

OVERVIEW: One of the primary achievements of *dynamic semantics* (Heim 1982, Kamp 1981, Groenendijk & Stokhof 1991, Dekker 1994) is a theory of anaphoric dependencies, where the *left-to-right* nature of anaphora resolution is built into semantic composition.¹

- (1) a. A man^x walked in. He_x sat down. b. # He_a sat down. A man^a walked in.

In this paper, we focus on (apparent) *cataphoric* dependencies – instances of binding where the bound expression *precedes* the binder, as in (2).

- (2) Every student who admired him_a asked Chomsky^a to sign *Syntactic Structures*.

Cataphora has largely been ignored in the literature; not coincidentally, there is a tension between the availability of cataphoric binding and the core properties of dynamic semantics.

The logic of this paper is as follows: in the first section, we set-up the problem space by surveying the dynamic theory of anaphora. In the second section, we introduce data motivating our primary empirical claim: definite antecedents license cataphora, whereas indefinite antecedents do not. We present novel data and argumentation based on the interaction between cataphoric binding and VP ellipsis, which motivates a treatment of cataphora as *binding*. In the final section of the paper, we present our analysis, which is based on the idea that cataphoric binding is binding by a *presupposition*. Our aim is to derive the following putative generalization:

- (3) Presupposition projection, but not scope, may feed binding.

In order to capture this idea, we propose two refinements to orthodox dynamic theories: (a) presuppositions are dynamic statements and (b) definites carry a full-blown existential presupposition. This last move bridges the gap between the Heimian theory of definites and the classical Fregean analysis.

DYNAMIC PRIMER: One major achievement of dynamic semantics is that it provides a theory of *anaphora* that famously accounts for sentences such as (1a), while ruling out (1b). We adopt a version of Dynamic Predicate Logic (DPL; Groenendijk & Stokhof 1991) as our metalanguage.

A DPL formula denotes a relation between two information states. For our purposes, information states can simply be partial assignments.² Indefinites are translated into existential quantifiers, which trigger random assignment (following Heim 1991 we assume the novelty condition on indefinites is derived pragmatically and not stated in the semantics). We adopt infix notation – $f \approx_x h$ means assignments f and h are different at most in the value they assign to x .

- (4) $f \llbracket \exists x[\varphi] \rrbracket g :\Leftrightarrow$ there is h such that, $f \approx_x h$ and $h \llbracket \varphi \rrbracket g$

Definites on the other hand are translated into variables. Note that, since assignments are partial, if the variable isn't in the domain of the input assignment, the result will be undefined (c.f., Heim's notion of *familiarity*). The translations for the two sentences in the discourse (1a) are as follows:

¹Throughout, we use a superscript variable to indicate the *binder*, and a subscript variable to indicate the *bound* expression. Variables x, y, z indicate anaphoric dependencies, and a, b, c cataphoric dependencies.

²Note that we depart here from Groenendijk & Stokhof 1991 who assume that information states are *total* assignments. We make this move in order to integrate a Heimian theory of (in)definiteness in terms of novelty and familiarity into a DPL-like system.

- (5) $f \llbracket \exists x[\text{man } x \wedge \text{walkedIn } x] \rrbracket g \Leftrightarrow f \approx_x g$ and $g(x) \in I(\text{man})$ and $g(x) \in I(\text{walkedIn})$
 $g \llbracket \text{satDown } x \rrbracket h \Leftrightarrow g = h$ and $g(x) \in I(\text{satDown})$

In order to account for anaphora, and its left-to-right nature, dynamic semantics makes composition sensitive to linear order. For example, \wedge , to which discourse sequencing is translated into, is order-sensitive in that $\phi \wedge \psi$ and $\psi \wedge \phi$ are not always equivalent.³ Indefinites may bind definites to their right, while binding to the left is not possible.

Note that it's trivial to adopt a semantics for definites according to which they can dynamically bind to their right. We can even treat pronouns as dynamic binders while retaining their orthodox semantics by assigning them an additional index. This will be important for our analysis of cataphora.⁴

- (6) He_x^a walked in $\leadsto \exists a[x = a \wedge \text{walkedIn } x]$ $f \llbracket x = y \rrbracket f : \Leftrightarrow f = g$ and $f(x) = f(y)$

CATAPHORIC BINDING: Dynamic semantics is tailored to ensure that *dynamic binding* proceeds from left-to-right. At face value, this looks like an over-simplification. While indefinites do not typically license *cataphoric* dependencies, definites seem to – *it* and *the new book by Chomsky* can pick out the same entity in (7).

- (7) Every professor who wants to read it_a bought $\{ \# a^a \mid \text{the}^a \}$ new book by Chomsky.

For the dynamic semanticist, the obvious move is to blame this on *accidental coreference* rather than genuine binding. We provide a novel argument based on the strict-sloppy ambiguity (Sag 1976, Williams 1977) that this cannot (always) be the case. Sag famously observed that elliptical sentences with pronouns are ambiguous, as in (8):

- (8) Ivan met his student, and Jorge did $\left\{ \begin{array}{ll} \text{meet Ivan's student} & \text{strict} \\ \text{meet Jorge's student} & \text{sloppy} \end{array} \right.$

Every theory of the sloppy reading of (8) requires *binding* between *Ivan* and *his* in the antecedent (see Tomioka 1999, Charlow 2012 for related discussion). Crucially, dynamic binding licenses sloppy readings too:

- (9) Every farmer who owns a donkey^x, beats it_x ,
and every farmer who owns a MULE^y does beat it_y too.

Example (10), involving VP ellipsis, shows that the *Chomsky's book* can *bind* the pronominal to its left, since the elliptical sentence has a sloppy reading.

- (10) Every LINGUISTICS professor who wanted to read it_a bought CHOMSKY's book^a,
and every PHILOSOPHY professor who did want to read it_b bought YABLO's book^b.

There is another strategy that the dynamic semanticist could adopt in order to account for cataphora in (10) while maintaining that dynamic binding proceeds from left-to-right – *crossover*.

³Note that DPL and related theories must stipulate the semantics of logical operators (see, e.g., Schlenker 2009 for related criticism), but see Charlow (2014) for a compositional dynamic semantics that does not have this undesirable property.

⁴One can straightforwardly define a shifter for converting referring expressions into dynamic binders. We omit the compositional details here for ease of exposition.

The idea would be that the definite antecedent scopes over the pronominal, and thereby is evaluated before it. We schematize this as QR for ease of exposition:

(II) Chomsky’s book^a [Every linguistics professor who wanted to read it_a bought t_a]

This is conceptually undesirable since, if crossover derivations are generally available, this *subverts* the dynamic explanation for the left-to-right nature of anaphora, since there is no reason why indefinites shouldn’t be able to bind to their left via crossover. Empirically, this also makes bad predictions: we observe that cataphoric binding may co-occur with standard anaphoric binding by an indefinite. In fact, the cataphoric pronoun can even be part of the indefinite antecedent, as in (I2) (again, we use sloppy identity to force a binding derivation).

(I2) [Every professor who taught [a LINGUISTICS student who wanted to read it_a]^x],
bought CHOMSKY’s book^a for them_x,
and [every professor who taught [a PHILOSOPHY student who did want to read it_b]^y]
bought YABLO’s book^b for them_y.

The binding relations in (I2) cannot be dealt with in orthodox dynamic semantics – for anaphora to be licensed, the indefinite must be evaluated before the VP that contains the anaphoric pronoun *them*, but at that point the antecedent for the cataphoric pronoun *it* has not been evaluated! Crossover won’t help here; (I3) shows that the definite NP must be able to stay in the scope of the subject NP under the relevant reading, due to the bound pronoun.

(I3) [Every professor who wanted [a LINGUISTICS student]^y to read it_a]^x
printed out [his_x DISSERTATION]^a for them_y,
and [every professor who wanted [a PHILOSOPHY student]^y to read it_b]^x
printed out [his_x first JOURNAL ARTICLE]^b for them_y.

BINDING BY PRESUPPOSITIONS: We would like to be able to account for the ability of definite antecedents to bind to their left, without dispensing with the achievements of dynamic semantics in the domain of *anaphora*. Our claim is that, unlike orthodox dynamic binding of a definite by an indefinite, as captured by dynamic semantics, *cataphora* involves binding by a *presupposition*.

We depart from the standard dynamic treatment of definites as denoting variables, and instead adopt something closer to a Fregean analysis in the sense that the presupposition is an existential statement. One crucial difference, however, is that our presupposition is a *dynamic* statement triggering random assignment. From now on, sentences are translated into a pair of DPL statements. We adopt the Sauerland notation, $\frac{\phi}{\psi}$, where ϕ represents the presupposition and ψ the at-issue meaning. $\frac{\phi}{\psi}$ represents a partial function over information states whose domain is $\{i \mid i[\phi]j \text{ for some } j\}$.

(I4) The_x^a new book is sold out $\rightsquigarrow \frac{\text{dom } x \wedge \exists! a[\text{newBook } a] \wedge x = a}{\text{soldOut } x}$
 $\exists! x[\phi] := \exists x[\phi \wedge \neg \exists y[\phi[x/y] \wedge x \neq y]]$ where ϕ is free for y

We define an accommodation operator \mathbb{A} that takes a partial DPL statement $\frac{\phi}{\psi}$ and returns a total one in the following manner. \top here is a trivial identity test, i.e. $i[\top]j := \Leftrightarrow i = j$.

$$(15) \quad \mathbb{A} \left(\frac{\phi}{\psi} \right) := \frac{\top}{\phi \wedge \psi}$$

In what follows, we simply write $\phi \wedge \psi$ for this.

Let's see how this accounts for a basic case of cross-sentential cataphora. In order to account for cataphora licensed by proper names and pronominals, we assume that they also have existential presuppositions.

(16) He_a sat down. Then the new arrival_x^a yawned.

$$(17) \quad \text{a. } \text{he}_a^b \text{ sat down} \rightsquigarrow \frac{\text{dom } a \wedge \exists b[a = b]}{\text{satDown } a}$$

$$\text{b. } \text{the new arrival}_x^a \text{ yawned} \rightsquigarrow \frac{\text{dom } x \wedge \exists! a[\text{newArrival } a] \wedge x = a}{\text{yawned } x}$$

$$\text{c. } \mathbb{A} \left(\frac{\text{dom } a \wedge \exists b[a = b] \wedge \text{dom } x \wedge \exists! a[\text{newArrival } a] \wedge x = a}{\text{satDown } a \wedge \text{yawned } x} \right) \\ = \text{dom } a \wedge \exists b[a = b] \wedge \text{dom } x \wedge \exists! a[\text{newArrival } a] \wedge x = a \wedge \text{satDown } a \wedge \text{yawned } x$$

This strategy for licensing cataphora is of course not available for indefinites, since indefinites aren't *presuppositional* in the relevant sense.⁵

Furthermore, we provide an empirical argument in favour of the presuppositional account of cataphora, based on the following prediction: *local satisfaction bleeds cataphora*. We observe that in cases where the existential presupposition associated with a definite antecedent can be locally satisfied, it fails to license cataphora. In (18), since the existential presupposition of the definite antecedent is contextually entailed by the conditional antecedent, it fails to project.

(18) #Every student who pre-ordered it_a knows that
[if Chomsky is active, then his new book_x^a is sold out].

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⁵We still need to rule out crossover derivations. Every dynamic theory must have a story about this; in the talk we discuss a principled way of deriving the ban on crossover.