Where is the destructive update problem?*

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Abstract Though much research assumes or argues that there's a 'destructive update' problem for dynamic accounts of anaphora, it isn't easy to see what this problem is supposed to consist in. There do not, in particular, seem to be any problematic empirical predictions associated with destructive update. In a sense, this is unsurprising: destructive update of assignments is a characteristic feature of how binding is perpetrated in static systems (including first-order logic and the λ-calculus). The difference between static and dynamic systems isn't that only dynamic systems allow destructive update — it's that only dynamic systems treat assignment functions as bona fide semantic values, as information.

1 Dynamic semantics précis

In dynamic treatments of anaphora, sentences denote relations on assignments, type $s \to s \to t$ (classic references include Barwise 1987, Groenendijk & Stokhof 1991a, Muskens 1996). For example, sentence (1) is associated with the dynamic meaning in (2). This relation maps an input assignment g into a set of possible outputs which assign the index 3 to a man who walked in the park (and are otherwise just like g).

(1) A man^3 walked in the park.

(2) $\lambda g.\,\{g^{3\to x} \mid \mathsf{man}\,x \wedge \mathsf{witp}\,x\}$

The idea is that (2) models how (1) updates the value associated with the index 3 in context. Processing (1) means coming to associate 3 with a man who walked in the park.

The central motivation for dynamic sentence meanings is that indefinites can bind pronouns they don't scope over (i.e., c-command at LF). If (1) is continued with (3), it's possible and natural to hear the indefinite and the pronoun as covalued, even though it is unlikely the indefinite could ever come to have scope over a pronoun in a separate sentence.

(3) He$_3$ whistled.

Dynamic sentence meanings allow binding without scope. Dynamic conjunction, defined in (4), feeds the assignments output by a left conjunct as inputs to a right conjunct; in other words, the right conjunct is evaluated in the anaphoric context established by the left conjunct. Assuming sentence (3) has the semantics in (5), dynamically conjoining (2) and (5) yields (after a few elementary simplifications) the meaning in (6), which covalues the man who walked in the park and the whistler, as desired.

(4) $[\![;]\!] := \lambda r.\,\lambda l.\,\lambda g.\,\bigcup_{h \in l g} r\,h$

(5) $\lambda g.\,\{g\}$ if $\mathsf{whistled}\,g_3$ else $\emptyset$

(6) $\lambda g.\,\{g^{3\to x} \mid \mathsf{man}\,x \wedge \mathsf{witp}\,x \wedge \mathsf{whistled}\,x\}$

Familiar truth conditions can be extracted from dynamic propositions by existentially quantifying over outputs at a given input assignment, as in (7):

(7) π is True at g iff $\exists h \in \pi\,g$

According to this definition, (2) is True at an input g iff there is a man who walked in the park; (5) is True at g iff g_3 whistled; and (6) is True at g iff there is a man who walked in the park, and who whistled.

∗ Thanks to …

2 Destructive update in dynamic semantics

Almost since the advent of dynamic semantics, it's been suggested that the simplest versions of it have an undesirable feature: indices can be chosen poorly, in a way that allows downstream indefinites to usurp upstream ones. Consider the text in (8). It hosts two indefinites, in separate sentences, bearing *the same index*. Given the obvious dynamic meanings for the individual sentences and the semantics for dynamic conjunction in (4), this text ends up associated with the interpretation in (9). The first indefinite updates 6 to be associated with some linguist who entered the room. The second indefinite tosses out the work of the first, reassigning 6 to a linguist who was already there.

(8) A linguist^6 entered the room. A linguist^6 was already there.

(9) $\lambda g. \bigcup_{h \in \{g^{6 \to x} \mid \text{linguist}\, x \wedge \text{entered}\, x\}} \{h^{6 \to y} \mid \text{linguist}\, y \wedge \text{there}\, y\}$

$\equiv \lambda g. \{(g^{6 \to x})^{6 \to y} \mid \text{linguist}\, x \wedge \text{entered}\, x \wedge \text{linguist}\, y \wedge \text{there}\, y\}$

This feature of dynamic theories, which goes by various names — the destructive update problem, the overwrite problem, the downdate problem, and so on — has been much discussed in the literature. A standard way of avoiding it uses *partial* assignment functions to gauge whether an incoming assignment already harbors values for any indices a given sentence is looking to update. If so, some sort of non-default behavior is triggered — for instance, undefinedness, as in (10).[1] Proposals along these lines have been mooted by Heim (1982), Dekker (1993), van den Berg (1996), Nouwen (2007), Haug (2014), and others.

(10) $\lambda g : \neg \exists y. \langle 6, y \rangle \in g. \{g^{6 \to y} \mid \text{linguist}\, y \wedge \text{there}\, y\}$

(11) $\lambda s. \{s^\frown y \mid \text{linguist}\, y \wedge \text{there}\, y\}$

A related approach replaces assignment functions with sequences or stacks of discourse referents, and models update with a monotonic operation like sequence extension, as in (11). Proposals along these lines have been discussed by Vermeulen (1993, 1995), Dekker (1994), Groenendijk, Stokhof & Veltman (1996), van Eijck (2001), de Groote (2006), Nouwen (2007), Brasoveanu (2007), Charlow (2014), Bumford (2015), Nouwen et al. (2016), and others.

3 Where is the problem of destructive update?

I'd like to question the conventional wisdom that texts like (8) and meanings like (9) represent a problem in need of a solution.

It is fairly obvious that there are no under-generation issues associated with (8) and (9). It is certainly true that after uttering *a linguist entered the room; a linguist was already there*, subsequent pronouns will be able, in principle, to refer back to either linguist — for example, in a sentence like *she greeted him*. It's also true that (9) doesn't allow this. The only linguist available after both sentences have been processed is the second one; the first has been dismissed from the conversational record.

But under-generation is a property of *theories*, and not of particular objects generated by a theory. As such, while it is clear that (8) and (9) do not make available enough discourse referents in contexts where we seek to refer back to both linguists, it is also clear how the theory copes: it generates a parse just like (8), but with contra-indexed indefinites. Such a parse is, of course, consistent with the actual utterance, which has no overtly expressed indices.

Another sort of case, discussed by Brasoveanu (2007: 113) and Haug (2014: 463) involves sentences with an indefinite under a distributively interpreted conjunction, like the *and* $\gg$ *a donkey* reading of

1 $\ulcorner \lambda g : \phi. \psi \urcorner$ names the partial function f, such that $\text{Dom}\, f \subseteq \{h \mid \phi[h/g]\}$, and for any $h \in \text{Dom}\, f$, $f\, h = \psi[h/g]$.

(12). If proper names are interpreted as dynamic generalized quantifiers, and the conjoined subject is interpreted via generalized dynamic conjunction, as in (13) and (14), only one donkey will be available for subsequent anaphoric reference (in this case, the donkey associated with Sue). The reason is similar to (8): (12) ends up equivalent to *Bill¹ owns a donkey³, and Sue² owns a donkey³*, as in (15). The "second" occurrence of the indefinite erases the information contributed by the "first".

(12) Bill^1 and Sue^2 own a donkey^3. (Muskens 1996: 181, ex. 66)

(13) $[\![\text{Bill}^1]\!] = \lambda c.\, \lambda g.\, c\, \mathsf{b}\, g^{1\to \mathsf{b}}$

(14) $[\![\text{Bill}^1 \text{ and Sue}^2]\!] = \lambda c.\, [\![;]\!]\, ([\![\text{Sue}^2]\!]\, c)\, ([\![\text{Bill}^1]\!]\, c)$

(15) $\lambda g.\, \{(g^{1\to \mathsf{b}, 3\to x})^{2\to \mathsf{s}, 3\to y} \mid \mathsf{donkey}\, x \wedge \mathsf{owns}\, x\, \mathsf{b} \wedge \mathsf{donkey}\, y \wedge \mathsf{owns}\, y\, \mathsf{s}\}$

The contra-indexing trick that helped with (8) is no help here, since there is just one indefinite to play with (absent literal syntactic conjunction reduction). Still, it is difficult to locate any under-generation issues in this vicinity. Notably, a simple continuation like *it$_3$ brays* forces the wide-scope-indefinite reading of (12), on which there is a donkey that Bill and Sue own. There is no way to anaphorically target Bill's or Sue's individual donkeys on the wide-scope-*and* reading without making it clear which donkey we're interested in, for example with a locution like *in Bill's case, it$_3$ brays*.

These facts closely parallel what is observed with indefinites under quantifiers like *every linguist*. This suggests that, as is frequently done for indefinites under quantifiers, we should associate the indefinite in the relevant interpreation of (12) with a *parametrized* (i.e., functional) discourse referent, as in (16) (Krifka 1996; see Brasoveanu 2007, 2008, Solomon 2011 for related ideas). Here, the index 3 is mapped to a parametrized donkey, 'intermediate' in a sense between Bill's and Sue's donkeys. Locutions like *in Bill's case, ...* are one way to indicate how this parametric donkey is to be precisified.

(16) $\lambda g.\, \{g^{1\to \mathsf{b}, 2\to \mathsf{s}, 3\to f} \mid \mathrm{Dom}\, f = \{\mathsf{b}, \mathsf{s}\} \wedge \forall x \in \mathrm{Dom}\, f : \exists y \in \mathsf{donkey} : \mathsf{owns}\, y\, x \wedge f\, x = y\}$

Despite initial appearances, then, constructions like (12) don't present under-generation issues for simple dynamic theories with destructive update. Independently motivated analyses associate (12) with meanings like (16) rather than (15).[2] And (16) harbors, in its own way, all the donkeys we could need.

4 Over-generation?

Are there, conversely, any *over*-generation issues associated with destructive updates? From one vantage point, the answer is a simple 'no': destructive update doesn't ever generate incorrect truth conditions. Recalling our characterization of truth-at-an-assignment in (7), we observe that, at any input g, (9) returns an output iff (i) there's a linguist who entered the room, and (ii) there's a linguist who was already there. These are, as the reader can check, the same truth-conditions as we'd derive with contra-indexed indefinites. Notice, in particular, that co-indexing two indefinites does *not* cause them to be co-valued.[3]

We might, though, mount another sort of argument *ad over-generationum*. An utterance of *a linguist entered the room; a linguist was already there* doesn't have any readings that only serve up one of the two linguists for subsequent anaphora. In other words, it just doesn't seem possible to interpret that text in a way that makes it impossible to refer back to the first-mentioned linguist. Yet the LF in (8) generates precisely such an interpretation. Isn't that a problem?

2 Though see Bumford 2015 for a contrary view. I leave it open how to understand the relationship between sentential conjunction and the conjunction that figures in distributive quantification, as in (12). This topic seems under-investigated.

3 This isn't to say there could *never* be a theory where co-indexed indefinites were co-valued. Indeed, avoiding spurious co-valuation is an important reason Heim's (1982) File Change Semantics requires indefinites' indices to be novel. There are also static theories that sometimes co-value co-indexed indefinites (i.e., the choice-functional theory of Reinhart 1997).

There is something to this argument. Yet it cuts so deeply, and against so many theories, that caution is warranted. For one, this sort of 'over-generation' is seen in any theory that treats binding modularly — i.e., as the result of optional grammatical processes. The argument is straightforward. If an operation necessary for binding applies optionally, it will be always be possible to derive structures that 'erroneously' preclude *in principle* binding relationships that are possible — i.e., structures in which the operation necessary for binding has not applied! Such modularity is characteristic of a huge swath of theories, from static assignment-based systems like Büring (2005), to sequence-based dynamic theories like the one advocated in Charlow (2014), to systems that eschew assignment functions entirely, like the variable-free treatments of Jacobson (1999) and Barker & Shan (2014).

Moreover, even in static assignment-based systems, it is possible to choose indices poorly, i.e., in ways that 'erroneously' rule out certain anaphoric relationships. Consider (17).

(17) Every linguist^6 told every philosopher^6 that she$_6$ read her$_6$ paper.

Here, two quantificational DPs bear the same index. Given standard assumptions about static interpretation (e.g., Heim & Kratzer 1998, Büring 2005), only one of these DPs can bind the downstairs pronouns. If, for example, *every linguist*^{6} c-commands *every philosopher*^{6} at LF, as the quantifiers churn through linguists x and philosophers y, the downstairs pronouns will be interpreted relative to doubly-shifted assignments $(g^{6\to x})^{6\to y}$. These assignments map 6 only to the philosopher y — the linguist x has been written into and then out of the picture. As in the dynamic case, it is difficult to detect any such 'reading' of the quantified DPs, one which positively prevents binding by both.[4]

5 Destructive update in static semantics

This is, of course, just to say that destructive assignment modification isn't the sole province of dynamic theories. The simplest static theories (e.g., Heim & Kratzer 1998, Büring 2005) allow assignments to be over-written as the interpretation function recursively descends the tree. However, unlike dynamic theories, in static accounts of pronominal binding the overwritten assignment is used only in the service of calculating denotations for phrase markers (crucially, those with free prounouns). Once this happens, the modified assignment flickers out of existence. Modified assignments, in other words, are only passed *down* the tree, to constituents c-commanded by whatever modified the assignment in the first place.[5]

In dynamic theories, by contrast, modified assignments are retained as components of semantic values. They aren't just passed down the tree; they live on as an observable record tracing (aspects of) how a sentence came to be associated with its meaning. Destructive update is characteristic of both static and dynamic frameworks; only dynamic theories rub our faces in it.

Let's examine this point more formally. Consider Figure 1, a simple analysis of *John saw Mary*^{5}. You can think of this tree as divided into two parts — everything below ↑, and everything above it. The basic strategy is to separate things that muck with assignment functions (or, as we'll see in a second, depend on them) from things that have nothing to do with assignments. In Figure 1, the things below ↑ include the proper name *John* (type e), the transitive verb *saw* (type $e \to e \to t$), and a trace t_x (also type e).[6]

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4 In Heim & Kratzer (1998), Büring (2005), binding indices aren't really borne by binders, but by syncategorematically interpreted abstraction nodes. The theory sketched in Section 5 has a treatment of binding with indexed binders.

5 Of course, this is also how the standard Tarskian treatments of variable binding in first-order logic and the λ-calculus work.

6 N.B.: I intend Figure 1 as a logical form (that is, a semantic object) and not as a true LF (which are syntactic). If this was a real LF, we'd of course have to say something about how the trace gets interpreted — perhaps something involving assignments! I am choosing (largely for expository simplicity) to theorize about pronominal binding separately from whatever ties a scoped-out expression to its trace. Similar dissociations between pronominal and trace binding are seen in Muskens 1996: 166–9, in Büring's (2005) distinction between β and μ operators, and indeed in any semantic approach to scope (e.g., Hendriks 1993, Barker & Shan 2014).

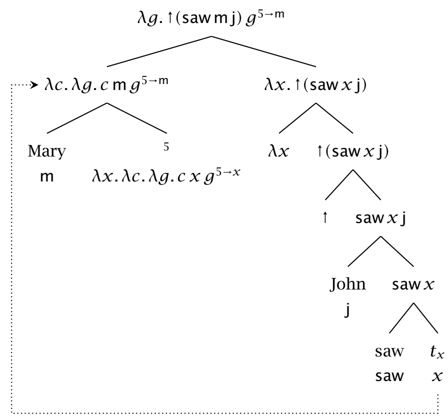

Figure 1: A modular perspective on static vs. dynamic semantics.

	$[\![\uparrow]\!]$	Result for Figure 1
Static	$\lambda p.\,\lambda g.\,p$	$\lambda g.\,\mathsf{saw}\,\mathsf{m}\,\mathsf{j}$
Dynamic	$\lambda p.\,\lambda g.\,\{g\}$ if p else $\emptyset$	$\lambda g.\,\{g^{5\to\mathsf{m}}\}$ if $\mathsf{saw}\,\mathsf{m}\,\mathsf{j}$ else $\emptyset$

Table 1: Ways to get static and dynamic sentence meanings out of Figure 1.

Above ↑, we have (besides a λ-abstract binding the trace), the scoped-out, superscripted object *Mary*^{5}. Superscripting is treated categorematically: $\cdot^5$ turns *Mary* from a simple individual-denoting proper name into a scope-taker that evaluates its scope relative to a shifted assignment — here, one mapping 5 to Mary (compare the dynamic entry for a proper name in (13)).

Doing functional application bottom-up yields $\lambda g.\,\uparrow(\mathsf{saw}\,\mathsf{m}\,\mathsf{j})\,g^{5\to\mathsf{m}}$ as the meaning of the sentence. What this amounts to turns on how we understand ↑. Two possibilities are given in Table 1. The first option — treating ↑ as a function that takes a truth value and an assignment and returns the truth value — yields a *static* proposition, a function from assignments to truth values (in this case, since the sentence contains no unbound pronouns, a constant function from assignments to truth values). The second option — treating ↑ as a function that takes a truth value and an assignment, and returns the assignment, conditional on the truth value — yields a *dynamic* proposition, a relation on assignments.[7]

Simple-minded as it is, this modular approach to static vs. dynamic semantics turns out to be pretty flexible. We are free to superscript and scope out the subject in addition to (or, if you like, in lieu of) the object. Static and dynamic meanings for indefinites and quantified expressions integrate seamlessly, as well (with the notable consequence that the quantifier's *trace* is what bears the binding superscript; I leave the details of this as an exercise). More relevantly for present purposes, if we wish to bind an in-scope pronoun, as in constructions like *Polly*^{6} *cited her*$_6$ *paper*, we can appeal to a lexical entry for pronominal expressions like (18) and a logical form like (19). With a static treatment of ↑, (19) returns $\lambda g.\,\mathsf{cited}\,(\mathsf{paper}\,\mathsf{p})\,\mathsf{p}$. With a dynamic-friendly ↑, (19) yields $\lambda g.\,\{g^{6\to\mathsf{p}}\}$ if $\mathsf{cited}\,(\mathsf{paper}\,\mathsf{p})\,\mathsf{p}$ else $\emptyset$.

(18) $[\![\text{her}_6]\!] \coloneqq \lambda c.\,\lambda g.\,c\,g_6\,g$

(19) Polly^6 [λx [her$_6$ [λy [↑ [t_x cited t_y's paper]]]]]

7 To obtain the continuized dynamic propositions of Dynamic Montague Grammar (e.g., Groenendijk & Stokhof 1990, Zimmermann 1991, Chierchia 1995, Szabolcsi 2003, de Groote 2006), you can set $[\![\uparrow]\!] \coloneqq \lambda p.\,\lambda g.\,\lambda k.\,p \wedge k\,g$.

From this point of view, then, the static/dynamic divide boils down to how we choose to think of ↑, the operator that builds a bridge between the parts of a sentence that care about assignment functions and the parts that do not.[8] This in turn casts the static vs. dynamic perspectives on destructive updates into sharp relief. Consider the logical form in (20), an analysis of *Polly*^{5} *gave Anna*^{5} *her*$_5$ *paper.* It has two proper names jockeying for a single index. The two co-indexed superscripts trigger a succession of assignment function updates; the first associates 5 with Polly, and the second re-associates 5 with Anna. The pronoun is evaluated against this doubly-shifted assignment, and thus ends up denoting Anna. We end up with the possibly static, possibly dynamic proposition in (21).

(20) Polly^5 [λx [Anna^5 [λy [her$_5$ [λz [↑ [t_x gave t_y t_z's paper]]]]]]]

(21) $\lambda g.\uparrow(\mathsf{gave\ a\ (paper\ a)\ p})\ (g^{5\to\mathsf{p}})^{5\to\mathsf{a}}$

The key difference between the static and dynamic approaches, as in the previous examples, is what happens to the doubly-shifted (i.e., destructively updated) assignment. With a static ↑, it vanishes entirely: (21) reduces to (22). With a dynamic ↑, it is retained as a component of the output: (21) reduces to (23).

(22) $\lambda g.\,\mathsf{gave\ a\ (paper\ a)\ p}$

(23) $\lambda g.\,\{(g^{5\to\mathsf{p}})^{5\to\mathsf{a}}\}$ if $\mathsf{gave\ a\ (paper\ a)\ p}$ else $\emptyset$

What this tells us is that the crucial difference between the static and dynamic perspectives on sentence meanings doesn't have much of anything to do with (destructive) assignment modification. As we move between the static and dynamic analyses of Figure 1, the treatment of assignment modification (i.e., superscripting) is invariant. In fact, the *only* thing that distinguishes the static analysis of Figure 1 from the dynamic one is the way in which ↑ is understood. A static ↑ uses modified assignments to fix the denotations of bound pronouns, and then summarily tosses them out. A dynamic ↑ retains these modified assignments for future use.

6 Conclusion

So where is the problem of destructive update? One reasonable answer, by my lights, is 'nowhere'. Try as we might, we haven't been able to locate any problematic empirical predictions associated with it (a whiff of over-generation was shared by a wide range of static and dynamic theories, including ones that have nothing whatsoever to do with assignments).

Another possible answer, informed by the modular take on the static/dynamic divide just sketched, is: 'in the dynamic ↑'. Though destructive updates figure in both static and dynamic systems, the dynamic ↑ retains destructively updated assignments instead of discarding them on evaluation. On this reading, destructively updated assignments aren't problematic per se (I am not aware at present of any complaints lodged against 'the destructive update problem for static semantics'), but something about holding onto these assignments — something about the dynamic ↑ as opposed to its static counterpart — does harm.

What is this something? Perhaps the most straightforward answer comes from the metasemantic gloss we tend to give to dynamic formalisms. Dynamic semantics, the story goes, models information

8 This division of labor (and of logical form) between different 'kinds' of meaning, mediated by an operator like ↑, is reminiscent of Karttunen's (1977) analysis of questions (with ↑ playing a role analogous to Karttunen's proto-question rule). It is also characteristic of *monadic* approaches to semantics (Shan 2002). In fact, the static ↑ in Table 1 is already monadic, though the dynamic version isn't; a monadic, dynamic entry for ↑ is $\lambda p.\lambda g.\{\langle p, g\rangle\}$. A properly monadic ↑ turns out to be important for turning the modular approach sketched in Figure 1 into a full-fledged grammar. As a bonus, monadic dynamic semantics immediately generates an account of exceptionally scoping indefinites (e.g., Fodor & Sag 1982, Reinhart 1997). See Charlow (2014) for discussion.

growth; using a dynamic ↑ means treating assignment functions as information, as components of semantic values, and not as mere preconditions for returning semantic values. Information growth is a monotonic process. Destructive update is non-monotonic. Ergo, destructive updates go against the spirit of dynamic semantics.

This is a reasonable interpretation, though it turns on philosophical/metasemantic matters, and not properly linguistic ones. Here, by way of closing, is another possibility. Rothschild & Yalcin (2015), while trying to pin down the essential features of static vs. dynamic intrepretation, characterize what they call 'weakly static' update systems — those representable by intersective (i.e., Stalnakerian (1978)) systems with a degree of context-sensitivity — as exactly those that are *antisymmetric*. Quite informally, an update system is antisymmetric iff there's no way to turn back time — no way to undergo a series of updates only to find yourself back where you started. Though the dynamic systems considered here aren't, strictly speaking, update systems in the relevant sense (update-theoretic dynamic propositions are functions from sets of assignments to sets of assignments; see Groenendijk & Stokhof 1991b: 60 for an update-theoretic recasting of the relational view of dynamics assumed here), their tolerance for destructive updates means they fail to be antisymmetric. We might begin with an assignment mapping n to x, overwrite n to point to some new value y, and finally overwrite n again to point to x, bringing us back where we started. The notion has a certain irony: dynamic systems with destructive update are more powerful than they need to be — truly dynamic, when weakly static would do.

References

Barker, Chris & Chung-chieh Shan. 2014. *Continuations and natural language*. Oxford: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780199575015.001.0001.

Barwise, Jon. 1987. Noun phrases, generalized quantifiers, and anaphora. In Peter Gärdenfors (ed.), *Generalized Quantifiers*, 1–29. Dordrecht: Reidel. http://dx.doi.org/10.1007/978-94-009-3381-1_1.

van den Berg, Martin H. 1996. *Some aspects of the internal structure of discourse: The dynamics of nominal anaphora*. University of Amsterdam Ph.D. thesis.

Brasoveanu, Adrian. 2007. *Structured nominal and modal reference*. Rutgers University Ph.D. thesis. http://semanticsarchive.net/Archive/TFjZGZjN/.

Brasoveanu, Adrian. 2008. Donkey pluralities: plural information states versus non-atomic individuals. *Linguistics and Philosophy* 31(2). 129–209. http://dx.doi.org/10.1007/s10988-008-9035-0.

Bumford, Dylan. 2015. Incremental quantication and the dynamics of pair-list phenomena. *Semantics and Pragmatics* 8(9). 1–70. http://dx.doi.org/10.3765/sp.8.9.

Büring, Daniel. 2005. *Binding theory*. New York: Cambridge University Press. http://dx.doi.org/10.1017/cbo9780511802669.

Charlow, Simon. 2014. *On the semantics of exceptional scope*. New York University Ph.D. thesis. http://semanticsarchive.net/Archive/2JmMWRjY/.

Chierchia, Gennaro. 1995. *The dynamics of meaning: Anaphora, presupposition and the theory of grammar*. Chicago: University of Chicago Press. http://dx.doi.org/10.7208/chicago/9780226104515.001.0001.

Dekker, Paul. 1993. *Transsentential meditations: ups and downs in dynamic semantics*. University of Amsterdam Ph.D. thesis. http://hdl.handle.net/11245/1.392554.

Dekker, Paul. 1994. Predicate logic with anaphora. In Mandy Harvey & Lynn Santelmann (eds.), *Proceedings of Semantics and Linguistic Theory 4*, 79–95. Ithaca, NY: Cornell University. http://dx.doi.org/10.3765/salt.v4i0.2459.

van Eijck, Jan. 2001. Incremental dynamics. *Journal of Logic, Language and Information* 10(3). 319–351. http://dx.doi.org/10.1023/A:1011251627260.

Fodor, Janet Dean & Ivan A. Sag. 1982. Referential and quantificational indefinites. *Linguistics and Philosophy* 5(3). 355–398. http://dx.doi.org/10.1007/BF00351459.

Groenendijk, Jeroen & Martin Stokhof. 1990. Dynamic Montague grammar. In Laszlo Kalman & Laszlo Polos (eds.), *Proceedings of the Second Symposium on Logic and Language*, 3–48. Budapest: Eötvös Loránd University Press.

Groenendijk, Jeroen & Martin Stokhof. 1991a. Dynamic predicate logic. *Linguistics and Philosophy* 14(1). 39–100. http://dx.doi.org/10.1007/BF00628304.

Groenendijk, Jeroen & Martin Stokhof. 1991b. Two theories of dynamic semantics. In. *Logics in AI: European Workshop JELIA '90 Amsterdam, The Netherlands, September 10–14, 1990 Proceedings*. Jan van Eijck (ed.). Berlin, Heidelberg: Springer Berlin Heidelberg. 55–64. http://dx.doi.org/10.1007/BFb0018433.

Groenendijk, Jeroen, Martin Stokhof & Frank Veltman. 1996. Coreference and modality. In Shalom Lappin (ed.), *The Handbook of Contemporary Semantic Theory*, 179–216. Oxford: Blackwell.

de Groote, Philippe. 2006. Towards a Montagovian account of dynamics. In Masayuki Gibson & Jonathan Howell (eds.), *Proceedings of Semantics and Linguistic Theory 16*, 1–16. Ithaca, NY: Cornell University. http://dx.doi.org/10.3765/salt.v16i0.2952.

Haug, Dag Trygve Truslew. 2014. Partial dynamic semantics for anaphora: Compositionality without syntactic coindexation. *Journal of Semantics* 31(4). 457–511. http://dx.doi.org/10.1093/jos/fft008.

Heim, Irene. 1982. *The semantics of definite and indefinite noun phrases*. University of Massachusetts, Amherst Ph.D. thesis. http://semanticsarchive.net/Archive/Tk0ZmYyY/.

Heim, Irene & Angelika Kratzer. 1998. *Semantics in generative grammar*. Oxford: Blackwell.

Hendriks, Herman. 1993. *Studied flexibility: Categories and types in syntax and semantics*. University of Amsterdam Ph.D. thesis.

Jacobson, Pauline. 1999. Towards a variable-free semantics. *Linguistics and Philosophy* 22(2). 117–184. http://dx.doi.org/10.1023/A:1005464228727.

Karttunen, Lauri. 1977. Syntax and semantics of questions. *Linguistics and Philosophy* 1(1). 3–44. http://dx.doi.org/10.1007/BF00351935.

Krifka, Manfred. 1996. Parametrized sum individuals for plural anaphora. *Linguistics and Philosophy* 19(6). 555–598. http://dx.doi.org/10.1007/BF00632708.

Muskens, Reinhard. 1996. Combining Montague semantics and discourse representation. *Linguistics and Philosophy* 19(2). 143–186. http://dx.doi.org/10.1007/BF00635836.

Nouwen, Rick. 2007. On dependent pronouns and dynamic semantics. *Journal of Philosophical Logic* 36(2). 123–154. http://dx.doi.org/10.1007/s10992-006-9029-8.

Nouwen, Rick, Adrian Brasoveanu, Jan van Eijck & Albert Visser. 2016. Dynamic semantics. In Edward N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*, Fall 2016. http://plato.stanford.edu/entries/dynamic-semantics/.

Reinhart, Tanya. 1997. Quantifier scope: How labor is divided between QR and choice functions. *Linguistics and Philosophy* 20(4). 335–397. http://dx.doi.org/10.1023/A:1005349801431.

Rothschild, Daniel & Seth Yalcin. 2015. On the dynamics of conversation. *Noûs*. Online first edition. http://dx.doi.org/10.1111/nous.12121.

Shan, Chung-chieh. 2002. Monads for natural language semantics. In Kristina Striegnitz (ed.), *Proceedings of the ESSLLI 2001 Student Session*, 285–298. http://arxiv.org/abs/cs/0205026.

Solomon, Michael. 2011. True distributivity and the functional interpretation of indefinites. Unpublished ms. http://semanticsarchive.net/Archive/zkxN2M4M/solomon-functional-indefinites.pdf.

Stalnaker, Robert. 1978. Assertion. In Peter Cole (ed.), *Pragmatics*, vol. 9 (Syntax and Semantics), 315–332. New York: Academic Press.

Szabolcsi, Anna. 2003. Binding on the fly: Cross-sentential anaphora in variable-free semantics. In Geert-Jan M. Kruijff & Richard T. Oehrle (eds.), *Resource-Sensitivity, Binding and Anaphora*, 215–227. Dordrecht: Kluwer Academic Publishers.

Vermeulen, C. F. M. 1993. Sequence semantics for dynamic predicate logic. *Journal of Logic, Language and Information* 2(3). 217–254. http://dx.doi.org/10.1007/BF01050788.

Vermeulen, C. F. M. 1995. Merging without mystery or: Variables in dynamics semantics. *Journal of Philosophical Logic* 24(4). 405–450. http://dx.doi.org/10.1007/BF01048354.

Zimmermann, Thomas Ede. 1991. Dynamic logic and case quantification. In Martin Stokhof, Jeroen Groenendijk & David Beaver (eds.), *Quantification and Anaphora I (DYANA Deliverable R2.2.A)*, 191–195.