Centering in Dynamic Semantics

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Abstract

Centering theory posits a discourse center, a distinguished discourse entity that is the topic of a discourse. A simplified version of this theory is developed in a Dynamic Semantics framework. In the resulting system, the mechanism of *center shift* allows a simple, elegant analysis of a variety of phenomena involving sloppy identity in ellipsis and "paycheck pronouns".

1 Introduction

Centering (Grosz et al., 1995) and Dynamic Semantics[1] both concern the sequential processing of discourses, with particular emphasis on the resolution of pronouns. In Dynamic Semantics, the semantic structure of a discourse gives rise to constraints on the resolution of anaphoric expressions. Centering theory claims that a discourse always has a single topic, or center. Constraints on the resolution of anaphoric expressions arise, in part, from the ways in which the center can change in a discourse. There is an important difference in the way discourses are viewed in Centering and in Dynamic Semantics. In Dynamic Semantics, a discourse is viewed as a monotonic increase in information, as discourse referents are constantly added to the domain of discourse. Centering draws attention to a particular *role* that a discourse entity can hold; from time to time, the current center will be *shifted* with a new center. In this paper, I will implement a simplified version of the centering theory in a dynamic system, and of phenomena involving sloppy identity in ellipsis and "paycheck pronouns".

Since Montague, a major goal of semantics has been to describe a compositional method for converting a syntactic representation of a sentence into a logical representation of the sentence meaning, and then to evaluate that representation with respect to a given context. A primary insight of dynamic semantics is that sentences have a systematic relation to context in two ways: not only are they evaluated with respect to the current context, but they also systematically change that context. This insight has particular relevance for the apparent puzzle presented by sloppy identity and related phenomena. While anaphoric expressions are normally thought to be identical in meaning to their antecedents, they receive a different interpretation than their antecedents in these cases. Given the dynamic perspective, the puzzle evaporates: the anaphoric expression and its antecedent might represent exactly the same meaning, since meaning is fundamentally a potential to be evaluated with respect to some context. What changes is the context, in the discourse intervening between antecedent and anaphoric expression.

Consider the following example involving sloppy identity in VP ellipsis:

(1) Tom$_1$ loves his$_1$ cat. John$_1$ does too. [loves his$_1$ cat]

The sloppy reading results from a change in context, in which the value of 1 becomes *John* rather than *Tom*. This allows an extremely simple account of the "recovery mechanism" involved in sloppy identity; the elided VP is exactly identical to its antecedent. Several authors (Gardent, 1991; Hardt, 1994) have suggested a dynamic account along these lines, arguing that sloppy identity and related phenomena reflect the *reassignment* of an index in the discourse context.[2]

Alternative approaches postulate complex recovery mechanisms for sloppy identity, such as higher-order matching (Dalrymple et al., 1991) or the syntactic matching of parallel dependencies (Fiengo and May, 1994). Below, I will argue that the dynamic account is more general and empirically adequate, as well as being simpler than alternative accounts.

The dynamic account raises the following problem: since the index of the the initial "controller" is *reassigned*, it becomes inaccessible in subseserved for the discourse center, and the discourse center will always occupy another index as well as 0. We will use the * to designate references to the discourse center. Thus the above example will be notated as follows:

(2) Tom_{1*} loves his_* cat. John_{2*} does too. [loves his_* cat]

In the first sentence, *Tom* is the value of index 1, and is also the discourse center, i.e., the value of index 0. The pronoun *his** is equivalent to his_0, and thus refers to the discourse center. In the second sentence, *John* becomes the value of index 2, and also replaces *Tom* as the discourse center and thus *John* becomes the value of index 0. This *center shift* gives rise to the sloppy reading. However, both *Tom* and *John* remain accessible in subsequent discourse.

The paper is organized as follows: In Section Two, I present a dynamic framework based on the system described in (Muskens, 1996), with extensions for the discourse center, VP ellipsis, and paycheck pronouns. Section Three concerns an "expanded paradigm" for sloppy identity; it is shown that the proposed approach uniformly accounts for a broad range of sloppy identity phenomena, including some not previously examined in the literature. Conclusions and plans for future work are given in Section Four.

2 A Dynamic Framework

The basic dynamic framework is the dynamic logic system of (Muskens, 1996). This framework has, for the sake of simplicity, restricted the study of anaphora to pronouns that are extensionally identified with their antecedents[3]. I will extend Muskens' system to permit anaphora involving VP's as well as NP's, and to allow antecedents to be dynamic as well as ordinary (extensional) objects.

In Muskens' system, linearized DRT boxes are integrated with the type logic (Church, 1940) that underlies Montague Semantics. Linearized DRT boxes are simply a more concise way of writing standard DRT boxes (Kamp, 1980). Muskens shows that DRT boxes can be viewed as abbreviations for expressions in ordinary type logic. Consider the following discourse: the discourse: *A_1 farmer walks. He_1 laughed.*

This is represented by the following linearized DRT box:

$$[u_1 \mid \text{farmer}(u_1), \text{walk}(u_1), \text{laugh}(u_1)]$$

[3]There are several researchers who have extended dynamic frameworks to account for ellipsis and related phenomena: (Klein, 1984) is an early example. (Asher, 1993) examines a variety of extensions to the DRT framework. (van Eijck and Francez, 1993) explore similar issues of indexing and ellipsis in a dynamic setting. (Gardent, 1991) also extends a dynamic semantics system for ellipsis and anaphora.

This is an abbreviation for the following type logic formula:

$$\lambda ij(i[u_1]j \wedge \text{farmer}(u_1 j) \wedge \text{walks}(u_1 j) \wedge \text{laughs}(u_1 j))$$

In the above formula, the variables i and j represent input and output states, and the variable u_1 (akin to a discourse marker) is a function from states to individuals. In what follows, we use the DRT abbreviations without further comment. The reader is referred to (Muskens, 1996) for further examples and the details of the system.

We now define a simple fragment of English, based on the one given in (Muskens, 1996).

a_n	$\Rightarrow$	$\lambda P_1\, P_2([u_n \mid];P_1(u_n);P_2(u_n))$
John_n	$\Rightarrow$	$\lambda P([u_n \mid u_n = \text{John}];P(u_n))$
he_n	$\Rightarrow$	$\lambda P\, P(\delta)$ where δ=dr(ant(he_n))
if	$\Rightarrow$	$\lambda pq\, [\ \mid p \Rightarrow q]$
and	$\Rightarrow$	;
walk	$\Rightarrow$	$\lambda v\, [\ \mid \text{walk}(v)]$
cat	$\Rightarrow$	$\lambda v\, [\ \mid \text{cat}(v)]$
love	$\Rightarrow$	$\lambda Q\, \lambda v\, (Q(\lambda u'[\ \mid \text{loves}(v,u')]))$

Note that the translation for he_n refers to $dr(ant(he_n))$. This is defined as the discourse representation of the antecedent of he_n(see (Muskens, 1996, page 20)). The translation for *and* is the *sequencing operator*, ;. As described in (Muskens, 1996), the sequencing of two boxes K,K′ is an abbreviation for the following type logic expression:

$$[\![K_1;K_2]\!] \Rightarrow \{<i,j> \mid \exists k\, (<i,k> \in [\![K_1]\!]\ \&\ <k,j> \in [\![K_2]\!])\}$$

Typically, two DRT boxes appearing in sequence can be *merged* into a single box, consisting of the union of the discourse markers in the two boxes and the union of the conditions. This is described in the *Merging Lemma* of (Muskens, 1996, page 8). In the representations that follow, we will often merge boxes without comment to simplify representations. However, the merge of two boxes is not always possible - if there is a reassignment of an index, it will not be possible to perform the merge. This will arise in the cases of sloppy identity examined below.

The above fragment, following the Kamp/Heim accounts, considers only one type of anaphora, involving individuals. We will extend the fragment in the following ways:

- we will add the idea of a *discourse center* to the system
- we will allow dynamic properties to be added to contexts, as antecedents for VP ellipsis
- we will allow dynamic individuals to be added to contexts, to account for "paycheck pronouns"

2.1 Discourse Center

We define position 0 in the context as the *Discourse Center*. At any given point in the discourse, the discourse entity designated as the discourse center occupies position 0 as well as its other position. We designate this with a *, as in the following example:

(3) A_1* farmer walks. He* laughed.

This is represented as follows:

$[u_0,u_1 \mid u_0 = u_1, \text{farmer}(u_1), \text{walk}(u_1),\text{laugh}(u_1)]$

In this discourse, the entity introduced by A_1* *farmer* is the discourse center, and thus occupies position 0 as well as position 1.

We must add additional rules for indefinite expressions and names, when they add an object to context that is the discourse center.

a_n* $\Rightarrow$
$\lambda P_1 P_2([u_0,u_n \mid u_0 = u_n]; P_1(u_n);P_2(u_n))$
John_n* $\Rightarrow$
$\lambda P([u_0,u_n \mid u_0 = u_n,u_n = \text{John}];P(u_n))$

We will apply a very simplified version of centering theory, consisting of the following constraints:

- Every discourse utterance (except the discourse initial utterance) must have a center.
- If any pronouns occur in an utterance, at least one pronoun must refer to the center.

We define two types of ***transitions*** from one utterance to the next:

1. *Center Continuation*: the center remains the same
2. *Center Shift*: the center changes

The actual centering theory involves an additional data structure, the *forward-looking centers*, and defines four transition types, with a preference ordering among them. The reader is referred to (Grosz et. al., 1995) for a full account of this. For our purposes, we will rely on the mechanism of *center shift* to implement the reassignment that we argue is crucial to the dynamic account of sloppy identity.

2.2 VP Ellipsis

Next, we extend the system for VP ellipsis: first, verbs are separated into a base form and an inflection (INFL). This facilitates the treatment of VP ellipsis; the INFL category adds the new property to the context, just as the determiner "a" adds a new individual to the context. An alternative meaning for the INFL category is given for VPE occurrences, where a property is accessed from the input context.

$\text{INFL}_n \Rightarrow \lambda P\, \lambda x\, [P_n \mid P_n = P]\, ;\, P(x)$
$\text{INFL}_n \Rightarrow \text{dr}(\text{ant}(\text{INFL}_n))$

The INFL category ranges over verbal inflections (PAST, PRES, etc.) and auxiliary verbs (do, should, etc.)[4]

Consider the following example of VP ellipsis:

(4) a. Tom walks. John does too.
b. Tom_1* PRES_2 walk. John_3* does_2 too.

The two sentences receive the following interpretations:

Tom_1* PRES_2 walk. $\Rightarrow$
$[u_0, u_1, P_2 \mid u_0 = u_1, u_1 = \text{Tom},$
$P_2 = \lambda x[\mid \text{walk}(x)], \text{walk}(u_1)\ ]$
John_3* does_2 VPE_2 too. $\Rightarrow$
$[u_0, u_3 \mid u_0 = u_3, u_3 = \text{John}]\ ;\ P_2(u_3)$

Next, we join the two sentence interpretations with the sequencing operator, and we apply the value of P_2 to u_3:

Tom_1* PRES_2 walk. John_3* does_2 VPE_2 too. $\Rightarrow$
$[u_0, u_1, P_2 \mid u_0 = u_1, u_1 = \text{Tom},$
$P_2 = \lambda x[\mid \text{walk}(x)], \text{walk}(u_1)\ ]\ ;$
$[u_0, u_3 \mid u_0 = u_3, u_3 = \text{John}, \text{walk}(u_3)]$

Next, we will consider an example involving sloppy identity. To do this, it will be necessary to add genitive NP's, such as "his cat" to our system.

his ($\text{he}_n\text{'s}_m$) $\Rightarrow$
$\lambda P_1 P_2\ ([u_m \mid \text{of}(u_m, u_n)];\ P_1(u_m);\ P_2(u_m)\ )$

We need two indices: n is the index of *he*: this is an individual defined in input context. The index m is the index of the object possessed by he_n; this object is added to the output context. (For clarity, we will often write $his_n cat_m$; but the "official usage" is he_n *'s*$_m$ *cat*.)

Now, we examine a simple case of sloppy identity in VP ellipsis:

(5) a. Tom loves his cat. John does too.
b. Tom_1* PRES_2 love his* cat_3. John_4* does_2 too.

Tom_1* PRES_2 love his* cat_3 $\Rightarrow$
$[\ u_0, u_1, P_2, u_3 \mid u_0 = u_1, u_1 = \text{Tom},$
$P_2 = \lambda x([u_3 \mid \text{of}(u_3, u_0),$
$\text{cat}(u_3), \text{love}(x,u_3)]),$
$\text{of}(u_3,u_0),\text{cat}(u_3), \text{love}(u_1,u_3)]$
John_4* does_2 (too) $\Rightarrow$
$[\ u_0, u_4 \mid u_4 = u_0, u_4 = \text{John}]\ ;\ P_2(u_4)$

Next, we join the two sentences together and apply the value of P_2 to u_4:

[4] We ignore the semantic contribution of INFL, apart from the above-described interaction with the discourse context.

$\text{Tom}_1{}^*\ \text{PRES}_2$ love his* cat_3 (and)
$\text{John}_4{}^*\ \text{does}_2$ (too) $\Rightarrow$

$$[u_0, u_1, P_2, u_3 \mid u_0 = u_1, u_1 = \text{Tom}, \\ P_2 = \lambda x[u_3 \mid \text{of}(u_3, u_0), \text{cat}(u_3), \text{love}(x,u_3)], \\ \text{of}(u_3,u_0),\text{cat}(u_3), \text{love}(u_1,u_3)] \ ; \\ [u_0, u_4 \mid u_4 = u_0, u_4 = \text{John}] \ ; \\ [u_3 \mid \text{of}(u_3, u_0), \text{cat}(u_3), \text{love}(u_4,u_3)]$$

The antecedent for the VPE is "love his cat". This object (P_2) is introduced into the context by PRES_2. P_2 represents the property of "loving u_0's cat", where u_0 is the discourse center defined in the input context. In the first sentence, the center is TOM. The second sentence *shifts* the center to JOHN. It is this change in context that gives rise to the sloppy reading. Thus a sloppy reading is made possible when there is a *center shift.*

Finally, we allow the possibility that a property might be the discourse center. This means we must add an alternative rule for INFL, so that it adds a property that is the discourse center:

$$\text{INFL}_n{}^* \Rightarrow \\ \lambda P\ \lambda x\ [P_n \mid P_0 = P_n, P_n = P]\ ;\ P(x)$$

2.3 Paycheck Pronouns

The phenomenon of "paycheck pronouns",[5] is illustrated by the following example

(6) Smith spent his paycheck. Jones saved it.

The reading of interest is where the pronoun "it" refers to Jones' paycheck, although its antecedent ("his paycheck") refers to Smith's paycheck. Our account for this parallels the account of sloppy identity in VP ellipsis. The antecedent "his_i paycheck" introduces a *dynamic individual*: a relation between contexts that introduces i's paycheck to the output context, where the value of i is determined by the input context. The following rule makes it possible for NP's like "his paycheck" to add dynamic individuals to the context.

$$\text{his}\ (\text{he}_n\text{'s}_m) \Rightarrow \\ \lambda P_1\ P_2\ [x_m \mid x_m = \lambda P\ ([u_m \mid \text{of}(u_m,u_n)]; \\ P_1(u_m);P(u_m)); \\ x_m(P_2)$$

[5]This term comes from Kartunnen's example: *The man who gave his paycheck to his wife was wiser than the one who gave it to his mistress.* Various accounts of this phenomenon have been proposed, such as (Cooper, 1979; Engdahl, 1986; Jacobson, 1992; Gardent, 1991). (Heim, 1990) proposed extending the Sag/Williams account of VPE to the case of paycheck pronouns. Gardent makes a proposal similar to the current account: a dynamic approach in which paycheck pronouns and VPE are treated uniformly.

We use variables of the form u_i to denote ordinary *extensional* individuals; we use variables of the form x_i to denote *dynamic* individuals. There are two distinct effects on the output context. First, the dynamic individual x_m is added to context: this object adds an individual u_m to a given context, such that u_m is *of* u_n in that context. Second, x_m is *applied* to the property P_2. This actually adds u_m to the current context.

Finally, we need an alternative form for pronouns that refer to dynamic individuals:

$$\text{he}_n \quad \Rightarrow \quad \delta \text{ where } \delta = \text{dr}(\text{ant}(\text{he}_n))$$

The pronoun he_n recovers x_n from the current context. The desired reading can now be derived as follows:

(7) a. Smith spent his paycheck. Jones saved it.
b. $\text{Smith}_1{}^*\ \text{PAST}_2$ spend his* paycheck_3. $\text{Jones}_4{}^*\ \text{PAST}_5$ save it_3.

We take the two sentences individually. The first sentence introduces the dynamic individual x_3, as follows[6]:

$$\text{his* paycheck}_3. \Rightarrow \\ \lambda P_2\ [x_3 \mid x_3 = \lambda P([u_3 \mid \text{of}(u_3,u_0), \text{paycheck}(u_3)]; \\ P(u_3))\ ]; \\ x_3(P_2)$$

$$\text{spend his* paycheck}_3. \Rightarrow \\ \lambda v\ [x_3 \mid x_3 = \lambda P([u_3 \mid \text{of}(u_3,u_0), \text{paycheck}(u_3)]; \\ P(u_3))\ ]; \\ x_3(\lambda u'[\ \mid \text{spend}(v,u')])$$

$$\text{spend his* paycheck}_3. \Rightarrow \\ \lambda v\ [x_3 \mid x_3 = \lambda P([u_3 \mid \text{of}(u_3,u_0), \text{paycheck}(u_3)]; \\ P(u_3))\ ]; \\ [u_3 \mid \text{of}(u_3,u_0), \text{paycheck}(u_3)];[\ \mid \text{spend}(v,u_3)]$$

$$\text{Smith}_1{}^*\ \text{PAST}_2 \text{ spend his* paycheck}_3. \Rightarrow \\ [u_0,u_1,P_2,x_3 \mid u_0 = u_1,u_1 = \text{Smith}, \\ x_3 = \lambda P([u_3 \mid \text{of}(u_3,u_0),\text{paycheck}(u_3)]; \\ P(u_3))]; \\ [u_3 \mid \text{of}(u_3,u_0), \text{paycheck}(u_3),\text{spend}(u_1,u_3)]$$

We continue with the second sentence.

$$\text{save it}_3 \Rightarrow \\ \lambda Q\lambda v(Q(\lambda u'[\ \mid \text{save}(v,u')]))\ \text{dr}(\text{ant}(\text{it}_3))$$

We substitute the value of x_3 for $dr(ant(it_3))$:

$$\text{save it}_3 \Rightarrow \\ \lambda Q\lambda v(Q(\lambda u'[\ \mid \text{save}(v,u')])) \\ \lambda P([u_3 \mid \text{of}(u_3,u_0),\text{paycheck}(u_3)];P(u_3))]$$

We perform λ reductions, resulting in:

[6]To simplify the representation, we omit the values for VP variables P_2 and P_5, since they are not relevant to the current example.

save it$_3$ $\Rightarrow$
λv ([u_3 | of(u_3,u_0),paycheck(u_3)];
[| save(v,u_3)]))
Jones$_4$* PAST$_5$ save it$_3$. $\Rightarrow$
[u_0,u_4,P_5,u_3 | u_0 = u_4,u_4=Jones, of(u_3,u_0),
paycheck(u_3), save(u_4,u_3)]

The complete discourse is represented as follows:

Smith $_1$* PAST$_2$ spend his* paycheck$_3$.
Jones$_4$* PAST$_5$ save it$_3$. $\Rightarrow$
[u_0,u_1,P_2,x_3 | u_0 = u_1,u_1 = Smith,
x_3 =
λP([u_3 | of(u_3,u_0),paycheck(u_3)];P(u_3))
[u_3 | of(u_3,u_0), paycheck(u_3),spend(u_1,u_3)];
[u_0,u_4,P_5,u_3 | u_0 = u_4,u_4=Jones,
of(u_3,u_0),paycheck(u_3), save(u_4,u_3)]

The dynamic individual x_3 adds the paycheck of u_0 (the discourse center) to the context. In the second sentence, the discourse center is *Jones*. Thus we get the reading in which "Jones saved Jones' paycheck", as desired.

3 An Expanded Paradigm for Sloppy Identity

The proposed theory permits a simple, uniform treatment of sloppy identity in VPE and paycheck pronouns. This uniformity extends further. We simply permit sloppy identity for any proform, whenever the antecedent contains a proform within it. This is schematically represented as follows:

C1 $\ldots [_{XP} \ldots [_{YP}] \ldots] \ldots$ C2 $\ldots [_{XP'}]$
(C1, C2: "controllers" of sloppy variable **YP**)

Here, XP is the antecedent for some proform XP', and YP is the sloppy variable, i.e., a proform embedded within XP. A sloppy reading results whenever there is a *center shift* involving C1 and C2. That is, the interpretation of YP switches from controller $C1$ to $C2$.

Since the dynamic theory treats VP ellipsis uniformly with NP proforms, XP and YP both range over NP and VP. This predicts four possibilities. All four possibilities in fact occur, as shown by the following examples:

(8) Tom [$_{VP}$ **loves** [$_{NP}$ **his**] **cat**]. John does too.

(9) Smith spent [$_{NP}$ [$_{NP}$ **his**] **paycheck**]. Jones saved it.

(10) I'll help you if you [$_{VP}$ **want me to** [$_{VP}$]]. I'll kiss you even if you don't.[7]

(11) When Harry drinks, I always conceal [$_{NP}$ **my belief that he shouldn't** [$_{VP}$]]. When he gambles, I can't conceal it.

Examples (8) and (9) have already been discussed. (8) is the familiar case in which the VP antecedent (XP) contains a sloppy pronoun (YP). YP switches from $C1$, *Tom*, to $C2$, *John*. In example (9), we have an NP antecedent (XP) containing a sloppy pronoun (YP), and the two controllers for YP are *Smith* and *Jones*. Example (10) involves a VP antecedent containing a sloppy VP ellipsis; the VP ellipsis switches from *help you* to *kiss you*. Finally, example (11) involves an NP antecedent containing a sloppy VP ellipsis, switching from *drinks* to *gambles*.

We have already seen how the sloppy reading is derived for (8) and for (9). We now show the derivation for (10) (example (11) can be derived in a similar fashion.)[8]:

I$_1$ WILL$_2$* help you$_3$ [if] you$_3$ PRES$_4$ want me$_1$ to$_2$.
I$_1$ WILL$_5$* kiss you$_3$ [even if] you$_3$ DO$_4$ NOT. $\Rightarrow$
[u_1,P_0,P_2,u_3,P_4 | u_1 = I,P_0 = P_2,u_3 = You,
P_2 = λv([| help(v,u_3)]),
P_4 = λv([| want(v,P_0(u_1))]),
help(u_1,u_3),want(u_1,help(u_1,u_3))] ;
[P_0,P_5 | P_0 = P_5,
P_5 = λv([| kiss(v,u_3)]),NOT(P_4(u_3))]

The variable P_4 represents the property of "wanting u_1 to P_0". Below, we substitute the value λv([| want(v,P_0(u_1))]) for P_4, and then substitute the value λv([| help(v,u_3)]) for P_0, and apply it to u_3, giving the following result:

I$_1$ WILL$_2$* help you$_3$ [if] you$_3$ PRES$_4$ want me$_1$ to$_2$.
I$_1$ WILL$_5$* kiss you$_3$ [even if] you$_3$ DO$_4$ NOT. $\Rightarrow$
[u_1,P_0,P_2,u_3,P_4 | u_1 = I,P_0 = P_2,u_3 = You,
P_2 = λv([| help(v,u_3)]),
P_4 = λv([| want(v,P_0(u_1))]),
help(u_1,u_3),want(u_1,help(u_1,u_3))] ;
[P_0,P_5 | P_0 = P_5, P_5 = λv([| kiss(v,u_3)]),
NOT([| want(u_3,kiss(u_1,u_3))]),

It is the "center shift" involving P_2 ("help you") and P_5 ("kiss you") that makes the desired reading possible. That is, "what u_3 doesn't want is for u_1 to kiss u_3".

The dynamic theory explains all four of these cases in the same way; the embedded proform in the antecedent can be sloppy, because the controller for the embedded proform can undergo a *center shift*. The cases illustrated by (10) and (11)

[7]This example was provided by Marc Gawron (p.c.), who attributed it to Carl Pollard.

[8]We construct a representation as if the connectives *if* and *even if* were simple conjunctions. This allows us to avoid the complex issues involved in representing such "backwards conditionals" in a dynamic system.

have not, to my knowledge, been discussed previously in the literature. It is not clear how such examples could be handled by alternative theories, such as (Fiengo and May, 1994) or (Dalrymple et al., 1991), since these theories do not treat NP and VP anaphora in a uniform fashion.

4 Conclusions and Future Work

The dynamic perspective provides a framework for a simple, intuitive account of sloppy identity and related phenomena, by explaining the interpretive facts in terms of changes in context. This requires contexts to change in a way that is somewhat foreign to the dynamic perspective; a given position in the context must be reassigned, or *shift* its value. To implement this, I have incorporated the notion of *discourse center*, together with the mechanism of *center shift*, into a dynamic system. This makes it possible to give a novel, dynamic account of sloppy identity phenomena. I have shown that this approach accounts for an expanded paradigm of sloppy identity, going beyond the data addressed in alternative accounts. In future work, we will investigate incorporating additional aspects of centering theory, including the forward-looking centers list, and the preference orderings on transitions.

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