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Monsters in Kaplan's Logic of Demonstratives*

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Kaplan (1989a) insists that natural languages do not contain displacing devices which operate on character—such displacing devices are called *monsters*. This thesis has recently faced various empirical challenges (e.g. Schlenker (2003) and Anand and Nevins (2004)). In this note, the thesis is challenged on grounds of a more theoretical nature. It is argued that the standard compositional semantics of variable binding employs monstrous operations. As a dramatic first example, Kaplan's formal language, the *Logic of Demonstratives* (*LD*), is shown to contain monsters. For similar reasons, the orthodox lambda-calculus-based semantics for variable binding is argued to be monstrous. This technical point promises to provide some far-reaching implications for our understanding of semantic theory and content. The theoretical upshot of the discussion is at least threefold: (i) the Kaplanian thesis that "directly referential" terms are not shiftable/bindable is unmotivated, (ii) since monsters operate on something distinct from the assertoric content of their operands, we must distinguish *ingredient sense* from *assertoric content* (cf. Dummett (1973), Evans (1979) and Stanley (1997)), and (iii) since the case of variable binding provides a paradigm of semantic shift that differs from the other types, it is plausible to think that indexicals—which are standardly treated by means of the assignment function—might undergo the same kind of shift.

1 Monsters

The semantic framework in Kaplan (1989a) is standard and familiar, as is the distinction between two kinds of meaning that it proposes, the *character* and the *content* of an expression. Kaplan insists that these two aspects of meaning play very different roles in the semantic theory. The content is the information asserted by means of a particular utterance. Whereas, the character of an expression encodes what any utterance of the expression would have as content. This is modeled as a function from various contextual parameters to the

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information content the expression has relative to those parameters. For example, different utterances of 'I am a sick man' communicate different information depending, crucially, on who happens to be uttering the sentence. But this is not the only difference in roles played by the two aspects of meaning. Kaplanian *content* is also nominated as a privileged level of semantic representation: contents are understood to be the entities over which the composition rules should be defined—whereas character is understood to do its work prior to the compositional process. This commitment is encoded in Kaplan's prohibition of monsters.[1]

> My liberality with respect to operators on content, i.e., intensional operators...does not extend to operators which attempt to operate on character...Operators like 'In some contexts it is true that', which attempt to meddle with character, I call *monsters*. I claim that none can be expressed in English...And such operators *could not be added to it.* (Kaplan (1989a), p. 520–521)[2]

This can be made more precise. The domain of the character function is a set C. Each $c \in C$ is a tuple of content generating parameters—these tuples are standardly called "contexts of utterance". Character functions map contexts of utterance to contents. The content of an expression is itself a function from a set G to extensions. Each $i \in G$ is also a tuple of parameters, usually understood to be world-time pairs—these are called "circumstances of evaluation". Assigning a character to an expression amounts to assigning that expression an extension relative to all contexts c and circumstances i. I will use the standard notation $[\![\alpha]\!]^{c,i}$, which should be read as *the extension of* α *at context* c *and circumstance* i. Abstracting over the circumstance coordinate $\lambda i.[\![\alpha]\!]^{c,i}$ gives the content of α at a context c and abstracting over both the circumstance and the context coordinates $\lambda c, i.[\![\alpha]\!]^{c,i}$ gives the character of α. Kaplan's ban on monsters amounts to the claim that there are no operators in the language that take characters as argument.[3] Under the assumption that the relevant constructions have a compositional semantics this can be defined as follows.

[1] Note that this is not to say that the ban on monsters is incompatible with the semantics *being* compositional at the level of character. After all, if the semantics is compositional at the level of content, then it is thereby compositional at the level of character. One could in principle provide composition rules that are defined over characters and then supply a context to get the contents (and extensions) of the complex expressions. (See Westerståhl (forthcoming) for a detailed analysis of how compositionality at different semantic levels relate to each other.) The question rather is this: assuming that the language in question is compositional at the level of character, is it also compositional at the level of content? In this way the monster prohibition and the compositionality of character and content are connected via the following biconditional: A semantics is monstrous iff (i) it is compositional at the level of character and (ii) it fails to be compositional at the level of content—or as Westerståhl (forthcoming) puts it "Monsters destroy the compositionality of content".

[2] Although Kaplan does not provide an explicit argument against the existence of monsters, I think a fair rational reconstruction of his reasoning proceeds as follows: (i) the semantic composition rules are defined over the information contents associated with expressions, (ii) the information (or assertoric) content of an expression is never equal to the character-level value of an expression, (iii) thus, the language fails to contain monstrous operations.

[3] Again we should more precisely say that the monster ban requires that there not be any operators in the language that *must* take characters as argument. The qualification of "must" should be included because many non-character operators can be transformed into "equivalent" ones that takes characters as argument, e.g. any truth-functional connective can be given a semantics in terms of functions on characters.

Monster prohibition. *There is no sentential operator* Σ *of a natural language* $\mathcal{L}$ *such that* $[\![\Sigma\phi]\!]^{c,i}$ *is defined and fails to be a function of* $\lambda i.[\![\phi]\!]^{c,i}$.[4]

Assuming again that the relevant constructions are compositional the following provides a definition of a monstrous sentential operator.

Definition 1. *A sentential operator* Σ *is a* monster *in* $\mathcal{L}$ *if and only if there is a sentence* ϕ *in* $\mathcal{L}$ *such that* $[\![\Sigma\phi]\!]^{c,i}$ *is defined and* $[\![\Sigma\phi]\!]^{c,i} \neq [\![\Sigma]\!]^{c,i}(\lambda i.[\![\phi]\!]^{c,i})$.

In this sense, then, the monster ban prohibits "meddling with characters". Since the parameter c is identified with a sequence of "content generating parameters" we can also provide a more intuitive (but equivalent assuming compositionality holds) definition in terms of "shifting" the content generating parameter c (i.e. "context shifting").

Definition 2. *A sentential operator* Σ *is a* monster *in* $\mathcal{L}$ *if and only if in the semantic evaluation of a sentence* $\Sigma\phi$*,* ϕ *is evaluated with respect to a sequence of content generating parameters* c' *that is different from the sequence of content generating parameters* c *with respect to which* $\Sigma\phi$ *is evaluated.*

2 Tarskian semantics for quantifiers

All the sentential operators of the propositional calculus are truth-functional. This is not so with the predicate calculus—the quantifiers are *not* truth-functional. Tarski (1936) showed how to recursively assign sentences values of a different kind for the quantifiers to operate on. The relevant values are functions from *variable assignments* to truth-values.[5] Before rehearsing the Tarskian semantics in terms of assignments let's rehearse the syntax of predicate logic.

For the syntax we have a set of variables, $\{x_i\}_{i\in\mathbb{N}}$, a set of predicates $\{F_i^n\}_{i,n\in\mathbb{N}}$ (where F_i^n is an n-place predicate), the truth-functional connectives $\wedge$ and $\neg$ and the quantifier $\forall$. For these we have the following formation rules:

- If π is an n-place predicate and $\alpha_1, \ldots, \alpha_n$ are variables, then $\pi(\alpha_1, \ldots, \alpha_n)$ is a formula.

[4] The monster prohibition as stated rules out *all* hyperintensional operators, which is well-motivated since Kaplan glosses his monster prohibition as the thesis that "all operators that can be given an English reading are *at most* intensional" (Kaplan (1989a), p. 502n27). The definition would need to be modified if one wanted to allow for purported non-monstrous hyperintensional operators (e.g. quotational operators). The definitions are also simplified by limiting the focus to monstrous *sentential* operators. But in full generality a monster could be of any syntactic category. In general form the monster prohibition is the prohibition of the following composition rule (in the style of Heim and Kratzer (1998)): MONSTROUS FUNCTIONAL APPLICATION. If α is a branching node and $\{\beta, \gamma\}$ the set of its daughters, then for any context c and circumstance i: if $[\![\beta]\!]^{c,i}$ is a function whose domain contains $\lambda c, i.[\![\gamma]\!]^{c,i}$, then $[\![\alpha]\!]^{c,i} = [\![\beta]\!]^{c,i}(\lambda c, i.[\![\gamma]\!]^{c,i})$.

[5] Actually, Tarski (1936) formulated it in terms of functions from *sequences* to individuals. Assignments are functions from variables to individuals, whereas Tarski's sequences were just sequences of individuals—and variables were indexed to positions in sequences. There is clearly no essential difference here. I use the formulation in terms of assignments for continuity with Kaplan (1989a) and contemporary semantic frameworks, e.g. Heim and Kratzer (1998).

- If ϕ and ψ are formulae, then $\phi \wedge \psi$ and $\neg\phi$ are formulae.
- If ϕ is a formula and α is a variable, then $\forall\alpha\phi$ is a formula.
- Nothing else is a formula.

Now for the semantics we have a structure $\{U, I\}$, where U is the set of individuals, and I is an interpretation function (which assigns sets of ordered tuples of individuals to the predicates). For our purposes, the important machinery is that of an "assignment function", which assigns values to the variables. An assignment function g is a function from variables to individuals, $g : \{x_i\}_{i\in\mathbb{N}} \to U$. We write $g[\alpha := i]$ to denote the assignment function that is just like g except that it assigns to the variable α individual i. Given this setup we can give the Tarskian semantics for predicate logic by recursively defining 1 (or "truth") relative to an assignment function as follows:[6]

- For a variable α, $[\![\alpha]\!]^g = g(\alpha)$.
- For n-place predicate π and variables $\alpha_1, \ldots, \alpha_n$, $[\![\pi(\alpha_1, \ldots, \alpha_n)]\!]^g = 1$ iff $([\![\alpha_1]\!]^g, \ldots, [\![\alpha_n]\!]^g) \in I(\pi)$.
- For a formula ϕ, $[\![\neg\phi]\!]^g = 1$ iff $[\![\phi]\!]^g = 0$.
- For formulae ϕ and ψ, $[\![\phi \wedge \psi]\!]^g = 1$ iff $[\![\phi]\!]^g = 1$ and $[\![\psi]\!]^g = 1$.
- For formula ϕ and variable α, $[\![\forall\alpha\phi]\!]^g = 1$ iff for all $i \in U$, $[\![\phi]\!]^{g[\alpha:=i]} = 1$.

The important thing to note here is what the semantic value of the quantifier is. The last clause says that '$\forall\alpha\phi$' is 1 at an assignment g just in case for all assignments g', 'ϕ' is 1 at g', where for all $i \in U$ each g' is just like g except that it assigns i to the variable α. The quantifier, then, looks to the profile across assignments of its embedded formula and gives 1 if the embedded formula is 1 across all assignments and gives 0 otherwise. Assuming that the compositional semantics of such quantified constructions proceeds via functional application, the lexical entry for '$\forall\alpha$' is as follows:[7]

- $[\![\forall\alpha]\!]^g = \lambda p_{\langle\gamma,t\rangle}.\prod_{i\in U} p(g[\alpha := i])$

Thus, on the standard Tarskian semantics for predicate logic, quantifiers are assignment-shifting sentential operators.[8]

[6] This actually gives Tarski's definition of "satisfaction by a sequence", Tarski reserves the term "truth" for formulae that are satisfied by all sequences.

[7] Where $\prod$ is the integer product of the sequence of truth-values (i.e. the sequence of 0s and 1s) and p is a function from assignments to truth-values, i.e. of type $\langle\gamma, t\rangle$.

[8] This is also evident in the the algebraization of the semantics of predicate logic in terms of cylindrical algebra.

3 The monstrous quantifiers of LD

You know where this is headed: Kaplan's formal language the *Logic of Demonstratives* (LD) contains monsters. This is due to the fact that LD employs assignment-shifting quantifiers and the fact that assignment-shifters meddle with character functions. To demonstrate this I will focus only on a fragment of Kaplan's LD that has to do with variables and quantification.[9]

The fragment of LD we are concerned with has the same syntax as predicate logic. The semantics is slightly more complicated but for reasons that do not concern quantification. For the semantics of LD we have a structure $\{C, W, T, U, I\}$, where C is the set of contexts, W is the set of worlds, T is the set of times, U is the set of individuals, and I is an interpretation function (which gives extensions to predicates at circumstances $j \in T \times W$). The extensions of expressions are given relative to a point $\langle c, g, t, w\rangle$ where $c \in C$, $t \in T$, $w \in W$ and g is an assignment function. Given this setup the semantics is also essentially the same as predicate logic, except the points at which we recursively define 1 (or "truth") are expanded, i.e.$\langle c, g, t, w\rangle$. To see this consider the Kaplanian clause for the universal quantifier.

- For formula ϕ and $\alpha \in V$, $[\![\forall\alpha\phi]\!]^{c,g,t,w} = 1$ iff for all $i \in U$, $[\![\phi]\!]^{c,g[\alpha:=i],t,w} = 1$.

The extra parameters in the point of reference are, of course, to handle indexicals and modal and temporal operators, which we are currently ignoring.[10]

Kaplan maintains that *variables are the paradigms of directly referential terms* (and when he is in a Russellian mood he expresses this by saying that a "variable's first and only meaning is its value") (see Kaplan (1989a), p. 484 and Kaplan (1989b), pp. 571-573). In the formal part of "Demonstratives" he gives an explicit account of the content of variables and open formulae. Here he introduces the notation $\{\alpha\}_{c,g}$ to mean "the content of α in the context c under the assignment g" and tells us that the content of a variable is as follows (Kaplan (1989a), p. 546).

- If α is a variable, then $\{\alpha\}_{c,g}$ = that function which assigns to each $t \in T$, $w \in W$, $[\![\alpha]\!]^{c,g,t,w}$.

That is, the content of a variable α, $\{\alpha\}_{c,g}$, is a constant function from circumstances to $g(\alpha)$. The content, then, of a variable or an open formulae (or all expressions trivially) is only given relative to an assignment function. So among the list of parameters that character is a function from, we must include an assignment of values to variables. That is to say that the assignment function is among the content generating parameters. We can understand this, if we like, as the thesis that the assignment function should be included as a parameter of the "context". In fact, Kaplan (1989b) encourages us to do this.

[9]The formal system LD is presented in Kaplan (1989a), §$XVIII$, pp. 541-553. In what follows I make a few notational changes to ease the exposition.

[10]If we added the first person pronoun 'I', we would add the clause: $[\![I]\!]^{c,g,t,w}$ = the agent of c. If we added the modal operator '$\Box$' we would add the clause: $[\![\Box\phi]\!]^{c,g,t,w} = 1$ iff for all $w' \in W$, $[\![\phi]\!]^{c,g,t,w'} = 1$, etc.

> ...context is a package of whatever parameters are needed to determine the referent, and thus the content, of the directly referential expressions of the language... Taking context in this more abstract, formal way, as providing the parameters needed to generate content, it is natural to treat the assignment of values to free occurrences of variables as simply one more aspect of context. (Kaplan (1989b), p. 591)

But whether we officially package up the assignment function as a parameter of "context" or not, the general point remains that character functions—the functions that output contents—require inputs, which include, in addition to an agent, a time, a location and a world, an assignment of values to variables. Either way assignment-shifters operate on character and thus assignment-shifters are monsters. That Kaplan's *LD* is replete with monsters follows directly from the observation that the quantifiers of *LD* are assignment-shifting operators and the observation that character functions require assignments as inputs.[11]

4 Generalized quantifiers and lambda binders

Kaplan's *LD* was put forward as a partial formal model of natural language—"a machine against which we can test our intuitions". If our best formalization of natural language included monsters that would surely show that Kaplan's monster prohibition was mistaken. But *LD* was never put forward as our best formalization of natural language. One place that it is clearly lacking is in its treatment of quantificational devices. Kaplan was more concerned with formalizing the interaction of indexicals and intensional operators, than with the semantics of quantifiers. In a more complete model of natural language he would, we should assume, replace the old Tarskian quantifiers with more empirically adequate quantificational devices. We do not treat the semantics of natural language quantification in the style of predicate logic—natural language quantification is instead treated with generalized quantifiers, where the assignment function does not even enter into the semantic clauses. Why, then, does pointing out this relatively small quirk of Kaplan's *LD* matter?

Here is why. Quantificational noun phrases, like 'Every women' are indeed not standardly treated as assignment-shifting operators. Instead they are treated as predicates of predicates, i.e. of type $\langle\langle e, t\rangle, t\rangle$. But that is not the end of the story. When employing generalized quantifiers we still need a way to get from the value of a sentence to an associated predicate value. That is to say that we need an account of *variable binding.* For example, consider the following sentence, where the quantificational noun phrase occurs in object position.

(1) Eros loves every woman.

A standard way to treat this sentence is to suggest that its logical form differs from its surface structure. It is instructive to consider how sentence (1) would be formalized in predicate

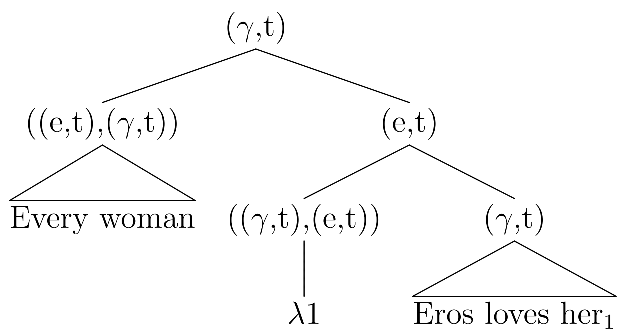
[11] To my knowledge the fact that Kaplan himself employs monsters in *LD* has never been argued for before, although a related issue in terms of bound pronouns is discussed in Zimmerman (1991) (see especially §4.1).

logic: $\forall x(women(x) \rightarrow loves(\text{Eros}, x))$. That is to say that it has the same truth-conditions as the more stilted "Every woman is such that Eros loves her".

Since 'every woman' requires an argument of type $\langle e, t\rangle$, but 'Eros loves her' is type t, we need a way to get from the value of the sentence 'Eros loves her' to the value of the predicate 'being loved by Eros'. The common strategy is to introduce "lambda binders" into the object language syntax such that when a lambda binder is prefixed to a formula ϕ the complex expression takes on the value of a predicate.[12]

- $[\![(\lambda\alpha.\phi)]\!]^g = \lambda i.[\![\phi]\!]^{g[\alpha:=i]}$

In this way, the pronoun gets bound by the lambda and everything can proceed up the tree via functional application.



As is clear from the syntax tree the lexical entry for a lambda binder is given as follows:[13]

- $[\![\lambda\alpha]\!]^g = \lambda p_{\langle\gamma,t\rangle}.(\lambda i_e.p(g[\alpha := i]))$

Lambda binders, then, are assignment-shifting devices. And that brings us to the general thesis: variable binders, such as the quantifiers of *LD* or the lambda binders of compositional natural language semantics, are monstrous.[14] We needn't look far and wide for the existence of exotic monstrous languages, we need only look closer at the details of variable binding at home. The monster prohibition, and the assumptions about compositionality and asserted content that support it, must be reconsidered.

[12] See, e.g., Heim and Kratzer (1998), p. 186.

[13] I have never seen a lexical entry for the lambda binders but it seems fairly obvious and uncontroversial that this is the way to do it. And I hope that some will find this explicit rendering of the semantics of lambda enlightening.

[14] Importanly, one could make the same point with other examples of natural language variable binding (see Partee (1989) for various cases). The arguement here does not essentially rely on the use of lambda binders nor on a syntactic story about quantifier raising. For example, consider the type of binding concerend in so-called *binding arguments* in Stanley (2000): an utterance of "Every bottle is green" in context might express the proposition that every bottle in *this room* is green. But when "Every bottle is green" is embedded, e.g., in "In every room, every bottle is green" the quantifier domain variable is bound such that the utterance expresses the proposition that in every room x, every bottle in x is green. So the variable binding operator is monstrous.

5 Reactions

I have argued that variable-binding operators must be understood to be monsters; and this includes the devices used in a lambda-calculus-based semantics for variable-binding. If right, not only does this refute the Kaplanian thesis that "directly referential" terms are not shiftable/bindable, it suggests a natural model of semantical shiftiness which can be applied to indexicals.[15] Moreover, since monsters operate on entities that are distinction from the assertoric content of their embedded clause, we have a straightforward and powerful argument for Dummett's ingredient sense/assertoric content distinction (see Dummett (1973), p. 447). But there are a few reactions to this discussion that suggest ways of avoiding the conclusion or at least downplaying its significance. I will briefly discuss what I take to be the most salient and interesting reactions.

Reaction 1. The assignment function is not strictly speaking part of the "context", so shifting the assignment is not strictly speaking "context-shifting". Thus, an assignment-shifiter is not strictly speaking a "monster".

Response. This reply can take two forms. Either the assignment is construed as (i) part of the circumstance (index) or as (ii) neither part of the context nor the circumstance (index) (cf. Zimmerman (1991), §4.1). Kaplan cannot accept (i), since this would conflict with the thesis that free variables are "directly referential". This understanding would also be committed to the questionable thesis that "what is said" (content) is assignment neutral (i.e. propositions would be construed as functions from world-time-assignments triples to truth-values). In other words, the assignment function would not be understood as a "content generating parameter", it would instead be understood as a part of the circumstance of evaluation. For these reasons, it seems that Kaplan cannot accept this strategy. Nevertheless, other theorists who do not share Kaplan's commitments on "direct reference" and "what is said" may find this option the most attractive. But if such a theorist does not agree with Kaplan that the composition rules are defined over *contents* qua the objects of assertion, it seems that they have already given up the spirit of the monster prohibition, which was the idea that there are no semantic operations at a level of "meaning" more fine-grained than the level of "what is said". On the current approach, technically speaking, there wouldn't be operators on "character", but characters also would not be functions that output "what is said". So as I understand it, giving up the thesis that sets of circumstances are assertoric contents, and thereby making sets of circumstances entities apt for compositionality is merely a way to accept the conclusion under a different guise.[16]

On option (ii)—where the assignment is construed as neither part of the context nor the circumstance—we have to make a decision about the domain and co-domain of the character functions. On the first approach, which seems to be the considered Kaplanian position,

[15] One can view Cumming (2008) as applying this strategy to proper names; and Santorio (2010) applies such a strategy directly to indexicals.

[16] One might insist that compositional semantics should not concern itself with a notion of "what is said" or assertoric content. If so, then I say so much the worse for Kaplan's monster prohibition, since it is fundamentally entangled with such a notion.

"character" is a function that takes a sequence of parameters and outputs a content (sets of world-time paris). On this understanding, character functions require inputs, which include, in addition to an agent, a time, a location and a world, an assignment of values to variables. Here assignment-shifting devices would be operators on character. One might insist that monsters shouldn't be understood as just any character operator but instead only the special kind of character operators that shift the "strict context" (i.e. $\langle w, t, p, x\rangle$ without the assignment g). First of all, this understanding has the awkward consequence that even if variables—the paradigms of direct reference—are shiftable, such shifting devices wouldn't be "monsters". Moreover, remember that Kaplan glosses his claim that there are no monsters as the claim that all semantic operations are operations on content, so variable-binding, which cannot be construed as operations on content, would seem to be deserving of the pejorative "monster". Especially, since it is still the case that in the semantic evaluation of a sentence $\Sigma\phi$, the complement clause ϕ is evaluated with respect to a sequence of content generating parameters c' that is different from the sequence of content generating parameters c with respect to which $\Sigma\phi$ is evaluated. The second option with respect to the domain and co-domain of the character functions is to diverge from Kaplan and modify the definition of "character" to be a function from "strict contexts" to a function from assignments to contents.[17] But here again there would be semantic operations (variable-binding), which are not operations on content (i.e. "what is said") and this I think suffices to call such operations "monstrous".

Reaction 2. As the abundance of scare-quotes already makes clear, what exactly counts as a "monster" seems to depend on a terminological choice. There are several characterizations of monsters floating around: (i) monsters are operators that take characters as arguments, (ii) monsters are context-shifting operators, (iii) monsters are operators that have semantic effects on "indexicals". So isn't all this merely a terminological dispute?

Response. To some extent that is my point: The statement of the monster prohibition requires some finessing. But it is not merely terminological. I think the driving force behind Kaplan's ban on monsters is the idea that the composition rules should be defined at the level of assertoric content (or propositional constituents).[18] If there are semantic operations that don't operate at the level of content, there is a good case to be made that such operations count as *monsters*. Especially, since such an operator shifts the parameters on which semantic interpretation depends in a way that alters the content of its embedded clause—since in the semantic evaluation of a sentence containing such an operator its embedded clause must be evaluated with respect to distinct sequences of content generating parameters. Although there is no doubt an element of terminological arbitrariness here, in the context of Kaplan's article, I think the terminology is on my side. So I would displace the charge that this

[17] There is an analogous maneuver in Salmon (1986), where he re-defines "character" as the function that maps a context to a function from times to contents.

[18] See Ninan (2010) and Rabern (forthcoming) for some recent critical discussion of the dogma that compositional semantic values are to be identified with the objects of assertion (of course historically there has been an undercurrent of theorists who have gone against the dogma, most notably Dummett (1973), Evans (1979) and Stanley (2002)).

discussion merely makes a terminological point towards those who wish to avoid the conclusion. The strategies above for avoiding the conclusion that variable binders are monstrous are merely terminological: the substantive point that due to variable binding semantic composition must proceed at the level of character (or, at a non-content character-like level) is not avoided.

Reaction 3. Strictly speaking, in the semantics that Kaplan provides (Kaplan (1989a), p. 545) the quantifiers do not "operate" on anything at all. The semantics, as given, provides the interpretation of the quantifiers by means of a *syncategorematic rule*—a rule that says "When you have $\forall\alpha$ followed by a formula ϕ, the interpretation of $\forall\alpha\phi$ is such-and-such". In this case, there is no lexical entry or semantic value provided for the quantifier itself. We should not assume that the syncategorematic rule is a mere abbreviation of a treatment that involves a lexical entry—the syncategorematic rule can be understood to provide a full treatment. Likewise, we needn't provide a lexical entry for the lambda operators and we needn't provide a semantics of lambda terms that adheres to the rule of functional application. In fact, to do so is nonstandard. Heim and Kratzer (1998) do not provide a lexical entry for the lambda binders, instead they provide the syncategorematic Predicate Abstraction Rule.[19] If the semantics of variable binding, is understood to proceed via a syncategorematic rule like predicate abstraction instead of a composition rule like functional application, the thesis that variable binding is monstrous cannot even get off the ground.

Response. First note that a syncategorematic rule such as the following seems to be a paradigmatic example of a monstrous semantics.

- $[\![\text{In some context } \phi]\!]^{c,g,t,w} = 1$ iff there exists a context c' such that $[\![\phi]\!]^{c',g,t,w} = 1$.

But the definitions I provided actually don't even apply, since the definitions I provided were given under the assumption that the constructions at issue were *compositional*. I have been assuming that the semantics of variable binding is determined by a compositional process—and, in fact, I have provided lexical entries according to which variable binding constructions come out as compositional (in both the Tarski-style and the lambda-calculus-style frameworks).

So I concede that my thesis has a conditional element: The semantics of variable binding is monstrous if (and only if) the semantics of variable binding is compositional. Of course it is open for a theorist to insist that variable binding should be given a non-compositional treatment. If variable binding is assumed to be evaluated by a non-compositional rule, then there is no sense to the question of whether or not its semantic evaluation involves monstrous mechanisms. The claim that a given linguistic construction is monstrous will only be true (and really only make sense) under the assumption that its semantic evaluation proceeds via a genuinely compositional rule.[20] While I concede that my thesis is conditional in this

[19] Predicate Abstraction Rule: Let α be a branching node with daughters β and γ, where β dominates only a lambda binder λx. Then, for any variables assignment g, $[\![\alpha]\!]^g = \lambda z.[\![\gamma]\!]^{g[x:=z]}$ (Heim and Kratzer (1998), p. 186).

[20] See Pagin and Westerståhl (2010) for a detailed analysis of when a rule is genuinely compositional.

way, I'd like to present the following challenge to any theorist who is tempted to accept my conclusion by denying my antecedent: Why should variable binding be handled by a non-compositional syncategorimatic rule, when a straightforward compositional treatment is available?[21]

Reaction 4. Kaplan treats free variables and bound variables very differently (just as he does free and bound pronouns). For him, free variables are sensitive to the assignment function but bound variables are not. In "Afterthoughts" Kaplan says, "The case we are dealing with here is the free occurrence of a variable in a premise or conclusion of an argument. Do not confuse this case, the case with the interpretational gap, with the case in which a bound occurrence of a variable appears free because we are focusing attention on a subformula. . . So the rules for evaluating bound occurrences of variables are another story entirely, and an irrelevant one" (Kaplan (1989b), p. 592). So it seems that for Kaplan although quantifiers may shift an assignment function, they would not shift the assignment function that free variables are sensitive to—and so we have no reason to think they are monstrous.

Response. This indeed seems to be Kaplan's position. It would also require a syntactic distinction between two classes of homographic expressions in the langauge, e.g. 'x', which only occurs free and '`x`', which only occurs bound (on analogy with Kaplan's claim that "pronouns are lexically ambiguous, having both an anaphoric and a demonstrative use" (Kaplan (1989b), p. 572)). In fact, an appeal to homography or ambiguity would suffice. But why would one treat free and bound variables by means of separate semantic mechanisms, if a single mechanism sufficed? Taking this idea seriously threatens to make Kaplan's monster prohibition true by the definitions of "free variable/pronoun" and "bound variable/pronoun". The claim is uninteresting if it is just the claim that free pronouns are not bound! So I concede that there is a way to avoid the conclusion by, e.g., having two separate assignment functions, one for the treatment of free variables and one for the treatment of bound variables. But I see no independent motivation for this complexity. This points to an oddity in Kaplan's whole approach, namely his division of pronouns into "demonstrative" and "anaphoric" pronouns.[22] Since it makes no sense to treat free and bound variables by means of a different mechanism, in so far as the analogy between variables and pronouns holds, it makes no sense to treat free and bound pronouns by means of a different mechanism. Once we see this it becomes difficult to uphold a substantive prohibition of monsters.

[21] It's unclear whether the motivation for Heim and Kratzer's syncategorimatic treatment of variable binding was done for merely pedagogical reasons or for some unstated theoretical reason. But I suspect it was the former, since they are theoretically guided by Frege's Conjecture (i.e. that semantic evaluation proceeds via functional application). This seems especially likely since although $[\![.]\!]^g$ is not compositional $[\![.]\!]$ itself clearly is compositional.

[22] Kaplan (1989a), p. 489 says: "[Pronouns] have uses other than those in which I am interested (or, perhaps, depending on how you individuate words, we should say that they have homonyms in which I am not interested)".

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