the case that Jane would be happy in those circumstances, we would regard the Subjunctive reading as false.

The merit of this account is that its prediction for the reverse Sobel sequence automatically conforms to our intuition. Evidently, when 'if A and B then D' and 'if A then D' is uttered in this order, no indicative-subjunctive shift will be triggered: $\Diamond(A \wedge B)$ itself entails $\Diamond A$, and if $\Box((A \wedge B) \supset D)$ is false then so is $\Box(A \supset D)$.

An interesting pragmatic feature to note here is that the hi-world associated with a speaker can actually be a dynamic entity, in the sense that it can evolve with discourse. For example, a new U^1 may evolve from a previous U^2 after a discourse involving the strengthening of the antecedent. I believe that this can serve as the ground for a general account of Belief Revision. However, it will have to be dealt with elsewhere.

The other two invalid argument forms that are discussed in Lewis' account of counterfactual, namely Contraposition and Transitivity, can be similarly analyzed.

The Lewis-style example of "Contraposition"

If Peter drinks, he won't get drunk.
———————————————
∴ *Had Peter gotten drunk, he didn't drink.*

can be translated into the following argument and it is invalid.

$$\frac{\Diamond A \wedge \Box(A \supset \sim(A \wedge D))}{\therefore \Diamond^2 (A \wedge D) \wedge \Box^2((A \wedge D) \supset \sim A)}$$

And the Lewisian example of "Transitivity"

If J. Edgar Hoover had been a communist, he would have been a traitor,
If he had been born a Russian, then he would have been a communist,

∴ *If he had been born a Russian, he would have been a traitor.*

can be translated into the following argument[18] and it is invalid.

$$\dfrac{\begin{array}{c}\Diamond C \wedge \Box(C \supset T)\\ \Diamond^2 R \wedge \Box^2(R \supset C)\end{array}}{\therefore\ \Diamond^2 R \wedge \Box^2(R \supset T)}$$

Finally, the belated resolution of the second paradox of strict implication is achieved by spelling S2 out as

$$\text{S2}\ \Box q\ /\therefore\ \Diamond^2 p \wedge \Box^2(p \supset q),$$

which is invalid again as expected.

5. *A Further Complication Concerning the Thomason conditionals*

Let us now come back to the charge of Chalmers & Hájek (2007) that Ramsey + Moore = God. For brevity and relevancy to the present paper, I shall consider issues associated with Moore #1 only, and leave Moore #2 untouched here—interested readers can work out the latter without much difficulty. In other words, I shall only be concerned with whether Ramsey + Moore = Omniscience. According to (R), for S to accept 'if p then I believe p' is for S to hypothetically add p into her stock of knowledge and considers 'I believe p' and accepts 'I believe p'. In terms of ($\mathfrak{R}$), Moore #1 should be stated as

> [Moore #1 ($\mathfrak{R}$)] For every rational being S who considers 'if p then I believe p', S poses herself as an $\hat{S}$ that is like S in every aspect except that $\hat{S}$ has p in her stock of knowledge, and $\hat{S}$ considers 'I believe p', and $\hat{S}$ accepts 'I believe p'.[19]

On the face of it, this seems obviously true, but in that case, aren't we on our way to the claim that Ramsey + Moore = Omniscience? I now draw the reader's attention to a subtle point that distinguishes two readings of [Moore #1 ($\mathfrak{R}$)]. As I have pointed out earlier in Section 3, it

[18] Despite that the first premise takes the form of a subjunctive conditional, it reckons the possibility that future evidences reveal that Hoover was indeed a communist, so should be translated according to the Default interpretation.

[19] Alternatively, in terms of ($\mathfrak{R}$*), we can think of S as a hi-world s and $\hat{S}$ as capable of leading us to a set $\check{s}_p$ of hi-worlds such that for any s' in $\check{s}_p$, p holds. And our job is to decide whether 'I believe p' holds for s' as well. Recall that for a non-modal p, my notion of S and $\hat{S}$ actually correspond to hi-worlds s and $\hat{s}$ respectively. But, as the reader may not be familiar with the abstract notion of hi-world semantics, in the main text, I will continue using the metaphorical S and $\hat{S}$ to explain what is going on.

is important to note that in the consideration of q—i.e. 'I believe p'—it is $\hat{S}$ who does the reasoning, while $\hat{S}$ is a hypothetical individual who plays only a temporary role for the duration of the evaluation of the conditional. In that case, what is the referent of the 'I' that appears in q? There are two possibilities

i) (Autistic-$\hat{S}$ reading) The 'I' denotes $\hat{S}$. In this case, Moore #1 is true. The term 'autistic' is adopted here because, during the reasoning process, $\hat{S}$ thinks of the referent 'I' as sharing her mental state concerning the belief p.[20]

ii) (Realistic-$\hat{S}$ reading) The 'I' denotes S. In this case, Moore #1 is false. Here $\hat{S}$ thinks of the referent 'I' as S, i.e. the person she really was.

In sum, according to the autistic reading, when considering 'if p then q', the subject in q shares the knowledge state of the hypothetical individual $\hat{S}$, while in the realistic reading, the subject in q is unaffected by the knowledge state of $\hat{S}$. And so long as we bear in mind the distinction between these two readings, we can easily see that while Moore #1 may hold for the autistic Ramsey, it does not hold for the realistic Ramsey. Given the absurdity of 'Ramsey + Moore = Omniscience', we conclude that when taken as a statement of *rationality*, 'if p then I believe p' suggests an autistic reading (which is obviously true); yet when taken as a statement of *omniscience*, 'if p then I believe p' suggests a realistic reading (which is unlikely to be true). And ($\mathfrak{R}$) itself does not tell us how $\hat{S}$ is to conceive of the "I".

To illustrate this point further, consider the following pair of sentences.

A1 If there is a bomb in this room, I will leave the room in no time.
R1 If there is a bomb in this room, I will be blown into pieces.

Both sentences sound acceptable. However, if Ramsey's remark that 'if p, q' and 'if p, $-q$' are contradictories is correct, then A1 and R1 cannot be both true. But, how come we feel that both of them are true? It is because that in A1, $\hat{S}$ reads the 'I' as $\hat{S}$, while in R1, $\hat{S}$ reads the 'I' as S. And while $\hat{S}$ knows that there is a bomb in this room, S does not. It is important to note that in considering a conditional, S seems to gain an additional pair of eyes, namely that of the hypothetical $\hat{S}$, yet it is $\hat{S}$ who does the reasoning and $\hat{S}$ can decide whether she would like the self-reflexive 'I' to refer to $\hat{S}$ or S. Similar examples abound.

[20] It is helpful to recall a famous setting concerning autism. Suppose an individual $\hat{S}$ was watching, through a semi-transparent glass window, what another individual S was doing in his room. Now, before S went out of the room to fetch some water, he put his fountain pen into #1 drawer of the desk and closed the drawer. While S was absent, someone sneaked into the room and took out the pen, put it into the #2 drawer, closed the drawer and then left. Now, when we ask $\hat{S}$ 'Which drawer would S open in order to retrieve his fountain pen after he comes back?' an autistic $\hat{S}$ would allegedly say #2, while an $\hat{S}$ with second person perspective would have said #1.

A2 If there is a ton of gold buried under my house, I would dig it up and become a rich man.
R2 If there is a ton of gold buried under my house, I wouldn't have known it and would thus remain poor.
A3 If tonight's lottery winning numbers are 1~6, I will pick these numbers on my ticket and win the lottery.
R3 If tonight's lottery winning numbers are 1~6, I will have no chance of winning it.

Here, in the autistic A2 and A3, the 'I' refers to $\hat{S}$, who has the antecedent in her stock of knowledge, while in the realistic R2 and R3, the 'I' refers to S, who, under realistic conditions, does not have the antecedent in her stock of knowledge.

Note that the Thomason Conditional as discussed in van Fraassen (1980) can be similarly analyzed.

(3) If my business partner is cheating on me, I will never know it.

Apparently, the autistic reading of the 'I' as $\hat{S}$ in (3) renders it obviously false, and the realistic reading of the 'I' as S in (3) renders it likely true. However, the fact that the knowledge state of 'I' is the sole concern of the consequent suggests that the 'I' should be understood as S rather than $\hat{S}$—given that the antecedent is by default in the stock of knowledge of $\hat{S}$, pragmatics would deem it inappropriate for someone to deny this very fact in the consequent—thus (3) is likely to be true even in the realm of RT.

Now consider two analogous examples from Lewis (1986) and Jackson (1987) respectively:[21]

(4) If Reagan works for the KGB, I'll never believe it.
(5) If Reagan is bald, no one outside his immediate family knows it.

Note that Ramsey's Test itself does not, as many might have supposed, render (4) false directly, because, once again, we have two possible readings of the 'I' in (4). For (4) to be informative, the truth of the consequent should not be too obvious. Yet the autistic reading of (4), namely seeing the 'I' as $\hat{S}$, will, together with the assumption that $\hat{S}$ is rational, render the consequent evidently false. Therefore, the only possible reading left is the realistic one. Similarly, for (5) to be possibly true rather than trivially false, $\hat{S}$ can only adopt the realistic reading, not counting $\hat{S}$ as someone outside Reagan's immediate family who knows of Reagan's baldness.

In sum, in (3) ~ (5), the realistic reading renders them possibly true, while the autistic reading renders them false, and the Non-Triviality criterion of the consequent suggests that the realistic reading is preferred. Our analysis can be generalized even further to cases where

[21] According to Willer (2010), footnote 2, what is characteristic of such conditionals, is that "the consequent asserts the agent's ignorance or disbelief of the fact described in the antecedent".

the consequent does not involve the first person. Consider the following conditional,

(6) If Reagan works for the KGB, Ramsey will know it.

When S is trying to determine the truth of (6), she would first turn herself into an $\hat{S}$, and then decide whether $\hat{S}$'s Ramsey shares with $\hat{S}$ the knowledge of the antecedent of (6). If the answer is 'yes', then she is having the autistic reading of Ramsey, i.e. forcing her Ramsey to know out of the blue the thing she herself knows. The use of the term 'autistic' is justified by the fact that $\hat{S}$ imposes the knowledge of Reagan's being a double agent—part of $\hat{S}$'s mental state—onto Ramsey. If the answer is 'no', then the 'Ramsey' is read realistically. And I believe most people would, taking into consideration the Non-Triviality criterion I mentioned earlier, read (6) the realistic way and render it likely false.

Variants of (6) can admit an autistic reading as well. Consider, for instance, the following conditional,

(7) If Reagan works for the KGB, Ramsey will report it.

If the 'Ramsey' in (7) is read realistically, then there is no guarantee that he knows that Reagan works for the KGB, and then how on the earth can we expect him to report it? Nonetheless, many people would be happy to accept (7), taking into account the fearless character of Ramsey. That is to say, they tend to read the Ramsey in (7) as already possessing, as $\hat{S}$ does, the knowledge of Reagan's being a double agent. I believe such an autistic reading is the default reading when one faces (7). In contrast to the Non-Triviality criterion that I have employed in the reading of (6) so as to make sure that (6) is informative rather than being a truism, here a Relevancy criterion ensures that the 'Ramsey' in (7) has the relevant background information for him to decide upon whether to report it or not.[22]

As is evident from the analysis of this Section, our account set up in the previous sections alone cannot successfully resolve Chalmers and Hájek's challenge. However, with the discovery of this additional subtle distinction between autistic and realistic readings, such problems are solved in the end.

[22] Finally, it is interesting to observe that (7) can admit a realistic reading still, and it can be easily illustrated by the following dialogue.

Q: If Reagan works for the KGB, will Ramsey report it?

A: No way!

Q: How come?

A: Ramsey died before Reagan turned nineteen!

6. *Conclusion*

Becker prompts us to distinguish between talks about cases and talks about case-classes, and Ramsey reminds us how conditionals are used in daily language, in particular, he stresses the key step of imposing the antecedent in the process of evaluating a conditional. Hi-world semantics incorporates Becker's insight into a single framework so that all sentences are evaluated against a hi-world *s*, which consists in a string of worlds of all levels (U^0, U^1, U^2, …). Indicative conditional 'if *p*, *q*' and subjunctive conditional 'were *p*, *q*' can then, usually, be expressed as $\Diamond p \wedge \Box(p \supset q)$ and $\Diamond^2 p \wedge \Box^2(p \supset q)$ respectively.

One further complication concerning conditionals was illustrated by a recent debate about whether Ramsey + Moore = God. Our account sheds light on this matter by revealing that an autistic reading and a realistic reading of the indexical 'I' in 'If *p* then I believe *p*' have been employed by Chalmers and others to affirm the thesis of rationality and to assert the omniscience thesis at the same time. While rationality thesis generally concerns about the reaction of an individual *S* after she is aware of the affair *p*, i.e. it concerns $\hat{S}$ rather than *S*, for *S* to be omniscient and know things in the future, she is expected to know them beforehand, and this amounts to reading the 'I' in 'If *p* then I believe *p*' as *S* rather than $\hat{S}$. This subtle shift from reading 'I' as $\hat{S}$ to reading it as *S*, subsequently turning an acceptable rationality statement to an unacceptable omniscience statement, then accounts for the confusion involved in Chalmers and Hájek (2007) and Barnett (2008).

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