

# The Representational Inadequacy of Ramsey Sentences<sup>1</sup>

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*Abstract:* We canvas a number of past uses of Ramsey sentences which have yielded disappointing results, and then consider three very interesting recent attempts to deploy them for a Ramseyan Dialetheist theory of truth, a modal account of laws and theories, and a criterion for the existence of factual properties. We think that once attention is given to the specific kinds of theories that Ramsey had in mind, it becomes evident that their Ramsey sentences are not the best ways of presenting those theories.

*Keywords:* Ramsey sentence, Ramseyan theoretical truth, Dialetheism, modal theories, factual properties.

## 1. Ramsey Sentences

*Old Replacement Problems.* Ever since Frank P. Ramsey's views on theories became known through Richard B. Braithwaite's publication of a collection of his papers, the use of Ramsey sentences has been a simple yet powerful source of solutions to philosophically hard problems<sup>2</sup>. In the first section we review several important early uses of Ramsey sentences and the loss of interest in those problems and the consequent loss of interest in the sentences themselves. In the second section we review a kind of revival: some recent uses of Ramsey sentences to settle problems about truth (Dialetheism), laws (their modal character), and to help determine what (factual) properties exist. Despite the real interest that these new uses of Ramsey sentences generates, we want to argue that that interest is seriously diminished once it is realized that there are reasons not to take the Ramsey sentence as a good representation of a theory. In the third and final section we argue that if you consider a kind of theory that was taken to be illustrative of the theories that could be Ramsified, then there are compelling reasons not to take the Ramsey sentence as the best rep-

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<sup>1</sup> Special thanks to Isaac Levi and Nils-Eric Sahlin for some very astute advice and encouragement.

<sup>2</sup> Ramsey [1]

resentation of a theory. Ramsey proposed a canonical way of presenting a theory, which he claimed was the best way of presenting it<sup>3</sup>. Moreover the device for converting a theory that was already in a standard form was simple and direct. If the theory  $T$  was presented in a standard form with theoretical predicates and relations  $\tau_1, \tau_2 \dots, \tau_n$ , and observational predicates and relations  $o_1, o_2 \dots o_n$ , then replace all the theoretical terms with second-order variables (different terms being replaced by different variables), and, to the result of this replacement, prefix the existential quantifiers with respect to those second order variables. If the original theory is written as  $T(\tau_1, \tau_2 \dots, \tau_n)$  (with the observational terms suppressed), then the Ramsey sentence  $R(T)$  of the theory  $T$  is

$$(\exists X_1) (\exists X_2) \dots (\exists X_n) T(X_1, X_2, \dots, X_n).$$

A replacement problem of great interest was whether a theory that had theoretical terms could be replaced by a theory that didn't, but nevertheless had the same observational consequences.<sup>4</sup> The urgency of settling the replacement problem diminished with the realization that the distinction between an observational and a theoretical vocabulary was not a good starting point, nor was it a good ending point. It should be noted that Ramsey's own discussion was framed using a distinction between primary and secondary languages, and did not require a hard and fast distinction between an observational and theoretical vocabulary, uniformly imposed across all theories. Nevertheless the construction of Ramsey sentences was taken to be dependent upon a distinction between observational and theoretical predicates, and when interest in this kind of application attenuated, so too did the interest in Ramsey sentences themselves. This isn't to say that there couldn't be applications which depended upon the segregation of the terms of a theory along other lines; perhaps a primary/second-

<sup>3</sup> Ramsey [2], p.131. The early literature on replacement seems to have made the natural assumption that the Ramsey sentence of a theory  $T$  also was a theory. Ramsey says that "[t]he best way to write our theory seems to be this  $(\exists \alpha, \beta, \gamma)$  dictionary. Axioms)". We assume that this is intended for all theories. It is true that in a fragment "C. Probability and Partial Belief" in Ramsey [1990] pp.95–96, he anticipates the Tarskian notion of a theory as any set of propositions that is closed under finite conjunctions and logical consequence. That is not our present concern.

<sup>4</sup> Cf. Sheffler (1) for a lucid summary of those results. The exchange between Sheffler (2) and Bohnert (2) on whether the Ramsey sentence of a theory yields an observational replacement has more than passing interest. See Nils-Eric Sahlin, Chapter 5 for further discussion and references.

ary quality distinction. As far as I know, no interest in exploring these other kinds of applications ever surfaced.

### 1.2. *Factoring Theories into Factual and Analytic Components.*

A very interesting second application was introduced by R.Carnap<sup>5</sup> in which the Ramsey sentences are constructed by the identification of the primary/secondary system distinction of Ramsey with the observational/theoretical distinction between terms. He proposed a way in which a theory  $T(\tau_1, \tau_2 \dots, \tau_n)$  is logically equivalent to a conjunction of a factual part  $F$ , the Ramsey sentence  $R(T)$  of the theory, and an analytic part  $A$ , given by the conditional  $R(T) \rightarrow T(\tau_1, \tau_2 \dots, \tau_n)$ . The Ramsey sentence,  $R(T)$ , has exactly the same observational consequences as  $T$  does, and I suppose that that was Carnap's reason for describing it as the factual purely observational part of the theory – those consequences that contain observational but no theoretical terms.

The conditional  $R(T) \rightarrow T(\tau_1, \tau_2 \dots, \tau_n)$  is easily seen to have this interesting property: We know that a theory  $T$  and its Ramsey sentence  $R(T)$  have exactly the same observational consequences. We also know that the conditional  $R(T) \rightarrow T(\tau_1, \tau_2 \dots, \tau_n)$  has none of the (purely) observational consequences of  $T$ . That is, for any purely observational statement  $O$ ,

(1) If  $T$  implies  $O$ , then  $[R(T) \rightarrow T]$  does not imply  $O$ .

The reason is that if  $O$  is any observational consequence of  $T$ , i.e.  $T \vdash O$ , then it is also an observational consequence of  $R(T)$ . That is,  $R(T) \vdash O$ . To see that, we first note that for any  $A$  and  $B$ , if  $A$  logically implies  $B$ , then any existential generalization of  $A$  implies that generalization of  $B$  (whether the existential quantifier is first or second order). Since  $T$  implies  $O$ , it follows that  $R(T)$  implies  $R(O)$ . However, “ $O$ ” is purely observational, so none of its predicates and relations were replaced by second order variables in forming its Ramsey sentence. Thus there is no quantification over any second order variables. That is,  $R(O)$  is logically equivalent to  $O$ . Consequently  $R(T)$  implies  $O$ <sup>6</sup>. Of course since  $T$  implies  $R(T)$  it follows that every observational consequence of  $R(T)$  is also a consequence of  $T$ . Therefore we have the well known result,

<sup>5</sup> Carnap, Chapter 28, Analyticity in a Theoretical Language.

<sup>6</sup> Sheffler (1) attributes this proof to H.G. Bohnert (1).

of which Ramsey was aware, that any theory and its Ramsey sentence have exactly the same observational consequences. Suppose further that  $O$  is also an observational consequence of  $R(T) \rightarrow T$ . Then, since  $\neg R(T)$  implies  $R(T) \rightarrow T$ , it follows that  $\neg R(T) \vdash O$ . As a result we have both that  $R(T) \vdash O$  and  $\neg R(T) \vdash O$ . Therefore  $O$  is a consequence of  $R(T) \vee \neg R(T)$ , so that  $O$  cannot be an observational sentence; it is a logical truth. Carnap described the Ramsey sentence  $R(T)$  as separating out the factual part of the theory (one that implied the observational consequences of the theory), and the Ramsey conditional ( $R(T) \rightarrow T$ ) as separating out the analytic part of the theory – presumably meaning that it was the part of the theory that had none of the factual consequences of the theory  $T$ .<sup>7</sup>

In fact the result can be strengthened: the Ramsey conditional has no observational consequences whatever. Again it is a fairly direct matter: We have in general that for any statement  $O$ ,

(2) If  $[R(T) \rightarrow T]$  implies  $O$ , then  $T$  implies  $O$ .

Assume that  $O$  is any observational statement that is a consequence of the Ramsey conditional  $[R(T) \rightarrow T]$ . Then, since  $T$  implies  $[R(T) \rightarrow T]$ , it follows that  $O$  is a consequence of  $T$ . By (1),  $O$  is not a consequence of  $[R(T) \rightarrow T]$ . Therefore the Ramsey conditional has no observational consequences. It is observationally empty.

For a certain kind of philosopher, Carnap's parsing of theories would be very significant: Carnap seemed to think (wrongly we think) that the Ramsey conditionals of a theory were analytic. To some philosophers, that would be very welcome news. Analytic truths are (on a once influential view) the stock and trade of philosophy. This suggests that for every physical theory, there is some part of it (it's Ramsey conditional) that is forever philosophy. That's a pretty grand conclusion. Nevertheless it is an understatement to say that interest in this kind of parsing of theories has not been sustained, and it has gone the same way that a one-time interest

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<sup>7</sup> The theory  $T$  is therefore equivalent to the conjunction of  $R(T)$ , the Ramsey sentence of  $T$ , and  $R(T) \rightarrow T$ , the Ramsey conditional of  $T$ . Each is a consequence of  $T$ , but generally not equivalent to  $T$  itself. It would seem then that Carnap's use of the Ramsey sentence may not be the best way of presenting a theory. What it does according to Carnap, is to divide the theory into two parts, one of which yields all the observational consequences of the theory, and the other has all the non-observational consequences of the theory as consequences. It has to be argued that this is the best way of presenting a theory. Otherwise the purposes of Carnap and Ramsey are very different.

in separating out the conventional part and the non-conventional parts of theories.

These particular applications of the Ramsey sentences have not given them a sustained interest or value as a valuable philosophical tool. If this were all there were to Ramsey sentences, then their importance would be mainly as devices dedicated to solving problems that have no current interest, or worse, as helpful in defining dubious distinctions.

## 2. Ramsey Sentences and Truth, Modality, and Metaphysics

The current interest in Ramsey sentences extends dramatically beyond the few examples just mentioned. In more recent times there have been some uses that involve Ramsey sentences and variants of Ramsey sentences, that can be used to support claims about dialetheism, the modality of laws and a criterion for the existence of factual properties. These applications are significant ones in the theory of truth, the philosophy of science, and contemporary metaphysics. Each of those claims have other arguments going for them. We want to show that the use of Ramsey sentences does not give them additional support beyond what they already had.

2.1. *Truth.* We begin with some recent uses of Ramsey sentences that concern truth. Although Ramsey has been usually credited with a Redundancy theory of Truth, there is another notion of truth that can be linked to the way he described the use of Ramsey sentences.<sup>8</sup> It is based on some things that Ramsey said, but it is not an account that he explicitly defended; nor is it one that I believe he would have advocated<sup>9</sup>. Just to avoid confusion, I will use “ $T_R$ ” to indicate this non-Redundancy concept of truth that is based upon the use of Ramsey sentences – and call it *Ramsey-Theoretical truth*.

There are three types of results about  $T_R$  which deserve to be separated. According to the first, truth (“ $T_R$ ”) does not respect implication.

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<sup>8</sup> In fact there is yet a third version which Ramsey wrote in 1922 in a paper for the Apostles, which contains a subtle account of truth as an ‘incomplete symbol’. See Koslow.

<sup>9</sup> On this point I am convinced by the astute comments (in correspondence) of Nils-Eric Sahlin. The support of Dialetheism was certainly not in the agenda of Ramsey (if he ever had one), and in any case, the support doesn’t yield the strong version of Dialetheism that is most interesting – that there are some contradictions that are true.

That is, there are cases where true premises will not always imply true conclusions. There are (say) A and B which together imply some C, but the statements “A is true” and “B is true” together do not imply that “C” is true. The second type shows that the logical laws of Conjunction and Modus Ponens fail to be truth-preserving (using “ $T_R$ ”). Proofs of this kind of result have been developed in different ways by Clark Glymour<sup>10</sup> and Vann McGee<sup>11</sup> which we will briefly describe below. The third kind of result involves Dialetheism, a view which comes in a strong form -that there are some contradictions (conjunctions of sentences with their negations) that are true, and two weaker forms -that there are certain sentences such that they and their negations are both true, and a still weaker form: there are sentences such that it’s *possible* that they and their negations are both true.

The result that “ $T_R$ ” does not respect implication requires reference to some very suggestive things that Ramsey said about the truth of theoretical sentences. Ramsey sometimes describes what a theory asserts as its meaning or content<sup>12</sup>, and he notes that if one wanted to ask whether a theoretical sentence A (expressed in the theoretical vocabulary of some theory T) is true, there is the complication that theoretical sentences, according to Ramsey, are not propositions. The question whether A is true or not seems to depend on whether the Ramsey sentence of the result of adding A to some theory T is true, – that is, whether  $R(T \wedge A)$  is true. Ramsey adds a further qualification that the stock of observational sentences (“Stock”) that are associated with the theory should be included so the question of A’s truth is a matter of whether  $R(T \wedge \text{Stock} \wedge A)$  is true<sup>13</sup>. He also notes that it is a “practical” matter whether A or its negation would fit better with the additions that we make or hope to make to the theory T and its Stock. That aside is of course Ramsey’s pragmatism making itself felt.

These remarks of Ramsey suggest that a theoretical sentence A is true just in case it is part of a theory whose Ramsey sentence is true. That is, for any theoretical sentence A, we can define A as Ramsey-Theoretically true if and only if A is a part of *some* theory T (A is a consequence of T),

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<sup>10</sup> Glymour.

<sup>11</sup> Vann McGee.

<sup>12</sup> Ramsey [1], p.232; Ramsey [2], p.132.

<sup>13</sup> “Stock” indicates, for Ramsey, some set of ‘propositions’ drawn from the primary and secondary systems.

such that  $R(T)$ . That is,

$$(3) \quad T_R(A) : [(T \text{ implies } A) \text{ and } R(T), \text{ for some theory } T].$$

There is an equivalent version of (3) which sometimes makes calculations easier, according to which  $A$  is Ramsey-theoretically true if and only if it is added to some theory  $T$ , and  $R(T \wedge A)$ . That is

$$(3') \quad T_R(A)^{14} : [(T \text{ implies } A) \text{ and } R(T \wedge A), \text{ for some theory } T].$$

Several consequences are immediate:

$$(4) \quad \text{For any theoretical sentence } A, T_R(A) \text{ is equivalent to } R(T) \text{ for some theory } T.$$

$$(5) \quad \text{For any theoretical sentence } A, T_R(A) \text{ implies } R(A).$$

The reason is that by (3),  $T_R(A)$  implies  $R(T)$  for some theory  $T$ , such that  $T$  implies  $A$ . However, for any  $A$  and  $B$  such that  $A$  implies  $B$ , it follows that  $R(A)$  implies  $R(B)$ . Therefore  $R(T)$  implies  $R(A)$ , and consequently,  $T_R(A)$  implies  $R(A)$ .

$$(6) \quad R(A) \text{ implies } T_R(A), \text{ for any theory } A.$$

The reason is this: Assume that  $R(A)$ . Since there is a theory  $T$  which implies  $A$  and such that  $R(T)$  (namely the theory “ $A$ ”), it follows that  $T_R(A)$ . Thus, from (5) and (6) it follows that

$$(7) \quad T_R(A) \Leftrightarrow R(A), \text{ for any theory } A.$$

There is no question that this notion of Ramsey-Theoretical truth has some unusual features. It is not preserved by implication. To see this, two theses have to be distinguished:

- (i) (*Single Premise Case*). If  $A$  and  $B$  are theoretical sentences, and  $A$  implies  $B$ , then  $T_R(A)$  implies  $T_R(B)$ , and
- (ii) (*Multiple Premise Case*). If (for example)  $A$ ,  $B$  and  $C$  are theoretical sentences, such that  $A$  together with  $B$  imply  $C$  then it does *not* follow in general that  $T_R(A)$  together with  $T_R(B)$  imply  $T_R(C)$ .

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14 We use a notation appropriate for an operator. Those who wish to think of “Ramsey theoretically true” a predicate will need to supply the usual quotation marks where needed.

That is, for single premise implications Ramsey-Theoretical truth is preserved, and for multiple premise implications, it is not.

Consider (i). Any consequence of a Ramsey-Theoretically true  $A$  is also Ramsey-Theoretically true. The reason is this: Suppose that  $T_R(A)$  and that  $A$  implies  $B$ . Then by (3),  $R(T)$  for some theory  $T$  that implies  $A$ . Since  $A$  implies  $B$ , we have  $R(T)$  for some theory  $T$  that implies  $B$ . By (3), we conclude that  $T_R(B)$ . Consequently,  $T_R(A)$  implies  $T_R(B)$ . Consider (ii): Suppose that  $A$ ,  $B$  and  $C$  are theoretical sentences, such that  $A$  together with  $B$  imply  $C$ .  $T_R(A)$  together with  $T_R(B)$  will imply  $T_R(C)$  if and only if (1) [Some theory  $T$  implies  $A$  and  $R(T \wedge A)$ ] together with (2) [Some theory  $U$  implies  $B$  and  $R(U \wedge B)$ ] imply that (3) [Some theory  $V$  implies  $C$  and  $R(V \wedge C)$ ]. However that will not happen in general, for two reasons. Even if there are theories  $T$  and  $U$  such that  $T$  implies  $A$ , and  $U$  implies  $B$ , it will not follow that there is some theory  $V$  which implies the consequences of  $A$  and  $B$  (say their conjunction). Many examples of such theories will readily come to mind. Further, since Ramsey sentences are existentially quantified sentences, it is not generally true that if  $A, B$  imply  $C$ , then  $(\exists X)[T \wedge A(X)]$ ,  $(\exists X)[U \wedge B(X)]$  imply  $(\exists X)[V \wedge C(X)]$ . The existential quantifier does not always distribute over multiply premised implications. If it did, then it would follow that the existential quantification of any sentence would imply its universal quantification, and that is just not generally so. Consequently, Ramsey-Theoretical truth is not preserved under implication.

Clark Glymour<sup>15</sup> noted that the logical laws of Conjunction and Modus Ponens failed to respect truth. His point seems to have been misunderstood<sup>16</sup> because it was taken as the claim that Ramsified sentences fail to satisfy the rules of Conjunction and Modus Ponens. Glymour's point was not that from two Ramsey sentences you couldn't always infer their conjunction (that  $R(A)$  and  $R(B)$  failed to imply  $R(A) \wedge R(B)$ ). He meant that there would be theoretical sentences  $A$  and  $B$  such that the Ramsey-Theoretical truth of  $A$  together with that of  $B$  would not imply the Ramsey-Theoretical truth of their conjunction.

Vann McGee has very recently called attention to this feature of a concept of truth based on the Ramsey sentences, and noted another feature that is even more dramatic. Ramsey-Theoretical truth is Dialethic: there

<sup>15</sup> Glymour, pp.20–27.

<sup>16</sup> D.Braddon-Mitchell and R. Nola.

are some (theoretical) statements that are both true and false (true negation). McGee explains Ramsey's ideas on the truth of theoretical sentences by casting them in terms of Tarskian models:

A model is acceptable for Ramsey if it respects the standard values of the observations terms, and a theory is true if it is true in at least one acceptable model.

What is reaffirmed on model-theoretic grounds is the claim that a theory is true if its Ramsey sentence is true. And the remarkable result that this leads to Dialetheism is succinct: In the Ramsey sentence of a theory, the theoretical terms will have been replaced by (second-order) variables which are existentially quantified. McGee notes that:

Since there will typically be many different ways to assign extensions to the theoretical terms all consistent with the true observational statements, there will be many different, formally incompatible true theories. A sentence counts as true if it's part of a true theory; hence there will be many sentences that are both true and false.

For example: Consider a theory  $T$  that has just one theoretical term  $\tau$  in it, so that its Ramsey sentence is given by  $(\exists X)T(X)$ . Suppose that some extension  $\tau_0$  is assigned to the term  $\tau$ , of an admissible model such that  $T$  is true in it, and another extension  $\tau_1$  is assigned to  $\tau$ , under which  $T$  is false. Then it follows that there is an admissible model in which  $(\exists X)T(X)$  is true and so  $T$  is true, and there is also an admissible model in which  $(\exists X)\neg T(X)$  is true, so that  $\neg T$  is also true. Hence the Dialetheism. The form of Dialetheism that Vann McGee developed, yields the weaker result that there are sentences for which they and their negations are true, but not the strong form according to which the conjunctions of some statements and their negations are true. With this kind of weak Dialetheism, no contradiction,  $P \wedge \neg P$  is true.

There are general reasons having to do with the existential form of Ramsey sentences which yield a still weaker (very weak) Dialetheism: that it is *possible* for some theoretical sentences and their negations to both be true. Consider for the sake of a simple example, some theory  $T(\tau)$  that has only one theoretical term, and such that it is *possible* that the Ramsey sentences  $(\exists X) T(X)$  and  $(\exists Y) \neg T(Y)$  are both true.

One can give a small argument to show that there is a theory  $T$  for which this is *possible*: Suppose that for some theory  $T$ , it is impossible that the conjunction of  $(\exists X) T(X)$  and  $(\exists Y) \neg T(Y)$  is true. Then it is necessarily the case that their conjunction is false. Consequently, it is necessarily the

case that [If  $(\exists X) T(X)$  then  $(\forall Y)T(Y)$  ]. Therefore  $(\exists X)T(X)$  implies  $(\forall Y)T(Y)$  which in turn implies  $T(\tau)$ , so that the Ramsey sentence of  $T$  implies  $T(\tau)$ . And since the converse is also true, the Ramsey sentence of  $T$  is equivalent to  $T$ . Then there's not much point to presenting theories in their Ramsey form since the two are equivalent.

The upshot then is that *if* there is a theory  $T(\tau)$  that is not equivalent to it's Ramsey sentence, then it is *possible* that  $(\exists X) T(X) \wedge (\exists Y) \neg T(Y)$ . Consequently it is also possible that  $[(T(\tau) \text{ implies } T(\tau)) \wedge R(T) \wedge (\neg T(\tau) \text{ implies } \neg T(\tau)) \wedge R(\neg T)]$ . Therefore it's possible that  $[T_R(T) \wedge T_R(\neg T)]$ . Hence, very weak Dialetheism: it is *possible* that both  $T$  and its negation are Ramsey-Theoretically true.

One might object to this, that it makes little sense to suppose as the argument does, that both  $T$  and its negation are theories, so that the preceding argument for the weak Dialethic conclusion is not convincing. It's hard to see any basis for the objection. Surely it's not that theories are universal in form, so that no  $T$  and it's negation could both be theories. That is not generally so, but adhering to it would rule out the use of Ramsey sentences as theories, right from the beginning, since they are existential in form rather than universal. This was a point recognized early on by R. B. Braithwaite<sup>17</sup> when he noted that on Ramsey's view the idea that a scientific hypothesis was universal, would have to be modified. I don't find this objection convincing.<sup>18</sup>

However one can get a result that bypasses the objection: instead of using some theory and its negation, one can construct a similar argument using theories  $U$  and  $V$  which are incompatible, and for which it is possible that their Ramsey sentences,  $R(U)$  and  $R(V)$ , are both true. Then it is possible that  $[(U \text{ implies } U \text{ and } R(U)) \text{ and } (V \text{ implies } V) \text{ and } R(V)]$ . Thus it is possible that  $[T_R(U) \text{ and } T_R(V)]$ . That is, it is possible that two classically incompatible theories  $U$  and  $V$  are (Ramsey-theoretically) true.

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<sup>17</sup> Braithwaite, p. 81.

<sup>18</sup> Nevertheless one has to be careful in speaking of the equivalence or non equivalence of a theory  $T$  with its Ramsey sentence  $R(T)$ . To begin, Ramsey didn't think of theories presented with specific theoretical terms as propositional. For him it seems that some theories might not have a truth value. That could present problems in showing the familiar result that a theory  $T$  and its Ramsey sentence have the same observational consequences, since there has to be a notion of logical consequence in which things have their logical consequences even though they may not have a truth value, and two things may have the same observational consequences even if one or both of them does not have truth value. This is an issue that is easily settled; but not here.

It is surprising that whether one uses McGee's model theoretic version of Ramsey-Theoretical truth, or the account just suggested by exploiting the existential form of Ramsey sentences, there are some sentences such they and their negations are true, or that it's possible that they and their negations are true. However the support that is given to Dialethiesm on either version has to be a disappointment to the committed Dialetheist. It doesn't identify which true sentences have true negations. There's not a word about the Liar or any favorite candidate of strong Dialetheists. In fact it doesn't even follow from  $T_R(T)$  and  $T_R(\neg T)$  that  $T_R(T \wedge \neg T)$ , because, as Glymour and McGee have noted, Ramsey-theoretical truth does not respect the Law of Conjunction. It doesn't follow that some theoretical contradictions are true, or even that it's *possible* that some theoretical contradictions are true. In fact on either account it becomes evident that no contradiction is Ramsey-Theoretically true. The use of Ramsey-Theoretical truth has intriguing features, but it offers little support to (strong) Dialetheism. In fact even those features become less interesting once we see below, how poorly a theory is represented by its Ramsey sentence. Whatever support there is for strong Dialetheism, it is not increased by appeals to Ramsey-Theoretical truth.

2.2. *Modality.* The use of Ramsey sentences also has consequences for a current issue in the philosophy of science. The issue of whether theories and their laws have modal character has a positive answer if theories are best presented in their Ramsey form.

Let's define a *Ramsey Operator*  $R$  to be a sentential operator - a function that maps sentences to sentences this way: to each sentence  $A$ , let  $R(A)$  be the Ramsey sentence of  $A$ . For example, if  $T(\tau)$  is a theory with just one theoretical term  $\tau$ , then " $(\exists X) T(X)$ " is its Ramsey sentence,  $R(T(\tau))$ .  $R$  has some properties which have a certain familiarity to them:

- (1)  $A$  implies  $R(A)$ , for every  $A$ , but not conversely.
- (2)  $R(A)$  implies  $R(R(A))$ , and conversely.
- (3)  $R(A \vee B)$  implies  $R(A) \vee R(B)$ , for all  $A$  and  $B$ .
- (4) If  $A$  implies  $B$ , then  $R(A)$  implies  $R(B)$ .
- (5) For some  $A$  and  $B$ ,  $R(A)$ ,  $R(B)$  fails to imply  $R(A \wedge B)$ .

It is obvious that these features of the Ramsey Operator are formally

those of a normal modal of possibility, and that  $R(T)$  the Ramsey sentence for  $T$  should be thought of as  $\Diamond(T)$ , where the diamond represents some kind of possibility modal. Ramsey, Braithwaite, and McGee write of the Ramsey sentence in terms that hint of this modal character.

Ramsey, writing of the addition of a theoretical sentence to a theory says that it has to be added within the scope of the existential quantifiers of the Ramsey sentence of that theory. He prefixes a fictional locution to the theoretical sentences:

They are not, therefore, strictly propositions by themselves just as the different sentences in a story beginning “Once upon a time” have not complete meanings and so are not propositions by themselves.

The fictional prefix is emphasized by Braithwaite, stressing that it is a possibility, a story that is being related, and deemphasizing the fictional aspect (its falsity):

[a] treatise of physics would really be one big long sentence – it would be rather like a fairy story starting ‘Once upon a time there was a man who ...’ or ‘Once upon time there was a frog which ...’, the rest of the story going on to describe the adventures of the man or the adventures of the frog. A treatise on electrons, in Ramsey’s view, starts by saying ‘There are things which we will call electrons which ...’, and then goes on with the story about the electrons...only of course you then believe the whole thing, the whole ‘There is ...’ sentence, whereas in a fairy story of course you don’t.<sup>19</sup>

So unlike fictionalist accounts, a scientific theory is a story, but it is

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<sup>19</sup> H.D. Mellor [1]. I have here followed Braithwaite in stressing that the Ramsey sentences of theories are objects of belief. That makes it reasonable that they are propositional. However, things may be more controversial, since they are existentially quantified. It is known that Ramsey was influenced fairly late by the views of Hermann Weyl on quantification. U. Majer’s paper makes the connection evident, and Nils-Eric’s reference to Weyl’s claim “Ein Existentialsatz ... ist überhaupt kein Urteil im eigentlichen Sinne, das einen Sachverhalt behauptet.” leaves no ambiguity about Weyl’s view in 1921. P. Mancosu’s translation from Weyl (1921) also reinforces the view that “[u]niversal and existential theorems are not judgments in the proper sense; they do not make a claim about a state of affairs, but they are judgment instructions and judgment abstracts respectively...”(78), and “The general statement ‘every number has property E’ – for example, ‘for every number  $m$ ,  $m+1 = 1 + m$ ’ – is equally not an actual judgement, but rather a general *instruction for judgments*.”(79). This talk of rules for making judgments resonates with Ramsey’s considered views on conditionals of course.

There is no decisive way we can determine exactly how Ramsey intended the quantifiers to be understood from these few texts; he doesn’t say. Nevertheless even if the theory  $T$  is not propositional, still the best way of presenting is might be its Ramsey sentence, which would also not be propositional. They would match.

hopefully a true story, which tellers of it supposedly believe. Those familiar with analyses of fictional discourse that give a modal status to the prefix “In the fiction T, ...” will recognize the possibility operator present in Ramsey sentences right up front, as it were.

D. Lewis, for example, offered a good example of how the fictional prefix can go modal.<sup>20</sup>

Vann McGee’s construal of the Ramsey sentence  $R(T)$  is also supportive of a possibility construal of the Ramsey operator. On his account, the Ramsey sentence would be true if and only if there’s at least one acceptable model in which the theory is true. If we think of the acceptable models as possible worlds, then a Ramsey sentence  $R(T)$  will be true if and only if  $T$  is true in some possible world. That suggests that the Ramsey operator is a kind of possibility modal. Thus a theory  $T$  may not be modal, but its Ramsey sentence  $R(T)$  will be. If true, it says something like this: There is a possible world (acceptable model) in which the predicate  $T(X_1, X_2, \dots, X_n)$  holds of certain extensions that are assigned to the second-order variables  $X_1, X_2, \dots, X_n$ . Consequently, if Ramsey sentences are the best way to present theories, then a case has been made for the modality of those theories that are best presented.

That is not really such good news for the friends of the modality of laws. Suppose that  $L$  is a generalization using only observational predicates and relations. Its Ramsey sentence,  $R(L)$ , is then just  $L$  itself (none of its predicates and relations will be replaced by second order variables). Since  $L$  is equivalent to  $R(L)$  on all these (observational) laws, we have what is usually referred to as the collapse of the modal on all these laws. The modal operator  $R$  is just the identity operator on laws like  $L$ . Of course on theories, that have some theoretical term, there is no such collapse. Thus this case for the modality of laws is very weak, and will become weaker still if we can show that Ramsification is a poor way of presenting theories.

*2.3. Total Ramsey sentences and the metaphysics of properties.* There is a strengthened version of Ramsey sentences that has been proposed. It has been employed to give a simple but dramatic answer to the problem of identifying those properties that exist – a milestone in metaphysics if ever there was one. Recall that a Ramsey sentence involves second order

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<sup>20</sup> D. Lewis [1]

quantification over the second order variables that have replaced all the theoretical terms in a sentence  $T$ . Let us say that  $R^*(T)$  is a *Total Ramsey sentence* of  $T$  if and only if *all* the predicate and relation terms (other than mathematical ones) in  $T$  are replaced by second order variables, and the result is then preceded by existential quantifiers with respect to those variables. We shall denote this kind of Total Ramsification with an asterisk.

Here is a suggestion by Hugh Mellor that uses Total Ramsey sentences to determine what factual properties there are in the world.

...[I] take not just theoretical predicates but all predicates in statements of law of nature. I then imagine conjoining all these law statements – to allow for predicates like ‘mass’, which occur in many laws – and replacing all the predicates in this conjunction with variables. This gives an imaginary Ramsey sentence which says that ‘there are in the world properties in this conjunction with this and that way in laws of nature’. And then I say that those are all the factual properties there are – where by factual properties I mean things like mass and charge, not mathematical properties like ‘being a prime-number’: in other words, all the properties of things in the world that affect how they behave.<sup>21</sup>

This is an attractive suggestion. On a widely shared view, it is the business of scientific laws to relate factual properties. On that view it would be the most natural thing to take those properties to be what are related by all laws.

In each of these applications of the Ramsey sentence, and as we shall see in the use of Total Ramsey sentences, the results are disappointing – though for different reasons. Part of the reason for the disappointment is the belief that we were obtaining interesting results about the truth of theoretical statements, their modality, and the way that they involve properties by reverting to a canonical form for theories which provides the best way of presenting them. Unfortunately this is not so. They are not even a good way of representing theories. We turn next to this admittedly controversial claim.

### 3. How well do Ramsey Sentences represent theories?

To judge the quality of the representation, let’s begin with what looks like an extremely simple, some would say absurdly simple example: suppose that the theory consisted of just one law, say Ohm’s Law which in the sim-

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<sup>21</sup> A-S. Maurin and J. Persson, pp. 2–21.

plest form is just an equation between two physical magnitudes,  $E = R \times I$ , where  $E$  is the electromotive force in the circuit,  $R$  is some constant characteristic of the circuit, and  $I$  is the current in the circuit. The physicist (say it's Ohm) doesn't have much more at this point. He does have several ways of measuring the strength of  $E$  and  $I$ , though he doesn't think of them as part of the theory, but as important parts of any application of his theory. That's one natural way to look at theories. Even classical mechanics doesn't include the various ways of measuring masses or forces.

The problem is that the Ramsey sentence of the theory that consists just of Ohm's law is obviously a logical truth. The reason is that both the electromotive force ( $E$ ) and the product of  $R$  and the current  $I$  are theoretical rather than observational terms (I don't like to push the distinction, but this does seem right), so that the Ramsey sentence of this equation between two magnitudes is just that there is an  $X$  and there is a  $Y$  such that  $X = Y$ , i. e.  $(\exists X)(\exists Y)(X = Y)$ . That's just a logical truth, since it is a consequence of the logical truth  $X = X$ .<sup>22</sup> Representing physical theories by logical truths doesn't seem to me to be the best way of presenting them. Moreover there would be lots of theories consisting of equations between magnitudes, which would all be presented in the same way, so that neither the individual structure nor the differences between these theories would be well represented by their Ramsifications. The Ramsey sentences of various theories seems to be the same for theories which we might want to distinguish. As a representation of our theories, this does not bode well for Ramsification.

This theory had only theoretical terms, and in its Ramsey sentence, all those terms were replaced by second order variables, and existentially quantified. It could be reasonably objected that the example is unfair to Ramsey in at least two ways. We quantified over all the predicates of the theory, and we used a very simple kind of theory. Things would have gone otherwise it is suggested, if there were observational terms included in the theory, and we treated more complex theories. Unfortunately, even with the added complexity, the situation is not improved much.

It is true that Ramsey had in mind those theories that included state-

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<sup>22</sup> Here and elsewhere I use "logical truth" without explanation. Since we are here usually talking about second-order quantification, it has to be explained what "consequence" means, it has to be shown that consequences of logical truths are logical truths, and that expressions such as " $X = X$ " are logical truths, where the variables can range over sets, predicates or properties depending on the appropriate model theory.

ments and vocabulary in both the primary and secondary language – that is, the theory has some observational terms in it. That is reasonable enough, given the way that N. Campbell had set things up<sup>23</sup>, and the fact that Ramsey thought Campbell was right to do it that way. The use of “observational” terms would be appropriate in all those cases where the theory was applied to account for observational matters (like calculating the values of certain constants), or where it was used to explain certain singular observational matters, or general “observational” laws.

Let us therefore extend the little Ohm theory,  $E = R \times I$ , by supplementing it with observational connections, so as to include some coordinating definitions, dictionary statements or bridge laws. This theory represents a simplification in two ways: It is only a first-order approximation to Ohm’s Law. That’s not that serious a simplification. The second simplification seems more serious. The theory is basically one equation between two magnitudes. As theories go it doesn’t have much complexity or power. Nevertheless it is worth noting that in fact Campbell’s own illustration of his concept of a theory uses an equation ( $c = d$ ), supplemented with two dictionary entries. In his bare bones example, Campbell lists this equation as an hypothesis, while all the other hypotheses of the theory just list a variety of variables and constants of the theory, as well as specifying certain mathematical conditions on specific functions of these magnitudes.<sup>24</sup> Even in this simple case Campbell claims that it provides a deductive explanation of why the ratio of the resistance of a pure metal to its absolute temperature is constant. Campbell follows his bare bones example with a scientifically more interesting bread and butter example from physics. Again among the hypotheses there is one equation, and other hypotheses which describe the mathematical apparatus, constants and variables, the reversal in value of velocity functions for values of arguments that correspond to the limits of a box. The example is a kinetic theory of finitely many particles of a gas contained in a box, with no mutual interactions. The claim is that from this theory (supplemented with specific dictionary entries which are provided), there follows a deductive explanation of the laws of Boyle and Gay-Lussac.<sup>25</sup> This version of a dynamical theory of gases was intended by Campbell to be a clear case of what was ordinar-

<sup>23</sup> N. Campbell, pp. 120–140.

<sup>24</sup> Campbell, pp.123–24.

<sup>25</sup> Campbell, pp.126–128.

ily called a theory, and which conformed to what he meant by a theory. If there was any claim about theories in general, it ought to hold of this example in particular. If for example it were claimed that the Ramsey sentences of theories are the best way to present them, then that should also hold for this simple kind of theory. The example is a test case for Campbell's view of theories. And in our view it is also a test case for Ramsey's proposal.

In what follows, we shall use a simple example of a Campbellian theory similar in form to the examples that Campbell himself relied on. It will be essentially Ohm's Law with two dictionary items. In form it is just like the bare bones, and the kinetic theory of gas examples of Campbell, only without the mathematical complexity. It will turn out that these simple test cases of theories are not well represented by their Ramsey sentences. It is not good news for the general case.

In order to make the Ramsey Sentence of a theory more evident, probably at the expense of making the exposition considerably more boring, we will express the theories by using predicates and relations, rather than the more natural use of functions, functionals and the more customary mathematical operations and operators. That's a bit more pedantic than the more natural mathematical way of expressing theories, but perhaps it is better for the purposes for seeing how to construct Ramsey sentences for theories.

Let us first recover the result that when Ohm's Law was all there was to the theory, then the Ramsey sentence was a logical truth, and then add the complication of including some observational connections.

Let "E(x,r)" express the condition that circuit x has voltage r, let "RI(x,r)" express the condition that the product of the constant R and the current in the circuit x has the value r. The original theory can then be expressed by

$$T: (\forall x)(\forall r) [E(x, r) \leftrightarrow RI(x, r)].$$

Here we have replaced the more natural way of expressing the equation between two magnitudes (functions) by the "if and only if" connective that is more appropriate, now that we have decided to represent the theory using predicates and relations. When we have a theory such as T, it becomes evident that the Ramsey sentence for it is:

$$R(T): (\exists X)(\exists Y)[(\forall x)(\forall r) [X(x, r) \leftrightarrow Y(x, r)]].$$

The conclusion is that the Ramsey sentence of this theory is an obvious logical truth since it follows from the obvious logical truth that  $(\exists \mathbf{X})[(\forall x)(\forall r) [\mathbf{X}(x, r) \leftrightarrow \mathbf{X}(x, r)]]$  – just let  $\mathbf{X}$  and  $\mathbf{Y}$  be the same.

Any scientific theory which can be presented as an equation between magnitudes, or as a conjunction of finitely many such equations, will all become logically equivalent statements when we pass to their Ramsey sentences (they will all be logical truths). Whatever distinctions there were between those theories, are of course obliterated by their Ramsey sentences. It seems pretty clear once again, that using the Ramsey sentence for such theories is not the best way to present them.

Let's turn next to the kinds of theories, or better, the kinds of applications of theories, which Ramsey had in mind. Here too, the situation is not much better. What was missing from the first example was the inclusion of what N. Campbell called the "dictionary". It contains statements that connect up some theoretical terms of the theory with some observational terms. Here's one possible way of supplementing theory T: add on two sentences. The first states that when a voltmeter hooked up to a circuit  $x$ , registers the value  $r$ , then the voltage  $E$  in that circuit is  $r$ . Thus  $V(x, r) \rightarrow E(x, r)$ , for all  $x$  and  $r$ . And the second sentence in the dictionary connects up the values of an ammeter with the current in the circuit. That is,  $RI(x, r) \rightarrow A(x, r)$  (the value of the ammeter for the circuit  $x$ , is  $r$ , if that is the value of  $R$  times the current in the circuit). We think of the relations "V" and "A" as being "observational" in their recording of the readings of familiar measuring instruments. The new theory,  $T^*$ , looks like this:

$$T^*: (\forall x)(\forall r)[(E(x, r) \leftrightarrow RI(x, r)) \wedge (V(x, r) \rightarrow E(x, r)) \wedge (RI(x, r) \rightarrow A(x, r))]$$

Then the Ramsey sentence  $R(T^*)$  of  $T^*$  is given by

$$(\exists \mathbf{X})(\exists \mathbf{Y})[(\forall x)(\forall r) [\mathbf{X}(x, r) \leftrightarrow \mathbf{Y}(x, r)] \wedge (V(x, r) \rightarrow \mathbf{X}(x, r)) \wedge (\mathbf{Y}(x, r) \rightarrow A(x, r))].$$

Unlike  $R(T)$ , there is no possibility of showing that  $R(T^*)$ , the Ramsey sentence of  $T^*$ , is true just on logical grounds. The reason is that  $T^*$  implies L:

$$L: (\forall x)(\forall r) (V(x, r) \rightarrow A(x, r)),$$

an empirical generalization relating the values of the voltmeter and the ammeter. Consequently,  $R(T^*)$  implies the empirical result L. [If  $T^*$

implies any  $A$ , then  $R(T^*)$  implies  $R(A)$ . In particular then  $R(T^*)$  implies  $R(L)$ . However since  $L$  doesn't contain any theoretical terms,  $R(L)$  is just  $L$ .] That's the good news for the Ramsey sentence of  $T^*$ : it is not a logical truth. The bad news however is that  $L$  logically implies the Ramsey sentence of  $T^*$ .

The reason is that if we assume  $L$ , then there is an  $X$  and  $Y$ , such that  $(\forall x)(\forall r)[(X(x, r) \leftrightarrow Y(x, r)) \wedge (V(x, r) \rightarrow X(x, r)) \wedge (Y(x, r) \rightarrow A(x, r))]$ . Let " $X(x, r)$ " and " $Y(x, r)$ " be " $V(x, r)$ ". With those values, all three clauses are true – the first and second on logical grounds, and the third is just the empirical generalization  $L$ , which is assumed. So we now have the Ramsey sentence of  $T^*$  being logically equivalent to the empirical generalization  $L$  -  $T^*$ 's law so to speak<sup>26</sup>. I.e.

$$R(T^*) \Leftrightarrow (\forall x)(\forall r)(V(x, r) \rightarrow A(x, r)).$$

Ramsey himself regards just such empirical generalization which are consequences of the theory as laws. This particular law is obviously is not very interesting. It's just a general coordination of the values of an ammeter and a voltmeter for a circuit. Nevertheless this is the kind of case where the theory (in this case Ohm's Law) explains an experimental law ( $L$ ) with the aid of certain bridge laws. That's possible with the theory  $T^*$ , but not possible with the Ramsey sentence of  $T^*$ . The reason is that  $R(T^*)$  is deductively equivalent to  $L$ , and therefore cannot explain  $L$ . In this case then, in shifting from the theory  $T^*$  to its Ramsey sentence we have lost an explanation. This reinforces the doubt raised above, that the Ramsey sentence of a theory is not the best way of presenting that theory. Certainly not, if the cost is that we will lose explanations if we Ramsify. We can generalize this result a bit by considering theories  $T'$  that have finitely many equations and various bridge laws, which explain each of the laws,  $L_1, L_2, \dots, L_n$ . In this case  $R(T')$  is logically equivalent to the conjunction of these laws, and that seems impossible. A conjunction doesn't explain each of its conjuncts.

The claim that the Ramsey sentence of any Campellian (or Ramseyan) theory  $T$  implies each of its ("observational") laws that are consequences of it seems to be in conflict with the claim of Demopoulos and Friedman that the Ramsey sentences of Russellian theories are (modulo cardinality considerations) mathematical truths. I believe that the conflict is only

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<sup>26</sup> Ramsey[1], p. 115; Ramsey [2], p. 215.

apparent – the Ramsification of Russell’s theories and the Campellian ones are different.<sup>27</sup>

3.1. *Total Ramsey sentences.* We began with a theory T, essentially consisting of Ohm’s Law. Its Ramsey sentence R(T) involved quantifying over all its theoretical terms, and in this case, that was all it’s terms. The result was that its Ramsey sentence was a logical truth. Extending T to T\* with the addition of dictionary entries to T, the Ramsey sentence of T\* wasn’t a logical truth but turned out, surprisingly to be equivalent to a law of T\* – a law that could be explained by the theory T\*, but could not be explained by its Ramsey sentence. Whether it is T or T\*, the Ramsey sentences of these theories are not a suitable ways to represent them.

It’s worth noting that the Ramsey sentence of T was formed by existentially quantifying over *all* its terms (once they were replaced by distinct second order variables). That’s because T has no observational terms. The result for T was a logically true sentence. In the case of T\*, the existential quantification is carried out only for the theoretical terms, leaving the observational ones of which there are two. The result was certainly not a logical truth. Nevertheless if one now replaced all the terms of T\* (theoretical *and* observational), by appropriate variables, and then Ramsified, the result the result is the same as for T: a logical truth. That is, if we replace *all* the predicates of T\* by second order variables and prefix that result by existential quantifiers with respect to those variables, the result is:

$$R^*(T^*): (\exists X)(\exists Y)(\exists U)(\exists W)[(\forall x)(\forall r)[(X(x, r) \leftrightarrow Y(x, r)) \wedge (U(x, r) \rightarrow X(x, r)) \wedge (Y(x, r) \rightarrow W(x, r))]].$$

For any theory S, let R\*(S) be the result of replacing *all* the different factual (theoretical and observational) predicates, other than the mathematical or logical predicates of S by different second order variables and prefixing existential quantifiers with respect to those variables. We shall call the result the *Total Ramsification* of S. We shall let “R\*”, with an asterisk indicate Total Ramsification.

In the case of our theory T\* (the basic Ohm theory with the addition

<sup>27</sup> J. Ketland has an elegant discussion of some of these issues where he argues among other things that given a certain plausible reading of “empirical adequacy”, and a cardinality condition the Ramsey sentence of a theory, if true, will imply that the theory is empirically adequate.

of suitable “observational” connections to theoretical terms), its Total Ramsification  $R^*(T^*)$  follows from the logically true sentence

$$(\exists \mathbf{X})[(\forall x)(\forall r)[(\mathbf{X}(x, r) \leftrightarrow \mathbf{X}(x, r)) \wedge (\mathbf{X}(x, r) \rightarrow \mathbf{X}(x, r)) \wedge (\mathbf{X}(x, r) \rightarrow \mathbf{X}(x, r))]],$$

obtained by taking all of  $\mathbf{X}(x, r)$ ,  $\mathbf{Y}(x, r)$ ,  $\mathbf{U}(x, r)$  and  $\mathbf{W}(x, r)$  in  $R^*(T^*)$  to be the same. Consequently, the Total Ramsification of  $T^*$  is a logical truth though  $T^*$  is not.

If the theory we used as an example is a good example of the kind of theory that Campbell and Ramsey intended to cover, then their Ramsey sentences are a poor way to present them, but their Total Ramsey sentences would be a disastrous way to represent contingent theories. It’s an immediate corollary that if any law is a consequence of a theory whose Total Ramsey sentence is a logical truth, then the Total Ramsey sentence of that law will also be a logical truth. That is simply because if  $A$  implies  $B$ , then  $R^*(A)$  implies  $R^*(B)$ . This would be true for any consequence of  $T^*$ , law or not. Thus, in particular, the Total Ramsification of the law  $L$  that was a consequence of  $T^*$  (relating the voltage and ammeter readings for closed circuit) is a logical truth.

We are interested in the Total Ramsification of laws (or conjunctions of laws). If they are consequences of theories whose Total Ramsifications are logical truths (as the case with  $T^*$ ), then their Total Ramsifications are also logical truths. However there is a more direct argument to show that the Total Ramsification of laws or conjunctions of laws are logical truths, without assuming that there is a background theory with a logically true Total Ramsificaton.

We shall sketch an argument below that shows that the Total Ramsifications of laws are logical truths. And that result if correct, would spell trouble for the criterion for the existence of properties that is under consideration. If the Total Ramsey sentences for laws are logical truths, they will be too weak to settle which factual properties exist and which do not.

We can show that in many cases, the Ramsey sentence of a law will be a logical truth. It’s hard to say more than that. Much depends on how laws are represented. In what follows we consider what happens when laws are represented in a number of familiar ways. The long and the short of such an imperfect survey is that the Total Ramsification of laws turns out to be a logical truth. Here’s a sketch of how laws get converted to logical truths

under Total-Ramsification:

If laws are represented as universal conditionals with whatever constraints on the conditional that one favors, (the so-called “Humean” position), then  $L: (\forall x)(Fx \rightarrow Gx)$  becomes  $R^*(L): (\exists X)(\exists Y)(\forall x)(Xx \rightarrow Yx)$ , where the single arrow indicates the material conditional. But this is a logical truth since it follows from the logical truth  $(\exists X)(\forall x)(Xx \rightarrow Xx)$ .

The conclusion is the same even if one thought that there was a special conditional “ $\Rightarrow^*$ ” (other than the material conditional), such that the law could be represented as  $L^*: (\forall x)(Fx \Rightarrow^* Gx)$ . The reason again is that  $R^*(L^*)$  is  $(\exists X)(\exists Y)(\forall x)(Xx \Rightarrow^* Yx)$  which follows from  $(\exists X)(\forall x)(Xx \Rightarrow^* Xx)$ , which is a logical truth, assuming that all instances of  $A \Rightarrow^* A$  are logical truths. It should also be noted that there is an additional significant assumption made in this argument: there are coherent notions of first and second order quantification involving the new conditional, so that laws and their Total Ramsifications can be expressed by “ $(\forall x)(Fx \Rightarrow^* Gx)$ ” and “ $(\exists X)(\exists Y)(\forall x)(Xx \Rightarrow^* Yx)$ ” respectively. Suppose that in the best case scenario, one could make good on all these assumptions. It would follow that the truth of the Total Ramsey sentence for  $L^*$  is determined just by the reflexivity condition on conditionals. That condition is, I believe, a logical truth, but I really cannot argue the case since I assumed only the proposed use of such a conditional, without knowing any of the details of such a proposal. If the details were sufficient to prove that reflexivity is a logical truth, then we could make the case that the Total Ramsification of such laws are logical truths.

We can do better than this general sort of proposal if we consider a special case where we have some idea of how the details go: let the special conditional be the subjunctive conditional, using David Lewis’ account (VC) for the sake of the argument<sup>28</sup>. W. E. Johnson for example is someone who not only believed that expressed laws imply counterfactuals, but are also equivalent to them<sup>29</sup>.

In this case, a law would be represented as  $L': (\forall x)(Fx \Box\rightarrow Gx)$ , (where “ $A \Box\rightarrow B$ ” is a counterfactual conditional that says that if A were true then B would be true). The conclusion is still the same. In this case, the

<sup>28</sup> Lewis [2], P.132.

<sup>29</sup> W. E. Johnson is a good example of someone who expressed scientific laws as counterfactuals. Under certain weak conditions it can be shown that if a law implies its corresponding counterfactual conditional, then it is equivalent to that counterfactual. Thus there may be many more people who are committed to this view of Johnson than one might think.

Total Ramsey sentence for  $L'$  is  $(\exists X)(\exists Y)(\forall x)(Xx \sqsupset Yx)$  which follows from  $(\exists X)(\forall x)(Xx \sqsupset Xx)$ . However, in the Lewisian system VC, this is deductively equivalent to the logical truth  $(\exists X)(\forall x)(Xx \rightarrow Xx)$ .<sup>30</sup>

Again it should be pointed out that this argument requires that first order quantification over counterfactuals is available for the expression of  $L'$ , and it also requires second order quantification for the expression of  $R^*(L')$ .

Lastly consider yet another way of representing laws that combines something like Lewisian subjunctive conditionals with the requirement that the consequent express a chance. The idea is that if it is a law that all Fs are Gs, then representing it would use a modified Lewisian-like conditional (" $\Rightarrow$ "), and some notion of chance, so that the idea that the law that all Fs are Gs would be represented by

$$(\forall x)(Fx \Rightarrow [\text{Ch}(Gx) = 1]),$$

(If anything were an F then the chance of its being G is 1) and the law that with probability  $p$ , all Fs are G, would get represented as  $(\forall x)(Fx \Rightarrow [\text{Ch}(Gx) = p])$ .<sup>31</sup>

Laws represented this way fare no better than laws represented in the ways we have already described, though Total Ramsification for laws with this kind of representation is a little more complex than the others. There are three specific terms that have to be replaced by second-order variables: " $Fx$ ", " $Gx$ ", and " $\text{Ch}$ ". The case for chance can be handled by taking it as a magnitude, just as " $Fx$ ", and " $Gx$ " are. One way to do this is to think of " $\text{Ch}(Gx) = 1$ " as a predicate " $P_Gx$ ", indexed to  $G$ , which holds of  $x$  if and only if  $\text{Ch}(Gx) = 1$ . The law would then be represented as  $(\forall x)(Fx \Rightarrow P_Gx)$ , so that its Total Ramsey sentence is just  $(\exists X)(\exists Y)(\forall x)(Xx \Rightarrow Yx)$ , which follows from  $(\exists X)(\forall x)(Xx \Rightarrow Xx)$ . As in the previous argument, this is equivalent in Lewis' system VC, to the logical truth  $(\exists X)(\forall x)(Xx \rightarrow Xx)$ .

We have been considering the Total Ramsification of laws taken singly, and the proposal for the existence of properties involves the conjunction

<sup>30</sup> This is easily seen by checking that " $A \sqsupset A$ " is deductively equivalent to " $A \rightarrow A$ " in VC. Cf. Lewis [2], p. 132 for the relevant axiomatization of VC. In fact all that is needed for the deductive equivalence is very little: that the material conditional " $A \rightarrow A$ " is always a theorem, and that Modus Ponens holds: B is deducible from A together with  $A \sqsupset B$ .

<sup>31</sup> This ingenious way of treating probabilistic and non-probabilistic laws in this unified way originates I believe with Hugh Mellor [3].

of all laws. There is the possibility that their number may be infinite, in which case we would require the use of a logically complex system that could represent infinite conjunctions. We needn't go to such lengths to see that there is a serious problem even in the case of arbitrarily large conjunctions of laws. Consider instead the conjunction  $\Omega$  of any finite number (however large) of scientific laws:  $L_1, L_2, \dots, L_n$ , and the Total Ramsey sentence of their conjunction,  $R^*(\Omega)$ :  $R^*(L_1, L_2, \dots, L_n)$ . It seems to me a simple matter to show under some simplifying assumptions, that it is equivalent to a logical truth. First, suppose that each of the laws is a conditional, with the  $i$ -th law having antecedent  $A_i$  and consequent  $B_i$ . Next, allow that some of the  $A_i$ s may be identical to each other, some  $B_j$ s are identical to each other, and that some  $A_i$ s may be identical to some  $B_j$ s, but that none of the  $A$ s and  $B$ s are logical compounds of each other. Thus we set to one side the possibility that if "F" and "G" occurred in some laws, that there might be laws in which their disjunction was employed. Suppose that we confine ourselves to this simple case, and that each of the laws  $L_i$  has the form  $Q_i$  (a string of quantifiers) prefixed to  $(A_i \rightarrow B_i)$ , where the single arrow indicates either the material, indicative, counterfactual conditional, or some other kind of conditional whose reflexivity is a logical truth. We have not assumed therefore that all laws are represented by the same kind of conditional but allow for the possibility of a robust variety of them. Even so the news is not good.

The Total Ramsey sentence for  $\Omega$  has the form

$$R^*[Q_1(A_1 \rightarrow B_1) \wedge Q_2(A_2 \rightarrow B_2) \wedge \dots \wedge Q_n(A_n \rightarrow B_n)],$$

which is the second-order statement

$$(\exists X_1) (\exists Y_1) (\exists X_2) (\exists Y_2) \dots (\exists X_n) (\exists Y_n) [Q_1(X_1 \rightarrow Y_1) \wedge \dots \wedge Q_n(X_n \rightarrow Y_n)].$$

Clearly  $R^*(\Omega)$  is equivalent to a logical truth (just let all the  $X$ s and  $Y$ s be the same).

This result, if correct, spells trouble for the view of properties, according to which those factual properties exist which are quantified over in the Total Ramsey sentence of the conjunction of all the laws of nature. Since the Total Ramsey sentence is a logical truth, there's nothing which the second order quantifiers range over, for which the sentence following the quantifiers would be false. It is similar to asserting that those proper-

ties exist which the quantifier “ $(\exists X)$ ” ranges over in the logically true sentence “ $(\exists X)(\forall y)(X(y) \rightarrow X(y))$ ”. Nothing gets excluded.

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