

# The Semantics of Phi

## Number Features on Bound Pronouns

Yasutada Sudo  
Institut Jean-Nicod  
yasutada.sudo@gmail.com

ACTL Day 5  
June 28, 2013  
UCL

## 1 Number Features

---

### 1.1 Brief Introduction to Plurality

- Plural individuals as sets:

- Type  $e$  elements are *not* simply individuals, but *sets of individuals*.
- Singular/atomic individuals are singleton sets.

- (1) a.  $\llbracket \text{John} \rrbracket^{s,g} = \{\text{John}\}$   
b.  $\llbracket \text{John and Bill} \rrbracket^{s,g} = \{\text{John, Bill}\} (= \llbracket \text{Bill and John} \rrbracket^{s,g})$

To simplify, let's write 'John' for  $\{\text{John}\}$ .

- Collective vs. distributive vs. mixed predicates

- Collective predicates select for plural arguments.<sup>1</sup>

- (2) a. #This student gathered.  
b. These students gathered.
- (3) a. #This student is a couple.  
b. These students are a couple.

These predicates describe properties that only make sense for groups of individuals, rather than individuals themselves.

- (4)  $\llbracket \text{gathered} \rrbracket^{s,g} = \lambda x: |x| > 1. 1$  iff  $x$  gathered in  $s$

- Distributive predicates, on the other hand, are inherently about single individuals, e.g. 'yawn', 'be sick', etc.

- (5)  $\llbracket \text{yawned} \rrbracket^{s,g} = \lambda x: |x| = 1. 1$  iff (the unique member of)  $x$  yawned in  $s$

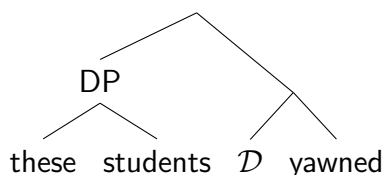
- But notice that distributive predicates can combine with plural subjects.

- (6) a. This student yawned.  
b. These students yawned.

What (6b) means is that each of the students yawned. In order to account for this, we use the distributivity operator.

- (7)  $\llbracket \mathcal{D} \rrbracket^{s,g} = \lambda P_{\langle e,t \rangle}. \lambda X_e. 1$  iff  $\forall x \in X [P(x) = 1]$

(8)



---

<sup>1</sup>Two well known exceptions: (i) group denoting nouns like 'the committee', 'the team'; (ii) so-called 'involvement' readings (Landman 1989).

The distributivity operator sometime gets realized as *all*, *each*, *both*.

(9) These students all yawned.

- Lastly, other predicates are neutral (mixed predicates), e.g. ‘wrote a love song’, ‘lifted a piano’, etc. They describe properties that can be true of singular and plural individuals.

(10) John and Bill wrote a love song.

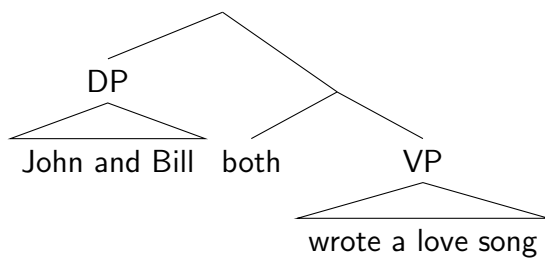
These ones have no restrictions:

(11)  $\llbracket \text{wrote a love song} \rrbracket^{s,g} = \lambda x. 1$  iff  $x$  wrote a love song in  $s$

Notice that *all*, *each*, *both*, force a distributive interpretation.

(12) John and Bill both wrote a love song.

(13)



(14)  $\llbracket \text{both} \rrbracket^{s,g} = \lambda P_{\langle e,t \rangle}. \lambda X_e: |X| = 2. 1$  iff  $\forall x \in X [P(x) = 1]$

## 1.2 Plural Pronouns

- There are two phenomena to account for.

### 1. Split antecedents

- (15) a. Each of the girls<sup>6</sup> asked one of the ladies<sub>5</sub> if **they**<sub>{6,5}</sub> could meet next week.  
 b. Only I<sup>9</sup> told each professor<sup>2</sup> that **we**<sub>{2,9}</sub> should write a paper together.

This is prima facie problematic for minimal pronouns. It's easier to deal with in a semantic account.

### 2. Semantically singular plural pronouns

- (16) a. The first-year students (all) think that **they** are the smartest student.  
 b. We (all) think that **we** are the smartest student.

Notice that these pronouns denote singular individuals!

- (17) a. #They are the smartest student.  
 b. #We are the smartest student.

This is straightforward for a minimal pronoun account. A semantic account has to say something

## 2 Heim's Analysis with Minimal Pronouns

---

- Heim (2008) modifies the minimal pronoun account to explain bound plural pronouns.

- In the minimal pronoun approach, the semantically singular plural pronouns are not problematic: the plural features are not semantically interpreted at LF (provided that transmission of number features is obligatory).
- For split antecedents, any account needs to postulate a mechanism for multiple binding.

(18) *Set Index*  

$$\llbracket \text{PRONOUN}_I \rrbracket^{s,g} = \bigcup_{i \in I} g(i)$$

When the index is a singleton, e.g. {3}, we simply write 3.

(19) 
$$\llbracket \mathbf{they}_{\{7,4\}} \rrbracket^{s,g} = g(7) \cup g(4)$$

- Heim proposes that phi-features are not on pronouns themselves, but on indices. And crucially, Feature Transmission targets indices.

(20) Each of the girls<sup>6</sup> asked one of the ladies<sub>5</sub> if **they**<sub>{6,5}</sub> could meet next week.

Here both 6 and 5 have [3rd, sg].

(21) Only I<sup>9</sup> told each professor<sup>2</sup> that **we**<sub>{2,9}</sub> should write a paper together.

In this case, 9 has [1st, sg], while 2 has [3rd, sg].

- We need spell-out rules that decide the form of a pronoun, depending on the feature compositions of the indices on it.

(22) *Spell-Out Rules*

A pronoun with a set index  $I$  is realized as

- 1st person, if some  $i \in I$  has [1st]
- 2nd person, if no  $i \in I$  has [1st] and some  $i \in I$  has [2nd]
- 3rd person otherwise;

and

- singular if  $|I| = 1$  and for the unique  $i \in I$ ,  $|g(i)| = 1$ ,
- plural, otherwise

(English plural pronouns have no gender specifications, but for other languages, you might want to add rules for gender too)

- Heim herself states at the end of the paper that an account that needs to resort to purely morphological rules like (22) that duplicate the semantic restrictions is not entirely satisfactory.

### 3 A Semantic Account of Number Features

---

- If the phi-features on bound pronouns are interpreted, split antecedents are not particularly problematic. They are plural because their referents are plural individuals. The person features can be accounted for in a semantically natural way.
- What about semantically singular plural pronouns?
- Semantically singular plural pronouns can be also found without a c-commanding antecedent (Dimitriadis 2000):

(23) The people who voted for John and Bill thought that **they** would win the election.  
 a. The people who voted for John thought that John would win the election.

b. The people who voted for Bill thought that Bill would win the election.

(24) The people who voted for John and me thought that **we** would win the election.

We need a semantic account of these sentences, regardless of our approach to phi-features on bound pronouns. I'll argue that whatever accounts for them also accounts for (16). So semantically singular plural pronouns pose no problem for a semantic approach to pronouns.

### 3.1 Choice Functions and Distributivity

- Idea: a semantically singular plural pronoun denotes the set of values that it ranges over.
- Proposal: The distributivity operator quantifies over **choice functions** that pronouns can make use of.

(25) A function  $f$  of type  $\langle e, e \rangle$  is a *choice function* if for any  $X$ ,  $f(X) = \{x\}$  such that  $x \in X$ .

A choice function is 'a way to choose a singular individual from a set of individuals'.

- Using choice functions, we analyze semantically singular plural pronouns in the following way:

(26) The first-years all<sup>f</sup> think that  $f(\mathbf{they})$  are the smartest student.

(27) For all ways  $f$  of choosing one person from  $\llbracket \mathbf{the\ first-years} \rrbracket^{s,g}$ ,  $f(\llbracket \mathbf{the\ first-years} \rrbracket^{s,g})$  thinks that  $f(\llbracket \mathbf{the\ first-years} \rrbracket^{s,g})$  is the smartest student.

- To achieve this technically, we define the distributivity operator as in (28) (omitting the pre-supposition that the subject is plural):

$$(28) \quad \left[ \left[ \begin{array}{c} \text{DP} \\ \diagup \quad \diagdown \\ \text{all}^i \quad \text{VP} \end{array} \right] \right]^{s,g} = 1 \text{ iff for all } f_{\langle e,e \rangle} \in \mathbf{RelCF}(\llbracket \mathbf{DP} \rrbracket^{s,g}, \llbracket \mathbf{VP} \rrbracket^{s,g[i \rightarrow f]}(f(\llbracket \mathbf{DP} \rrbracket^{s,g})))$$

– The distributivity operator universally quantifies over choice functions *which you can reuse in computing the meaning of VP*.

– We restrict the choice functions relative to the subject.

$$(29) \quad \mathbf{RelCF}(X_e) = \{f_{\langle e,e \rangle} : f \text{ is a choice function only defined for } X\}$$

– The assignment function is now allowed to return choice functions in addition to individuals.

- When interpreting pronouns, we can make use of such choice functions:

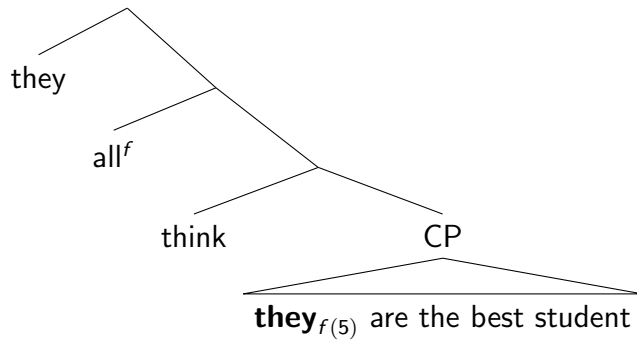
$$(30) \quad \llbracket \text{PRONOUN}_{i(n)} \rrbracket^{s,g} = g(i)(g(n))$$

– We have more structures in indices than before.

– **Assumption:** The phi-features of the pronoun target  $g(n)$ .

- Example:

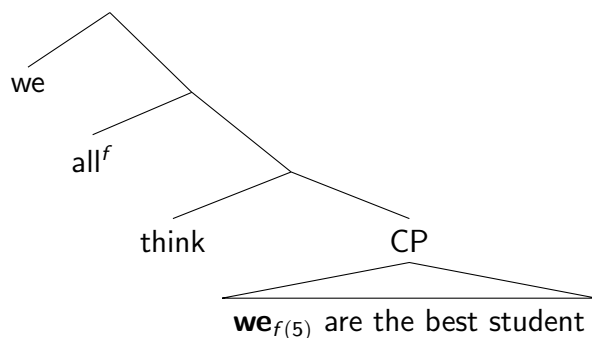
(31) They all think that **they** are the best student.



- All we need to make sure here is that  $g(5)$  is mapped to the same set of individuals as the denotation of 'they'.
- The pronoun is 3rd plural because  $g(5)$  denotes a plural individual that doesn't include the speaker or hearer.
- Notice that the two pronouns need not stand in a binding relation.

- We have no problem accounting for the effect of person features:

(32) We all think that **we** are the best student.



- In this case,  $g(5)$  should denote the same set of individuals as 'we'.
- So the pronoun should come out as 'we'.

### 3.2 Skolemized Choice Functions and Non-c-commanding Antecedents

- Recall:

(33) The people who voted for John and Bill thought that **they** would win the election.  
 a. The people who voted for John thought that John would win the election.  
 b. The people who voted for Bill thought that Bill would win the election.

- The denotation of 'they' depends on who the subject of 'think' is, and who that subject voted for.
- To account for this dependency, we make use of **Skolemized choice functions**:

(34) A function  $f$  of type  $\langle e, \langle e, e \rangle \rangle$  is a Skolemized choice function if  $|f(X, y)| = 1$  and  $f(X, y) \in X$ , for any  $X, y$ .

- More generally,

(35) A function  $f$  of type  $e^n (n > 0)$  is a Skolemized choice function if  $|f(X, y_1, \dots, y_{n-2})| = 1$  and  $f(X, y) \in X$ , for any  $X, y_1, \dots, y_{n-2}$ .

- (36) a.  $e^0 = e$   
 b.  $e^n = \langle e, e^{n-1} \rangle$

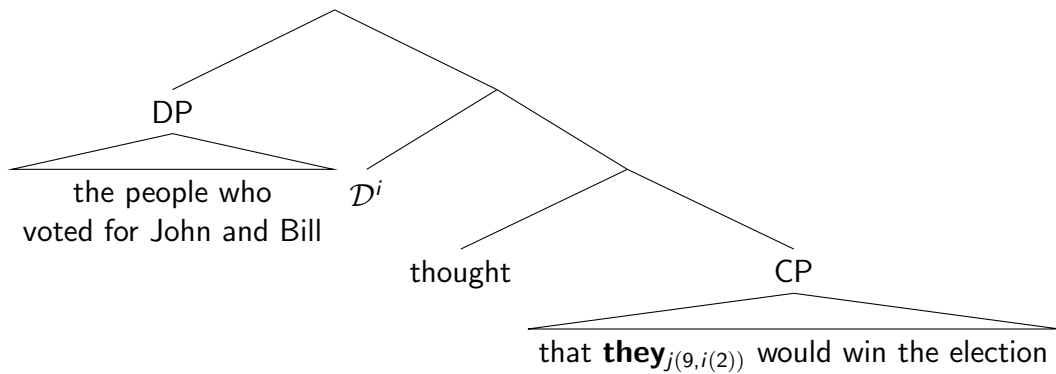
• Normal choice functions are a special case of Skolemized choice functions where the type is  $e^1 = \langle e, e \rangle$ .

• For (33), we want to refer to the following Skolemized choice function:

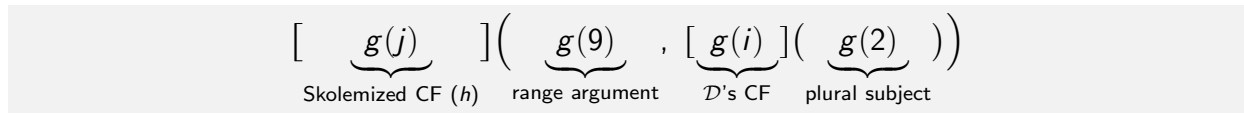
(37)  $h(\text{John and Bill})(x) = \text{the person among John and Bill that } x \text{ voted for}$

With this Skolemized choice function, we can analyze (33) as follows:

(38)



(39)  $[[\text{they}_{j(9,i(2))}]]^{s,g} = g(j)(g(9), g(i)(g(2)))$

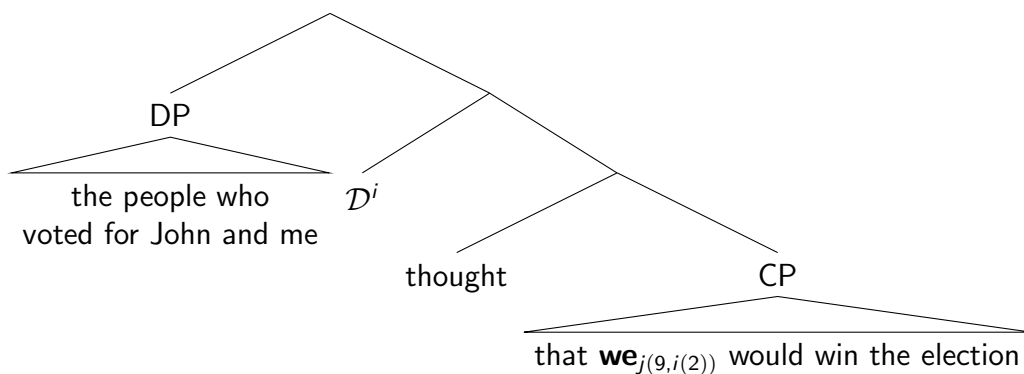


Under the intended reading,

- $g(j) = h$
- $g(9) = \text{John and Bill}$
- $g(2) = \text{the voters who voted for them.}$

- Recall the idea: the phi-features of these pronouns indicate the range of values that they take. The range is indicated by the first argument of the highest Skolemized choice function (i.e.  $h$ ).
- When  $g(9)$  includes the speaker, we'll get 'we'.

(40)



- To repeat, it is important that (complex) indices represent the functional structures in syntax. The phi-features apply to their 'range argument'.
- It's clear that not all phi-features on pronouns indicate the range of values that the pronouns take.

- (41) a. Each of the boys<sup>9</sup> thinks that **he**<sub>9</sub> is smart.  
 b. None of the boys<sup>9</sup> thinks that **he**<sub>9</sub> is smart.

But the bound pronouns here have a simple index 9. Assuming phi-features reflect the value of  $g(9)$ , it should be [3rd, sg, masculine].

- More precisely, we define the function **range**:

- (42) For any index  $i$ ,
- if  $i$  is simple, i.e.  $i$  is of the form  $n$ , then  $\mathbf{range}(i) = i$ ;
  - otherwise,  $\mathbf{range}(i) = \mathbf{range}(j)$  where  $j$  is the range argument (i.e. the first argument) of the topmost functional index of  $i$ .

– Phi-features reflect  $\mathbf{range}(i)$ .

– Recall that since we admit a structure in  $i$ , we can refer to the functional relation among the sub-indices in  $i$ .

- Notice that we successfully block singular pronouns:

- (43) a. The first-years all think that **he** is the smartest reading.  
 b. The people who voted for John and Bill thought **he** would win.

These sentences only have free/referential readings.

- We can also account for cases involving split antecedents:

- (44) These boys all<sup>f</sup> asked exactly one girl<sup>8</sup> if **they**<sub>{f(2),8}</sub> could dance.

In order to capture the phi-features of these cases, we need say that phi-features target the sum of the ranges of the indices:  $\bigcup_{i \in I} g(\mathbf{range}(i))$ .

In (45), the phi-features reflect  $g(2) \cup g(8)$ , which is not singleton and contains the speaker.

- (45) We all<sup>f</sup> asked exactly one girl<sup>8</sup> if **we**<sub>{f(2),8}</sub> could dance.

### 3.3 Unbound Dependent Plural Pronouns and Economy Condition

- If we can refer to choice functions freely, we overgenerate for free pronouns:

- (46) a. #**They** are the smartest student.  
 b. #**We** are the smartest student.

- In order to prevent this, we postulate the following economy condition:

- (47) *Economy Condition*

An index  $i$  with a choice-functional index is anti-licensed if a structurally simpler index can be used to derive the same meaning.

- Example:

- (48) a. #**They**<sub>i(5)}</sub> are the smartest student.

- b. He<sub>7</sub> is the smartest student.

The values of these indices are all contextually determined (unbound). If you can use  $i(5)$ , then you should know that 7 maps to the same individual.

## 4 Summary: State of the Art

---

- Two approaches to phi-features on pronouns:

### 1. Minimal Pronoun + Feature Transmission

- Needs to say something about feature mismatch cases: Grammatical vs. gender features, ‘Each of us’
- Split antecedents require conceptually unattractive spell-out rules (Heim 2008).

### 2. Semantic approach

- Needs to rule out person mismatch.

- (49) a. \*Only one student<sup>5</sup> likes her<sub>5</sub> mother.  
 b. \*Only I<sup>5</sup> like her<sub>5</sub> mother.

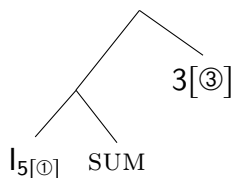
- A solution: person features are not presupposition triggers, but markings on indices.
- (Number features are not particularly problematic for semantic approaches)

- Plural 1st/2nd person pronouns

- Singular 1st person: I<sub>5[①]</sub>

- We want to make ‘we’ out of (49). Here’s an idea: ‘we’ is structurally more complex:

(50) We



(51)  $[[\text{SUM}]]^{s,g} = \lambda x. \lambda y : x \in y. y$

- ‘We’ has a 3rd person index that can be bound by quantifiers:

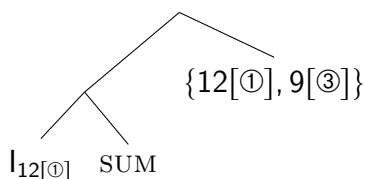
(52) Each of us has a right to control OUR own body.

The presupposition is as expected.

- We can account for split antecedents (with  $g(9[③])=Mary$ ):

(53) Only I<sup>12[①]</sup> asked Mary if **we** can dance.

(54)



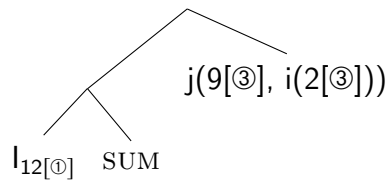
Recall the projection property of ‘only DP’: the presupposition of (54) is that  $g(12[①]) \cup g(9[③])$  contains the speaker.

- Need to say something about semantically singular ‘we’:

(55) The people who voted for John and me thought **we** would win.

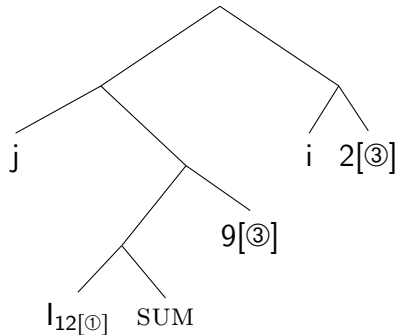
The following representation is wrong:

(56)



Need something like this:

(57)



And need to make sure that this gets spelled-out as 'we'. This runs into the same conceptual problem as Heim's account.

We want SUM to be meta-linguistic and operate on an index  $I$  itself:

(58)  $\llbracket \text{SUM} \rrbracket^{s,g} = \lambda x. \lambda I: x \in \bigcup_{i \in I} g(\text{range}(i)). \llbracket I \rrbracket^{s,g}$

This way, we can maintain the structure in (56)

- Further questions: Agreement markings on predicates.

- Do we want to analyze agreement in the same way as phi-features on pronouns?
- There are some differences: Predicative agreement is more rigid.

(59) a. Each of us **has** a right to control OUR own body.  
 b. %They **like** **themselves**. (singular 'they')

(60) *Greek*

- a. Mono to koritsi mas dhiakosmise to dhomatio **tu**.  
 only the.NEU girl.NEU our decorated the room its.NEU  
 'Only our girl decorated her room.'
- b. Mono to koritsi mas dhiakosmise to dhomatio **tis**.  
 only the.NEU girl.NEU our decorated the room her.FEM  
 'Only our girl decorated her room.' (adopted from Spathas 2010:225)

(61) *Greek*

- a. To koritsi ine **omorfo**.  
 the.NEU girl.NEU is pretty.NEU  
 'The girl is pretty.'
- b. \*To koritsi ine **omorfi**.  
 the.NEU girl.NEU is pretty.FEM

- But in some languages, you find similar mismatches (cf. Georg's papers)

- (62) *Bulgarian*
- a. Povecheto visoki zheni imame hubavi drehi.  
 most tall women have.1pl nice clothes  
 'Most tall women have nice clothes.'
- b. Nikoi visoki zheni njamame hubavi drehi.  
 no tall women not.have.1pl nice clothes  
 'No tall women have nice clothes.' (Schlenker 2006:520, fn.16)

- (63) *Brazilian Portuguese*
- a. a maiora de nós somos linguistas.  
 the most of us are.1pl linguists  
 'most of us are linguists.'
- b. ?cada um de nós somos linguistas.  
 each one of us are.1pl linguists  
 'Each of us is a linguist.' (Rafael Nonato, p.c.)

– Just as in the case of pronouns, 1sg agreement never allows mismatches.

- (64) *Bulgarian*
- a. točno tri visoki jeni imame hubavi drehi.  
 exactly three tall women have.1pl beautiful clothes  
 'Exactly three tall women (including the speaker) have beautiful clothes.'
- b. \*točno edna visoka jena imam hubavi drehi.  
 exactly one tall woman have.1sg beautiful clothes  
 'Exactly one tall woman (namely the speaker) has beautiful clothes.'  
 (Snejana Iovtcheva, p.c.)

- (65) *Bulgarian*
- a. visoki-te jeni imame hubavi drehi.  
 tall-the women have.1pl beautiful clothes  
 'The tall women (including the speaker) have beautiful clothes.'
- b. \*nai-visoka-ta jena imam hubavi drehi.  
 tallest-the woman have.1sg beautiful clothes  
 'The tallest woman (namely the speaker) has beautiful clothes.'  
 (Snejana Iovtcheva, p.c.)

- (66) *Brazilian Portuguese*
- a. ?Exatamente três linguistas somos felizes.  
 exactly three linguists are.1PL happy  
 'Exactly three linguists (including the speaker) are happy.'
- b. \*Exatamente um linguista sou feliz.  
 exactly one linguist am.1SG happy  
 'Exactly one linguist (namely the speaker) is happy.'

## References

---

Dimitriadis, Alexis. 2000. *Beyond Identity: Topics in Pronominal and Reciprocal Anaphora*: University of Pennsylvania Ph.D. dissertation.

- Heim, Irene. 2008. Features on bound pronouns. In Daniel Harbour, David Adger & Susana Bejar (eds.), *Phi Theory: Phi-Features Across Modules and Interfaces*, 35–56. Oxford University Press.
- Landman, Fred. 1989. Groups, I. *Linguistics and Philosophy* 12(5). 559–605.
- Schlenker, Philippe. 2006. Ontological symmetry in language: A brief manifesto. *Mind and Language* 21(4). 504–539.
- Spathas, Giorgos. 2010. *Focus on Anaphora*: Universiteit Utrecht Ph.D. dissertation.