

Operator Arguments Revisited

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Abstract

Certain passages in Kaplan’s ‘Demonstratives’ are often taken to show that non-vacuous sentential operators associated with a certain parameter of sentential truth require a corresponding relativism concerning assertoric contents: namely, their truth-values also must vary with that parameter. Thus, for example, the non-vacuity of a temporal sentential operator ‘always’ would require some of its operands to have contents that have different truth values at different times. While making no claims about Kaplan’s intentions, we provide several reconstructions of how such an argument might go, focusing on the case of time and temporal operators as an illustration. What we regard as the most plausible reconstruction of the argument establishes a conclusion similar enough to that attributed to Kaplan. However, the argument overgenerates, leading to absurd consequences. We conclude that we must distinguish assertoric contents from compositional semantic values, and argue that once they are distinguished, the argument fails to establish any substantial conclusions. We also briefly discuss a related argument commonly attributed to Lewis, and a recent variant due to Weber.

1 Introduction

The idea that the truth value of a sentence is relative to some parameters is a familiar and uncontroversial one. For example, ‘The President of the U.S. is a Republican’ is false now but has been true at various times in the past, and it will be true later this year. ‘It is raining on January 13th, 2017 at 3:04 P.M. Central European Time’ is false here but is true at various other locations. And the bare ‘It is raining’ is true here and now but is false at various other combinations of times and locations, as well as at various combinations of worlds, times, and locations, other than the actual, present, and local one. Sentential truth, as the last example shows, is relative to at least world, time, and location. Even the most dedicated opponents of ‘relativism’ and ‘relativist semantics’ do not deny this.¹

In the sense of this paper, the truth value of a bearer of truth is ‘relative to’ a given parameter P (such as *world*, *time*, or *location*) – or is ‘ P -relative’, or ‘has a P -relative truth value’ – just in case it is true at some value of P and false at another; and the truth values of a class of truth-bearers are ‘ P -relative’ just in case at least one member of that class has a P -relative truth value. In our sense, the truth value of a truth-bearer may be relative to a parameter even

¹See, e.g., Zimmerman (2007) and Cappelen and Hawthorne (2009).

when the relativity is analyzable in terms of a monadic truth predicate and other logical resources. For example, we may accept that the truth values of propositions – of the assertoric contents of sentences in contexts – are world-relative, while allowing that this may amount to nothing more than the fact that some propositions are contingent, i.e., are both possibly true *simpliciter* and possibly false *simpliciter*.

Some expressions which seem to be sentential operators ‘shift’ parameters of sentential truth in the sense that the truth value of a sentence formed by the operator in a given context depends on the truth values its operand has at values of the parameter other than the one supplied by the context. For example, ‘sometimes’ shifts the time parameter, because ‘Sometimes the President of the U.S. is a Republican’ is true in a context c if and only if ‘The President of the U.S. is a Republican’ is true relative to some configuration of all of the parameters of sentential truth that differs from the configuration supplied by c at most with respect to time. Similarly, ‘possibly’ shifts the world parameter and ‘somewhere’ shifts the location parameter.

For each context c and each sentence φ , c and the compositional semantic value φ has in c together determine the truth value φ has in c . A compositional semantic value, too, has a truth value – at least on the standard assumption that the compositional semantic value of a sentence in a context is its assertoric content in that context. (Although we will question it later, we will work with this assumption for now.) But the relativity of the truth value of a sentence to a given parameter does not guarantee a corresponding relativity of the truth value of its compositional semantic value.

For example, the speaker-relativity of the truth value of ‘I have been insulted’ alone does not imply that the truth value of the compositional semantic value of ‘I have been insulted’ is speaker-relative. In fact, the mainstream view in the philosophy of language follows Kaplan in taking ‘I have been insulted’ to have different compositional semantic values (what Kaplan calls ‘contents’) in different contexts, none of which has a speaker-relative truth value.

According to one view, the relativity of sentential truth to a parameter entails the relativity of the truth values of the compositional semantic values of sentences to the same parameter whenever there are sentential operators that shift the parameter in question. This view has been encouraged by the success of a certain kind of Kripke semantics for multimodal logics. In such a semantics for a language with operators for n independent modalities, sentences are evaluated for truth at n -dimensional points of evaluation – *indices*, as we’ll call them, following Lewis (1980) – and the compositional semantic values of sentences are functions from such points to truth values. If the only non-truth-functional operators in the language are modal and temporal operators – say, ‘possibly’ and ‘sometimes’ – then the compositional semantic values of sentences will be functions from ordered pairs of worlds and times to truth values. ‘Possibly φ ’ will be evaluated as true at an index $\langle w, t \rangle$ just in case the compositional semantic value of φ assigns truth to (is true at) $\langle w', t \rangle$, for some world w' , and ‘Sometimes φ ’ will be evaluated as true at $\langle w, t \rangle$ just in case the compositional semantic value of φ assigns truth to (is true at) $\langle w, t' \rangle$, for some time t' . A sentence will be evaluated as true at a context just in case it is true at the index of the context, which in this case may just be taken to be the context

itself.² It follows that the non-vacuity of ‘possibly’ and ‘sometimes’ requires some compositional semantic values of some sentences to be true at some indices and not others. And in particular it requires the truth value of a compositional semantic value to be relative to both world and time.

We have just described a standard way of doing semantics for operators that shift parameters of sentential truth, in which it is natural to posit compositional semantic values whose truth values are relative to the parameters of sentential truth that get shifted. (At least this has been felt to be natural for many operators. Curiously, quantifiers have traditionally been exempted from this treatment, in virtue of having traditionally been spared a compositional treatment entirely – a matter to which we will return below.) The naturalness of such ‘relativism’ concerning the truth of compositional semantic values is no proof that the existence of an operator that shifts a parameter P of sentential truth requires the compositional semantic values of sentences to be P -relative.

David Kaplan, however, is widely read as having offered such a proof in a little understood but frequently cited passage that occurs early in his classic work ‘Demonstratives’ (Kaplan, 1989 [1977]). David Lewis is widely read as having shortly thereafter offered another proof in his ‘Index, Context, and Content’ (Lewis, 1980).³ Their discussions are different enough to warrant separate treatment. In this paper we will focus on Kaplan’s discussion, which, we find, lends itself to more interesting reconstructions. However, we will briefly discuss the relevant passages in Lewis.

In ‘Demonstratives’, Kaplan (1989 [1977], p. 503) writes:

If we built the time of evaluation into the contents [...] it would make no sense to have temporal operators. To put the point another way, if *what is said* is thought of as incorporating reference to a specific time [...] it is otiose to ask whether what is said would have been true at another time [...]. Temporal operators applied to eternal sentences (those whose contents incorporate a specific time of evaluation) are redundant.

(Here Kaplan uses ‘circumstance’ for what we call an ‘index’.) In a footnote to the above passage, Kaplan (1989 [1977], pp. 503–504, fn. 28) elaborates on this remark:

Technically, we must note that intensional operators must, if they are not to be vacuous, operate on contents which are neutral with respect to the feature of circumstance the operator is interested in. Thus, for example, if we take the content of [‘I am writing’] to be [the proposition that David Kaplan is writing at 10 A.M. on 3/26/77], the application of a temporal operator to such a content would have no effect; the operator would be vacuous. [...] A content must be the *kind* of entity that is subject to modification in the feature relevant to the operator.

²In the case of a language as simple as the one described, there is no need to draw a distinction between context and index. For more interesting languages, such as Kaplan’s LD (Kaplan (1989 [1977])), truth at a context is defined by first defining truth at a pair of a context and an index; and φ is defined as true at c just in case φ is true at $\langle c, i_c \rangle$, where i_c is the index of c .

³We will be suggesting later that the literature may have misconstrued the intentions of one or both of these authors.

These remarks are sometimes referred to as Kaplan’s *operator argument*.

It should be noted that in the quoted passages Kaplan talks about ‘contents’, which he does not unambiguously identify with compositional semantic values, although he does identify them with assertoric contents (or with ‘what is said’ by a sentence in a context, to use his words).⁴ However, the operator argument is most naturally understood as based on the assumption that the compositional semantic value of a sentence in a context is its assertoric content in that context. In fact, we think this is false: as argued persuasively in Rabern (2012) and Yli-Vakkuri (2013), these two theoretical roles are occupied by different entities.⁵ But for the purpose of understanding Kaplan’s operator argument, we will first make this assumption, calling what is intended to play both the roles of compositional semantic values and assertoric contents simply ‘contents’. Using this terminology, Kaplan’s operator argument has widely been taken to demonstrate the following.

CONTENT TEMPORALISM: The truth values of contents are time-relative.

We use CONTENT ETERNALISM for its negation.

We will reconstruct and formalize Kaplan’s argument (section 2). It turns out that the argument relies on an unmotivated premise (section 3), but that this premise can be motivated if quantification over contents is formalized using sentential quantification, as this allows for a natural way of expressing the idea that truth is transparent – an idea very much in the spirit of standard disquotational principles about truth (section 4).⁶ This completes the argument; indeed, we show that these resources allow for a much simpler argument for content temporalism (section 5).

Like Kaplan himself and much of the subsequent literature, the sections just outlined focus on the case of temporal operators and time for illustration. But as the footnote quoted above makes clear, Kaplan intends his operator argument to apply to arbitrary ‘feature[s] of circumstances that the operator is interested in’ – not only time and world.⁷ We argue that the argument for content temporalism generalizes to many other parameters. In fact, we argue that it generalizes to cases which lead to absurd conclusions, such as the claim that the truth values of contents are relative to assignment functions; this is absurd since contents are assumed to play the role of assertoric contents. As we see it, this is a way of bringing out that assertoric contents cannot be identified with compositional semantic values (section 6).

If assertoric contents and compositional semantic values are distinguished, might a version of the operator argument still establish some interesting conclusion concerning one of these kinds of entities? We consider some natural versions

⁴The terms ‘compositional’ and ‘compositionality’ do not occur in Kaplan (1989 [1977]). See also the discussion of ‘propositions’ and ‘contents’ in Kaplan (1989 [1977], p. 546).

⁵Of course, others have also argued for the conclusion that these theoretical roles are occupied by different entities: Dummett (1973, 1991), Humberstone (1976), Evans (1979), Davies and Humberstone (1980), Lewis (1980), Stanley (1997, 2002), to mention a few. But we find these arguments less persuasive than the recent ones by Rabern and Yli-Vakkuri, which concern the semantics of variable-binding operators.

⁶We say ‘in the spirit of’ because no quote marks occur in the principles.

⁷Although Kaplan’s semantics does not have contents with location-relative truth values, Kaplan (1989 [1977], p. 504) affirms that the presence of locational operators in a language would require the truth values of the contents expressed by its sentences to vary with location.

of the argument and argue that they fail to do so (sections 7 and 8). The remainder of the paper sums up the conclusions reached (section 9) and presents the derivations used in our reconstructions of the operator argument (appendix).

To readers familiar with recent work on tense in natural language semantics, discussions of the operator argument may have the appearance of ‘semantic archeology’:⁸ following Barbara Partee (1973), contemporary semanticists tend to treat tense and temporal expression as involving quantifiers binding hidden temporal variables rather than sentential operators. However, the operator argument applies to locational and other sentential operators just as well as to temporal operators; indeed, as we will discuss, it also applies to quantifiers. Furthermore, the conclusion of the operator argument concerns general, non-contingent, features of contents. To establish these conclusions, it suffices for there to be *some* language to which the argument can be applied; it is neither important that the language is a natural rather than a formal one, nor that the language is in fact spoken rather than merely possibly spoken.

2 Reconstructing Kaplan’s Operator Argument

We will reconstruct Kaplan’s operator argument by regimenting its premises and its conclusion in a formal language. In this formal language, we will have to quantify over contents and over times, and to formulate predications which ascribe truth to a content at a time. So let us introduce two kinds of variables, one for contents, for which we will use $p, q, \dots$, and one for times, for which we will use $t, t', \dots$. Both will be bound by a universal quantifier $\forall$. The syntactic status of the two variables can be left somewhat open at this point; for present purposes, we can work in a many-sorted first-order language, and take content and time variables to be two sorts of first-order variables. Truth at a time can then be expressed using a binary relation symbol T_r which takes a content variable and a time variable (the index r indicates that this truth predicate is *relational*, distinguishing it from a monadic truth predicate T_m which will be used below).

With these resources, content eternalism can be formalized as the claim that any content p true at any time t is true at every time t' :

$$(E_r) \quad \forall p \forall t (T_r(p, t) \rightarrow \forall t' T_r(p, t'))$$

Kaplan’s operator argument is intended to show that, if (E_r) is true, then any temporal operator will be vacuous. So fix any temporal operator expression Ω , and a context of utterance c . Since contents are supposed to play the role of compositional semantic values, we assume that Ω determines a function on contents, mapping the content of any sentence S at c to the content of ΩS at c . Add to the formal language a function symbol O , read as expressing this function on contents. (Because we will be considering only one context, we will hear no more of c .) The vacuity of Ω can now plausibly be interpreted as the claim that the truth value of Op , at a given time t , is the same as the truth value of p :

$$(V_r) \quad \forall p \forall t (T_r(Op, t) \leftrightarrow T_r(p, t))$$

⁸Thanks to Hans Kamp for suggesting this phrase in this connection.

We can see no way of construing an argument from (E_r) to (V_r) : even if the truth-value of a content is independent of time, O may at least be sensitive to this eternal truth value.⁹ But the conclusion that temporal operators are truth-functional is good enough for a *reductio* of content eternalism, so we will construe the operator argument as deriving, using (E_r) , the conclusion that, for any time, if two contents have the same truth value at it, then O maps them to contents with the same truth values:

$$(TF_r) \quad \forall p \forall q \forall t ((T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow (T_r(Op, t) \leftrightarrow T_r(Oq, t)))$$

As we will construe it, the operator argument derives from content eternalism the claim that temporal operators are truth-functional. Regimenting content eternalism using (E_r) and the claim that a fixed operator (determining a function on contents O) is truth-functional using (TF_r) , we therefore need to regiment the claim that this fixed operator is a temporal operator. In the present setting, a natural proposal is the following, expressing that contents true at the same times are mapped to contents true at the same times by O :¹⁰

$$(O_r) \quad \forall p \forall q (\forall t (T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t (T_r(Op, t) \leftrightarrow T_r(Oq, t)))$$

And (TF_r) does follow from (E_r) and (O_r) . Informally, consider any p, q and t and assume that $T_r(p, t)$ just in case $T_r(q, t)$. By (E_r) , for all t' , $T_r(p, t')$ just in case $T_r(q, t')$, and analogously for q . So for all t' , $T_r(p, t')$ just in case $T_r(q, t')$. So by (O_r) , for all t' , $T_r(Op, t')$ iff $T_r(Oq, t')$, in particular $T_r(Op, t)$ iff $T_r(Oq, t)$.

This informal argument can straightforwardly be turned into a model-theoretic argument, showing that in the standard model theory for many-sorted first-order logic, every model of (E_r) and (O_r) is a model of (TF_r) . Since standard calculi for many-sorted first-order logic are complete with respect to this model theory, (TF_r) is derivable from (E_r) and (O_r) in such calculi.

With premise (O_r) , the operator argument as reconstructed here is valid. But is this premise true? We think don't think this is clear: even if O is the function on contents determined by a temporal operator, it is not obvious that the truth-value of Op at any time should be determined by the truth values of p at the various times. Why shouldn't O be sensitive to (temporal) features of contents other than the times relative to which they are true? In the next section, we present a toy model of contents which show how (O_r) may fail, and how (E_r) may be compatible with the failure of (TF_r) .

3 Timestamp Semantics

For purposes of illustration, consider a standard relational or 'Kripke' semantics for temporal operators, based on a set T of times and an 'accessibility' relation

⁹ Ω being vacuous may also be understood as the claim that the truth-value of Op at a given time is the same for all choices of p :

$$(V'_r) \quad \forall p \forall q \forall t (T_r(Op, t) \leftrightarrow T_r(Oq, t))$$

As with (V_r) , we see no way of construing an argument from (E_r) to (V'_r) .

¹⁰We understand temporal operators to be operators sensitive *only* to temporal features of their operands; they might be so trivially. There are other intuitive notions of a temporal operator that are not captured by (O_r) . E.g., on some intuitive notion, 'someone believes at 3 P.M. that' is a temporal operator, but it is not a temporal operator on the notion captured by (O_r) . Here we focus on that notion. This narrow focus is not a problem for our reconstruction of Kaplan insofar as Kaplan's argument is meant to apply *also* to operators that are temporal by the criterion (O_r) , which we assume it is.

R (perhaps a different one for each temporal operator) on T . In this kind of semantics, contents are sets of times (rather in the way that in possible worlds semantics, contents are represented as sets of possible worlds), and, as before, temporal operators correspond to functions from contents to contents. (Again, we are assuming that the context of utterance has been fixed.) These functions are specified using accessibility relations. For example, if we had an operator ‘it will at some time be the case that’, the associated accessibility relation R would relate each time to all times that are after it, and ‘it will at some time be the case that φ ’ would be stipulated to be true at a time t iff there is a time x after t (i.e., such that Rtx) at which φ is true. The same accessibility relation could be used for ‘it will always be the case that’, since ‘it will always time be the case that φ ’ may be interpreted to be true at a time t iff for every time x after t (i.e., such that Rtx), φ is true at x . Specifying the semantic condition for this second example as a function $o : \mathcal{P}(T) \rightarrow \mathcal{P}(T)$ on contents, we arrive at:

$$o(S) = \{t \in T : x \in S \text{ for all } x \in T \text{ such that } Rtx\}.$$

The set-theoretic objects used in the kind of semantics we have just described can easily be used to construct a model for the many-sorted first-order language used above: Let T be the domain that interprets the time variables and $\mathcal{P}(T)$ the domain that interprets the content variables; let O be interpreted by o and T_r by the relation $\tau_r \subseteq \mathcal{P}(T) \times T$ given by the following definition:

$$\tau_r(S, t) \text{ iff } t \in S$$

It is easy to see that suitable choices of T and R provide models of (O_r) which falsify all of (V_r) , (TF_r) and (E_r) ; e.g., let T be the set of integers and R be the strictly-less-than relation. This is a toy model of the kind of semantics Kaplan and many others have provided for temporal operators. As one would expect, contents do not conform to content eternalism (E_r) , and temporal operators have neither to be vacuous (V_r) nor truth-functional (TF_r) . Meanwhile contents true at the same times are mapped by temporal operators to contents true at the same times, as stated by (O_r) .

Now consider a simple variant model in which the domain used to interpret the content variables is not the set of sets of times, but the set of pairs of sets of times and times: $\mathcal{P}(T) \times T$. This variant semantic model will do exactly what Kaplan claims to be impossible: the content of a sentence builds in the time of utterance (by including it as the second member of the pair) without rendering temporal operators vacuous (or truth-functional). The contents of the old semantics now appear as the first members of the pairs that are the contents of the new semantics. The new semantics merely adds a *timestamp* as a second member. Adding this time stamp clearly need not render temporal operators either vacuous or truth-functional. Suppose, for example, that temporal operators operate on the first member of a time-stamped content just as they did in the old semantics and leave the second member untouched. Then it is easy to see that the temporal operators need not be vacuous or truth-functional. More concretely, we can define the function $o' : \mathcal{P}(T) \times T \rightarrow \mathcal{P}(T) \times T$ corresponding to ‘it will always be the case that’ so that:

$$o'(\langle S, t \rangle) = \langle \{x \in T : y \in S \text{ for all } y \in T \text{ such that } Rxy\}, t \rangle$$

In general, *every* function on $\mathcal{P}(T)$ can be lifted accordingly. Even if no definition of o in terms of a relation R is available, o' can be defined more simply directly in terms of o as follows:¹¹

$$o'(\langle S, t \rangle) = \langle o(S), t \rangle$$

To complete the variant model, we need to supply an interpretation for the relational truth predicate T_r . The following definition encodes the natural idea that a timestamped content is true at a time just in case the first component of the content contains the timestamp of the content, so let T_r be interpreted by the relation $\tau'_r \subseteq \mathcal{P}(T) \times T$ such that:

$$\tau'_r(\langle S, t \rangle, t') \text{ iff } t \in S$$

For concreteness, consider again the choice of T being the set of integers and R the strictly-less-than relation. This model verifies (E_r) , but it falsifies (V_r) , (TF_r) and (O_r) . Content eternalism is compatible with non-vacuous and non-truth-functional temporal operators if (O_r) is falsified, and (O_r) can be falsified in non-trivial ways. As reconstructed above, the operator argument is therefore unconvincing.¹²

4 The Argument Completed

The timestamp semantics of the last section shows how premise (O_r) may fail to hold. Nevertheless there is something quite strange about that semantics. Consider the content p associated with ‘It is raining’ as uttered at the current time t . This is $\langle S, t \rangle$, where S is the set of times at which it is raining. By the semantics of the relational truth predicate given in the previous section, whether that content is true at a time—say, last Tuesday—has nothing to do with how

¹¹In the terminology of modal logic, this shows that adding timestamps extends smoothly from a relational or Kripke semantics to a neighborhood or Scott-Montague semantics; see Chellas (1980) for a textbook treatment of the latter under the label ‘minimal models’. Similarly, it is straightforward to adapt the construction to operators taking more than one argument, as well as to so-called general frames, in which contents may be restricted to be only certain sets of worlds; see Blackburn et al. (2001) for a textbook treating such structures.

¹²The timestamp semantics indicates that Mark Richard’s discussion of Kaplan’s argument in Richard (1982) is too concessionary. In that paper he argues that insofar as temporal operators operate on propositions (assertoric contents), Kaplan’s view that there is no semantics compatible with eternalism which ‘provides an even minimally acceptable representation of the logical features of tensed English’ is ‘fair’ (p. 342). Many other philosophers have voiced similar thoughts, concerning temporal and other operators: see, e.g., Fitch (1999), King (2003), Stanley (2008, n. 43), Glanzberg (2007, p. 2), Glanzberg (2009, p. 285, n. 2), Glanzberg (2011), Ninan (2012), Kölbel (2009, p. 384), MacFarlane (2009, section 2), Brogaard (2012, chapter 6).

As Richard reconstructs Kaplan, a key premise is that ‘if eternalism is true, then it is eternalist intensions which are the formal representatives of propositions’ (p. 341). Here Richard is thinking of those intensions as something like sets of possible worlds. What he and others have not noticed is that this particular choice of formal representatives of eternalist propositions makes all the difference. As the time-stamped semantics illustrates, other choices of formal representatives do much better at providing an eternalist-friendly story about the logical features of tensed English that is ‘minimally acceptable’. Of course, many of these authors eschew sets of worlds as formal representatives in favor of structured propositions, but they have assumed that adding structure in this way is neither here nor there as far as Kaplan’s operator argument is concerned. But if the added structure is our time-stamped structure, that will make all the difference. Of course, our time-stamped structures does not look anything like the structures familiar from the literature on structured propositions, but insofar as those theories are consistent, it’s no hard to dress them up by adding time-stamps.

the weather is at that time. By contrast, it seems that whether last Tuesday it was raining has everything to do with how the weather was last Tuesday. But of course the content of ‘It is raining’, as uttered now is *that it is raining*, so there is an odd disconnect between whether that it is raining is true at a given time and whether it is raining at that time. In some sense, this violates a transparency principle for relational truth. This feature of the timestamp semantics is hard to bring out in the formal language in which the operator argument was formalized in section 2. There, we can only talk about the truth of contents at various times, but to formulate a transparency principle for truth, we need to assert contents in some sense directly.

Let’s just expand our language so that this is possible. So, in addition to allowing content variables to occur in the place of the first argument of a predication of relational truth, we allow them to take sentential position. It is then natural to think of the formal language not as a many-sorted first-order language, but a (fragment of a) higher-order language similar to the type theories used in formal semantics.¹³ In order to state the desired transparency principle, we also need, for each temporal variable t , a temporal operator $[t]$, where $[t]\varphi$ may be read as ‘at t , φ ’.¹⁴ With this, we can formalize the transparency principle as the claim that at any time t , a content p is materially equivalent to p being true at t :

$$(T_r) \quad \forall p \forall t [t](p \leftrightarrow T_r(p, t))$$

Before moving on to a discussion of how the operator argument can be completed using (T_r) , it is probably worth discussing potential worries concerning the status of this principle. First, one may wonder whether it is consistent in any standard classical logic, given the well-known inconsistency of the T -schema in classical first-order logic (and a suitable syntactic theory). The consistency of (T_r) is indeed doubtful on a structured conception of contents when propositional quantifiers are interpreted as ranging over the contents of the language in which (T_r) is stated.¹⁵ This is, however, unnecessary for the operator argument, so we may set the issue aside by assuming that propositional quantifiers only range over contents of a restricted object language, which in particular lacks the connective T_r used in (T_r) . Note also that we need not conclusively defend the use of the resources used here in the reconstruction of the operator argument; we may assume that the resources used here are in good standing for the sake of the argument – we will reject it on other grounds below.

With content variables taking sentential positions, we can also express properly that O is determined by a temporal operator: contents which are materially equivalent at all times are mapped by O to contents which are materially equivalent at all times:¹⁶

$$(O'_r) \quad \forall p \forall q (\forall t [t](p \leftrightarrow q) \rightarrow \forall t [t](Op \leftrightarrow Oq))$$

In contrast to (O_r) , this principle does not build in any substantial assumptions about the role of the truth of contents relative to times in the compositional

¹³Note that Kaplan himself often works with a higher-order language of this kind: see, e.g., Kaplan (1970, 1995).

¹⁴This notation is adapted from Cresswell (1990). These connectives are investigated systematically in hybrid logic, where $[t]\varphi$ is often written as $t : \varphi$ or $@_t\varphi$; see, e.g., Bräuner (2014).

¹⁵See Schwarz (2013) and Whittle (forthcoming) for discussion of such issues.

¹⁶The same caveats apply here as in footnote 10.

semantics of temporal operators. (O'_r) seems quite plausible for any temporal operator. At any rate, the following instance for the complex temporal operator $\forall t[t]$ is clearly unproblematic, and the operator argument can be carried out using only this instance:

$$\forall p \forall q (\forall t[t](p \leftrightarrow q) \rightarrow \forall t[t](\forall t[t]p \leftrightarrow \forall t[t]q))$$

For generality and simplicity, we assume (O'_r) .

We can now complete the operator argument, by deriving (O_r) from (O'_r) and (T_r) . One auxiliary premise is still needed, expressing that relational truth ascriptions are stable: p is true at t just in case at t , p is true at t .

$$(S_r) \quad \forall p \forall t (T_r(p, t) \leftrightarrow [t]T_r(p, t))$$

Note that this is even plausible for the content temporalist who rejects (E_r) . In any case, since we're interested in consequences derived from (E_r) , this stability principle is completely unproblematic – it would be a very strange kind of content eternalism that accepts (E_r) but rejects (S_r) .

(O_r) follows from (T_r) , (O'_r) and (S_r) . Informally, consider any p , q such that for all t , $T_r(p, t)$ just in case $T_r(q, t)$. With (T_r) , it follows that for all t , at t , p just in case q . So with (O'_r) , for all t , at t , Op just in case Oq . Hence with (T_r) again, for all t , at t , $T_r(Op, t)$ just in case $T_r(Oq, t)$. Finally, it follows by (S_r) that for all t , $T_r(Op, t)$ just in case $T_r(Oq, t)$. Moreover, as we have seen, once (O_r) is granted, one can validly argue from eternalism, as captured by (E_r) , to the truth-functionality of all temporal operators, as captured by (TF_r) . In short, given the transparency of relational truth, we can rehabilitate the operator argument.

In contrast to (many-sorted) first-order logic, the present language with quantifiers binding variables in sentence position and intensional operators like $[t]$ does not have a standard model theory nor a standard proof theory, and so of course also no soundness and completeness theorem linking them. But one can still formalize the informal argument just given by producing a proof system with plausible axioms and rules in which (O_r) can be derived from (T_r) , (O'_r) and (S_r) . Such a system is given in the appendix.

5 The Argument Simplified

Using the resources introduced in the last section, the operator argument can be simplified by moving from a relational to a monadic truth predicate; this allows us to dispense with quantification over times. So, introduce a monadic truth predicate T_m , taking content variables, and a unary sentential operator A for ‘always’. With these new resources, we can simplify the formalization of content eternalism:

$$(E_m) \quad \forall p (T_m p \rightarrow AT_m p)$$

The transparency of truth and the claim that O is determined by a temporal operator can now be formulated as follows:

$$(T_m) \quad \forall p A(p \leftrightarrow T_m p)$$

$$(O_m) \quad \forall p \forall q (A(p \leftrightarrow q) \rightarrow A(Op \leftrightarrow Oq))$$

Using standard resources of normal modal logics and an axiom stating that what is always the case is the case, we can derive from these three premises that O is truth-functional in the following sense:¹⁷

$$(TF_m) \quad \forall p \forall q ((p \leftrightarrow q) \rightarrow (Op \leftrightarrow Oq))$$

The derivation is given in the appendix.

This is the simplest version of the operator argument we can see. However, an even simpler argument against content eternalism can be formulated using the present resources: (E_m) and (T_m) entail the following principle, stating that what is the case is always the case:

$$(Ver_m) \quad \forall p (p \rightarrow Ap)$$

Informally, consider any p . If p , then by (T_m) , $T_m p$, so with (E_m) , always $T_m p$. But by (T_m) , it's always the case that p follows from $T_m p$, so always p . The appendix gives a corresponding derivation.

Prima facie, this would appear to be a *reductio* of eternalism, since (Ver_m) appears to licence such manifestly false claims as ‘If it is raining, it is always raining’. We will shortly see, however, that matters are not so simple.

6 Overgeneration

Let us now assess the operator arguments, as reconstructed so far. For simplicity, we focus on the simplified version using the monadic truth predicate deriving (Ver_m) from (E_m) and (T_m) , but everything we say applies as well to the version using O , and the version using the relational truth predicate. As suggested above, we can think of the formal language we have been working with as an extension of some language whose semantic theory we are developing. This might as well be English, so take English sentences to be formulae of the formal language used here, so that English sentences can take the place of p . Then the rule of universal instantiation (UI) allows us to derive from (Ver_m) both of the following:

(R) It is raining $\rightarrow A$ it is raining.

(NR) It is not raining $\rightarrow A$ it is not raining.

Since it is neither always raining nor always not always raining, one of these is false (in our fixed context c); this therefore completes the *reductio* of eternalism.

Given the assumption that the assertoric contents of sentences are their compositional semantic values, we think this argument is successful. (We will shortly elaborate on why.) But the argument overgenerates. The minimal assumptions required for the derivation of (Ver_m) from the transparency of truth (T_m) and content eternalism (E_m) apply to a wide range of operators beyond temporal ones. Analogous arguments can therefore be given using locational operators or the definiteness operator familiar from discussions of vagueness, and so used to argue against the claims that true contents are true everywhere and definitely. Many of those who are convinced by the operator arguments that what is said

¹⁷Note that this is quite a weak notion of truth-functionality: it is satisfied, for example, by ‘actually’.

must be true relative to some times but not others do not want to hold that what is said must be true relative to some locations but not others (Kaplan himself is a case in point here¹⁸), or relative to some precisifications but not others (standard theories of vagueness deny this¹⁹). This suggests that this style of argument proves too much.

An especially interesting case is that of the quantifiers. Consider the highly plausible view that the truth values of contents are not relative to variable assignments, which is naturally expressed in the object language as follows (where x is a variable, of any type, distinct from p):

$$(EQ_m) \quad \forall p(T_mp \rightarrow \forall x T_mp)$$

As above, (T_m) licenses the derivation of a corresponding principle omitting the truth operator:

$$(VerQ_m) \quad \forall p(p \rightarrow \forall xp)$$

Here we cannot use (UI) to obtain consequences which would lead to a *reductio* of (EQ_m) , since the standard restrictions on (UI) prohibit instantiations containing free variables which become bound in the instance.

However, we can complete the argument with the semantic assumptions made here: Since x does not occur freely in $p \rightarrow \forall xp$, classical quantification laws allow us prove that $\forall p(p \rightarrow \forall xp) \rightarrow \forall p \forall x(p \rightarrow \forall xp)$; thus the truth of $(VerQ_m)$ entails the truth of the following principle:

$$\forall p \forall x(p \rightarrow \forall xp)$$

If we could instantiate p with any formula φ , we could derive $\forall x(\varphi \rightarrow \forall x\varphi)$, which may well be false if x occurs freely in φ . We cannot do so using UI, since UI – for precisely this reason – disallows such instantiations. But we can argue that the semantic picture we have granted for the sake of argument licenses such instantiations: in it, assertoric contents play the role of compositional semantic values, and so the range of $\forall p$ includes the compositional semantic value of φ . Thus $\forall x(p \rightarrow \forall xp)$ must be true when p is interpreted using the compositional semantic value of φ ; by compositionality, $\forall x(\varphi \rightarrow \forall x\varphi)$ must be true as well. This completes the *reductio* of (EQ_m) . Thus the operator argument as reconstructed here applies as well to the quantifiers and so can be used to show that the truth values of assertoric contents are relative to variable assignments.

These consequences are unacceptable: the cases of location and definiteness may be up for debate,²⁰ but surely the truth of what is said is not relative to a variable assignment. We therefore take these instances of the operator argument to show that assertoric contents and compositional semantic values may not be identified: the latter but not the former may show sensitivity to parameters such as variable assignment. This is indeed precisely the point argued by Yli-Vakkuri (2013) and Rabern (2012).

The preceding reflections indicate that the assertoric content of φ in a context will not be the same as its compositional semantic value. The assertoric content

¹⁸See the treatment of ‘here’ in section XVIII of Kaplan (1989 [1977]).

¹⁹See Williamson’s (2003) discussion of supervaluationism and epistemicism.

²⁰Andrew Bacon (forthcoming) develops a sophisticated theory of vagueness in which the truth values of assertoric contents are precisification-relative. We are not aware of any comparably sophisticated theory of location, although Prior (1968) is suggestive of one.

will be generated by the variable assignment of the context, but the content so generated is unfit to serve as the compositional semantic value of φ . Nor is any other assertoric content fit to play that role.²¹ We are thus led to conclude that the compositional semantic values of sentences containing free occurrences of variables are a different type of entity from their assertoric contents.²²

Can anything like the operator argument be used to establish interesting conclusions about assertoric contents or compositional semantic values once these two kinds of entities are distinguished? We consider this question in the next two sections, focusing first on assertoric contents and then on compositional semantic values.

7 Assertoric Contents and Universal Instantiation

Given the distinction between assertoric contents and compositional semantic values, it is plausible that quantifiers binding variables in sentential position range over assertoric contents, rather than over compositional semantic values.²³ Compare the case of an individual quantifier like ‘everyone’. This ranges over persons, rather than the compositional semantic values of singular terms. After all, any distinct singular variables like x and y have distinct compositional semantic values. This can be illustrated by any formulas $\forall xFx$ and $\forall xFy$ that differ in truth value in some context: in any context in which they differ in truth value, $\forall xFx$ and $\forall xFy$ must have different compositional semantic values, because compositional semantic value together with context determines truth value; therefore, by compositionality x and y must also differ in compositional semantic value in any such context. Given an infinite supply of variables, there must therefore be infinitely many compositional semantic values of variables,

²¹See Heim and Kratzer (1998, p. 242) Note that we are not theorizing in complete abstraction from standard theoretical frameworks for natural language semantics. We can imagine alternative frameworks in which one assigns semantic values not to expressions in contexts but to *occurrences* of expressions in contexts in such a way that different occurrences of the same expression in the same context can have different semantic values, as in, e.g., the framework sketched in Salmon (2006), following the precedent of Frege’s doctrine of ‘indirect reference’. And we can imagine theoretical frameworks in which contexts are conceived in such a way that sentences containing free occurrences of variables do not have assertoric contents at all. No doubt the lessons of this paper could be adapted to many such eccentric frameworks, but we think it’s not profitable to try to express things in a way that is completely neutral between the standard framework and these alternatives.

²²Giving a general characterization of the compositional semantic values of sentences, including ones containing free occurrences of variables, is a delicate matter. According to one proposal (Yli-Vakkuri, 2013, pp. 554-555) they are something like Kaplanian characters. According to another (Yli-Vakkuri (2013, p. 562, n. 49); Yli-Vakkuri (2016); Yli-Vakkuri and Litland (2016)) they are three-dimensional objects that encode both metasemantic and semantic information. An alternative approach proposed by Fine (2003, 2007) recommends that we dispense entirely with the project of assigning semantic values piecemeal to sentences and theorize instead using *relations* between *occurrences* of expressions in sentences.

²³While we are confident that variables in sentential position range over assertoric contents rather than compositional semantic values, much of what we have to say would go through on the slightly weaker assumption that those variables don’t range over compositional semantic values. (But we are not going to explore views according to which propositional variables range over neither assertoric contents nor compositional semantic values.) Note also that we call anything that can serve as the content of an assertion an ‘assertoric content’, even if in fact, no assertion has it as a content.

and so of singular terms in general. Since there are finitely many people, cardinality considerations alone rule out that the compositional semantic values of singular terms – including variables – are people. Quantifiers restricted to people like ‘everyone’ of course range over people, so they don’t range over such compositional semantic values. It is plausible that the matter is analogous in the case of quantifiers binding variables in syntactic positions other than singular terms.

With its variables ranging over assertoric contents, the derivability of (Ver_m) from (E_m) might well seem like a *reductio*. But this is too quick: if compositional semantic values are not identified with assertoric contents, it is no longer clear that (R) and (NR) can be derived from (Ver_m) . We have already seen one way in which the derivation might be blocked: as applied to ‘always’, it might be that ‘Always it is raining’ can be understood as involving the binding of a temporal variable and so the standard ‘free for’ exception clause for universal instantiation kicks in.²⁴ But it is important to see that, even if ‘always’ is not a variable-binding operator, it might nevertheless be sensitive to features of the compositional semantic values of its operand which are not reflected in the assertoric contents they express; as one can put it, it might well be sensitive not only to what is expressed, but also how it is expressed. In that case rejecting the derivability of (R) and (NR) from (Ver_m) requires rejecting instances of UI. But there is nothing especially radical about rejecting the validity of UI for this kind of reason.²⁵ Indeed, there are very standard model-theoretic semantics that accompany standard philosophical views that reject UI on account of operators that do not operate on assertoric content. Perhaps the most prominent example is the semantic treatment of the definiteness operator that is used by both supervaluationists and epistemicists. According to this treatment the definiteness operator Δ is a universal modality for a valuation parameter, where a valuation is, in effect, a way of assigning contents to vague expressions.²⁶ Williamson (2003) argues that both supervaluationists and epistemicists should accept $\forall p(p \rightarrow \Delta p)$, which indeed does come out valid on his semantics. $\forall p(p \rightarrow \Delta p)$ is the natural way to formalize the claim that there is no vagueness in the world (as opposed to in language or thought). Note that even in the case where one propositionally quantifies into the scope of Δ , the operator Δ is sensitive not merely to the content expressed (under a variable assignment) by the bound propositional variable, but also to how that content

²⁴See the appendix for a statement of this restriction.

²⁵There are unrelated reasons, such as problems having to do with fictional names and names that fail to refer to anything, for rejecting the validity of universal instantiation. These are standardly used to motivate *free logics*, i.e. logics that do not validate existential generalization (EI—for the case of propositional quantification: $\varphi[\psi/p] \rightarrow \exists p\varphi$). EI is equivalent to UI by contraposition and the duality of the universal and existential quantifiers, so free logics, provided they validate contraposition and treat the quantifiers as duals—as all standard free logics do—also fail to validate UI. Note, then, that the logic of vagueness discussed by Williamson (2003) is a free logic.

²⁶In fact, in Williamson’s semantics, as in supervaluationist semantics generally, a valuation is an assignment of truth values rather than of contents to the atomic sentences; there is no need for valuations that assign more fine-grained entities to expressions when one is dealing with a language whose only non-truth-functional operator is the definiteness operator. However, when metaphysical modal operators are also present, valuations assign either contents or Kaplanian characters to the language’s atomic sentences: see the reconstructions of epistemicism and different forms of supervaluationism in Yli-Vakkuri (2016) and Yli-Vakkuri and Litland (2016).

are expressed. In general, Δ is sensitive to the variety of admissible precisifications of its operand. In the limiting case where its operand is a propositional variable, Δ is sensitive to the absence of any such variety, and this makes for a kind of inertness in that case that is expressed in the object language by the principle $\forall p(p \rightarrow \Delta p)$. As Williamson emphasizes, this ‘precision of variables is no technical accident’ (p. 703). Without such precision, our ability to properly express in the object language a variety of even completely uncontroversial theses about vagueness, such as that there is no number that is definitely the cut-off between baldness and non-baldness, would be threatened.²⁷

Of course Williamson does not think that any theorist of vagueness should accept every instance of $\varphi \rightarrow \Delta\varphi$. Accordingly, Williamson rejects UI (which does not come out valid on his semantics). Here, then, is a way of blocking operator arguments for the valuation-relativity of the truth values of assertoric contents, and there is no reason in principle why one could not analogously block the operator argument for time-relativity of the truth values of assertoric contents.

It is worth reconsidering the compositional semantics of quantifiers in the light of the conclusions reached here. First, the operator argument against (VerQ_m) sketched in the previous section suggests a somewhat more direct argument against the identification of assertoric contents and compositional semantic values: If quantifiers binding variables range over contents which play the role of compositional semantic values, then the truth of $\forall p\varphi \rightarrow \varphi[\psi/p]$ is not only guaranteed on the assumption that ψ is free for p in φ , but for all ψ . This of course leads to absurd consequences, as demonstrated above. The standard restrictions in UI (e.g., in the setting in the appendix that ψ be free for p in φ) can therefore be seen as arising from the fact that quantifiers are sensitive to aspects of compositional semantic values which are not reflected in assertoric contents. Thus an instance of the kind of restriction of UI we are proposing is already built into elementary quantification theory.

It might be useful to illustrate this possibility using a simple formal semantics. Consider a language along the lines we have been considering with sentential constants $c, d, \dots$, an operator A for ‘always’, an operator $\Box$ for ‘(metaphysically) necessarily’ in addition to Boolean connectives and quantifiers binding sentential variables $p, q, \dots$. Let a model for this language be given by a set W of worlds and a set T of times, and an interpretation function I mapping each sentential constant c to the set of pairs of worlds and times at which it is true; i.e., $I(c) \subseteq W \times T$. With much of the literature, assume that assertoric contents are sets of worlds. Since propositional quantifiers range over such contents, we let an assignment be a function a mapping each sentential variable p to a set of worlds; i.e., $a(p) \subseteq W$. A standard truth-conditional semantics using such models makes truth relative to three parameters: a world, a time and an assignment function, and specifies the following truth-conditions, in addition to the standard clauses for Boolean connectives:²⁸

$$w, t, a \models c \text{ iff } \langle w, t \rangle \in I(c)$$

$$w, t, a \models \Box\varphi \text{ iff } w', t, a \models \varphi \text{ for all } w' \in W$$

²⁷See Williamson (2003, p. 703-704) for discussion.

²⁸This is a standard way of treating modality and tense, one found in, e.g., Kaplan (1978, 1989 [1977]) and Fine (2005 [1977]). Montague (1973) gives a different treatment, as do Dorr and Goodman (forthcoming).

$w, t, a \models A\varphi$ iff $w, t', a \models \varphi$ for all $t' \in T$

$w, t, a \models \forall p\varphi$ iff $w, t, a' \models \varphi$ for all assignment functions a' agreeing with a on all variables distinct from p

$w, t, a \models p$ iff $w \in a(p)$

On this semantics, UI fails; e.g., $\forall p(p \rightarrow Ap) \rightarrow (c \rightarrow Ac)$ is false at any t and w (and a) such that $\langle w, t \rangle \in I(c)$, but $\langle w, t' \rangle \notin I(c)$ for some $t' \in T$.

Although the semantic clauses of this model are not themselves couched in terms of compositional semantic values, they can easily be rewritten in such terms: Let a compositional semantic value be a set of triples of parameters $\langle w, t, a \rangle$. The truth-conditional clauses straightforwardly determine functions on the set of such values; e.g., the temporal operator A is then associated with the function which maps every compositional semantic value S to the set of triples $\langle w, t, a \rangle$ such that $\langle w, t', a \rangle \in S$ for all $t' \in T$. As expected, compositional semantic values and assertoric contents play entirely different roles in the construction.

The preceding reflections indicate that a number of writers have been a little unimaginative in their recommendations for how to escape Kaplan-style operator arguments. Jeff King, for example, holds that Kaplan's operator argument goes through unless temporal operators are variable-binding operators. We have seen that this is at best tendentious. Once we recognize that variable-binding operators escape the operator argument on account of their operating on compositional semantic values rather than assertoric contents, it is natural to explore the possibility of operators that do not bind variables but still escape the operator argument on account of their operating on compositional semantic values. To maintain King's position one would have to somehow argue that this phenomenon only occurs in the special case of variable-binding (and hence for example that the supervaluationist is guilty of semantical nonsense). But King never provides any such argument.

That said, there are certainly examples in the literature of authors who defend content eternalism by distinguishing assertoric contents from compositional semantic values: e.g., Lewis (1980), Salmon (1986, Appendix C) and Mark Richard (1982). In particular, Richard proposes, on behalf of the eternalist, that temporal operators operate on the Kaplanian characters of their operands rather than their assertoric contents. Whether these authors would agree with our response to the operator argument as we have reconstructed it is not easy to see, since they do not discuss propositional quantifiers. As we have seen, such quantifiers are essential for formulating crucial principles such as the transparency principle (T_r). The situation is closely analogous to that of the theorist of vagueness, who, as Williamson points out in the passage quoted above, would be expressively deprived without the ability to quantify into the scope of Δ .

Even granting the defensive manoeuvres just adverted to, there may still be ways to argue for temporalism over eternalism. For example, one could try to appeal to direct judgments about the truth of assertoric contents at various times in order to argue for temporalism about assertoric contents. E.g., considering a case of someone claiming that it is raining, one might consider whether the truth of what they said entails that what they said is always true. But arguably, our pre-theoretical judgements about such matters are not very firm. In any case,

such an argument seems to bear very little resemblance to Kaplan’s operator argument.²⁹

8 Compositional Semantic Values

In contrast to the case of assertoric contents just considered, it is not clear how to apply any version of the operator argument to compositional semantic values. In fact, it is not even clear that we can in general make sense of the thesis of eternalism about compositional semantic values – that compositional semantic values have time-relative truth value – since it is not clear that there is a pretheoretically intelligible notion of truth for compositional semantic values.

Lewis (1980) distinguishes between assertoric contents and compositional semantic values³⁰ and goes on to give a highly abbreviated argument for the claim that the truth values of compositional semantic values are relative to times, locations, and other parameters. Fixing again on the example of time, his argument is that since temporal operators shift the time parameter, their operands must have compositional semantic values whose truth values are time-relative. The time-stamped semantics of section 3 raises questions about the force of this argument. Suppose that the same entities that figured as assertoric contents in the time-stamped semantics now serve instead as compositional semantic values, and that truth at a time for time-stamped compositional semantic values is defined just as it was for time-stamped contents: a compositional semantic value $\langle S, t \rangle$ is true at a time t' iff $t \in S$. Suppose also that we adopt the following very natural definition of sentential truth at a time: a sentence with compositional semantic value $\langle S, t \rangle$ is true at a time t' iff $\langle S, t' \rangle$ is true, i.e., iff $t' \in S$. (Recall that in section 3 we only made use of the notion of a content being true at a time. We need to define sentential truth at a time since this is deployed in the ideology of shifting, as understood by both Lewis (1980, see section 5) and us.) In this setting, temporal operators can still be said to shift the time parameter. For example, if at a context c , at the time of which it is not raining, one says ‘Sometimes, it rains’, the truth of the whole sentence will depend on the truth value of ‘It rains’ at times other than the time of c . Nevertheless, the compositional semantic value of ‘It rains’ will be true at all times if it is true

²⁹In this connection it is worth noting that the transparency *schema*

$(T_m^s) \ A(\varphi \leftrightarrow T_m\varphi)$

should look attractive even if we cannot validly derive each its instances from their universal generalization by UI. Although (T_m^s) plays no role in the formal reconstruction of the operator argument in section 4, an appeal to an analog of (T_m^s) for the relational truth predicate was implicit in our informal discussion of transparency at the beginning of that section. (T_m^s) introduces some interesting complications for the eternalist: if they endorse (T_m^s) and hold that A operates on features of compositional semantic values not reflected in assertoric contents, then they had better hold that the truth predicate is sensitive to compositional semantic values of its arguments in a coordinated way.

³⁰Lewis offer an escape route to the view that we must distinguish compositional semantic value from assertoric content. The key idea of the ‘Schmentencite strategy’ is that the sentence that we use to assert that it is raining (‘It is raining’) never combines with temporal operators. When it looks as if we are using the result of applying a temporal operator to that sentence, we are in fact applying a temporal operator to a homonymous expression that is not a sentence and has a different compositional semantic value. As with the other deviant theoretical frameworks we gestured at in note 20, we will not be exploring the Schmentencite strategy here.

at any time.³¹ (Because we defined truth at a time for time-stamped compositional semantic values in a way that parallels the definition of truth at a time for time-stamped contents, every compositional semantic value will be either true at all times or none.) Might the Lewisian shore up the argument by motivating a transparency of truth principle for compositional semantic values as an additional premise? After all, we ourselves questioned the time-stamped semantics of assertoric contents on the grounds that it violated a transparency principle for content truth—might not an analogous argument block a time-stamped construal of compositional semantic values? We think that this analogous line of thought is far weaker than the line of thought on which it is modeled. First, insofar as compositional semantic values are distinct from assertoric contents we do not have any firm pretheoretic judgments about the truth values compositional semantic values have with respect to various parameters, nor indeed about whether compositional semantic values are even the sort of things that have truth values (whether relative to a parameter or otherwise). It is thus difficult to be secure about the status of any transparency-of-truth principle concerning compositional semantic values. In this connection it is worth reminding the reader that the natural construal of propositional quantification takes the values of propositional variables to be assertoric contents. Thus (T_r) and (T_m) are not naturally construed as principles about compositional semantic values. Of course, one could try to stipulate that the propositional variables in these principles range over compositional semantic values. Even if this is coherent,³² it is difficult to evaluate them under this deviant interpretation, since doing so would require us to make judgments about the truth values of compositional semantic values in a setting where pretheoretic judgments provide no guidance.

Another version of the operator argument which is intended to apply to compositional semantic values even if they are distinct from assertoric contents is the one presented in Weber (2012). In contrast to Lewis’s argument, Weber’s argument does not assume any specific theory of compositional semantic values. Weber considers pairs of sentences such as the following, relative to a context whose time is the 22nd of August 2010 at 2:36 p.m.:

- (1) It is raining in Canberra.
- (2) It is raining in Canberra on the 22nd of August 2010 at 2:36 p.m.

He claims that according to eternalism about compositional semantic values, (1) and (2) must be associated (in the mentioned context) with the same compositional semantic value, which entails the false claim that (1) and (2) embed (relative to the mentioned context) alike under a temporal operator such as ‘always’; therefore eternalism about compositional semantic values must be rejected.

³¹Note that our definitions of truth at a time for sentences and truth at a time for compositional semantic values induce a kind of a disharmony in that sentential truth is time-relative while truth for the compositional semantic values of sentences is not. This kind of disharmony should not be especially discomforting. After all, eternalist orthodoxy has long learned to live with the idea that sentential truth is time-relative while content truth is not. The disharmony here ought to be even less disturbing since it is not disharmony between truth for sentences and their assertoric contents but between truth for sentences and their compositional semantic values. Arguably we are far less entitled to have direct intuitions about the latter.

³²For the record: we have our doubts.

Weber adds, however, the caveat that, while his argument for the sameness of the compositional semantic values of (1) and (2) ‘holds for the standard, unstructured or structured, theories of propositions’ (*cum* compositional semantic values), it ‘might fail for certain alternatives, such as the non-reductive account of Bealer (1998)’ (p. 209). The theory of timestamped contents in section 3, adapted to be a theory of compositional semantic values, as above, is a concrete example of an alternative for which Weber’s argument clearly does fail. Given that (2) results from the application of the temporally rigidifying operator ‘on the 22nd of August 2010 at 2:36 p.m.’ to (1), the compositional semantic value of (1), as uttered at t , will be a pair whose first component is the set of times at which it is raining in Canberra and whose second component is t . Meanwhile the compositional semantic value of (2) will be the pair of the set of times at which it is raining in Canberra on the 22nd of August 2010 at 2:36 p.m. and the time t .³³ Thus the first component of the latter compositional semantic value will be either the set of all times or the empty set. This will be so even though the time t is the 22nd of August 2010 at 2:36 p.m., as required by Weber. Carrying over the definition of truth at a time from section 3 (recalled earlier this section), this will be an eternalist theory of compositional semantic values, yet it will not identify the compositional semantic values of (1) and (2).

9 Some exegetical remarks

Where does our discussion leave Kaplan’s operator argument? Even on the most promising reconstruction of the operator argument against eternalism, the eternalist has plausible escape routes. Specifically, the eternalist has various plausible ways of denying the validity of universal instantiation into the scopes of temporal operators. Once the validity of universal instantiation is denied, there is room for affirming that, for all p , the proposition (assertoric content) that p is true iff, always, the proposition that p is true, while denying (for example) that it is raining iff, always, it is raining. Perhaps, however, Kaplan’s original intent far was less ambitious. Suppose one assumes that the contents of sentences can be modelled as intensions, i.e., as functions from sequences of parameter values to truth values, and one further assumes that what makes an expression a temporal operator is that it is only sensitive to which times the intension of its operand is true at. Against the background of this semantic framework it will be a straightforward and perfectly correct observation that if the truth values of intensions are not time-relative, i.e., if each is true either at all times or none, then all temporal operators will be truth-functional. Perhaps Kaplan only ever intended this mundane construal of his argument, one that simply assumed various components of his semantic framework as background. If so, then the subsequent literature has been misguided in taking Kaplan to be taking himself to be providing a compelling general argument against eternalism. On this construal the eternalist only need worry insofar as they also buy into the various rich components of the Kaplanian semantic framework that underwrote

³³Here we assume the standard treatment of operators like ‘on the 22nd of August 2010 at 2:36 p.m.’ in a stamp-free semantics for tense logic, in which the compositional semantic value of ‘On the 22nd of August 2010 at 2:36 p.m., φ ’ is the set of all times if the 22nd of August 2010 at 2:36 p.m. is a member of the compositional semantic value of φ and is the empty set otherwise. When we transform this into a time-stamped semantics following section 3, we get the desired result.

the straightforward observation. Analogous remarks apply to David Lewis's discussion. While there is an ambitious construal of his argument, there is also a far more modest one that relies on the details of his background semantic framework, and which will not go through in abstraction from his framework. In fact, we are rather sympathetic to the modest construals of the argumentative intentions of Kaplan and Lewis. But if we are correct in our exegetical suspicions, then much of the secondary literature has been, as Kaplan might put it, chasing wozzles.

A Appendix

In sections 4 and 5, several formulations of the operator argument were given in formal languages using quantifiers binding variables in sentential position. This appendix shows how to derive the conclusions of these arguments from their premises in natural axiomatic systems, similar to the axiomatic systems for propositional quantifiers already explored in Kaplan (1970).

The formalized principles involved in these arguments use sentential variables $p, q, \dots$ which are bound by a universal quantifier $\forall$, and a schematic temporal connective O . The reconstruction in section 4 also involves variables $t, t', \dots$ ranging over times which are bound by a universal quantifier $\forall$, a binary truth connective $T_r(\cdot, \cdot)$ taking a formula and a time variable as arguments, and a connective $[\cdot]$ which was used to construct a formula $[t]\varphi$ from any time variable t and formula φ ; let L_r be the set of formulas which can be constructed using these resources. In contrast, the arguments formalized in section 5 involve – besides propositional quantifiers and O – two unary sentential operators A and T_m ; let L_m be the set of formulas which can be constructed using these resources.

In both languages, define as usual the notion of a free occurrence of a variable in a formula, and of replacing every free occurrence of a sentential variable p in a formula φ by a formula ψ , written $\varphi[\psi/p]$. Define a formula ψ to be free for p in φ if no free occurrence of a variable in ψ is bound in $\varphi[\psi/p]$.

We define two axiomatic calculi in the two languages. Both will be based on a common core governing Boolean connectives and propositional quantifiers, consisting of the following axiom schemas and rules:

TAUT: tautologies

MP: $\varphi, \varphi \rightarrow \psi / \psi$

UD: $\forall p(\varphi \rightarrow \psi) \rightarrow (\forall p\varphi \rightarrow \forall p\psi)$

UI: $\forall p\varphi \rightarrow \varphi[\psi/p]$ if ψ free for p in φ

UV: $\varphi \rightarrow \forall p\varphi$ if p is not free in φ

UG: $\varphi / \forall p\varphi$

The axiom system for L_r contains the following axiom schemas and rules in addition to the common core:

TD: $\forall t(\varphi \rightarrow \psi) \rightarrow (\forall t\varphi \rightarrow \forall t\psi)$

TI: $\forall t\varphi \rightarrow \varphi[t'/t]$ if t' free for t in φ

TV: $\varphi \rightarrow \forall t\varphi$ if t is not free in φ

TG: $\varphi/\forall t\varphi$

PD: $[t](\varphi \rightarrow \psi) \rightarrow ([t]\varphi \rightarrow [t]\psi)$

PC: $[t](\varphi \leftrightarrow \psi) \leftrightarrow ([t]\varphi \leftrightarrow [t]\psi)$

PG: $\varphi/[t]\varphi$

A formula $\varphi \in L_r$ being derivable in this system will be written $\vdash_r \varphi$. As usual, this is extended to a finitary consequence relation by letting $\varphi_1, \dots, \varphi_n \vdash_r \psi$ abbreviate $\vdash_r (\varphi_1 \wedge \dots \wedge \varphi_n) \rightarrow \psi$.

The axiom system for L_m contains the following axiom schemas and rules in addition to the common core:

AD: $A(\varphi \rightarrow \psi) \rightarrow (A\varphi \rightarrow A\psi)$

AT: $A\varphi \rightarrow \varphi$

AG: $\varphi/A\varphi$

Analogous to the first system, derivability and consequence in this system will be notated using the symbol $\vdash_m$.

A few remarks on these systems: First, although we question UI in section 6, the rule is unproblematic in the present context, since we are here concerned with formalizing reconstructions of the operator argument based on the assumption that assertoric contents are compositional semantic values. As noted in section 6, UI is well-motivated on such an assumption – as is an implausibly strong extension of it, which is not derivable in the present systems.

Second, the axiom systems are no way intended to be complete, except for being sufficiently strong to carry out the deductions below. It is also unimportant whether derivability entails logical truth, on some understanding of the latter notion; all that is relevant is that derivable closed formulas are true (on the intended interpretation, given any choice of temporal operator O).

Third, we noted in section 4 that one may restrict the arguments of the truth connectives to sentences which themselves do not contain this connective. For simplicity, this is not enforced in the languages used here; nothing in the derivations below would need to be changed if one wanted to impose such restrictions, as the only instances of the truth connectives that are required take formulas of the form p or Op as arguments.

Fourth, the axiom system may allow us to derive false statements if it is not an eternal matter what propositions there are. Again, it would be routine to restrict the systems – along familiar ways involving quantification principles from free logic – without affecting the derivability of the conclusions reached below. For simplicity, such restrictions are not imposed here.

Finally, since the common core of the two axiomatic systems contains TAUT and MP, we can reason from premises using classical propositional logic; we will not note such appeals explicitly. A number of useful rules governing quantifiers are also easily derived in the common core:

US: $\varphi/\varphi[\psi/p]$ if ψ free for p in φ

UGC: $\varphi \rightarrow \psi/\varphi \rightarrow \forall p\psi$ if p not free in φ

Similarly, it is routine to derive the following in $\vdash_r$:

TGC: $\varphi \rightarrow \psi / \varphi \rightarrow \forall t\psi$ if t not free in φ

TPD: $\forall t[t](\varphi \rightarrow \psi) \rightarrow (\forall t[t]\varphi \rightarrow \forall t[t]\psi)$

TPG: $\varphi / \forall t[t]\varphi$

We are now ready to substantiate the claim of section 4 that (O_r) follows from (T_r) , (O'_r) and (S_r) . For convenience, the principles are reproduced here:

(T_r) $\forall p\forall t[t](p \leftrightarrow T_r(p, t))$

(O'_r) $\forall p\forall q(\forall t[t](p \leftrightarrow q) \rightarrow \forall t[t](Op \leftrightarrow Oq))$

(S_r) $\forall p\forall t(T_r(p, t) \leftrightarrow [t]T_r(p, t))$

(O_r) $\forall p\forall q(\forall t(T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t(T_r(Op, t) \leftrightarrow T_r(Oq, t)))$

Proposition 1. $(T_r), (O'_r), (S_r) \vdash_r (O_r)$.

Proof. To make the derivation of this claim more readable, we split it up using the following intermediate conclusion:

(O''_r) $\forall p\forall q(\forall t[t](T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t[t](T_r(Op, t) \leftrightarrow T_r(Oq, t)))$

We first show that $(T_r), (O'_r) \vdash_r (O''_r)$:

- | | | |
|-----|--|-----------------|
| (1) | $(T_r) \vdash_r \forall t[t](p \leftrightarrow T_r(p, t))$ | UI |
| (2) | $(T_r) \vdash_r \forall t[t](q \leftrightarrow T_r(q, t))$ | UI |
| (3) | $(T_r) \vdash_r \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t[t](p \leftrightarrow q)$ | (1,2), TPD, TPG |
| (4) | $(O'_r) \vdash_r \forall t[t](p \leftrightarrow q) \rightarrow \forall t[t](Op \leftrightarrow Oq)$ | UI |
| (5) | $(T_r) \vdash_r \forall t[t](p \leftrightarrow q) \rightarrow \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t))$ | (1,2), TPD, TPG |
| (6) | $(T_r) \vdash_r \forall t[t](Op \leftrightarrow Oq) \rightarrow \forall t[t](T_r(Op, t) \leftrightarrow T_r(Oq, t))$ | (5), US |
| (7) | $(T_r), (O'_r) \vdash_r \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t[t](T_r(Op, t) \leftrightarrow T_r(Oq, t))$ | (3,4,6) |
| (8) | $(T_r), (O'_r) \vdash_r (O''_r)$ | (7), UGC |

We now show that $(O''_r), (S_r) \vdash_r (O_r)$:

- | | | |
|------|---|--------------|
| (1) | $\vdash_r [t](T_r(p, t) \leftrightarrow T_r(q, t)) \leftrightarrow ([t]T_r(p, t) \leftrightarrow [t]T_r(q, t))$ | PC |
| (2) | $(S_r) \vdash_r T_r(p, t) \leftrightarrow [t]T_r(p, t)$ | UI, TI |
| (3) | $(S_r) \vdash_r T_r(q, t) \leftrightarrow [t]T_r(q, t)$ | UI, TI |
| (4) | $(S_r) \vdash_r (T_r(p, t) \leftrightarrow T_r(q, t)) \leftrightarrow [t](T_r(p, t) \leftrightarrow T_r(q, t))$ | (1–3) |
| (5) | $(S_r) \vdash_r \forall t(T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t))$ | (4), TGC, TD |
| (6) | $(O''_r) \vdash_r \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t[t](T_r(Op, t) \leftrightarrow T_r(Oq, t))$ | UI |
| (7) | $(S_r) \vdash_r \forall t[t](T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t(T_r(p, t) \leftrightarrow T_r(q, t))$ | (4), TGC, TD |
| (8) | $(S_r) \vdash_r \forall t[t](T_r(Op, t) \leftrightarrow T_r(Oq, t)) \rightarrow \forall t(T_r(Op, t) \leftrightarrow T_r(Oq, t))$ | (7), US |
| (9) | $(O''_r), (S_r) \vdash_r \forall t(T_r(p, t) \leftrightarrow T_r(q, t)) \rightarrow \forall t(T_r(Op, t) \leftrightarrow T_r(Oq, t))$ | (5,6,8) |
| (10) | $(O''_r), (S_r) \vdash_r (O_r)$ | (9), UGC |

Combining the two results, the claim follows with truth-functional reasoning. $\square$

Turning to the arguments in section 5, recall the following principles:

- $(E_m) \quad \forall p(T_mp \rightarrow AT_mp)$
- $(T_m) \quad \forall pA(p \leftrightarrow T_mp)$
- $(Ver_m) \quad \forall p(p \rightarrow Ap)$
- $(O_m) \quad \forall p\forall q(A(p \leftrightarrow q) \rightarrow A(Op \leftrightarrow Oq))$
- $(TF_m) \quad \forall p\forall q((p \leftrightarrow q) \rightarrow (Op \leftrightarrow Oq))$

We first substantiate the claim that (Ver_m) follows from (E_m) and (T_m) :

Proposition 2. $(E_m), (T_m) \vdash_m (Ver_m)$.

Proof.

- | | | |
|-----|---|----------|
| (1) | $(T_m) \vdash_m A(p \leftrightarrow T_mp)$ | UI |
| (2) | $\vdash_m A(p \leftrightarrow T_mp) \rightarrow (p \rightarrow T_mp)$ | AT |
| (3) | $(T_m) \vdash_m p \rightarrow T_mp$ | (1,2) |
| (4) | $(E_m) \vdash_m T_mp \rightarrow AT_mp$ | UI |
| (5) | $(E_m), (T_m) \vdash_m p \rightarrow AT_mp$ | (3,4) |
| (6) | $\vdash_m A(p \leftrightarrow T_mp) \rightarrow (AT_mp \rightarrow Ap)$ | AD, AG |
| (7) | $(T_m) \vdash_m AT_mp \rightarrow Ap$ | (1,6) |
| (8) | $(E_m), (T_m) \vdash_m p \rightarrow Ap$ | (5,7) |
| (9) | $(E_m), (T_m) \vdash_m (Ver_m)$ | (8), UGC |

□

Using this observation as a lemma, we substantiate the claim that (TF_m) follows from (E_m) , (T_m) and (O_m) :

Proposition 3. $(E_m), (T_m), (O_m) \vdash_m (TF_m)$.

Proof.

- | | | |
|------|--|-----------|
| (1) | $(E_m), (T_m) \vdash_m (Ver_m)$ | see above |
| (2) | $(E_m), (T_m) \vdash_m p \rightarrow Ap$ | (1), UI |
| (3) | $(E_m), (T_m) \vdash_m q \rightarrow Aq$ | (1), UI |
| (4) | $(E_m), (T_m) \vdash_m \neg p \rightarrow A\neg p$ | (1), UI |
| (5) | $(E_m), (T_m) \vdash_m \neg q \rightarrow A\neg q$ | (1), UI |
| (6) | $\vdash_m (Ap \wedge Aq) \rightarrow A(p \leftrightarrow q)$ | AD, AG |
| (7) | $\vdash_m (A\neg p \wedge A\neg q) \rightarrow A(p \leftrightarrow q)$ | AD, AG |
| (8) | $(E_m), (T_m) \vdash_m (p \leftrightarrow q) \rightarrow A(p \leftrightarrow q)$ | (2-7) |
| (9) | $(O_m) \vdash_m A(p \leftrightarrow q) \rightarrow A(Op \leftrightarrow Oq)$ | UI |
| (10) | $\vdash_m A(Op \leftrightarrow Oq) \rightarrow (Op \leftrightarrow Oq)$ | AT |
| (11) | $(E_m), (T_m), (O_m) \vdash_m (p \leftrightarrow q) \rightarrow (Op \leftrightarrow Oq)$ | (8-10) |
| (12) | $(E_m), (T_m), (O_m) \vdash_m (TF_m)$ | (11), UGC |

□

References

- Patrick Blackburn, Maarten de Rijke, and Yde Venema. *Modal Logic*, volume 53 of *Cambridge Tracts in Theoretical Computer Science*. Cambridge: Cambridge University Press, 2001.
- Torben Braüner. Hybrid logic. In Edward N. Zalta, editor, *The Stanford Encyclopedia of Philosophy*. Winter 2014 edition, 2014.
- Berit Brogaard. *Transient Truths*. Oxford: Oxford University Press, 2012.
- Herman Cappelen and John Hawthorne. *Relativism and Monadic Truth*. Oxford: Oxford University Press, 2009.
- Brian F. Chellas. *Modal Logic: An Introduction*. Cambridge: Cambridge University Press, 1980.
- M. J. Cresswell. *Entities and Indices*. Dordrecht: Kluwer, 1990.
- Martin Davies and Lloyd Humberstone. Two notions of necessity. *Philosophical Studies*, 38:1–30, 1980.
- Cian Dorr and Jeremy Goodman. Diamonds are forever. *Noûs*, forthcoming.
- Michael Dummett. *Frege: Philosophy of Language*. London: Gerald Duckworth, 1973.
- Michael Dummett. *The Logical Basis of Metaphysics*. Cambridge, MA: Harvard University Press, 1991.
- Gareth Evans. Reference and contingency. *The Monist*, 62:161–189, 1979.
- Kit Fine. The role of variables. *The Journal of Philosophy*, 100:605–631, 2003.
- Kit Fine. Prior on the construction of possible worlds and instants. In *Modality and Tense: Philosophical Papers*, pages 133–175. Oxford: Oxford University Press, 2005 [1977]. First published as postscript to *Worlds, Times and Selves* (with A. N. Prior), pp. 116–168, London: Duckworth, 1977.
- Kit Fine. *Semantic Relationalism*. Malden, MA: Blackwell, 2007.
- G.W. Fitch. Tense and content. *Philosophical Studies*, 94:151–158, 1999.
- Michael Glanzberg. Context, content, and relativism. *Philosophical Studies*, 136:1–29, 2007.
- Michael Glanzberg. Semantics and truth relative to a world. *Synthese*, 166: 281–307, 2009.
- Michael Glanzberg. More on operators and tense. *Analysis*, 71:112–123, 2011.
- Irene Heim and Angelika Kratzer. *Semantics in Generative Grammar*. Malden, MA: Blackwell, 1998.
- Lloyd Humberstone. Ingredient sense and assertive content. Manuscript, 1976.

- David Kaplan. S5 with quantifiable propositional variables. *The Journal of Symbolic Logic*, 35:355, 1970.
- David Kaplan. On the logic of demonstratives. *Journal of Philosophical Logic*, 8:81–98, 1978.
- David Kaplan. Demonstratives. In Joseph Almog, John Perry, and Howard Wettstein, editors, *Themes from Kaplan*, pages 481–563. Oxford: Oxford University Press, 1989 [1977]. Completed and circulated in mimeograph in the published form in 1977.
- David Kaplan. A problem in possible-world semantics. In Walter Sinnott-Armstrong, Diana Raffman, and Nicholas Asher, editors, *Modality, Morality, and Belief*, pages 41–52. Cambridge: Cambridge University Press, 1995.
- Jeffrey C. King. Tense, modality, and semantic values. *Philosophical Perspectives*, 17:195–245, 2003.
- Max Kölbel. The evidence for relativism. *Synthese*, 166:375–395, 2009.
- David Lewis. Index, context, and content. In Stig Kanger and Sven Öhman, editors, *Philosophy and Grammar*, pages 79–100. Dordrecht: D. Reidel, 1980. Reprinted in his *Papers in philosophical logic*, pages 21–44, Cambridge: Cambridge University Press, 1998.
- John MacFarlane. Nonindexical contextualism. *Synthese*, 166:231–250, 2009.
- Richard Montague. The proper treatment of quantification in ordinary english. In Patrick Suppes, Julius Moravcsik, and Jaakko Hintikka, editors, *Approaches to Natural Language: Proceedings of the 1970 Stanford Workshop on Grammar and Semantics*, pages 221–42. Dordrecht: D. Reidel, 1973. Reprinted in *Formal Philosophy: Selected Papers of Richard Montague*, pages 247–270, ed. Richmond H. Thomason, New Haven, Conn.: Yale University Press, 1974.
- Dilip Ninan. Propositions, semantic values, and rigidity. *Philosophical Studies*, 158:401–413, 2012.
- Barbara Hall Partee. Some structural analogies between tenses and pronouns in english. *The Journal of Philosophy*, 70:601–609, 1973.
- A. N. Prior. Egocentric logic. *Noûs*, 2:191–207, 1968.
- Brian Rabern. Against the identification of assertoric content with compositional value. *Synthese*, 189:75–96, 2012.
- Mark Richard. Tense, propositions, and meanings. *Philosophical Studies*, 41:337–351, 1982.
- Nathan Salmon. *Frege’s Puzzle*. Cambridge, MA: MIT Press, 1986.
- Nathan Salmon. A theory of bondage. *Philosophical Review*, 115:415–448, 2006.
- Wolfgang Schwarz. Variations on a Montagovian theme. *Synthese*, 190:3377–3395, 2013.

- Jason Stanley. Rigidity and content. In Richard Heck, Jnr., editor, *Language, Thought, and Logic: Essays in Honour of Michael Dummett*, pages 131–156. Oxford: Clarendon Press, 1997.
- Jason Stanley. Modality and what is said. *Philosophical Perspectives*, 16:321–344, 2002.
- Jason Stanley. Philosophy of language. In Dermot Moran, editor, *The Routledge Companion to Twentieth Century Philosophy*. London: Routledge, 2008.
- Clas Weber. Eternalism and propositional multitasking: in defense of the operator argument. *Synthese*, 189:199–219, 2012.
- Bruno Whittle. Self-referential propositions. *Synthese*, forthcoming.
- Timothy Williamson. Vagueness in reality. In Michael J. Loux and Dean W. Zimmerman, editors, *The Oxford Handbook of Metaphysics*, pages 690–716. Oxford: Oxford University Press, 2003.
- Juhani Yli-Vakkuri. Propositions and compositionality. *Philosophical Perspectives*, 27:526–563, 2013.
- Juhani Yli-Vakkuri. Epistemicism and modality. *Canadian Journal of Philosophy*, 46:803–835, 2016.
- Juhani Yli-Vakkuri and Jon Litland. Vagueness and modality. *Philosophical Perspectives*, 20, 2016.
- Aaron Z. Zimmerman. Against relativism. *Philosophical Studies*, 133:313–348, 2007.