Ramsification and the Ramifications of Prior's Puzzle

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Ramsification is a well-known method of defining theoretical terms that figures centrally in a wide range of debates in metaphysics. Prior's puzzle is the puzzle of why, given the assumption that *that*-clauses denote propositions, substitution of "the proposition that *P*" for "that *P*" within the complements of many propositional attitude verbs sometimes fails to preserve truth, and at other times fails to preserve grammaticality. On the surface, Ramsification and Prior's puzzle appear to have little to do with each other. But Prior's puzzle is much more general than is ordinarily appreciated, and Ramsification requires a solution to the generalized form of Prior's puzzle. Without such a solution, a wide range of theories will either fail to imply their Ramsey sentences, or have Ramsey sentences that are ill-formed. As a consequence, definitions of theoretical terms given using the Ramsey sentence will be either incorrect or nonsensical. I present a partial solution to the puzzle that requires making use of a neo-Davidsonian language for scientific theorizing, but the would-be Ramsifier still faces serious challenges.

1. Introduction

Ramsification is a method of defining theoretical terms that is of central importance to a range of debates in the philosophy of science, the philosophy of mind, metaphysics, ethics, and philosophical methodology. The method begins, following Ramsey, by taking a theory's postulate and replacing its theoretical terms with existentially bound variables, which yields the theory's Ramsey sentence. The method continues, following Lewis, by using the Ramsey sentence—along with a bit of extra machinery—to provide explicit definitions of each theoretical term.[1] The underlying idea is that the Ramsey sentence specifies the role each

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[1]What I am calling "Ramsification" is often called the "Ramsey-Lewis method of defining theoretical terms". In presenting the method, I will for the most part follow Lewis's [1970] presentation, which differs in certain important ways from Ramsey's original [1931] proposal, and from Carnap's [1956] proposal which incorporates it. However, my arguments will apply

term plays in the theory at large, and each term can be given a definition in terms of this role. Ramsification is the foundation for the Canberra plan, and it is also the canonical method of formulating functionalist theories of mind, and functionalist theories more generally. It is hard to overstate the method's importance.[2]

Prior's puzzle is a puzzle concerning substitution within the complements of propositional attitude verbs. On the standard semantics, propositional attitude verbs denote binary relations between agents and propositions. A sentence of the form "S Vs that P" is true iff the subject referred to by "S" stands in the relation V to the referent of the *that*-clause, which is a proposition. But if *that*-clauses refer to propositions, we should be able to substitute other, co-referring expressions for *that*-clauses *salva veritate*. But in many cases we cannot. Consider the following pair:

(1) a. Sally fears that Fido bites.
     b. Sally fears the proposition that Fido bites.

The standard theory tells us that "that Fido bites" refers to a proposition. It also seems clear that "the proposition that Fido bites" refers to a proposition—indeed, the very same proposition. And yet (1-a) can be true while (1-b) is false—Sally does not fear an abstract object. Further, in many other cases, we cannot even substitute such co-referring expressions *salva congruitate*. Consider (2):

(2) a. Sally hopes that Fido is nice.
     b. *Sally hopes the proposition that Fido is nice.

Again, the standard theory tells us that "that Fido is nice" refers to a proposition. It also seems clear that "the proposition that Fido is nice" refers to the very same proposition. But while (2-a) is true, (2-b) is ungrammatical.[3]

What does Ramsification have to do with Prior's puzzle? At first glance, the method and the puzzle appear to be totally unrelated. But Prior's puzzle is a much more general puzzle than is ordinarily appreciated, and with-

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equally to these earlier methods and to Lewis's development of them.

[2]Lewis himself thought that we should Ramsify *every* theory, but he is perhaps most widely known for applying Ramsification to the metaphysics of mind, and using functional definitions of mental terms to argue for the identity theory [see Lewis, 1972, 1988b, 2009]. But Ramsification has been applied to a wide range of other topics in metaphysics, including to causation [Menzies, 1996, Tooley, 1987] and normativity [Jackson and Pettit, 1995, Jackson, 1998, Colyvan, 2009]. For a discussion of the role that Ramsification plays in the Canberra plan, as well as a range of papers that employ it, see Braddon-Mitchell and Nola [2009].

[3]Nebel [2019] calls the puzzle concerning substitution *salva veritate* "Prior's Puzzle", and calls the puzzle concerning substitution *salva congruitate* "Rundle's puzzle". For simplicity, I use "Prior's puzzle" to subsume both, although I acknowledge that Rundle [1967] was the first to observe the grammatical puzzle.

out a solution to the generalized form of Prior's puzzle, Ramsification fails as a method of defining theoretical terms. Most importantly, Prior's puzzle has a quantificational variant that arises in the complements of *all* kinds of attitude (and indeed other) verbs, in adjectival positions, in adverbial positions, and in a range of other non-nominal grammatical positions. The quantificational puzzle is that if we give a nominal semantics for existential quantifiers occurring in such positions—i.e. if we spell out their semantics using first-order quantification in the metalanguage—it either renders existential generalization into these positions invalid, or renders the results ungrammatical.

Given that Ramsification depends essentially on replacing theoretical terms with existentially quantified variables, the generalized puzzle shows that a wide range of theories either fail to entail their Ramsey sentences, or have Ramsey sentences that are ill-formed. As a consequence, the Carnap sentences for such theories, which serve to interpret the theoretical terms of those theories, will either be false or ill-formed. In the former case, Lewis's explicit definitions of theoretical terms will be incorrect, while in the latter case they will be nonsense. Thus, without a solution to the quantified form of Prior's puzzle, Ramsification is doomed. While it is unclear whether there is a complete solution to the generalized form of Prior's puzzle, I present a solution to some of the core instances of Prior's puzzle that involves adopting a neo-Davidsonian semantic theory. I then argue that any complete solution to the puzzle, and so any vindication of Ramsification, must incorporate these neo-Davidsonian elements.

The remainder of the paper proceeds as follows. In §2, I describe the method of Ramsification in more detail. In §3, I discuss Prior's puzzle and its quantificational variant, and show how both versions arise in a much wider range of positions than is ordinarily appreciated. In §4, I show how the quantificational puzzle undermines Ramsification. In §5, I evaluate five approaches to saving Ramsification, and in §6 I show that the only approach that allows us to save Ramsification and solve the generalized form of Prior's puzzle requires doing our scientific and metaphysical theorizing in a neo-Davidsonian language that involves events and thematic roles. §7 is a brief summary and conclusion.

2. Ramsification

Ramsification is a method of defining theoretical terms using only vocabulary that is already understood.[4] Often, Ramsification is glossed as a method of giv-

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[4]Strictly speaking, one could Ramsify a theory, and so provide definitions of its theoretical terms, without *understanding* the theory's other vocabulary. Ramsification is just a method for coming up with definitions—whether those definitions help us understand the theoretical terms is another matter. However, the usual assumption—made by Lewis and many others—is that the non-theoretical vocabulary is already understood, and I will likewise make that assumption

ing a theoretical term's meaning in terms of its "place" or "location" in the theory at large—that is, in terms of how what the term denotes—if anything—is related to the denotations of the other *T*- and *O*-terms in the theory. But perhaps the best way of showing what Ramsification does is to understand how it works.

Lewis [1970] showed us how to Ramsify a theory in a few easy steps. Given a theory *T*, we begin by separating the vocabulary of the theory into two categories: the *T*-terms—or theoretical terms—which we are aiming to define, and the *O*-terms—the other terms—which are already understood. We then form the postulate of the theory:

$$\top[\tau_1 \ldots \tau_n],$$

which is a single sentence from which all of the theory's theorems follow, here written to exhibit the occurrences of the *T*-terms, $\tau_1 \ldots \tau_n$.[5] We then replace each of the *T*-terms in the postulate by a variable, which yields what Lewis calls the *realization formula* of the theory:

$$\top[x_1 \ldots x_n].[6]$$

Each *n*-tuple that satisfies this open formula—in the sense familiar from Tarski—is said to *realize* the theory. We then existentially generalize each variable in the realization formula, which yields the *Ramsey sentence*:

$$\exists x_1 \ldots x_n \top[x_1 \ldots x_n].$$

The Ramsey sentence is true if and only if the theory is realized.

On its own, the Ramsey sentence does nothing to help define the *T*-terms, for they do not occur in it. However, from the Ramsey sentence and the postulate we can form the *Carnap sentence*:

$$\exists x_1 \ldots x_n \top[x_1 \ldots x_n] \supset \top[\tau_1 \ldots \tau_n].$$

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here.

[5]What does Lewis mean by "theory"? There are three options. (i) Any set of sentences. (ii) Any set of sentences closed under logical consequence (for some appropriate consequence relation—like the consequence relation of classical first-order logic). (iii) A particular axiomatization of a theory in sense (ii), i.e. a set of sentences from which all theorems of the theory follow as logical consequences, given an appropriate relation of logical consequence. I suspect that in "How to Define Theoretical Terms", Lewis has (iii) in mind, and envisions the postulate of *T* as the conjunction of the axioms of *T*. However, when Lewis [1972] applies the method to folk psychology, the postulate is the conjunction of the platitudes of folk psychology. Whether or not the platitudes serve as an axiomatization of folk psychology is unclear. Nothing in my arguments turns on whether the postulate is a conjunction of the axioms of a theory, so long as all of the theory's theorems are its consequences, given some appropriate consequence relation.

[6]In Lewis's formulation, we replace each of the *T*-terms with first-order variables. In Ramsey's formulation, we replace the *T*-terms with higher-order variables. But as we will see below, nothing turns on whether we replace *T*-terms with first-order or higher-order variables. My arguments apply to variables of all types.

The Carnap sentence says that if the theory is realized, then the *T*-terms name one of its realizations. Since the Carnap sentence is a meaning postulate, it places constraints on the denotations of the *T*-terms; the *T*-terms denote whatever they must in order to ensure its truth. However, since the truth of the Ramsey sentence does not require that the theory be uniquely realized, the truth of the Carnap sentence does not require that the *T*-terms uniquely denote. Thus the Carnap sentence provides a partial, but not a full interpretation of the theory's *T*-terms.[7]

Lewis, however—*contra* Carnap—holds that in the case where a theory is multiply realized, the *T*-terms of that theory should be denotationless, and the postulate should be treated as false.[8] On his view, theoretical terms have denotations only if the theory is uniquely realized, and so he holds that partial interpretations of the sort given by the Carnap sentence are not adequate definitions of theoretical terms. Accordingly, Lewis modifies the Ramsey sentence to say that the theory is uniquely realized, which yields the *unique realization sentence*:

$$\exists y_1 \ldots y_n \forall x_1 \ldots x_n (\top[x_1 \ldots x_n] \leftrightarrow (y_1 = x_1 \& \ldots \& y_n = x_n)).$$

He then modifies the Carnap sentence to say that if the theory is uniquely realized, then the *T*-terms name the components of that unique realization:

$$\exists y_1 \ldots y_n \forall x_1 \ldots x_n (\top[x_1 \ldots x_n] \leftrightarrow (y_1 = x_1 \& \ldots \& y_n = x_n)) \supset \top[\tau_1 \ldots \tau_n].$$

Together with two other meaning postulates stipulating that if the theory is not uniquely realized, the *T*-terms do not denote, the modified Carnap sentence uniquely specifies the denotations of the *T*-terms.[9] Given this unique specifi-

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[7]The Carnap sentence is sometimes said to "implicitly define" a theory's theoretical terms. If by "implicitly define" we mean that the Carnap sentence merely constrains the interpretation of *T*-terms, without fixing their denotations uniquely, then it is uncontroversial that the Carnap sentence implicitly defines the *T*-terms. But if implicit definitions are to meet the standard criteria of being conservative and eliminable, then the Carnap sentence cannot be said to implicitly define the theoretical terms, because the criteria of conservativity and eliminability require uniqueness (as a consequence of Beth's definability theorem). The idea that definitions should be conservative and eliminable is presumably why Lewis modifies the Carnap sentence in the way that he does.

[8]Lewis [1988a] later relaxed this condition—he allowed that if a functional description is only imperfectly realized, that we should allow a theoretical term to denote imperfectly: we should allow the *T*-term to denote something "close enough". But if there is nothing close, then the term will be empty and the theory false. However, the question of uniqueness does not bear on my argument; as we will see, everything I say here holds for both the Ramsey and Carnap sentences and Lewis's modified versions that require unique realization.

[9]Lewis's three meaning postulates together provide an implicit definition—in the strong sense noted above—of the theory's *T*-terms: the *T*-terms have the same denotation in any model of the theory with the same domain that provides the same interpretation of the primitive expressions. Lewis also argues that these meaning postulates uniquely specify the *senses* of the *T*-terms: the meaning postulates uniquely fix the denotations of the *T*-terms at any possible world.

cation, Lewis then provides explicit definitions of the *T*-terms in terms of the unique realization sentence:

$$\tau_n = \imath y_n \exists y_1 \ldots y_{n-1} \forall x_1 \ldots x_n (\top[x_1 \ldots x_n] \leftrightarrow (y_1 = x_1 \& \ldots \& y_n = x_n))^{10}$$

This sentence defines t_n as the *n*th component of the unique realization of *T*, if there is one; if there isn't, t_n does not denote.

3. Prior's Puzzle Generalized

As we saw above, Prior's puzzle is typically taken to be a puzzle concerning a distinctive kind of substitution within the complements of propositional attitude verbs—substitution of a propositional description such as "the proposition that P" for its embedded *that*-clause. But Prior's puzzle has nothing specifically to do with substitutions of this sort. Consider again our example from above:

(3)   Sally fears that Fido bites.

Suppose that the *that*-clause in (3) refers to a proposition. We can then existentially generalize into that position; (4) follows from (3):

(4)   Sally fears something.

But now consider the standard semantics for the existential quantifier in type theory:

(5) $[\![\exists u_t \phi]\!]^{M,g} = 1$ iff there is some $a \in D_t$ such that $[\![\phi]\!]^{M,g^a_{u_t}} = 1$

In (5), u_t is a variable over the type *t*, and $[\![\phi]\!]^{M,g^a_{u_t}}$ is the result of assigning *a* to occurrences of u_t in ϕ. Letting *p* be the type of object denoted by "that Fido bites"—i.e. the type of propositions—the clause yields that (4) is true iff:

(6)   There is some $a \in D_p$ such that Sally fears *a*.

But clearly, (6) can be false even when (3) is true; Sally can fear that Fido bites without there being some *a* in the set of propositions such that Sally fears *a*. Thus, on the assumption that the standard semantic clause for the existential quantifier is correct, the apparently valid inference from (3) to (4) turns out to be invalid.[11] Moreover, this invalidity arises even when we make use of higher-

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[10]Given that Lewis's three postulates provide implicit definitions for the *T*-terms of *T*, Beth's definability theorem guarantees that such explicit definitions are provable from the axioms of *T* (provided that *T* is a first-order theory, which Lewis is assuming). See Beth [1953], Boolos et al. [2007], and Gupta [2019] for discussion.

[11]The view that this clause provides the correct semantics for "something" as it occurs in the complements of attitude verbs, and so the claim that "something" is a nominal expression,

order variables; in the clause above, u_t can be a variable of any type. The problem arises for any semantic clause that treats quantifiers like the one in (4) as nominal quantifiers—i.e. that specifies their semantics in the metalanguage using first-order quantification over sets.[12]

The failure of nominal substitution and quantification to preserve truth is not specific to *that*-clauses or propositional attitude verbs. Rather, we observe such failures in a wide variety of other grammatical positions. Consider the following examples:

(7)   a.   Sally seeks a unicorn
        b.   Sally seeks the generalized quantifier denoted by "a unicorn".

(8)   a.   Sally investigated who came to the party.
        b.   Sally investigated the question who came to the party.[13]

(9)   a.   Sally became wise.
        b.   Sally became the property of being wise.[14]

(10)   a.   Sally painted carefully.
        b.   Sally painted the property of events denoted by "carefully".

On the traditional, Montagovian semantics for the notional reading of an intensional transitive verb, the intensional NP "a unicorn" denotes an intensional generalized quantifier.[15] But substitution of a description of this semantic value in

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is widely endorsed. It is endorsed by, for instance, Frege [1902], King [2002], and Zimmermann [2006a], among many others, and is taken for granted in a range of presentations of type theory and higher-order logic. Notable exceptions, however, are Williamson [2013] and Sainsbury [2018].

[12]The semantics of higher-order quantification is standardly spelled out in the metalanguage as many-sorted first-order quantification. In this case, quantification over the complement of "fears" is spelled out as first-order quantification over a particular subset of the domain: D_p, the set of propositions.

[13]This substitution admittedly does not sound as strange as the others. However, it makes available a reading on which Sally is investigating an abstract object—a set of propositions—in the same sense that Robert Mueller investigated Donald Trump or a private investigator might investigate a person of interest. To bring out this reading, we might even reformulate the example to say that Sally investigated the set of propositions denoted by "who came to the party". Readers who are not convinced that even this substitution changes the truth-conditions of (8-a) are invited to reformulate the example using "forget" or "study".

[14]This example is due to Friederike Moltmann [2003, 2004]. Similar examples of failures of substitution in predicative positions are discussed at length by Rieppel [2016]. All of the examples of substitutions that fail to preserve truth here are instances of what Moltmann calls the *objectivization effect*.

[15]This proposal is not uncontroversial. On another account of the notional reading, due to Zimmermann [1993, 2006a], intensional NPs denote properties. But the same problem arises for this proposal:

(11)   a.   Sally seeks a unicorn.

(7) changes the sentence's truth-conditions—(7-a) can be true while (7-b) is false. Similarly, substitution of a description of the question denoted by the wh-phrase in (8) changes the sentence's truth-conditions: Sally can investigate who came to the party without investigating an abstract object. In (10), while Sally might have become wise, she did not become the property of being wise, and in (11), surely Sally can paint carefully without painting a function from properties to properties.[16]

   Further, the quantificational form of the puzzle arises for (7-a)-(10-a) as well. Consider the following inferences:

(12) a. Sally seeks a unicorn.
      b. Sally seeks something.

(13) a. Sally investigated who came to the party.
      b. Sally investigated something.

(14) a. Sally became wise.
      b. Sally became something.

(15) a. Sally painted carefully.
      b. Sally painted somehow.

In each case, application of the standard semantics for the existential, together with standard type assignments, yields the following truth-conditions for (12-b)-(15-b), respectively:

(16)   There is some $a \in D_{\langle s, \langle \langle s, \langle e,t \rangle \rangle, t \rangle \rangle}$ such that Sally seeks a.

(17)   There is some $a \in D_{\langle s, \langle s,t \rangle \rangle}$ such that Sally investigated a.

(18)   There is some $a \in D_{\langle s, \langle e,t \rangle \rangle}$ such that Sally became a.

(19)   There is some $a \in D_{\langle \langle e,t \rangle, \langle e,t \rangle \rangle}$ such that Sally painted a.

If these standard truth-conditions for the existential quantifier are correct, then each of the generalizations in (12)-(15) is invalid. Each of (16)-(19) can fail to

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      b.   Sally seeks the property of being a unicorn.

The substitution in (11) does not preserve truth, despite the fact that the definite description denotes exactly what the indefinite denotes.

   [16]Of course, no one thinks that "carefully" is a referring expression, so we might disallow such substitutions on the grounds that we cannot substitute referring expressions for obviously non-referring expressions. However, in orthodox type theory, and in most formal semantic theorizing, there is only one semantic relation that expressions bear to their semantic values, and so such distinctions cannot be drawn. See Potts [1979] and Forbes [2018] for discussion of this point. Further, the puzzle would arise for whatever relation "carefully" bears to its semantic value. For example, we could just as easily formulate the puzzle using "has semantic value", "denotes", or any number of other locutions.

be satisfied even while (12-a)-(15-a) are true. Again, the problem is that a nominal semantics for the quantifier—specified in a metalanguage that involves first-order quantification over sets—yields invalidity for what appears to be the very same reason that substitution of a coreferential definite description yields invalidity.

But nominal substitution and quantification do not just lead to false conclusions—they often lead to ungrammaticality. Consider again our second example from the introduction:

(20)   Sally hopes that Fido is nice.

Again, supposing that the *that*-clause in (20) refers to a proposition, we can generalize over that proposition; (21) follows from (20):

(21)   *$\exists x_p$(Sally hopes x_p),

where x_p is a nominal variable ranging over the set of propositions. But (21) is not well-formed; Sally does not, and cannnot, hope a proposition.[17] Further, reformulating (21) using a pronoun, the natural language analog of a nominal variable, again yields ungrammaticality:

(22)   *There is a proposition such that Sally hopes it.

Finally, applying the semantics in (5) to (20) yields an ungrammatical ascription of truth-conditions in the metalanguage:

(23)   *There is some $a \in D_p$ such that Sally hopes a.

Thus, like nominal substitution, nominal quantification into the complements of propositional attitude verbs sometimes leads to ungrammaticality.

But as before, this result is not limited to the case of propositional attitude verbs. Rather, nominal substitution and quantification lead to ungrammaticality across a range of positions. Consider the following examples:

(24)   a.   John wonders who came to the party.
         b.   *John wonders the question who came to the party.

(25)   a.   Mary is sleeping soundly.
         b.   *Mary is sleeping the property of events denoted by "soundly"

(26)   a.   Johnny seeks something flammable.

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[17]Strictly speaking, since (21), with its explicit use of typed variables, is already out of the running as a candidate grammatical sentence of English, in saying that it is not well-formed what is meant is that even in the natural extension of English accommodating such formal devices, (21) would be ungrammatical (by contrast, say, with the result of putting "denies" for "hopes" in (21).)

b.   *Johnny seeks something the property of being flammable.

In each case, while the original sentence is perfectly grammatical, substituting a nominal expression reduces the original to ungrammaticality. Further, nominal quantifications into these positions again yields ill-formed results; consider (24)-(26):

(27)   a.   John wonders who came to the party.
       b.   *$\exists x_{\langle\langle s,t\rangle,t\rangle}$(John wonders $x_{\langle\langle s,t\rangle,t\rangle}$).
       c.   *There is a question such that John wonders it.

(28)   a.   Mary is sleeping soundly.
       b.   *$\exists x_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$(Mary is sleeping $x_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$).
       c.   *There is a way such that Mary sleeps it.

(29)   a.   Johnny seeks something flammable.
       b.   *$\exists x_{\langle e,t\rangle}$(Johnny seeks something $x_{\langle e,t\rangle}$).
       c.   *There is a property such that John seeks something it.

Each of (27-b)-(29-b) is the result of replacing "who came to the party", "soundly", and "flammable" by variables of the appropriate type and binding them with an existential quantifer. But if the semantics of these quantifiers are given by (5), then the variables in (27-b)-(29-b) will be nominal variables, and as a consequence, each of (27-b)-(29-b) will be ill-formed. (27-c)-(29-c) are the English analogs of (27-b)-(29-b) involving pronouns, each of which is ungrammatical.

The substitutional and quantificational forms of the puzzle are intimately related. If nominal quantification into a position preserves truth or grammaticality, then substitution of singular terms—including names and definite descriptions—will likewise preserve truth or grammaticality, because these singular terms serve as witnesses for nominal existential quantifiers.[18] Conversely, if substituting nominal expressions in a particular position preserves truth or grammaticality, then nominal existential quantification—henceforth just "nominal quantification"—into that position will likewise preserve truth or grammaticality, because those nominal expressions will be the expressions replaced by nominally quantified variables. Thus, the substitutional and quantificational puzzles go hand in hand.

The result is that Prior's puzzle can be generalized along two dimensions. First, the substitutional form of the puzzle is accompanied by a quantificational puzzle, which likewise yields both invalidity and ungrammaticality. Second, both the substitutional and quantificational puzzles arise in a wide range of nonnominal grammatical positions; we saw some examples of such positions above, and will encounter further examples presently.

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[18]By "witness" I here mean an expression that, when substituted for the existential quantifier, yields a true substitution instance of the quantified sentence.

This generalization shows that a wide range of proposed solutions to Prior's puzzle are either radically incomplete, or fail altogether.[19] First, consider views such as those endorsed by Zimmermann [2006b], Grzankowski [2018], and Nebel [2019], on which the invalidity of nominal substitution is explained by the fact that nominal substituends denote different things than the expressions they replace. For example, on Zimmermann's [2006b] view, "a unicorn", as it occurs in the complement of an intensional transitive verb, denotes the property of being a unicorn, while "the property of being a unicorn" denotes a distinct, higher-order property. Similarly, on Nebel's view, "that Fido bites" denotes a proposition, while "the proposition that Fido bites" denotes a propositional concept. Since these expressions denote distinct things, they contribute different arguments to the relation expressed by the verb, and so we should expect changes in truth-value.

The problem is that all such views fail to solve the quantificational form of the puzzle. Nominal quantifiers generalize over the very objects that serve as the semantic values of the expressions they replace, leaving no room for reference shift. And yet, nominal existential generalizations are still invalid. For example, on the standard semantics, "something" in (4), generalizes over the proposition that serves as the semantic value of "that Fido bites", not any other type of entity. And yet on that semantics, the generalization from (3) to (4) is still invalid. Thus, the invalidity of nominal existential generalization cannot be explained by a change in the denotation of the verb's complement.[20]

Second, consider views such as those developed by by Moffett [2003], Parsons [1993], and Harman [2003]. They hold that solving Prior's puzzle is simply a matter of finding the appropriate kinds of objects for each attitude, and finding the appropriate nominal substituends to pick out these objects. Once we find the appropriate substituends, they argue, nominal substiution *is* valid. For example, while we may not fear propositions, we do plausibly fear states of affairs. But again, this approach does not solve the generalized puzzle. Such a strategy does not work in the complements of intensional transitive verbs, as in (7), or in the case of adverbs, as in (10). The problem in both cases is that *any* nominal substiution will yield an invalidity. In the case of (7), any nominal substituend will yield the verb's specific reading, and in (10) will yield a transitive reading.[21]

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[19]I discuss the consequences of these generalizations for various proposed solutions to Prior's puzzle at length in my manuscript "Prior's Puzzle Generalized". Here I discuss them only briefly.

[20]We can even make a similar point using pronouns."Sally fears it" does not follow from "Sally fears that Fido bites", even when we stipulate that "it" refers directly to semantic value of "that Fido bites". This shows that the invalidity of nominal substitution cannot be due to reference shift.

[21]On the view proposed by Rieppel [2016], predicates (e.g. "happy") and their corresponding definite descriptions (e.g. "the property of being happy") bear different semantic relations

The failure of these approaches to Prior's puzzle pushes us toward a view on which the source of the invalidity, in both the substitutional and quantificational cases, is a change in the denotation of the verb, rather than in the denotation of the verb's complement. Views of this sort are endorsed by King [2002] and Forbes [2018]; as we will see below, I think this is the correct approach. However, King's view—which was devised to solve the problem occasioned by nominal substitution for *that*-clauses—cannot readily be extended to solve the generalized puzzle. By contrast, and as I will show below, Forbes' view can be so extended.[22] In section 6 develop the beginnings of a solution to the generalized puzzle that builds on Forbes's view.

4. Quantificational Prior's Puzzle undermines Ramsification

4.1. *The Problem, Illustrated*

In order to see the problem that the generalized form of Prior's puzzle poses for Ramsification, suppose that our theory has a postulate consisting of one sentence: "Sally feels emotional", and for the moment, suppose that "emotional" is its sole *T*-term.[23] In that case, the Ramsey sentence for the theory is:

(30) $\exists x_t$(Sally feels x_t).[24]

The problem is that our theory does not entail its Ramsey sentence. The standard semantics for the existential quantifier yields that (30) is true iff

(31)   There is some $a \in D_t$ such that Sally feels a.

But clearly, (31) can be false even while "Sally feels emotional" is true; replacing "emotional" with a nominal variable and binding the variable with an existential quantifier changes the meaning of the verb "feels".[25] In (31) "feels" is a transitive verb, whereas in "Sally feels emotional", "feels" is not—depending on one's

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to one and the same denotation. These different semantic relations trigger different semantic clauses employed in specifying the truth-conditions of sentences in which they occur. But as I will discuss in §5, this approach does not generalize beyond predicative positions.

[22]In the manuscript mentioned above, I also show that Forbes' view avoids the objections to King's view raised by Nebel [2019].

[23]Here I make use of a simple example merely for the purposes of illustration; clearly, the theories Lewis proposed to Ramsify were highly complex.

[24]Here I provide the variable x with a schematic type assignment t to emphasize that the quantificational version of Prior's puzzle arises no matter what type of variables we use, so long as we provide the quantifiers that bind those variables with a nominal semantics. Further, keeping the type assignment schematic allows me to remain neutral on exactly how to type the expressions that such variables replace—different compositional semantic theories disagree about how to type these expressions.

[25]I discuss the possibility of providing the quantifier with non-nominal semantics in §5.4.

preferred semantics, it is either intransitive or copular. As a consequence, the Ramsey sentence in (31) is the Ramsey sentence of the *wrong theory*, and does not even provide a correct *partial* interpretation of the theory's T-term.

Now consider the Carnap sentence for the theory:

(32) $\exists x_t$ (Sally feels x_t) $\supset$ Sally feels emotional.

In (32), the main verb used in the antecedent of the conditional has a different argument structure from the one used in the consequent—one is transitive and one is not. This shows that (32) can be false: supposing that "emotional" denotes a property, Sally can feel a property without feeling emotional. Ordinarily, the Carnap sentence is taken to be *analytic*, because it serves as a meaning postulate that partially interprets the theory's T-terms. But that fact that it is not only not analytic, but plausibly false, shows that it provides the wrong interpretation for the theory's T-term, "emotional".

The same problem arises for Lewis's modified Ramsey and Carnap sentences, and his explicit definition of theoretical terms given in terms of them. The unique realization sentence for this theory,

$$\exists y_1 \ldots y_n \forall x_1 \ldots x_n (\top[x_1 \ldots x_n] \leftrightarrow (y_1 = x_1 \& \ldots \& y_n = x_n)),$$

says that the theory is uniquely realized. But the problem is that this sentence is not a consequence of the postulate, even if we assume that the T-terms, $\tau_1 \ldots \tau_n$ are non-empty. For in removing these terms from the postulate and replacing them with nominally quantified variables, we change the meanings of the other expressions in the postulate so that the modified Ramsey sentence is no longer its consequence—it is the unique realization sentence of the wrong theory. Further, the same argument as above shows that the Carnap sentence for the theory, modified in order to claim that the T-terms denote only if the theory is uniquely realized, is not only not analytic, but plausibly false, and so is not suitable to interpret the theory's T-term.

Finally, consider Lewis's explicit definition of T-terms:

$$\tau_n = \imath y_n \exists y_1 \ldots y_{n-1} \forall x_1 \ldots x_n (\top[x_1 \ldots x_n] \leftrightarrow (y_1 = x_1 \& \ldots \& y_n = x_n))$$

In the case of our toy theory, this allows us to define "emotional" as follows:

(33)   emotional = $\imath y_1 \forall x_1$ (Sally feels x_1) $\leftrightarrow (y_1 = x_1)$.

The problem is that this definition forces "felt" to have its transitive reading, and so defines the property of being emotional as the unique thing felt—clearly the wrong definition.

It is important that this problem does not just show that Ramsification yields the wrong definitions for terms in non-nominal verbal complements, although it

does do that. Rather, it yields the wrong meaning for the verbs themselves: it forces the verb to take on a transitive reading. To see this, suppose that we not only treat "emotional" as a *T*-term, but also treat "feels" as a *T*-term. In that case, we would define "feel" as follows:

(34)   feels $= \imath y_1 \exists y_2 \forall x_1, x_2 ((\text{Sally } x_1 x_2) \leftrightarrow (y_1 = x_1 \& y_2 = x_2))$.

In this case, treating both "emotional" and "feels" as names forces "feels" to take on its transitive reading, and so yields the definition that "feeling" is the unique relation that Sally bears to a property—the property of being emotional. But since the Ramsey sentence is not a logical consequence of the postulate, this again yields the wrong definition. In it, "feels" has the structure of a binary relation between a person and a property. Logically, Sally can feel emotional without standing in such a relation—she does not need to feel anything in order to feel a particular way.[26] Thus, Ramsification not only yields the wrong definition of *T*-terms in verbs with non-nominal complements, it also yields the wrong definitions of the verbs themselves.

Now we turn to the case of ungrammaticality. Suppose that we have a theory whose sole sentence is (35):

(35)   Bill resembles a stockbroker,

and that "stockbroker" is the theory's sole *T*-term. Suppose further that we are considering this sentence on its notional reading: we are considering the case where Bill resembles a stockbroker, but not a particular one. In this case, the Ramsey sentence for our theory is (36):

(36) $\exists x_t (\text{Bill resembles a } x_t)$.

But if (36) involves nominal quantification, then (36) is ungrammatical. Making use of a nominal semantics for the quantifier assimilates the position in which x_t occurs to a position in which a name can occur. But treating the position this way yields nonsense, as we can see if we substitute names for the bound variable in (35):

(37)   a.   *Bill resembles a the property of being a stockbroker.
         b.   *Bill resembles a Bob.

Both of these sentences are obviously ungrammatical. But if the Ramsey sentence for our theory is ungrammatical, so too is its Carnap sentence:

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[26]While it may be true, metaphysically speaking, that in order to feel emotional, Sally must bear some binary relation or other to the property of being emotional, this is not a matter of logic. In order to secure this such an entailment we would need to invoke a meaning postulate. For further discussion, see §5.3.

(38) $\exists x_t$(Bill resembles a x_t) $\supset$ Bill resembles a stockbroker.

The same holds for both the unique realization sentence and the Lewis's modified Carnap sentence: nominal quantification renders both ungrammatical.

Two ways of avoiding such absurdity immediately come to mind. First, we might try reformulating (36) as in (39):

(39) $\exists x_e$(Bill resembles x_e & x_e is a stockbroker).

But this is clearly not a good paraphrase of (35)—(39) requires there to be a particular, existent stockbroker whom Bill resembles, while, as we said above, the notional reading of *d* does not require either. Alternatively, we might treat "a stockbroker" as a name of its semantic value (either a property or a generalized quantifier), and then quantify into the position it occupies as in (40):

(40)   a.   Bill resembles a stockbroker.
        b. $\exists x_t$(Bill resembles x_t).

Unlike the previous approach, (40-b) is grammatical. The problem is that, on the assumption that "a stockbroker" is a name of either a property or a generalized quantifier, (40-b) does not follow from (40-a); it does not follow from the fact that Bill resembles a stockbroker that there is some abstract object that he resembles. Thus, this response is no response at all—it takes us from one form of quantificational Prior's puzzle to another.

Moreover, the problems of invalidity and the problem of ungrammaticality are extremely general; they do not just occur on the fringes of our theories. Rather, they occur in a wide range of sentences that are prime candidates for Ramsification. First, the problems arise when we replace the complements of many propositional attitudes with nominally quantified variables. Such quantification is important for the Ramsifier, because generalizations over the content clauses of propositional attitudes play a key role in providing definitions of mental state terms. For instance, generalizations involving "believe" and "desire" play a key role in psychological theories, and so play a key role in defining "belief" and "desire". Consider a generalization such as the following:

(41)   If $\exists x_p$ and agent *a* desires x_p, and *a* believes that if *a* ϕs then x_p will be true, then, other things equal, *a* forms intention to ϕ.

The problem is that nominal existential generalization over the *that*-clause in the complement of "desires" yields the wrong argument structure for the verb. As a consequence, whenever such generalizations figure into a theory's Ramsey sentence, the resulting definitions will be incorrect. Similar problems arise for verbs whose complements denote questions as opposed to propositions.

The problems also arise for all intensional transitive verbs; consider two further examples:

(42)   a.   Maxwell seeks a perfect gas.
        b. $^*\exists x_{\langle e,t \rangle}$(Maxwell seeks a $x_{\langle e,t \rangle}$).
        c. $\exists x_{\langle e,t \rangle}$(Maxwell seeks $x_{\langle e,t \rangle}$).

(43)   a.   The program simulated a catastrophic selloff.
        b. $^*\exists x_{\langle e,t \rangle}$(the program simulated a $x_{\langle e,t \rangle}$ selloff).
        c. $\exists x_{\langle e,t \rangle}$(the program simulated $x_{\langle e,t \rangle}$).

Just as above, if we treat "perfect" and "catastrophic" as theoretical terms, the resulting Ramsey sentences—(42-b) and (43-b)—will be ungrammatical. If instead we treat the entire complement as, for instance, the name of a property, and replace it with an existentially quantified nominal variable to form our Ramsey sentencee, then we get an invalidity.

Finally, the problem of invalidity occurs with copular verbs and their predicative complements, as in (44), in adverbial positions, as in (45), and in the positions of adjunct predicates, as in (46).

(44)   a.   John became diabetic.
        b. $\exists x_{\langle e,t \rangle}$(John became $x_{\langle e,t \rangle}$).
        c.   There is some $a \in D_{\langle e,t \rangle}$ such that John became a.

(45)   a.   The child learned rapidly.
        b. $\exists x_{\langle \langle e,t \rangle, \langle e,t \rangle \rangle}$(the child learned $x_{\langle \langle e,t \rangle, \langle e,t \rangle \rangle}$).
        c.   There is some $a \in D_{\langle \langle e,t \rangle, \langle e,t \rangle \rangle}$ such that the child learned a.

(46)   a.   The fumes smell poisonous.
        b. $\exists x_{\langle e,t \rangle}$(the fumes smell $x_{\langle e,t \rangle}$).
        c.   There is some $a \in D_{\langle e,t \rangle}$ such that the fumes smell a.

If we treat "diabetic", "rapidly", and "poisonous" as theoretical terms, the resulting Ramsey sentences are given by (44-b)-(46-b), respectively. The truth conditions of those sentences are then given by (44-c)-(46-c). But clearly, these sentences can be false even when (44-a)-(46-a) are true, and so, as above, the definitions given in terms of (44-b)-(45-b) will be incorrect. Further, were we to try to Ramsify the verbs "become", "learn", and "smell", the resulting definitions would likewise be incorrect. Thus it appears that any time the Ramsifier attempts to define a term in a non-nominal position, define a verb whose complement is non-nominal, or Ramsify a verb and its modifier simultaneously, she will encounter Prior's puzzle, provide the wrong definitions.

5. Responses

Ideally, a solution to the problem for Ramsification would come in the form of a solution to the generalized form of Prior's puzzle. But as we saw above, most of the existing approaches to Prior's puzzle fail to solve the generalized puzzle, and it is just this puzzle that threatens Ramsification. In what follows, I briefly discuss two approaches to saving Ramsification without addressing Prior's puzzle, and find them inadequate. I then discuss three potential solutions to Prior's puzzle, and argue that one has significant advantages over the others.

5.1. Response 1: Exclusion

The first response is to simply ban expressions for which these puzzles arise from the theories that we intend to Ramsify. We could, for instance, exclude all attitude verbs for which the puzzle arises from the theories we intend to Ramsify, and refrain from ever treating adverbs, adjunct predicates, or predicative adjectives as theoretical terms. But this approach deprives Ramsification of much of its appeal. This is particularly obvious in the case of psychological theories. Any adequate psychological theory will employ a wide range of intensional locutions—including verbs like "fears", "hopes", and "feels". Adopting this approach and excluding such verbs would prevent us from Ramsifying anything like a genuine psychological theory.[27]

5.2. Response 2: Tolerance

The second response is to hold that Ramsification is perfectly safe as long as we allow for imperfect realization, and are tolerant of some small amount of falsehood. Imperfect realization would allow for some small amount of imprecision in our functional definitions. But the problem is that the mistaken definitions yielded by Ramsification are not the result of imprecision, and cannot be remedied by allowing for imperfect realization. Rather, they are glaringly untrue—they are often *category mistakes*. This is not the kind of problem that can be remedied by allowing for imperfect realization, or looking for a nearby realization, as Lewis suggests.

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[27]Lewis himself thought that we could formulate psychological theories with just two attitude verbs: "believes" and "desires". But the idea that every psychological verb can be given some analysis in terms of "believes" and "desires" is highly implausible, and has been largely discarded. How, for instance, could we analyze states of imagination, perception, or intention in terms of belief and desire? For arguments that such analyses are not feasible, see Ben-Yami [1997], Crane [2009, 2001], Grzankowski [2015], Merricks [2009]. But even if Lewis were right, Prior's puzzle arises for "desire" anyway, which prevents us from using generalizations about what agents desire in our psychological theories.

5.3. Response 3: Different Verbs in the Metalanguage?

A more plausible approach comes in the form of an objection, and potential solution to, the quantificational puzzle.[28] Consider again sentences (6) and (23), which specify the truth-conditions of nominal quantification over *that*-clauses:

(6)   There is some $a \in D_p$ such that Sally fears a.

(23)   There is some $a \in D_p$ such that Sally hopes a.

In both cases, I have, in effect, carried the English verbs into the semantic representation language, presuming that there is a direct translation—I have treated English as part of our semantic metalanguage. But one might reasonably ask whether this is legitimate. For example, a full formalization of (6) would look as follows:

(47)   There is some $a \in D_p$ such that $fear'(sally', a)$.

In (47), instead of there being some proposition that Sally fears, there is now some proposition that Sally $fear'$s. One might argue that since $fear'$ is not the same verb as the English "fears", there is no puzzle at all. It is perfectly fine, in the semantic representation language, for Sally to $fear'$ a proposition.

But this is to overlook an important fact about the relationship between "fear" and $fear'$: the latter is the conventional meaning of the former. Put slightly differently, our semantic theory says that "fears" means $fear'$, and interprets the latter as a relation that holds between subjects and propositions. Given this, we can offer the following argument. Suppose that there is some $a \in D_p$ such that $fear'(sally', a)$. The relation $fear'$ is what is denoted or meant by "fears". Therefore, there is some $a \in D_p$ such that Sally fears a. But this is just (6), which is the source of the quantificational puzzle.

But perhaps this is not the end of the story. Beyond simply translating English lexical items into the metalanguage, semanticists often go on to provide "lexical analyses" of the denotations the English words so translated, or to say that such analyses can be provided by philosophers (or other relevant experts). Given that $fear'$ and $hope'$ are interpreted as relations between agents and propositions, such lexical analyses spell out what it is to $fear'$ or $hope'$ a proposition. One might hope that such analyses could be used to solve the problems of invalidity and grammaticality.[29] For example, we might try to analyze '$fear'$ as

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[28]I am grateful to two anonymous referees for *Noûs* for raising this objection, albeit in two very different ways.

[29]The locus classicus of this strategy is Hintikka [1962, 1969], who provides such analyses of "knows" and "perceives", but see also Zimmermann [2006a], Richard [2013], and Grzankowski [2018]. Grzankowski spells out this strategy most clearly. On his view, a semantic theory does not tell us almost anything about the nature of fearing—it simply interprets "fears" as some

follows:

(48) $[fear'(sally', p)]$ iff Sally is in a state of fearing whose content is p.

Or we might try any number of other analyses; we might, to adapt a suggestion from Hintikka [1962], analyze *fear'* as a relation that holds between a subject and a proposition iff in every world where the subject's fears are realized, the proposition is true.[30]

But there are two reasons that this strategy will not solve the generalized form of Prior's puzzle. The first is the same worry raised above: if the meaning of "fears" is, via analysis, "x is in a state of fearing whose content is p", then we can legitimately say that there is some proposition such that *x* fears it. In other words, just because we can provide a lexical analysis of "fears" does not make it false that agents fear propositions. Such analyses may explain what it is to fear propositions, and in so doing, make fearing propositions less mysterious, but they do not solve the problem, which is that agents, in general, do not fear propositions.[31] Second, this strategy does not extend to our other examples; for instance, it is not plausible for cases of adverbial modification such as (28), since it is not plausible that "sleep" requires a lexical analysis into other terms.

5.4. *Response 4: Non-Nominal Resistance*

The quantificational form of Prior's puzzle arises from treating variables—of whatever type—as nominal variables, and providing a semantics for quantifiers that bind them using first-order quantification in the metalanguage. The third response to the problem presented by Prior's puzzle is to allow for genuinely non-nominal higher-order quantification. On this proposal, expressions of different semantic types—predicates, quantifiers, and various kinds of verbal complements—

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relationship or other that holds between a subject and a proposition, where the nature of this relationship to be spelled out by, for instance, philosophers of mind.

[30]Here it is instructive to return to the view proposed by Rieppel [2016]. If we were to try to extend Rieppel's view to the complements of attitude verbs, his view would encourage us to say that while *that*-clauses and their corresponding propositional descriptions denote the same things—propositions—they bear different relations to those propositions. But how does this difference yield a difference in truth-conditions? Here Rieppel would need to either provide a different analysis of the verb, or provide some very complicated semantic rule governing how the verb combines with the proposition. Thus, in effect, his view collapses into the view I have been discussing.

[31]In addressing the puzzle as it arises for intensional transitive verbs such as "seeks", Forbes [2006, p. 84] calls such analyses "philosophical glosses". This terminology is echoed by Grzankowski [2018, p. 136]. But the key point is that adding a philosophical gloss to the proposal that we fear propositions or seek properties does not alleviate the problem, which is that we do not fear or seek such entities at all. To put the point slightly differently, however the relations of fearing or seeking get spelled out, the result will simply give us an account of *what it is to fear* or *what it is to seek*, and so the problem will reemerge.

do not serve to name their semantic values, but rather have different semantic functions; predicates predicate, quantifiers quantify, *etc*. In order to validly quantify over expressions with these functions, we then need a theory of non-nominal quantification—one that does not interpret such quantifiers as binding variables that range over subsets of the first-order domain.

There are at least two approaches of this sort, one due to Rosefeldt [2008], and the other due to Williamson [2013]. Rosefeldt proposes that we modify the standard clause for the existential quantifier. In order to modify this clause, we first consider an interpretation I—a function from the expressions of our language into a model.[32] Rosefeldt then defines what he calls α_a-variant of an interpretation I. According to Rosefeldt, if α_a is a constant symbol of syntactic type a in a language L, then

(49)   an interpretation I^* is an α_a-variant of I iff I^* differs only in which element of D_a it assigns to α_a.

He then gives the truth-conditions for the existential quantifier as follows:

(50)   If ϕ is of the form $\ulcorner\exists\chi_a\psi\urcorner$ then ϕ is true under I iff $\psi[\alpha_a/\chi_a]$ is true under at least one α_a-variant of I.

However, this proposal is not non-nominal, and ultimately occasions the same problems as the standard clause. To see this, we need to recognize that I is a function, and is nominal in its output or value position.[33] Thus, I assigns a value to α_a from the appropriate domain by either naming such a value or by nominally quantifying over objects from that domain. But once we recognize this fact, we see that Rosefeldt's definition is equivalent to the standard clause above. In order to have a theory of non-nominal quantification, we would need an interpretation function that was non-nominal in its object position. So long as the interpretation function interprets the vocabulary of our theory by naming an expression and naming the piece of reality (or object in a model) that gets assigned to that expression, the resulting semantics will be a nominal semantics.

Williamson [2013, Ch. 5] recognizes this fact, and acknowledges that if we make use of a nominal interpretation or assignment function, the resulting semantics will not provide the intended interpretation of our language.[34]

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[32]Rosefeldt is not fully explicit about the behavior of I—he does not specify its domain and range. But I will assume that I performs roughly the same function as $\llbracket\cdot\rrbracket$ in standard compositional semantic theories, and that a sentence ϕ is true under I iff $I(\phi) = 1$, where 1 is one of two truth-values in the model.

[33]This point would also hold if I were a relation, in which case I would take names in its second argument place.

[34]Williamson is not directly concerned with Prior's puzzle; he is concerned with our ability to quantify over everything, and with the general problem of adequately expressing the semantics

Williamson's own proposal [2013, p. 237-8] is to provide a semantics for higher-order quantifiers in a language that is itself higher-order. On this view, the semantics for higher-order quantifiers makes use of those very higher-order expressions themselves, together with a higher-order function in the metalanguage that serves as both an interpretation and assignment function for expressions of all semantic types. This function, $\underline{a}^{\langle e, \lambda \rangle}$, is non-nominal in its second argument place, and can be used to interpret to both constants and variables of all types without naming their semantic values.[35] In this language, we can then specify the semantics of higher-order quantifiers in a way that is fundamentally non-nominal.

It has to be conceded: this proposal solves the quantificational form of Prior's puzzle. If we replace the clause in (5)—the clause that provides quantifiers with a nominal semantics—with the clause for the quantifier given by Williamson [2013, p. 238], higher-order existential generalizations into all different grammatical positions will be valid. This is due to the fact that we can make use of higher-order "something" in spelling out the semantics of "something" itself, and likewise make use of an assignment function that can interpret expressions of all different semantic types non-nominally. Further, the existential quantifier governed by that clause can be used to formulate higher-order versions of our Ramsey and Carnap sentences. Thus, higher-order Ramsification is at least intelligible.

However, there are two facts that count against an irreducibly higher-order approach to Prior's puzzle and the problem it poses for Ramsification. The first is that the higher-order solution makes the notion of realization—the semantic relation that is central to Ramsification—mysterious. This is not due to the fact that the semantics is itself higher-order; explaining the meaning of "something" using "something" itself in the metalanguage is perfectly intelligible, since we presumably already know the meaning of "something". Rather, the mystery comes from the fact that the higher-order analogue of realization—namely, satisfaction relative to $\underline{a}^{\langle e, \lambda \rangle}$—cannot be expressed in English or any other natural language. As far as we know, there are no transitive verbs in English or in any natural language that are radically type-polymorphic in their second argument place in the way that this higher-order assignment function must be.[36] Thus, the semantic relation expressed by this function, which plays the role of realization, differs radically from any semantic relation with which we are familiar: reference, satisfaction, truth-of, aboutness, indication, *etc*.

Second, the higher-order solution to the substitutional form of Prior's puz-

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of the object language. The quantificational puzzle falls under this last concern.

[35]Technically, $\underline{a}^{\langle e, \lambda \rangle}$ takes the infinite type λ in its second argument position, which is the limit of all finite types. In assigning $\underline{a}$ this type, Williamson intends it to be able to interpret expressions of all finite types simultaneously. In short, $\underline{a}^{\langle e, \lambda \rangle}$ is radically type-polymorphic in its second position.

[36]Although see Rieppel [2016, p. 654], and his discussion of "means".

zle may prove too strong. To see this, consider how the Williamsonian would approach the original substitutional form of Prior's puzzle. The higher-order solution would presumably be that expressions of different semantic types have interpretations of different types, and so cannot be substituted for one another. This ban on inter-categorial substitution is what blocks the substitution of nominal expressions for non-nominal ones, and solves the substitutional form of the puzzle. But this general prohibition against inter-categorial substitution is too strong; there are many such substitutions that are in fact truth-preserving. For instance, nominal substitution within the complements of many propositional attitudes is valid, as with "John believes that P" and "John believes the proposition that P". But the higher-order approach cannot discriminate; if one such substitution is invalid, they all are. These two facts give us reason to look elsewhere for a solution to Prior's puzzle and the problem it poses for Ramsification.

5.5. *Response 5: Nominal Assimilation and Regimentation*

The final, and in my view most plausible response is to avoid Prior's puzzle by regimenting our theories in advance of Ramsifying them. This was, in fact, Lewis's own approach.[37] Lewis recognized that Ramsification requires us to treat every theoretical term as a name, and he claimed that with the proper modifications in other areas of our theory, we could do just that:

> We may stipulate that our *T*-terms are names, not predicates or functors. No generality is lost, since names can purport to name entities of any kind: individuals, species, states, properties, substances, magnitudes, classes, relations, or what not. Instead of a *T*-predicate '*F*__', for instance, we can use '__ has *F*-hood'; '*F*-hood' is a *T*-name purporting to name a property, and '__ has __' is an *O*-predicate. It is automatic to reformulate all *T*-terms as names, under the safe assumption that our *O*-vocabulary provides the needed copulas:
>
> > '__ has the property __'
> > '__ is in the state __ at time __'
> > '__ has __ to degree __'
>
> and the like. We will later replace the *T*-terms with bound variables; by making the *T*-terms grammatically uniform, we avoid the need to introduce variables of diverse types. [Lewis, 1970]

[37]In endorsing this approach, Lewis undertakes what Prior [1971, Ch. 3] called the program of Platonism: of finding paraphrases for ordinary sentences that convert every non-nominal expression to a name, but are equivalent to the originals. Prior himself thought that the program of Platonism was viable, although he endorsed the opposite position. However, as we will see, there are reasons to doubt that Prior and Lewis were right about Platonism's viability.

Here Lewis proposes a method of regimentation to accommodate the nominalization of *T*-terms.[38] First, we stipulate that all *T*-terms are names. We then make use of copular verbs from our *O*-vocabulary to recapture the meanings of the pre-nominalized sentences. Thus, "John is tall" becomes "John has the property of being tall". Here, "the property of being tall" is open to nominal quantification: $\exists x_{\langle e,t \rangle}$ such that John has x.

As far as simple subject-predicate sentences are concerned, Lewis's method works perfectly—regimentations of the sort he proposes allow us to avoid Prior's puzzle. However, Lewis drastically underestimates the range of changes that need to be made to accommodate the nominalization of every *T*-term. Lewis claims that it is a safe assumption that our *O*-vocabulary contains the copulas needed for apt paraphrases. But not only is this assumption not safe, it appears to be false for all but the simplest sentences, at least without significant additions to our theory.

First, consider the case of propositional attitude ascriptions such as (51):

(51)   Mary desires that the lockdown come to an end.

Suppose we nominalize "that the lockdown come to an end". Without accommodation, this would yield an invalidity:

(52)   Mary desires the proposition that the lockdown come to an end.

But there is no obvious way to use a copula to preserve validity through nominalization. Given the arguments above, we can't say, for instance, that Mary bears the desire relation to a proposition. Thus, Lewis's strategy does not straightforwardly apply.

Further, consider again our example from above:

(53)   The fumes smell poisonous.

Nominal substitution and quantification into the position occupied by "poisonous" both lead to invalidity. So how can we regiment the sentence in a way that allows us to preserve truth through nominalization? We might try "The fumes smell like they have the property of being poisonous", but it is unclear whether this captures the original meaning. Moreover, in this case the puzzle simply arises again: "they have the property of being poisonous" is a sentence, which presumably denotes either a proposition or a truth-value. But the fumes do not smell like either a proposition or a truth-value.

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[38]But as we saw above, it is a mistake to think that not regimenting in this way would simply require us to introduce higher-order variables. On the contrary, regimentation would be required even if we introduced higher-order variables, so long as we treat them as nominal variables, and provide a nominal semantics for quantifiers that bind them.

Now consider a slightly different case. Suppose we want to Ramsify "rapidly", as it occurs in (54):

(54)   The child learned rapidly.

As we saw above, treating "rapidly" as a name yields an invalidity. But if we employ Lewis's strategy, and assimilate "rapidly" to a name—the property of being done rapidly—we need to find a bearer for this property. Clearly, the child is not what is done rapidly. It seems like the only plausible bearer for the property is the event of learning.[39] This pushes us toward treating adverbs as denoting properties of events, and so toward treating events as particulars that bear those properties. Thus, Lewis's strategy can be extended to account for adverbs, but only if we make use of a neo-Davidsonian language for our metaphysical theorizing. We will discuss this option at length below.

The most troubling cases for Lewis involve intensional transitive verbs. As we saw above, trying to Ramsify individual terms in the complements of ITVs leads to ungrammaticality, while trying to Ramsify the entire NP complement yields invalidity. Consider (55):

(55)   Maxwell seeks a perfect gas.

How can we apply Lewis's strategy? Trying to Ramsify "perfect" on its own yields ungrammaticality. But if we treat the entire complement as a name of a property, we get the result that Maxwell seeks property of being a perfect gas. But this is not what we mean: what he seeks is something that *has* that property. But how can we express this? We know that (55) is not equivalent to (56):

(56) $\exists x$ [perfect(x) & gas(x) & Maxwell seeks (x)].

This entails that there is a particular thing that Maxwell seeks. Nor would it be correct to paraphrase "seeks" as a propositional attitude; (55) is not aptly paraphrased as (57):

(57)   Maxwell is trying to make it the case that $\exists x$ [perfect(x) & gas(x) & Maxwell finds x].

Maxwell is not trying to make it the case that anything exists, perfect or otherwise. While we might continue to search for propositional decompositions of sentences involving intensional transitives, much literature suggests such a

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[39]Here I ignore the complication, noted by Davidson [1967, p. 38], that strictly speaking, being slow or rapid is not a property of an event. As Davidson points out, an event of swimming the English channel may be slow *qua* crossing but fast *qua* swimming, so the event itself is not fast or slow, absent further description.

project is doomed.[40] But even if we could find such paraphrases, this would simply defer the problem to the propositional case.

Intensional transitive verbs thus pose a serious problem for Ramsification. On the one hand, a huge number of psychological and perceptual verbs are intensional transitives; they are essential to any serious theory of the mind. Consider the following list:

(58)   covet, crave, desire, fancy, need, imagine, portray, think (of), be (about), think (about), believe (in), anticipate, expect, forsee, want, hanker (for), lust (for), thirst (for), yearn (for), prefer, hunt (for), scrounge (for), scavenge (for), seek, search (for), imitate, admire, disdain, fear, respect, worship, resemble, simulate, avoid, lack, omit, wait (for), plan, caricature, draw, represent, promise, recognize, indicate, point (to), signify, and portray.

Suffice it to say, it would be hard to formulate a realistic psychological theory while excluding them from our theoretical vocabulary. But on the other hand, intensional transitive verbs are the class of verbs for which Prior's puzzle is most recalcitrant. ITVs do not submit easily to paraphrase, and there do not appear to be any truth-preserving nominal substituends. In other words, the complements of ITVs, on the notional reading, appear to be *essentially non-nominal*. Thus, we must either ban them from our theories, accept that Ramsification fails, or find a novel method of nominal paraphrase.

6. A Neo-Davidsonian Proposal

Saving Ramsification requires a solution to the generalized form of Prior's puzzle that allows us to treat every *T*-term as a name. I will not present such a complete solution here, for I do not have a solution that I am confident generalizes to every grammatical position for which Prior's puzzle arises. However, a proposal due to Graeme Forbes [2006, 2018] provides a partial solution that addresses what I take to be the cases of Prior's puzzle most resistant to paraphrase, including the cases of adverbial modifiers, the complements of intensional transitive verbs, and some adjectival verbal complements. To my knowledge, no other proposed solution to Prior's puzzle can accomplish even this, and so it appears that any complete solution to Prior's puzzle must build on, and so incorporate, the partial solution that I present here.

Recall the case of adverbs such as "rapidly". Above I claimed that our best route to nominalizing such expressions was to treat them as names of properties, and then to use Lewis's method. There is already a kind of theory that treats

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[40]For instance, see Szabó [2003], Forbes [2006], and Montague [2009], among many others.

adverbs in just this way: a neo-Davidsonian theory, on which adverbs denote properties of events. In such a theory, the semantics for (59-a) is given by (59-b):

(59)   a.   The child learned rapidly.
        b. $\exists e$[learning(e) & agent(e,the child) & past(e) & rapid(e)]

We can then paraphrase each of these predications in the way that Lewis suggests: with copulas. In this case, the event of learning e has the property of being rapid. Thus, there is initial appeal to conducting our metaphysical theorizing in a language that allows us to name and quantify over events—it allows us to nominalize adverbs.

But this is not the only appeal of the neo-Davidsonian approach. Forbes [2006, 2018] develops a neo-Davidsonian semantics for attitude verbs that allows for nominal quantification over the complements of both intensional transitive verbs and propositional attitude verbs—Forbes' theory solves Prior's puzzle for the case of both ITVs and propositional attitude verbs. Forbes solves Prior's puzzle by distinguishing between two different roles that the denotation of the complement of a verb can play in an event. On the one hand, it can serve as the *theme* of the event, as in (60):

(60)   a.   John hit Bill.
        b. $\exists e$ [hitting(e) & agent(e,John) & theme(e,Bill)]

Here, Bill serves as the direct object of the event of hitting—he is what *gets hit*. Roughly speaking, the theme of a particular event V is what *gets V'd*. By contrast, the objects denoted by intensional noun phrases in the complements of ITVs do not denote the theme of the event introduced by the verb. Consider (61):

(61)   a.   Maxwell seeks a perfect gas.
        b. $\exists e$ [search(e) & agent(e,Maxwell) & char(e,the property of being a perfect gas)]

The notional reading of "seeks" occasions the introduction of a novel thematic role, "char", which is short for "characterizes" or "is characterized by". When Maxwell seeks a perfect gas, but not a particular one, "a perfect gas" has a denotation—depending on one's preferred semantics for intensional transitives, either a property or a generalized quantifier—but this denotation is not what *gets sought*. John does not seek either a property or a generalized quantifier. Rather, he seeks something that *has* the property of being a perfect gas, or seeks to find the things specified by the generalized quantifier.

With this novel thematic role in place, we can treat "a perfect gas" in (61-a) as a name, and then we can nominally quantify into the thematic role that it introduces:

(62)   a.   Maxwell seeks a perfect gas.
       b.   ∃*e* [search(*e*) & agent(*e*,Maxwell) & char(*e*,the property of being a perfect gas)]
       c.   ∃*P*, *e* [search(*e*) & agent(*e*,Maxwell) & char(*e*,*P*)]

(62-c) follows from (62-b): it says that there is some property that characterizes Maxwell's search. This is a perfectly valid generalization, and it makes sense of the role that abstract objects play in the semantics of intensional verbs. Substitution of a nominal expression for "a perfect gas" then serves to change the role that the denotation of "a perfect gas" plays in the event:

(63)   a.   Maxwell seeks the property of being a perfect gas
       b.   ∃*e* [search(*e*) & agent(*e*,Maxwell) & theme(*e*,the property of being a perfect gas)]

In (63-b), the substitution of a definite for an indefinite has occasioned a change in the argument structure of the verb; it specifies the theme of the verb, rather than characterizing it.[41]

Forbes deploys a similar tactic to solve the problem in the case of propositional attitude verbs. Consider (64):

(64)   a.   Mary fears that Fido bites
       b.   ∃*e* [fear(*e*) & in(Mary,*e*) & content(e,that Fido bites))]
       c.   ∃*p*, *e* [fear(*e* & in(Mary,*e*) & content(e,p))]

Here Forbes again introduces a thematic role, "content", in order to specify the role that propositions play in states such as fearing, hoping, desiring, *etc*. The "content" role, like "char", does not relate the event to its direct object or theme—the proposition is not what *gets feared*. Rather, the content role is what provides the state with its success- or correctness-conditions. Thus, the nominal quantification in (64-c) is perfectly intelligible, and follows from (64-a).

This allows us to Ramsify noun phrases in the complements of such verbs. In each of the cases above involving an intensional transitive verb, we let the verbal complement be a complex name for a property (or a generalized quantifier). We then remove that name and replace it with an existentially bound variable: we quantify into the "char" role. This allows us to offer definitions of terms such as

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[41]An anonymous referee suggests that Forbes's view cannot solve the puzzle as it arises in the complements of intensional transitive verbs, where the substituend is of the same phrasal category as the expression it replaces (both either DP or NP). But Forbes has an account of why definites block the notional reading, and force a thematic reading: it is what he calls the "definiteness effect". See Forbes [2006, pp. 146-148]. I grant, however, that accounting for the definiteness effect may depend on facts about expressions that go beyond their phrasal category.

"a perfect gas", "a catastrophic selloff", and "a psychopath"—each one serves as a name of a (complex) property. Thus, the neo-Davidsonian approach solves two of the central instances of Prior's puzzle.

How does this proposal resolve the form of Prior's puzzle that yields ungrammaticality rather than invalidity? The basic idea, proposed by Forbes [2018], is that verbs such as "hope", for which substitution yields ungrammaticality, lack a transitive reading, and so lack a lexical entry that employs the *theme* role. Thus, if we consider a string such as (65)

(65)   Mary hopes the proposition that Fido is nice,

it will be uninterpretable, because when there is a definite NP in the object position, it forces a thematic reading of the verb, but "hope" does not have the requisite lexical entry. Much the same is true for nominal quantifications. Since there is no lexical entry for "hope" that employs the *theme* role, (66) is ill-formed when "something" is construed as a quantification into the *theme* role:

(66)   Mary hopes something.

The only reading of (66) that is available is one on which "something" quantifies into the *content* role. Further, since the main verbs in these neo-Davidsonian logical forms are not relations at all, there is no fear of ungrammaticality; there is no concern that a name cannot occur in the second argument place of a verb, for such verbs are represented as monadic properties of events.

However, there are still many non-nominal positions to which the Davidsonian analysis does obviously apply. For instance, it is not clear how to nominalize the adjectival complements of perceptual verbs from our examples from above, repeated here along with the truth-conditions for their Ramsey sentences:

(67)   a. Sally feels emotional.
        b. $\exists a \in D_{\langle e,t \rangle}$ such that Sally felt a.

(68)   a. The fumes smell poisonous.
        b. $\exists a \in D_{\langle e,t \rangle}$ such that the fumes smell a.

One possibility is to extend the use of "char" above to these examples, as in (69) and (70):

(69)   a. Sally feels emotional.
        b. $\exists e$ [feeling(e) & in(e,Sally) & char(e,the property of being emotional)]
        c. $\exists P, e$ [feeling(e) & in(e,Sally) & char(e,P)]

(70)   a. The fumes smell poisonous.
        b. $\exists e$ [smelling(e) & theme(e,the fumes) & char(e,the property of being poisonous)]

    c. $\exists P, e$ [smelling(e) & theme(e,the fumes) & char(e,P)]

To extend the use of "char" in this way is, in effect, to turn "char" into a device for handling all non-nominal complements and modifiers. But such uses begin to feel unconstrained. "Char" was designed specifically to account for the non-nominal complements of intensional transitive verbs, and in that case, there are clear principles governing its behavior. There are no corresponding principles in this case.

Here I will not take a stand on whether these approaches are adequate for the purposes of the nominalizer. Rather, since these are surely not the only remaining examples of non-nominal verbal complements, I simply present such cases as a challenge to the Ramsifier. If the Ramsifier wishes to define the theoretical terms of a realistic psychological theory—i.e. one that captures a wide range of mental states, perceptual states, and emotional states—they must find a way to nominalize such non-nominal complements. The only alternative, on pain of giving definitions that are either incorrect or ill-formed, is to exclude such vocabulary from their theories.

7. Conclusion

We can now summarize our conclusions. Ramsification requires us to treat all theoretical terms as names, and in order to provide definitions of those terms, replaces those names with nominally quantified variables. But Prior's puzzle, whose scope has been drastically underappreciated, shows that attempting to assimilate expressions in a wide range of grammatical positions to names, and replacing them with nominally quantified variables, yields either invalidity or ill-formedness. Thus, Prior's puzzle, once fully appreciated, presents a serious challenge to Ramsification as a method of defining theoretical terms. If the postulate of a theory does not entail its Ramsey sentence, or has a Ramsey sentence that is ill-formed, then the corresponding definitions of theoretical terms will be either incorrect or nonsensical.

However, there is reason for measured optimism. Of the examples given, some were readily amenable to nominal paraphrase, and others could be treated with Forbes's neo-Davidsonian semantics. This approach has the consequence that if we admit intensional transitive verbs into our theories, and subsequently wish to Ramsify those theories, we will need to adopt a neo-Davidsonian language for our metaphysical theorizing. This has important metaphysical ramifications. Most importantly, we will, simply by dint of the desire to Ramsify, be committed to a metaphysics that includes events, and holds that such events have a rich structure that includes a range of roles that different objects can play in such events. The fact that a neo-Davidsonian semantics is required to handle

many natural language constructions is not surprising. But the fact that we must use such a language for our metaphysical theorizing is surprising. Ramsification comes with costs and consequences.

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