Reflexivity and Reciprocity with(out) Underspecification *

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Abstract

In languages like English, reflexivity and reciprocity are expressed by distinct proforms. However, many languages, such as Cheyenne, express reflexivity and reciprocity with a single proform. In this paper I utilize Dynamic Plural Logic (van den Berg, 1996) to a draw a semantic parallel between reflexive and reciprocal anaphors in English. I propose that they contribute overlapping but distinct requirements on the relations introduced by transitive verbs, requirements which fully specify reflexivity and reciprocity. This parallel is then extended to Cheyenne by appealing to underspecification. I propose the Cheyenne affix which expresses both reflexivity and reciprocity contributes only the shared requirement of the English anaphors. It is thus underspecified, not ambiguous. This accounts for its compatibility with both singular and plural antecedents as well as its variety of construals.

1 Introduction

Reflexivity and reciprocity in English are expressed by means of distinct reflexive and reciprocal anaphors. While these anaphors have been treated as a natural class by many syntactic theories (Lees and Klima, 1963; Pollard and Sag, 1992, a.o.), their semantic connection has received little attention in formal semantics. Most studies focus on reciprocals (Heim, Lasnik, and May, 1991; Schwarzschild, 1996; Dalrymple et al., 1998, a.o.), though some studies have begun to explore the formal relationship between reflexives and reciprocals (Langendoen and Magloire, 2003; Faller, 2007, a.o.).

Unlike English, many languages express both reflexivity and reciprocity with a single proform (Maslova, *to appear*; Langendoen and Magloire, 2003). One such language is Cheyenne (Algonquian), which expresses both with the verbal affix *-ahte*. In addition to reflexive and reciprocal construals, *-ahte* allows a mixed construal, which is partially reflexive and partially reciprocal.

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In this paper I propose an analysis of reflexivity and reciprocity in Dynamic Plural Logic (van den Berg, 1996) which draws a semantic parallel both within a language and cross-linguistically. In Section Two, I introduce and illustrate a fragment of Dynamic Plural Logic, focusing on the modified definition of an information state as a *set* of assignment functions. This unique way of modellng information states allows for a distinction between global and dependent values for variables. Utilizing this distinction, I then give an analysis of transitive verbs which accounts for their collective, cumulative, and distributive readings.

In Section Three I propose an analysis of English reflexives and reciprocals which treats them as anaphors that elaborate on the relations introduced by the verb, which can be collective, cumulative, or distributive. I draw a semantic parallel between reflexive and reciprocal anaphors by again utilizing the distinction between global and dependent values: the anaphors share a requirement on global values but have differing requirements on dependent values. These anaphors are treated as being fully specified for reflexivity and reciprocity. However, their proposed translations are general enough to allow for their variety of interpretations.

In Section Four, I appeal to underspecification to extend this semantic parallel to Cheyenne, a language which expresses both reflexivity and reciprocity with a single proform. I argue that such proforms have the same requirement on global values as the English anaphors. However, unlike the English anaphors, they lack any requirement on dependent values. These proforms are thus underspecified for reflexivity and reciprocity, not ambiguous. This accounts for their compatibility with both singular and plural antecedents, their variety of construals, and the possibility of *mixed elaboration*. Section Five is the conclusion.

2 Framework: Dynamic Plural Logic

In this section I introduce a fragment of Dynamic Plural Logic (van den Berg, 1996; henceforth DPlL) – an extension of Dynamic Predicate Logic (Groenendijk and Stokhof, 1991; henceforth DPL) developed to model pluralities and the anaphoric dependencies between them.

In §2.1 I discuss the general properties of this system, focusing on the modelling of an information state as a set of assignment functions, and highlight the DPlL distinction between global and dependent values for variables. Transitive verbs are then analyzed in §2.2, making use of this distinction to account for their collective, cumulative, and distributive readings as well as their various scope options. DPlL definitions are given in the Appendix.

2.1 Overview of the framework

As in DPL, formulae in DPlL denote relations between information states. However, in DPlL the notion of information state is modified to represent dependencies between variables as well as their values. Whereas a DPL information state is a (total) assignment function, a DPlL information state is a *set* of (partial) assignment functions that each assign at most one (atomic) individual to each variable. Such *plural information states* assign a (possibly empty) set to each variable. This set is the collection of values assigned to that variable by the individual functions in that information state.

For example, in the extension of DPL to pluralities in Kamp and Reyle (1993), $\{\mathtt{a},\mathtt{b}\}$ would be assigned to x, $\{\mathtt{c},\mathtt{d}\}$ to y, and $\{\mathtt{e}\}$ to z by a single assignment function that assigns sets to each variable: $g = \{\langle x,\{\mathtt{a},\mathtt{b}\}\rangle,\langle y,\{\mathtt{c},\mathtt{d}\}\rangle,\langle z,\{\mathtt{e}\}\rangle\}$.

In DPlL, these same values would be assigned to these variables by a set of assignment functions, each of which assigns only a single (atomic) individual to each variable. One such information state is $G = \{\{\langle x,\mathtt{a}\rangle,\langle y,\mathtt{c}\rangle,\langle z,\mathtt{e}\rangle\},\{\langle x,\mathtt{b}\rangle,\langle y,\mathtt{d}\rangle,\langle z,\mathtt{e}\rangle\}\}$. This information state can also be written as $G = \{g_1,g_2\}$ where $g_1 = \{\langle x,\mathtt{a}\rangle,\langle y,\mathtt{c}\rangle,\langle z,\mathtt{e}\rangle\}$ and $g_2 = \{\langle x,\mathtt{b}\rangle,\langle y,\mathtt{d}\rangle,\langle z,\mathtt{e}\rangle\}$. These information states are graphically represented as matrices in (1), below.

(1) Information states: assignment function vs. set of assignment functions

	x	y	z
g	$\{\mathtt{a},\mathtt{b}\}$	$\{\mathtt{c},\mathtt{d}\}$	$\{\mathtt{e}\}$

DPL

G	x	y	z
g_1	a	c	e
g_2	b	d	e

DPlL

Information states in DPlL allow *global values* and *dependent values* to be distinguished. The global value of a variable is the set of values assigned to that variable by the entire information state (e.g., the global value of y in (1) is $G(y) = \{\mathtt{c},\mathtt{d}\}$). A dependent value of a variable is a subset of its global value, assigned to that variable by a *sub-state* – the information state restricted to a particular value for another variable. For example, there are two x-singular sub-states in (1), $G|_{x=\mathtt{a}}$ and $G|_{x=\mathtt{b}}$, and thus two x-dependent y-values: $G|_{x=\mathtt{a}}(y) = \{\mathtt{c}\}$ and $G|_{x=\mathtt{b}}(y) = \{\mathtt{d}\}$. DPlL information states can assign the same global values to variables but differ on their dependent values, as in (2), below.

(2) Same global values, different dependent values

G	x	y	z
g_1	a	c	e
g_2	b	d	e

G'	x	y	z
g'_1	a	d	e
g'_2	b	c	e

G''	x	y	z
g''_1	a	c	e
g''_2	b	d	e
g''_3	b	c	e

The three information states in (2) agree on the global values for x, y, and z: they each assign $\{\mathtt{a},\mathtt{b}\}$ to x, $\{\mathtt{c},\mathtt{d}\}$ to y, and $\{\mathtt{e}\}$ to z. However, the information states assign different dependent values to the variables. Though they differ on the number of assignment functions, each of the information states in (2) has two x-singular sub-states, $G|_{x=\mathtt{a}}$ and $G|_{x=\mathtt{b}}$. However, these sub-states differ from state to state. For example, the $\mathtt{b}$-singular sub-states assign different values to y in each state: $G|_{x=\mathtt{b}}(y) = \{\mathtt{d}\}$ while $G'|_{x=\mathtt{b}}(y) = \{\mathtt{c}\}$ and $G''|_{x=\mathtt{b}}(y) = \{\mathtt{c},\mathtt{d}\}$.

These different dependent values represent different dependencies. G represents a dependency between $\mathtt{b}$ and $\mathtt{d}$ while G' encodes a dependency between $\mathtt{b}$ and $\mathtt{c}$. G'' encodes the same relation between $\mathtt{b}$ and $\mathtt{d}$ as G as well as an additional relation between $\mathtt{b}$ and $\mathtt{c}$.

Because the plural information states of DPlL can represent dependencies between variables – relations between individual members of pluralities – dependencies as well as values are passed on from state to state and from sentence to sentence. This feature of DPlL is utilized in the analysis of transitive verbs in §2.2 as well as in the analysis of reflexivity and reciprocity in English (§3) and Cheyenne (§4).

2.2 Collectivity, cumulativity, and distributivity

Sentences with plural subjects and objects can be read collectively, cumulatively, or distributively (Scha, 1981, a.o.) On distributive readings, the distributive operator can take either wide or narrow scope with respect to the object. This allows four readings of (3), which can be disambiguated as in (4).[1]

(3) Sandy and Kathy lifted four boxes.

(4) Sandy and Kathy ...

a. ... *together* lifted (a stack of) four boxes. (collective)
b. ... *between* them lifted (a total of) four boxes. (cumulative)
c. ... *each* lifted *the same* (stack of) four boxes. (narrow dist.)
d. ... *each* lifted a *possibly different* (stack of) four boxes. (wide dist.)

Assuming that there is an optional operator that distributes over the subject (δ_x) and that the scope of this operator may vary, these four readings can be accounted for in DPlL as in (5).

(5) Four translations of *lift*[2]

a. $lift^{y}_{x} \rightsquigarrow \epsilon_y \wedge Lxy$ (collective)
b. $lift^{y}_{\delta_x} \rightsquigarrow \delta_x(\epsilon_y) \wedge Lxy$ (cumulative)
c. ${}_{\delta_x}(lift)^{y} \rightsquigarrow \epsilon_y \wedge \delta_x(Lxy)$ (narrow dist.)
d. ${}_{\delta_x}(lift^{y}) \rightsquigarrow \delta_x(\epsilon_y \wedge Lxy)$ (wide dist.)

I assume the input to semantic composition to be an indexed string of morphemes interpreted left to right, where the translations are combined by dynamic conjunction (adapting Bittner (2007)). In the indexed form, superscripts introduce new values for variables, subscripts indicate anaphora to the input values, δ_x indicates distribution over x, and the indices x and y stand for the subject set and the object set, respectively. In DPlL, ϵ_y introduces values for the variable y.

When the object is introduced in the scope of distributivity ($\delta_x(\epsilon_y)$), as in (5b,d), different y-values can be introduced for each x-value. That is, dependencies between variables x and y can be introduced. This allows for a representation of Sandy and Kathy picking up different boxes on the cumulative and wide distributive readings (4b,d). On the cumulative reading there is a total of four boxes while on the wide distributive reading there can be between four and eight.

When the object is introduced outside the scope of the distributivity operator, as in (5a,c), the y-values must be the same for all x-values. That is, no dependencies can be introduced, requiring these two readings to have the same assignment structures. This allows for a representation of Sandy and Kathy picking up the same four boxes on the collective and the narrow distributive readings (4a,c). Possible assignment structures for the different readings of (3) are given in (6).

[1] In this section I discuss only *subject-distributive* readings – readings where the distribution is over the subject. There can also be distribution over the object, yielding four additional readings of (3). These additional readings are parallel to the ones in (4) but the boxes are lifted *one at a time*.

[2] C.f. van den Berg (1996, §5.4.2), who analyzes these using a 'pseudo-distributivity' operator which, for both the distributive and cumulative readings, scopes over both the variable introduction and the verb.

(6) Possible assignment structures for (3)

G	x	y
g_1	s	b_1
g_2	s	b_2
g_3	k	b_3
g_4	k	b_4

cumulative

G'	x	y
g'_1	s	b_1
g'_2	s	b_2
g'_3	s	b_3
g'_4	s	b_4
g_5	k	b_5
g'_6	k	b_6
g'_7	k	b_7
g'_8	k	b_8

wide dist.

G''	x	y
g''_1	s	b_1
g''_2	s	b_2
g''_3	s	b_3
g''_4	s	b_4
g''_5	k	b_1
g''_6	k	b_2
g''_7	k	b_3
g''_8	k	b_4

collective, narrow dist.

DPlL information states represent relations between individuals, but these don't necessarily correlate with the predicate relations. Independent requirements imposed by a predicate determine what pairs, or n-tuples, are in its extension. For example, when the verbal relation is outside the scope of distributivity, as in (5a,b), the pair of the global value of x and the global value of y is required to be in the extension of the verb. On the collective and cumulative readings (4a,b), this requires $\langle\{\mathtt{s},\mathtt{k}\},\{\mathtt{b}_1,\mathtt{b}_2,\mathtt{b}_3,\mathtt{b}_4\}\rangle$ to be in $[\![L]\!]$, representing that the plurality of Sandy and Kathy picked up the plurality of the boxes.

When the verbal relation is in the scope of distributivity, as in (5c,d), each x-value is required to be paired with its dependent y-values in the extension of the verb. (For an input information state G and a verbal relation V, for every d in $G(x)$, the pair $\langle\{d\},G|_{x=d}(y)\rangle$ is required to be in $[\![V]\!]$.) For the wide distributive assignment structure G' in (6), this requires that both $\langle\{\mathtt{s}\},\{\mathtt{b}_1,\mathtt{b}_2,\mathtt{b}_3,\mathtt{b}_4\}\rangle$ and $\langle\{\mathtt{k}\},\{\mathtt{b}_5,\mathtt{b}_6,\mathtt{b}_7,\mathtt{b}_8\}\rangle$ are in $[\![L]\!]$, representing that Sandy picks up her four boxes and Kathy picks up hers.

These four readings of (3) are translated into DPlL as in (7). The translation of the subject is the same for all readings – the difference in meaning comes entirely from the VP. The NP (7i) and the VP (7ii) are to be combined by dynamic conjunction ($\wedge$).

(7) i. *Sandy and Kathy* ... $\rightsquigarrow$
$+[v=s]\wedge\epsilon_x\wedge x=v\oplus w\wedge+[w=k]$

ii. ... *lifted four boxes* $\rightsquigarrow$
$\epsilon_y\wedge Lxy\wedge 4y\wedge\delta_y(By)$ (collective)
$\delta_x(\epsilon_y)\wedge Lxy\wedge 4y\wedge\delta_y(By)$ (cumulative)
$\epsilon_y\wedge\delta_x(Lxy)\wedge 4y\wedge\delta_y(By)$ (narrow dist.)
$\delta_x(\epsilon_y\wedge Lxy)\wedge\delta_x(4y)\wedge\delta_x(\delta_y(By)))$ (wide dist.)[3]

The dependencies between x and y are introduced by the verb (through the introduction of values for the variable y); subsequent conditions are tests, elaborating on these dependencies by filtering out incompatible information states. These dependencies are then passed on to subsequent

[3]Since distribution is down to singularities (x-singular sub-states), the wide distributive translation in (7ii) is equivalent to a formulation with distributivity scoped over the entire VP: $\delta_x(\epsilon_y\wedge Lxy\wedge 4y\wedge\delta_y(By))$, representing that the object is read distributively. The object may also be read collectively, as in (11b).

discourse, as noted by van den Berg (1996). For example, in the context of the wide distributive reading of (3), where Sandy and Kathy each have their own stack of four boxes, the sentence *They brought them upstairs* is read analogously, where Sandy brought her stack of four boxes upstairs and Kathy brought her stack of four boxes upstairs.

3 Reflexive and Reciprocal Specification

Some languages, such as English, express reflexivity and reciprocity by means of distinct proforms. For example, English *themselves* expresses reflexivity while *each other* expresses reciprocity. In this section, I analyze such anaphors as elaborating on the dependencies introduced by the verb. I draw a semantic parallel between them by proposing that they share an identity requirement on global values (*global identity*) but differ in their requirements on dependent values (*distributive overlap* vs. *distributive non-overlap*).

In §3.1 I give the proposed translation of the plural reflexive and reciprocal anaphors and discuss the different interpretations that they account for. In §3.2 I extend the analysis to singular reflexives and explain why the proposed analysis of reciprocals predicts that they are incompatible with singular subjects. In §3.3 I discuss several alternate translations of the anaphors and explain why they are inadequate. Finally, in §3.4 I discuss some examples of reciprocals in discourse which show that the relations specified by these anaphors are passed on from sentence to sentence, determining the interpretation of subsequent anaphors.

3.1 Plural anaphors

In this section, I propose meanings for the English plural reflexive and reciprocal anaphors which account for a variety of their interpretations. Only one translation of each anaphor is given– their various interpretations can be derived from independent factors, such as differing translations of the verb and the way that DPlL models plurality. The proposed translations of the plural reflexive and reciprocal are given in (8) and (9) respectively.

(8) $\textit{themselves}_{y,x} \quad \rightsquigarrow \quad +[PLy] \wedge +[y = x] \wedge +[\delta_y(y \bigcirc x)]$

(9) $\textit{each other}_{y,x} \quad \rightsquigarrow \quad +[y = x] \wedge +[\delta_y(y \oslash x)]$

According to (8), the plural reflexive presupposes (+) plurality, like non-reflexive plural pronouns, as well as global identity ($+[y = x]$) and distributive overlap ($+[\delta_y(y \bigcirc x)]$). The reciprocal (9) has two presuppositions: global identity, like reflexives, and distributive non-overlap ($+[\delta_y(y \oslash x)]$). The shared presupposition of global identity requires that two arguments of the verb (here, the subject x and the object y) denote the same set. The distributive conditions impose further constraints on the dependencies between x and y that were introduced by the verb.

Consider the plural reflexive sentence in (10).

(10) Some students helped themselves

The collective and distributive readings of (10) can be accounted for with a single translation of the reflexive anaphor. All that need vary is the translation of the verb, as in (11) (where $S = \textit{student}$ and $H = \textit{help}$). (11a) is the translation of the collective interpretation, where the group of students helped the group; (11b) is the translation of the distributive interpretation, where each student in the group helped (at least) himself.

(11) a. $\epsilon_x \wedge \delta_x(Sx) \wedge PLx \wedge \epsilon_y \wedge Hxy \wedge +[PLy] \wedge +[y = x] \wedge +[\delta_y(y \bigcirc x)]$
b. $\epsilon_x \wedge \delta_x(Sx) \wedge PLx \wedge \delta_x(\epsilon_y \wedge Hxy) \wedge +[PLy] \wedge +[y = x] \wedge +[\delta_y(y \bigcirc x)]$

The distributive translation (11b) requires that each student is paired with himself, but allows additional pairings, making it compatible with several assignment structures. For students $\{\mathtt{a}, \mathtt{b}\}$, (11b) is compatible with each of the information states in (12). The collective translation (11a), however, is compatible only with the one with no dependencies between variables (G''' in (12)).

(12) Assignment structures for (11)

G	x	y
g_1	a	a
g_2	b	b

G'	x	y
g'_1	a	a
g'_2	b	a
g'_3	b	b

G''	x	y
g''_1	a	a
g''_2	a	b
g''_3	b	b

G'''	x	y
g'''_1	a	a
g'''_2	a	b
g'''_3	b	a
g'''_4	b	b

While the English reflexive *themselves* is specified for reflexivity, on the distributive reading it does not specify how many relations must hold between the individual members of the plurality. This underspecification allows (10) to be true in a variety of situations. The same is true for the English reciprocal: it is fully specified for reciprocity, but the number of relations between the individuals can vary. Consider the reciprocal sentence in (13).

(13) Some students helped each other

Sentence (13) can be true in a wide variety of situations, including ones where each student helped one other student, some other students, or every other student, and ones where in addition he helped himself. All of these situations are allowed by the DPlL translation in (14), which uses the distributive translation of the verb – there is no (subject-)collective reading of (13) (see §3.3).

(14) $\epsilon_x \wedge \delta_x(Sx) \wedge PLx \wedge \delta_x(\epsilon_y \wedge Hxy) \wedge +[y = x] \wedge +[\delta_y(y \oslash x)]$

Translation (14) requires that the x and y sets are identical and that each y-value (student) is assigned a non-overlapping dependent x-value (is paired with at least one other student and not himself). This later requirement – the distributive non-overlap condition – requires only as many relations as there are members of the antecedent set. It allows, but does not require, any number of additional relations between members of that set, accounting for the various interpretations of (13). Correspondingly, (14) is compatible with several assignment structures, including the ones in (15) for students $\{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$. While the distributive non-overlap requirement rules out assignment structures which pair an individual with itself, (14) is still true in a situation where a student additionally helped himself (see definition (D4) in the appendix).

(15) Possible assignment structures for (14)

G	x	y
g_1	a	b
g_2	b	c
g_3	c	a

G'	x	y
g'_1	a	b
g'_2	b	c
g'_3	b	a
g'_4	c	a

G''	x	y
g''_1	a	b
g''_2	a	c
g''_3	b	c
g''_4	b	a
g''_5	c	a
g''_6	c	b

3.2 Singular anaphors

The analysis proposed in the previous section can be extended to singular reflexive anaphors, e.g. *himself*, by means of a simple modification. The translation of the singular reflexive pronoun, given in (16), differs from the plural, (8), only in the number presupposition.

(16) $himself_{y,x} \quad \rightsquigarrow \quad +[SGy] \wedge +[y = x] \wedge +[\delta_y(y \bigcirc x)]$

There is only one interpretation of singular reflexive sentences such as *The student helped himself*. There is also only one assignment structure for the corresponding translation of this sentence: the assignment structure where the member of the antecedent set is mapped to itself. This analysis also predicts a presupposition conflict for sentences with number disagreement between the antecedent and the reflexive anaphor, e.g. *#The students helped himself*.

The above analysis of reciprocals in §3.1 predicts that they are not compatible with singular antecedents, e.g. *#The student helped each other*. With a singular antecedent, the presuppositions of the reciprocal, global identity ($+[y = x]$) and distributive non-overlap ($+[\delta_y(y \oslash x)]$), cannot be both satisfied. Specifically, when the antecedent denotes a singleton, the member of the antecedent set will be mapped to itself, and the distributive non-overlap condition will fail.

3.3 Alternate translations

In this section I discuss several possible alternate translations of the reflexive and reciprocal proforms, all of which turn out to be inadequate. Translations without global identity, as in (17), would incorrectly allow for different members in the x and y sets.

(17) a. $themselves_{y,x} \quad \rightsquigarrow \quad +[PLy] \wedge +[\delta_y(y \bigcirc x)]$
b. $each\ other_{y,x} \quad \rightsquigarrow \quad +[\delta_y(y \oslash x)]$

The translation of the plural reflexive in (17a) incorrectly allows for the y set to be a proper subset of the x set. The translation of the reciprocal in (17b) incorrectly allows for sets y and x to be disjoint, additionally incorrectly permitting both sets to be singletons (see §3.2).

A translation of the reflexive with distributive identity instead of overlap, as in (18a), is too strong, while the reciprocal with non-identity instead of non-overlap, (18b), is too weak.

(18) a. *themselves* $_{y,x}$ $\rightsquigarrow$ $+[PLy] \wedge +[y = x] \wedge +[\delta_y(y = x)]$
b. *each other*$_{y,x}$ $\rightsquigarrow$ $+[y = x] \wedge +[\delta_y(y \neq x)]$

The translation in (18a) incorrectly precludes a collective interpretation of the reflexive (e.g., *The students praised themselves*) because it is incompatible with a collective interpretation of the verb. The last conjunct of (18a) requires that each member of the y set is assigned only itself; however, this is incompatible with the collective verb's requirement that there be no dependencies between variables.[4]

The translation in (18b) incorrectly predicts a subject-collective interpretation of the reciprocal because (18b) is compatible with the collective interpretation of the verb. For example, it would predict a reading of *The window-washers lifted each other* where the entire x group together lifts the entire group (all on a scaffold, each pulling a rope – true on a collective reading of the *reflexive*).

3.4 Elaboration by subsequent discourse

The above analysis treats reflexive and reciprocal anaphors as sentence-internal elaborations on the dependencies introduced by the verb. But, these relations can also be elaborated on by subsequent discourse. Consider for example the discourse in (19): both (19ii) and (19iii) depend on the relations introduced in (19i) by the verb and elaborated on by the reciprocal object.

(19) i. Some girls dressed up like each other (for Halloween).
ii. They borrowed outfits from each other.
iii. The next day they returned them.

Each girl in the antecedent set borrowed an outfit from the girl she dressed up as and returned that outfit to that girl. Crucially, the representation of both the plurality of girls and the relations between them are passed on from (19i) to the subsequent discourse. If only the values were passed on, then the relations between the individual girls could be reassigned in subsequent sentences. These observations are captured by the analysis of discourse (19) given in (20), where $G = girl$, $D = dress.up.like$, $B = borrow.from$, $O = outfit$, and $R = return$.

(20) i. $\epsilon_x \wedge \delta_x(Gx) \wedge PLx \wedge \delta_x(\epsilon_y \wedge Dxy) \wedge +[y = x] \wedge +[\delta_y(y \oslash x)]$
ii. $+[PLx] \wedge \delta_x(\epsilon_z \wedge Bxzy) \wedge \delta_z(Oz) \wedge PLz \wedge +[y = x] \wedge +[\delta_y(y \oslash x)]$
iii. $+[PLx] \wedge \delta_x(Rxzy) \wedge +[PLz]$

One might argue that pragmatic reasoning may independently provide the relevant pairings for discourse (19). Though possible for (19), this is not always the case. Consider the related example in (21), whose only interpretation is pragmatically odd.

(21) i. Some girls dressed up like each other (for Halloween).
ii. They didn't know each other.

[4]The translation in is also incompatible with the narrow distributive; see §2.2 for more on translations of verbs.

Discourse (21) means that each girl in the group didn't know the girl she dressed up as (perhaps receiving her outfit by a random exchange over the internet). Crucially, (21) cannot mean that each girl dressed up as one other girl but didn't know a *different* girl. However, if the reciprocal relations could be assigned in each sentence, this interpretation should be available, and possibly pragmatically favored.

There are also examples where pragmatic reasoning suggests certain pairings and yet these are not accessible to the reciprocal. One such example is *Two rival teams just merged. The athletes like each other but they dislike each other.* This discourse sounds contradictory. There is no reading of it where the members of the one team like each other but dislike members of the other team. Such a scenario, however, is possible, and in fact made salient by the first sentence of the discourse.

Examples such as these show that plural reflexives and reciprocals are anaphoric not only to their antecedent pluralities but also to relations between the members of those pluralities.

4 Reflexive/Reciprocal Underspecification

While English expresses reflexivity and reciprocity with distinct proforms, many languages express reflexivity and reciprocity with a single proform. One such language is Cheyenne, which expresses both with the verbal affix *-ahte*. With a plural antecedent, Cheyenne *-ahte* allows reflexive, reciprocal, and mixed construals (§4.1) but only allows a reflexive construal with singular antecedents (§4.2). With plural antecedents, a reciprocal construal can be specified with an additional modifier (§4.3) and a mixed construal can be specified in subsequent discourse by mixed elaboration (§4.4).

4.1 Plural antecedents

The Cheyenne verbal affix *-ahte* is compatible with both singular and plural antecedents. When used with a plural antecedent, as in (22)[5], Cheyenne *-ahte* allows a reflexive construal, translated into English as (23), as well as a reciprocal construal, translated into English as (24).

(22) *Ka'ėškóne-ho é-axeen-**ähtse**-o'o*
child-PL.AN 3-scratch.AN-*ahte*-3PL.AN

(23) Some children scratched *themselves*

(24) Some children scratched *each other*

In addition to allowing both a reflexive and a reciprocal construal, Cheyenne (22) allows a mixed construal, which is partially reflexive and partially reciprocal. On a mixed construal, which is difficult to translate into English, (22) can refer to a group of children, some of whom scratched each other while others scratched themselves.

[5]Cheyenne abbreviations are AN := animate, CNJ := conjunction, and NON.ID := non-identity

I propose that proforms such as Cheyenne *-ahte* in (22) are underspecified for reflexivity and reciprocity. They can be analyzed as having only the global identity presupposition of the English reflexive and reciprocal anaphors, as in the translation in (25).

(25) *-ahte* $\rightsquigarrow$ $+[y = x]$

For plural antecedents, (25) does not specify what relations must hold between the members of the antecedent set, as the English anaphors do. This underspecification allows for various construals. Cheyenne *-ahte* is compatible with all translations of the verb; the distributive translation of (22) into DPlL is given in (26), where $C = child$, and $S = scratch$.

(26) $\epsilon_x \wedge \delta_x(Cx) \wedge PLx \wedge \delta_x(\epsilon_y \wedge Sxy) \wedge +[y = x]$

The translation in (26) is compatible with various assignment structures. For example, for children $\{\mathsf{c}_1, \mathsf{c}_2, \mathsf{c}_3\}$, (26) is compatible with the information states in (27).

(27) Possible assignment structures for (26)

G	x	y
g_1	c_1	c_1
g_2	c_2	c_2
g_3	c_3	c_3

G'	x	y
g'_1	c_1	c_2
g'_2	c_2	c_3
g'_3	c_3	c_1

G''	x	y
g''_1	c_1	c_1
g''_2	c_2	c_3
g''_3	c_3	c_2

In (27), information state G corresponds to the reflexive construal, G' to the reciprocal construal, and G'' to the mixed construal, where c_1 is mapped to itself and c_2 and c_3 are mapped to each other. Several other assignment structures are compatible with (26), all of which are supersets of the information states in (27).

4.2 Singular antecedents

Cheyenne *-ahte* is also compatible with singular antecedents, as in (28). There is (unmarked) singular agreement on the noun and verb, which is sufficient to specify a reflexive interpretation.

(28) *Hetané-ka'ėškóne é-axeen-**ahtse***
man-child 3-scratch.AN-*ahte*
'A boy scratched himself.'

Cheyenne (28) has only a reflexive interpretation, where the boy denoted by the subject scratched himself. The proposed translation of *-ahte* in (25) accounts for this. Since the subject in (28) is singular, x is assigned a singleton set. The contribution of *-ahte* requires identical subject (x) and object (y) sets, so y will be assigned the same singleton as x, yielding a reflexive interpretation. The translation of (28) into DPlL is given in (29).

(29) $\epsilon_x \wedge \delta_x(Cx) \wedge SGx \wedge \delta_x(\epsilon_y \wedge Sxy) \wedge +[y = x]$

The translation in (29) differs from (26) only in the number presupposition. However, (29) only allows one type of assignment structures – ones with identical singleton sets assigned to x and y.

4.3 Specification of reciprocity

The underspecified Cheyenne sentence in (22) can be modified to specify a reciprocal construal. This is achieved by the addition of a preposed verbal modifier, as in (30).

(30) *He'é-ka'èškóne-ho noná-mé'tó'e é-axeen-**åhtse**-o'o*
woman-child-PL.AN *noná*-NON.ID 3-scratch.AN-*ahte*-3PL.AN
'The girls scratched each other.'

I propose to analyze this modifier as contributing the distributive non-overlap condition of the English reciprocal, as in (31). The translation of (30) into DPlL is given in (32).

(31) *noná-mé'tó'e* $\rightsquigarrow$ $+[\delta_y(y \oslash x)]$

(32) $\epsilon_x \wedge \delta_x(Cx) \wedge PLx \wedge \delta_x(\epsilon_y) \wedge +[\delta_y(y \oslash x)] \wedge \delta_x(Sxy) \wedge +[y = x]$

(32) is just the translation of the underspecified case (26) with the addition of (31), interpreted from left to right, assuming that *noná-mé'tó'e*, as the first item to reference the object, introduces the object variable($\delta_x(\epsilon_y)$). It is equivalent to the translation in (14) of the English reciprocal sentence (13), modulo predicate differences, and allows the same range of assignment structures.

4.4 Mixed elaboration

A mixed construal of underspecified Cheyenne (22) is compatible with mixed elaboration – the specification in subsequent discourse of different relations for different subgroups of the antecedent. This is exemplified by the discourse in (33), where the first sentence (33i) is (22) and the second sentence (33ii) is the conjunction of (28) and (30).

(33) i. *Ka'èškóne-ho é-axeen-**åhtse**-o'o*
child-PL.AN 3-scratch.AN-*ahte*-3PL.AN
ii. *Hetané-ka'èškóne é-axeen-**ahtse***
man-child 3-scratch.AN-*ahte*
*naa he'é-ka'èškóne-ho noná-mé'tó'e é-axeen-**åhtse**-o'o*
CNJ woman-child-PL.AN *noná*-NON.ID 3-scratch.AN-*ahte*-3PL.AN

The conjunction (33ii) is a *mixed elaboration* of (33i): it specifies different relations for different subgroups of the children. Specifically, when 'some children' in the first sentence denotes a set of a boy and two girls ($\{c_1, c_2, c_3\}$), (33ii) specifies a reflexive relation for the (singular) subgroup of the boy ($\{c_1\}$) and a reciprocal relation for the subgroup of the girls ($\{c_2, c_3\}$). The translation of (33) into DPlL – the dynamic conjunction of (26), (29), and (32) – allows only a *mixed* assignment structure (G'' in (27)), just one of the structures possible for (22).

The Cheyenne discourse (33) is difficult to translate into English. The least awkward translation is (34), where Cheyenne (33i) is rendered as (34i), without any object.

(34) i. Some children *were scratching*.
ii. The boy scratched *himself* and the girls scratched *each other*.

(35) i. Some children scratched { *themselves* / *each other* }
ii. #The boy scratched *himself* and the girls scratched *each other*.

If there is a reflexive or reciprocal object, as in (35i), then mixed elaboration is infelicitous (#).[6] The proposed analysis accounts for this because the English reflexive and reciprocal anaphors are fully specified. If the relations between the members of the antecedent are specified in the first sentence, subsequent discourse can not specify different relations. By the same reasoning, the mixed elaboration discourse in (33) rules out an ambiguity analysis of Cheyenne *-ahte*.

Though there is no direct translation of Cheyenne (33) into English, parallel discourses are acceptable in other languages which express reflexivity and reciprocity with a single proform. This holds regardless of the morphological category of that proform – it can be an affix, as with Cheyenne *-ahte*, a clitic, or an independent word. Additional examples of such proforms are Polish *się* (M. Bittner, p.c.), Romanian *se* (A. Brasoveanu, p.c.), French *se* (V. Déprez, p.c.), Spanish *se* (C. Fasola, p.c.), and German *sich* (J. Tonhauser, p.c.). The above proposal is a step toward understanding what appears to be a robust cross-linguistic pattern.

5 Conclusion

The DPlL distinction between global and dependent values allows a semantic parallel to be drawn between English reflexive and reciprocal anaphors. The anaphors share a requirement on global values (global identity) but differ in requirements on dependent values (distributive overlap and distributive non-overlap, respectively). Each anaphor is fully specified for reflexivity and reciprocity, but their translations are general enough to allow a variety of interpretations.

By appealing to underspecification, this semantic parallel can be extended to languages such as Cheyenne that express reflexivity and reciprocity with a single proform. Like the English anaphors, these underspecified proforms presuppose global identity. However, unlike the English anaphors, they have no further requirements on dependent values – they do not specify what sort of relations must hold between the individual members of the antecedent set. This accounts for their variety of construals with plural antecedents, the specification to reflexivity with singular antecedents, and the possibility of mixed elaboration.

The cross-sentential interactions of reflexivity and reciprocity in both English and Cheyenne show the need for a richer notion of context, one which represents the dependencies between variables as well as their values (see Nouwen, 2003; Brasoveanu, 2007, a.o.).

[6] A discourse like (35) may be acceptable with 'themselves' on a collective interpretation. The proposed analysis of reflexives is compatible with collective translation of the verb: see §2 and §3.

Appendix: Dynamic Plural Logic, Definitions [7, 8]

(D1) u-to-d Alternatives and u-Alternatives

- $g[u/d] = h$ iff $(\text{Dom } g \cup \{u\}) = \text{Dom } h \;\&\; h(u) = d \;\&\; \forall u' \in (\text{Dom } g - \{u\}) : g(u') = h(u')$
- $g \approx_u h$ = $\exists d \in D^{\mathcal{M}} : g[u/d] = h$

(D2) Global Values, State Restriction, and Variable Introduction

- $G(u)$ = $\{g(u) \mid g \in G \;\&\; g(u) \neq \star\}$
- $G|_{u=d}$ = $\{g \in G \mid g(u) = d\}$
- $G|_{u=\star}$ = $\{g \in G \mid g(u) = \star\}$
- $G[u/D]$ = $\{g[u/d] \mid g \in G \;\&\; d \in D\}$
- $G \approx_u H$ iff $\exists D : G[u/D] = H$

(D3) Semantics of DPlL

- $G[\![\epsilon_u]\!]H = \top$ iff $G \approx_u H \;\&\; G(u) = \varnothing$
- $G[\![\alpha]\!]$ = $G(\alpha)$ if α is a variable, $\{[\![\alpha]\!]\}$ if α is a constant
- $G[\![\alpha_1 \oplus \alpha_2]\!]H$ = $G[\![\alpha_1]\!] \cup G[\![\alpha_2]\!]$
- $G[\![\beta\alpha_1 \ldots \alpha_n]\!]H = \top$ iff $G = H \;\&\; \langle G[\![\alpha_1]\!], \ldots, G[\![\alpha_n]\!]\rangle \in [\![\beta]\!]$
- $G[\![SG\alpha]\!]H = \top$ iff $G = H \;\&\; |G[\![\alpha]\!]| = 1$
- $G[\![PL\alpha]\!]H = \top$ iff $G = H \;\&\; |G[\![\alpha]\!]| > 1$
- $G[\![\alpha_1 = \alpha_2]\!]H = \top$ iff $G = H \;\&\; G[\![\alpha_1]\!] = G[\![\alpha_2]\!]$
- $G[\![\alpha_1 \subseteq \alpha_2]\!]H = \top$ iff $G = H \;\&\; G[\![\alpha_1]\!] \subseteq G[\![\alpha_2]\!]$
- $G[\![\phi \wedge \psi]\!]H = \top$ iff $\exists K : G[\![\phi]\!]K = \top \;\&\; K[\![\psi]\!]H = \top$
- $G[\![+[\phi]]\!]H = \top$ if $G[\![\phi]\!]H = \top$

(D4) Definition of Truth with respect to an Input State I

- $\models_{\mathcal{M},I} \phi$ iff $\exists K : I[\![\phi]\!]K = \top$

(D5) Definition of Distributivity, Overlap, and Non-overlap

- $G[\![\delta_x(\phi)]\!]H = \top$ iff $G(x) = H(x) \;\&\; G|_{x=\star} = H|_{x=\star} \;\&\; \forall d \in G(x) : G|_{x=d}[\![\phi]\!]H|_{x=d} = \top$
- $G[\![\alpha_1 \bigcirc \alpha_2]\!]H = \top$ iff $G = H \;\&\; G[\![\alpha_1]\!] \cap G[\![\alpha_2]\!] \neq \varnothing$
- $G[\![\alpha_1 \oslash \alpha_2]\!]H = \top$ iff $G = H \;\&\; G[\![\alpha_1]\!] \cap G[\![\alpha_2]\!] = \varnothing$

[7] DPlL is a partial logic. Given space considerations, I give only the conditions for truth, though there are also definedness conditions and conditions for falsehood. I adopt the definitions given in van den Berg (1996), except for distributivity, where I assume the modified definition of Nouwen (2003). The definition of subset ($\subseteq$) given above corresponds to *free subset*($\subseteq^F$) in van den Berg (1996, §4.2.3).

[8] I have added semantic definitions for overlap ($\bigcirc$) and non-overlap ($\oslash$).

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