Dependent Plural Pronouns with Skolemized Choice Functions[*]

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March 29, 2014

Abstract

Rullmann (2003, 2004) discusses two interesting phenomena concerning phi-features on plural pronouns: (i) plural pronouns that denote atomic individuals (*dependent plural pronouns*), and (ii) plural pronouns with more than one binder (*partial binding*; see also Heim 2008). In this paper I offer a novel account of these two phenomena, according to which all occurrences of phi-features are both semantically and morphologically relevant. For such a 'uniformly semantic account' of phi-features, dependent plural pronouns constitute a theoretical challenge, while partial binding is more or less straightforwardly accounted for. In order to make sense of the semantic effects of the phi-features on dependent plural pronouns, I pursue the following idea: the phi-features on a dependent plural pronoun reflect *the range of values that the pronoun takes*, rather than the particular value it denotes at a time. This idea is implemented in a compositional semantics by making use of (Skolemized) choice functions. An appealing feature of the present account is that unlike its predecessors it accounts for dependent plural pronouns without c-commanding antecedents (cf. Dimitriadis 2000) in essentially the same way as those with c-commanding antecedents. It is also shown how this account of dependent plural pronouns can straightforwardly be augmented with set indices to account for partial binding.

1 Introduction

Rullmann (2003, 2004) discusses two interesting phenomena concerning the phi-features on plural pronouns, which I call (i) *dependent plural pronouns* and (ii) *partial binding* (see also Heim 2008). Dependent plural pronouns occur in sentences like (1).

(1) a. The first-years all think that **they** are the smartest student.
     b. John and Bill both read a book by an author that **they** really like.

Under the most natural reading of (1a), for instance, the plural pronoun *they* in the embedded clause denotes an atomic individual, despite its plural morphology. Compare this to a simpler sentence like (2), which is infelicitous due to the conflict between the plurality inference of *they* and the meaning of the predicate.[1]

(2)   **#They** are the smartest student.

Similarly, the plural pronoun *they* in (1b) can be read as denoting an atomic individual. Thus the sentence does not necessarily imply that John and Bill like the same author.

Some researchers take dependent plural pronouns as evidence for semantically inert number features, and put forward an analysis along the lines of Kratzer's (1998a) 'minimal pronoun' approach (Sauerland 2003, Heim 2008, Kratzer 2009). The minimal pronoun approach would account for (1a) as follows: the plural feature of *they* is just a morphosyntactic reflex of the binding relation with the matrix subject *the first-years*, and is copied from this binder at the PF component. This is achieved by a PF operation called *Feature Transmission* that transmits the phi-features of a DP to all pronouns that it binds.[2] By assumption, the plural feature so transmitted is invisible to semantics, and hence the pronoun is semantically compatible with an atomic referent, which explains the felicity of (1a). By contrast, *they* in (2) does not have a binder, and thus its plural feature originates in the pronoun itself and requires the denotation to be plural, which causes a semantic clash with the predicate.

Rullmann (2003), on the other hand, pursues a semantic explanation of the same phenomenon, according to which all occurrences of the plural feature are semantically active.[3] Although I will not go into the details of his analysis in this paper, Rullmann (2004) points out that his analysis falls short of accounting for the interaction with person features. As Rullmann observes, dependent plurals can be first person, as shown in (3).[4]

(3)   a.   John and I both think that **we** are the richest linguist.
       b.   John and I both read a book by an author that **we** like.

The main problem for Rullmann's account is how to force the dependent pronouns in these exam-

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[1] English is confounded here, as for many speakers, *they* can be used to designate an atomic individual in sentences like (2), i.e. the so-called 'singular *they*'. Thus (2) is not strictly speaking infelicitous. Importantly for our purposes here, however, the contrast between (1a) and (2) obtains in languages that do not allow singular *they*, such as German and French. Also, there are several ways to exclude singular *they* readings in English. One is to use sentences where *they* refers to inanimate objects, as singular *they* is obligatorily animate. Another way to avoid singular *they* is to put the sentence in a context where the gender of the referent is known. For instance, (2) is infelicitous for all speakers when *they* is used deictically to refer to a particular person who is known to be female. For the sake of brevity, I will abstract away from these complications regarding singular *they* in the body of this paper, but it is recognized as a complication that needs to be controlled in assessing judgments.

[2] Kratzer (2009) claims that the relevant PF operation should be formulated as *Feature Sharing*, rather than an asymmetrical transmission operation, but this technicality is immaterial for the purposes of this paper.

[3] While advocating a minimal pronoun approach, Kratzer (2009) concludes that number features on bound pronouns are always interpreted in the manner suggested by Rullmann (2003), unlike other phi-features (person and gender features, in particular), which can be transmitted.

[4] I omit second person data entirely in this paper, as English second person pronouns do not have a number distinction in many dialects. In other languages like German and French, it can be observed that first and second person pronouns work in exactly the same manner, and the account proposed later in this paper is applicable to examples involving plural second person pronouns.

ples to be plural, rather than singular. On the other hand, the minimal pronoun account straightforwardly explains these sentences too: since the conjunctive subject *John and I* is specified as [plural, 1st], the dependent plural pronoun acquires the same set of features at PF and comes out as plural first person. Again, these features on pronouns are assumed to be semantically inert and do not restrict their possible referents.

The second phenomenon, partial binding, has the opposite nature: it *prima facie* favors a semantic account like Rullmann's over the minimal pronoun approach that makes use of Feature Transmission. The phenomenon is illustrated by the following sentence.

(4)   No student asked any professor if **they** can work together.

This sentence has a reading where the pronoun *they* is simultaneously bound by both of the quantifiers, *no student* and *any professor*. This phenomenon is standardly accounted for by a mechanism of multiple indexing (Rullmann 2003, 2004, Heim 2008, Kratzer 2009), and I will also assume it in this paper (see Section 5 for details). In (4), for instance, the pronoun *they* bears two indices, each of which is bound by a quantifier.

Notice importantly that the plural pronoun in (4) is bound by two *singular* quantifiers. If the pronoun needs to inherit the features of its binder or binders, as the minimal pronoun account contends, where does the plural feature come from? Heim (2008) gives a solution to this problem of the minimal pronoun account by allowing each index to carry phi-features and redefining Feature Transmission so that it targets each index, rather than the pronoun itself. Specifically, *they* in (4) has two indices, both with [singular] that is transmitted from the respective binders by Feature Transmission, but it is assumed that the morphology spells out a pronoun with multiple indices as a plural pronoun, no matter what the number features on the indices. As we will discuss in greater detail in Section 6, one characteristic of Heim's account is that it heavily relies on a set of purely morphological spell-out rules that determine the form of a pronoun based on the composition of the phi-features of its indices, e.g. 'if a pronoun has multiple indices, the pronoun needs to be plural regardless of the number features of the indices'. Heim herself remarks that these morphological rules seem to be redundant and lack an explanatory value, given the semantic naturalness of the phenomenon. On the other hand, partial binding is given a straightforward explanation in a semantic account like Rullmann's (2003): the denotation of *they* is a plurality consisting of two individuals, so the pronoun is plural.

Thus, these two phenomena seem to create a tension between the two approaches to phi-features on plural pronouns: Dependent plural pronouns seem to motivate a morphosyntactic operation like Feature Transmission and semantically inert phi-features, while partial binding seems to favor a semantic view of pronominal phi-features where all of occurrences are semantically active. The aim of this paper is to contribute to this debate by offering a novel 'semantic account' of the above two phenomena. It is a 'semantic account' of phi-features in the sense that all occurrences of phi-features on pronouns are semantically interpreted, just as in Rullmann's analysis and unlike in the minimal pronoun account.[5] As briefly explained above, the main puzzle for such an account

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[5]It should be noted that part of my proposal is morphosyntactic in nature, especially regarding the structure of indices. In this sense, my account is not purely 'semantic', as an anonymous reviewer rightly pointed out to me. Nonetheless, I would like to stress that my analysis makes it possible to semantically interpret all occurrences of phi-features on pronouns uniformly, and consequently to dispense with Feature Transmission, at least for the two phenomena under consideration (see also the discussion in Section 7).

is dependent plural pronouns. For this reason, I will first exclusively focus on dependent plural pronouns, and then extend the proposal to partial binding in the second half of the paper.

The main idea underlying my analysis of dependent plural pronouns is as follows: the phi-features on a dependent plural pronoun reflect the *range* of values the pronoun takes, rather than the particular value it denotes at a time. To illustrate, consider the first example we saw in (1a). There, the pronoun *they* denotes an atomic individual at a time, but varies across all the first-years. Consequently, the phi-feature is third person plural. On the other hand, for (3a), the pronoun varies across John and the speaker, and hence it comes out as first person plural. Thus, although the phi-features are seemingly in conflict with the individual referents of the pronouns (i.e. they denote atomic individuals but they are plural), they make sense with respect to the range of the values. It will be made clearer how exactly this works in a compositional semantics in Sections 2-4.

Before delving into the details, I would like to mention one piece of empirical support for this analysis. Dimitriadis (2000) observes that dependent plural pronouns do not require a c-commanding antecedent. Consider the following example, modeled after Dimitriadis'.

(5)   The people who voted for *John and Bill* thought that **they** would win.

This sentence can be read as meaning:[6]

(6)   a.   The people who voted for John thought that John would win, and
        b.   The people who voted for Bill thought that Bill would win.

Both the minimal pronoun account and Rullmann's (2003) semantic account assume that a dependent pronoun needs to be c-commanded by some antecedent that semantically binds it. However, this is not the case in (5). Thus, these previous analyses need to be supplemented with a separate mechanism to account for sentences like (5). Although I will leave it open how such a modification is achieved within these approaches, in my opinion, it would be undesirable to give separate explanations to dependent plural pronouns with c-commanding antecedents as in (1) and (3), on the one hand, and those without like (5), on the other. I agree with Dimitriadis in this respect, who suggests a uniform analysis of all dependents plural pronouns. However, I claim now that his analysis of (5) is unsatisfactory in that it fails to capture the effects of phi-features.

Dimitriadis (2000) proposes to account for (5) by assigning a complex denotation to the pronoun that involves a function of type $\langle e, e \rangle$ and a bound variable that acts as the argument of this function (see Cooper 1979, Engdahl 1986, Chierchia 1993 for related ideas). Informally put, his idea is that the plural pronoun *they* in (5) is interpreted as 'the person that *x* voted for', as depicted in (7) (where *D* is a distributivity operator).

(7)   The people who voted for John and Bill *D* λx thought
                                that **the person that *x* voted for** would win.
                                           'they'

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[6]It is important for the present argument that the relevant reading of (5) is not a cumulative reading. As Dimitriadis (2000:§3.3) discusses at length, (5) can mean something more specific than a mere cumulative reading that is equivalent to (i).

(i)   The people who voted for John and Bill thought that one of them would win.

For reasons of space, I will not reproduce his arguments here, which I think are convincing.

Although this analysis derives the desired truth-conditional meaning of the sentence, one crucial shortcoming is that it does not address the issue of phi-features on such functional pronouns. Firstly, it is unexplained why the pronoun in (7) is realized as a plural pronoun, rather than a singular pronoun. Given its atomic denotation, one might expect the pronoun to be able to be singular, at least as an option. However, when a singular pronoun is used, the sentence loses the dependent reading. Secondly, dependent plural pronouns in a structure like (5) can be first or second person, as demonstrated by the following sentence.

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

Just like (5), (8) has a reading paraphrased by (9).

(9)   a.   The people who voted for John thought that John would win, and
         b.   The people who voted for me thought that I would win.

According to Dimitriadis' account, *we* in (8) should be interpreted in exactly the same fashion as *they* in (5). That is, it denotes the person that x voted for, as illustrated in (10).

(10)   The people who voted for John and me $D \lambda x$ thought

that **the person that** x **voted for** would win.

'we'

Crucially, in order for the dependent reading to be possible, the pronoun needs to be plural first person. This is quite puzzling for Dimistriadis' analysis, because the structure of the pronoun is identical in the two cases. Thus, it does not explain why the pronoun in (8) must be pronounced as *we*, while that in (5) must be pronounced as *they*, under the dependent reading.

In this paper I pursue an account that is inspired by Dimistriadis' but is capable of explicating the effects of phi-features. As mentioned above, the idea to be pursued is that the phi-features of a dependent plural pronoun, with or without c-commanding antecedents, are determined by the range of values the pronoun takes. Concretely, in sentences like (1) and (5), it ranges over several individuals excluding the speaker or hearer, namely the first-years in (1), and John and Bill in (5). As a consequence, these pronoun are realized as plural third person. In (3) and (8), on the other hand, the pronouns range over John and the speaker, and as a result they are realized as plural first person. In order to implement this idea in a compositional fashion, I will make an extensive use of (Skolemized) choice functions.

This paper is structured as follows. In Section 2, I will spell-out my account of dependent plural pronouns that makes use of Skolemized choice functions, and illustrate how it accounts for the core set of data introduced above. In Section 3 I will address several empirical and conceptual concerns of the proposal. In Section 4 I will demonstrate in detail how the semantic effects of phi-features are captured in the present account. It will be emphasized that the present analysis makes it possible to semantically interpret all occurrences of phi-features on dependent plural pronouns, obviating the need for a purely morphological rule with no semantic import like Feature Transmission. In Section 5, I will discuss partial binding, and demonstrate that the proposal can readily be augmented with set indices, and the resulting theory successfully accounts for partial binding and its interaction with dependent plural pronouns. Section 6 compares the proposed analysis with its most empirically successful alternative in the current literature, Heim's (2008)

minimal pronoun approach. Section 7 contains conclusions and further issues.

2 Dependent Plural Pronouns and (Skolemized) Choice Functions

2.1 Dependent Plural Pronouns with C-Commanding Antecedents

As mentioned above, the key idea pursued here is that the phi-features of dependent plural pronouns reflect the range of values that they take in the sentence, rather than a single value with respect a particular assignment. Thus, the phi-features do not restrict the denotations of the dependent plural pronouns themselves, and they are allowed to denote an atomic individual as its value, as far as it ranges over two or more individuals. In order to make sense of this in a compositional semantics, it is necessary to represent at the local level where the pronoun is interpreted what values the pronoun ranges over, in addition to the particular value it denotes. To this end, I will pursue the following strategy: a dependent pronoun like the one in (1a), repeated below, refers to a choice function that picks out an atomic individual from a plurality, where the plurality represents the range of the atomic values.

(1a)   The first-years all think that **they** are the smartest student.

Specifically, I propose that the dependent plural pronoun *they* in this example denotes $f(\textbf{first.years})$, where f is a *choice function* that picks out a first-year from the plurality consisting of all the first-years. Choice functions are those functions that pick out an atomic member from a plurality (Kratzer 1998b, Reinhart 1997, Schlenker 2006, Winter 1997, 2002).[7]

Definition 1 (Choice Function) A function f of type $\langle e, e \rangle$ is a *choice function* if $f(X)$ is an atomic part of X for all X.

Assuming that *they* in (1a) denotes $f(\textbf{the.first.years})$, it is necessary to quantify over f in order to capture the intended reading where the value of *they* ranges over the first years, rather than being a particular first year. But which choice functions should f range over? Notice that in the intended reading of (1a), the subject of the (inherently distributive) predicate *think* and the value of *they* co-vary. That is, the reading we want to capture can be represented as follows.

(11)   For each first year x, x thinks that x is the smartest student.

I assume that a distributive reading with a plural subject is enabled by a *distributivity operator*, which can optionally be pronounced as 'floating quantifiers' like *all*, *both*, etc. (but see Schwarzschild 1994, 1996, Brisson 2003 for different analyses of floating quantifiers). What a distributivity operator does is to break down a plurality X into atomic individuals x and applies a (singular) predicate denoted by its sister to x. In the example in (1a), the distributivity operator *all* takes the plurality consisting of the first years, and applies the predicate *thinks that ...* to each of its atomic members.

Crucially, in order to capture the co-variation between the semantic subject of *thinks that ...* and the denotation of the pronoun as paraphrased in (11), we need to know the way in which the dis-

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[7]In this paper, I take choice functions to be functions from plural individuals to atomic individuals, i.e. of type $\langle e, e \rangle$, rather than functions from, sets of individuals to their members, but since the domain of plural individuals and the domain of sets of individuals are isomorphic (cf. Landman 1989, Van den Berg 1996, Schwarzschild 1996, Winter 2001), it is not hard to recast everything proposed here in terms of choice functions from sets to their members.

tributivity operator *all* breaks down the plurality denoted by *the first years* at the local point where *they* is interpreted. To this end, I propose that the distributivity operator universally quantifies over choice functions, and furthermore, I assume that such choice functions can be reused later on in the semantic interpretation of the components of VP. I enable this long-distance relationship by registering the choice functions in the assignment function. For technical reasons, indices are from now on augmented with type information, e.g. $6[e]$ denotes an individual, and $9[\langle e, e \rangle]$ denotes a choice function, etc. (cf. Heim & Kratzer 1998). The distributivity operator *all* is analyzed as follows (I assume the same denotation for its silent counterpart).[8]

(12) $[\![\text{all}_i \text{ VP}]\!]^g(X_e) = 1$ iff $\forall f_{\langle e,e \rangle} \in \text{RelCF}(X)[[\![\text{VP}]\!]^{g[i \mapsto f]}(f(X))]$

Here, $g[i \mapsto f]$ is the assignment function that differs from g at most in that $g(i) = f$. It is important that *all* bears an index i, which is used to memorize the value of the universally quantified variable f in the assignment function. In order to ensure that f will not be used to decompose other pluralities, I assume that f ranges over a particular kind of choice functions, namely the choice functions that are only defined for X. This set is denoted by $\text{RelCF}(X)$.

$\text{RelCF}(X) := \{f_{\langle e,e \rangle}: \ f(X)$ is an atomic part of X and $f(Y)$ is undefined for all $Y \neq X\}$

According to the meaning in (11), the universally quantified choice function variable f can be reused in interpreting the VP, i.e. it can be retrieved as $g(i)$. To illustrate this concretely, let us apply the analysis to (1a). I assume the following Logical Form for it.

(13)
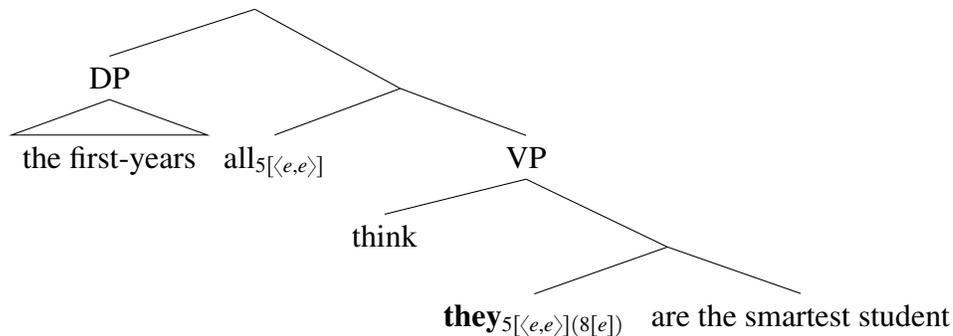
A crucial assumption here is that *they* can bear a complex index, e.g. $5[\langle e, e \rangle](8[e])$, which is assumed to be interpreted with respect to an assignment function g as $[g(5[\langle e, e \rangle])](g(8[e]))$. Thus, we admit a structure inside an index that specifies the function-argument structure of the choice function. This assumption is non-standard, and is an essential part of the analysis put forward here (see also Engdahl 1986, Chierchia 1993). Crucially the index $5[\langle e, e \rangle]$ is 'bound' by the distributivity operator. On the assumption that $g(8[e])$ denotes the plurality consisting of all the first years, we arrive at the desired interpretation for (1a):

(14)   For each $f \in \text{RelCF}(\textbf{the.first.years})$, $f(\textbf{the.first.years})$ thinks that $f(\textbf{the.first.years})$ is the smartest student.

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[8]Since it is a routine to incorporate non-atomic distributive readings by referring to 'covers' (Schwarzschild 1996), I will ignore such readings throughout this paper for the sake of simplicity.

Turning now to the question of how phi-features are interpreted, it is important to realize that the range of values that the pronoun takes in (14) is represented as the argument of the choice function, e.g. the first years in this particular example, and this is syntactically accessible as a part of the complex index, $8[e]$ in $5[\langle e, e \rangle](8[e])$. The core of the present analysis consists in the assumption that phi-features put semantic constraints on this value, rather than on the denotation of the complex index as a whole. In the above example, for instance, the number and person features demand that $g(8[e])$ must be plural and must not include the speaker or the hearer, which is met in this case. In the following we will refer to this part of the index, the *range argument* of the choice functional index, or simply the *range* of the index (see Section 4 for an explicit definition).

The present analysis of phi-features on dependent plural pronouns also accounts for sentences with first person dependent plural pronouns like (3a), reproduced here.

(3a)   John and I both think that **we** are the richest linguist.

I assume an LF structure that is isomorphic to (13). Assuming as before that the plural pronoun bears a complex index like $2[\langle e, e \rangle](6[e])$ such that $2[\langle e, e \rangle]$ is bound by the distributivity operator *both* and $6[e]$ denotes the plurality $j \oplus a_c$ consisting of John and the speaker, the desired reading is captured:

(15)   For each $f \in \text{RelCF}(j \oplus a_c)$, $f(j \oplus a_c)$ thinks that $f(j \oplus a_c)$ is the smartest student.

Furthermore, it is not hard to see why the relevant pronoun is *we*, rather than *they* or *I*. That is, the range of the index denotes $j \oplus a_c$, which consists of more than one individual and includes the speaker a_c, so the pronoun is first person plural. More precise discussion of the semantic function of phi-features is deferred until Section 4, but it should be stressed here that the phi-features of dependent plural pronouns make semantic sense with respect to the denotation of the range of their complex index.

Notice that in the present analysis, the portion of the complex index that denotes the argument of the choice function—$8[e]$ in (13)—does not have to be semantically bound by the matrix subject, although it could well be in the above example. As we will see now, this point is crucial in accounting for Dimitriadis' non-c-commanding cases like (5) mentioned in Section 1.

2.2   Dependent Plural Pronouns without C-Commanding Antecedents

The above account is now shown to be able to explain examples without c-commanding antecedents like (5).

(5)   The people who voted for *John and Bill* thought that **they** would win.

In this case the relevant pronoun ranges over John and Bill, so according to the idea pursued here, the pronoun should be realized as third person plural, a desired result. In order to make this idea work in a compositional manner, we will again make use of choice functions, but of a more complex kind. Notice first that as in cases involving c-commanding antecedents that we analyzed in the previous subsection, the denotation of *they* in (5) is dependent on the subject of *thought* in the manner represented in (16):

(16)   For each x of the people who voted for John and Bill,

$$\underbrace{x \text{ thought that } \textbf{the person that } x \textbf{ voted for}}_{\text{'they'}} \text{ would win.}$$

In deriving this reading of (5), I again postulate a distributivity operator, which is phonologically implicit in the present example. In addition, there is another dependency to be accounted for, i.e. dependency between x and the person that x voted for. To this end I will make use of 'Skolemized choice functions', defined as follows.

Definition 2 (Skolemized Choice Function) A function f of type e^n ($0 < n$) is a *Skolemized choice function* if $f(X, y_1, \ldots, y_{n-2})$ is an atomic part of X for any X and any $y_1, \ldots, y_{n-2}$.

To facilitate the exposition, I define a series of types e^n (for $n \in \mathbb{N}$) as (17).

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

A Skolemized choice function of type e^n (for $n > 0$) takes n individual arguments, and returns an atomic individual that is part of the first argument of the function. Normal choice functions as defined in the previous subsection are, then, a special case of Skolemized choice functions whose type is $e^1 = \langle e, e \rangle$.

Coming back to the example in (5), I analyze it with the following Skolemized choice function of type e^2:

(18) $h(X, y)$ = the person among X that y voted for

The first argument X of this function specifies the range of values that it returns, which is exactly the range of values that the pronoun in (5) denotes. The second argument y is used to capture the dependency between this pronoun and the semantic subject of *thought*, by making reference to a type-e^1 choice function introduced by the silent distributivity operator. Specifically, I assume the following LF structure for (5).

(19)
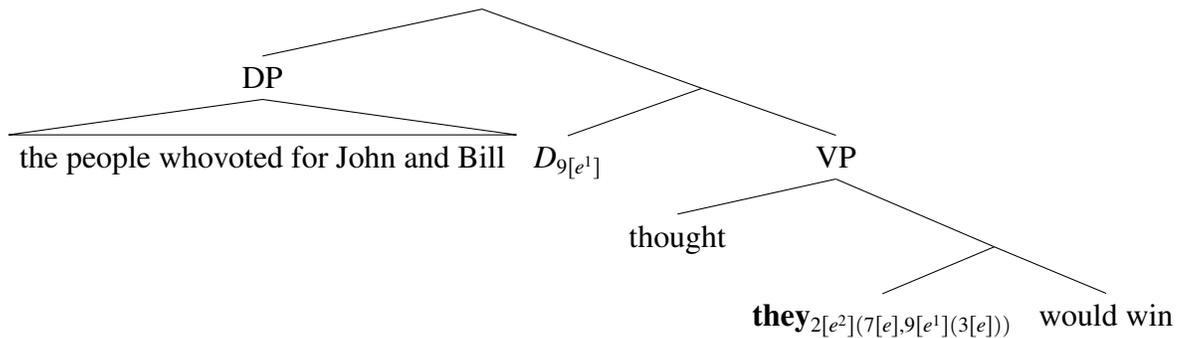
In order to derive the intended reading, I assign the following complex index to the plural pronoun *they*: $2[e^2](7[e], 9[e^1](3[e]))$. This index by assumption is interpreted with respect to g as follows (see Section 4 for details):

(20) $\Big[\underbrace{g(2[e^2])}_{\text{Skolemized CF}} \Big] \Big(\underbrace{g(7[e])}_{\text{range argument}} , \underbrace{[g(9[e^1])]}_{D\text{'s CF}} \big(\underbrace{g(3[e])}_{\text{plural subject}} \big) \Big)$

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The first component here $g(2[e^2])$ is assumed to denote the Skolemized choice function h of type e^2 such that $h(X, y)$ is the person among X that y voted for for any X and y. Its first argument, $g(7[e])$, determines the range of values that h returns. In this case, it is the plurality $j \oplus b$ consisting of John and Bill. The third component is the choice function that D quantifies over, i.e. the ways to pick out an atomic individual from the plural matrix subject *the people who voted for John and Bill*. Finally, $g(3[e])$ is simply the plurality denoted by the subject. Then, the resulting reading can be paraphrased as follows. I denote the plurality of the people who voted for John and Bill by A.

(21)   For each $f \in \text{RelCF}(A)$, $f(A)$ thought that $h(j \oplus b, f(A))$ would win.
         (i.e. for each atomic part a of A, a thought that the person among $j \oplus b$ that a voted for would win)

Notice that this analysis does not require any semantic binding relation, except that $9[e^1]$ be bound by D. Thus, the phrase *John and Bill* does not have to c-command the pronoun.

 Turning now to the phi-features of the pronoun, it is crucial that the range argument of the Skolemized choice function is syntactically represented in the structure in (19) by the index $7[e]$. According to the present analysis, the phi-features of the pronoun reflect the value of this index (this will be detailed in Seciton 4). Since its value is $j \oplus b$, the pronouns is plural third person.

 This analysis also explains the plural first person dependent pronoun in (8).

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

I assume an LF structure isomorphic to (20). The only difference from the previous example is that the range argument of the Skolemized choice function now denotes $j \oplus a_c$, instead of $j \oplus b$. As a consequence, the pronoun ranges over this plurality, which includes the current speaker a_c. Thus, the pronoun is pronounced as first person plural, as desired.

 This concludes the presentation of the novel account put forward in this paper. Especially, that it explains the phi-features on dependent plural pronouns without c-commanding antecedents is an empirical advantage over its predecessors. As mentioned in Section 1, the only existing account that I am aware of, namely Dimitriadis (2000), fails to explain the effect of phi-features on these pronouns. Furthermore, the present account achieves a unified analysis of dependent plural pronouns with and without c-commanding antecedents, unlike Heim's (2008) minimal pronoun approach and Rullmann's semantic account, which only deal with those with c-commanding antecedents. In the next section, we will address several conceptual and empirical issues that the present analysis gives rise to.

3   Tying Up the Loose Ends

The analysis of dependent plural pronouns proposed in the previous section makes heavy use of Skolemized choice functions and structurally complex indices. Having introduced this new machinery, we should carefully consider potential ramifications it might bring about, and in this section, I will discuss several such issues. The first problem concerns why dependent plural pronouns are plural and cannot be singular. Relevant to this problem are other functional readings of pronouns, especially 'paycheck pronouns' (Geach 1962, Karttunen 1969, Jacobson 2000, Elbourne 2005). Although paycheck pronouns are very similar in meaning to dependent plural pronouns,

they can be singular.[9] The second issue has to do with the distribution of complex indices with choice functional components. Especially, they need to be anti-licensed in matrix and other contexts where no dependency is available. To this end, I will postulate an economy condition. The third issue concerns how Skolemized choice functions of type e^2 in sentences like (5) are contextually picked out. In line with the analysis presented above, I argue that they must be contextually salient but need not have a linguistically expressed antecedent.

3.1 Why Dependent Plural Pronouns Are Plural

To reiterate the core idea underlying the current analysis, the phi-features on dependent plural pronouns reflect the range of values they take, rather than constraining the denotation of the entire pronoun. It is evident, however, that not all occurrences of pronouns have phi-features that reflect their value range. For instance, consider sentences like (22).

(22)   a.   Each of the boys thinks that **he** is rich.
        b.   None of the boys thinks that **he** is rich.

Under the bound pronoun interpretation, these pronouns do range over multiple individuals, but they are nonetheless singular.

I argue that these sentences pose no problem, since their bound pronoun interpretations can only be generated with a simple index of type e. Crucially, we cannot use a Skolemized choice function to generate the readings of (22) we are after, because with a singular quantifier like *each of the boys* and *none of the boys* that quantifies over atomic individuals, the matrix clause does not contain a distributivity operator, and hence nothing quantifies over choice functions. Assuming that when the index is of type e, the phi-features target its denotation (simply because there is nothing else to apply to; see Section 4 for details), it follows that the pronouns should be masculine singular third person in (22). Therefore we do not overgenerate for these sentences.[10]

Also, it is not hard to explain the fact that dependent plural pronouns with c-commanding antecedents need to be plural and cannot be singular. For instance, consider (23).

(23)   The boys all think that **he** is the smartest student.

The lack of a dependent reading for this example is explained as follows. Simply put, there is no adequate semantic binder for the singular pronoun *he* in this sentence. That is, *the boys* is a plural pronoun, and it is safe to assume that it cannot directly bind a singular pronoun for semantic

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[9]This issue is a general problem that any account of sentences like (5) needs to address. Dimitriadis (2000), who essentially analyzes dependent plural pronouns as paycheck pronouns, however, do not explain their difference in number.

[10]For the sake of completeness, we should also consider the possibility of using a singular pronoun of some other person than third person in (22), which also needs to be ruled out. If person features are presupposition triggers, they should give rise to inferences that all the boys are the speaker/hearer (cf. Heim 2008). Since this inference is bound to be false, this assumption is enough to rule out the possibility of using a non-third person pronoun in (22). Stokke (2010) and Sudo (2013) raise skepticisms against the presuppositional analysis of person features, but even if they are right about this, it is independently necessary to assume that third person quantifiers like *each of the boys* and *none of the boys* cannot bind non-third person pronouns. Thus, only third person pronouns can be used to derive the bound readings of (22).

reasons.[11] That is, the singular feature of the pronoun requires its denotation to be singular, which is impossible if it co-varies with a plural noun phrase like *the boys*. Also, given our assumption that the distributivity operator *all* quantifiers over choice functions, it cannot directly bind an index of type e. Thus, the singular pronoun must remain free.

However the singular variant of (5) given in (24) needs more discussion.

(24)   The people who voted for John and Bill thought that **he** would win.

Notice that (24) does not have the dependent reading that its plural counterpart in (5) has. This seems puzzling at first, especially given so-called 'paycheck pronouns' like the following:

(25)   John gave his paycheck to his mistress. Most other guys put **it** in the bank.

The pronoun *it* in (25a) can be construed as denoting the paycheck of each of the men who put their paychecks in the bank, rather than a particular paycheck. In this sense the pronoun is dependent on the plural quantifier *most other guys*, and this dependency is strikingly similar to the dependency involved in dependent plural pronouns. Yet, the pronoun in (25) is still singular, rather than plural. The questions that arise here are, how does this reading come about, and why is it that the pronoun in (25) is singular, while that in (5) needs to be plural?

A standard account of paycheck pronouns posits a functional component in their denotation (Cooper 1979, Engdahl 1986, Heim 1990, Heim & Kratzer 1998, Jacobson 2000, Elbourne 2005). For example, the meaning of the second sentence of (25) can be informally represented as follows.

(26)   Most other guys$_X$ D_h put $f(h(X))$ in the bank.   (where $f(x)$ is x's paycheck)

As before, we assume that the distributivity operator D quantifies over (restricted) choice functions h (although this is orthogonal to the analysis of the paycheck pronoun *per se*). The key assumption is that the pronoun also refers to another type e^1 function f, which takes an individual and returns his or her paycheck. Notice that this function is not a choice function, which will be crucial in distinguishing dependent plural pronouns and paycheck pronouns.

If such a representation is available for a pronoun, it becomes unclear why (24) does not have the dependent pronoun reading. That is, this reading should be available with the following functional reading of the pronoun:

(27)   [The people who voted for John and Bill] D_h thought that $f(h(X))$ would win.
        (where X is the people who voted for John and Bill, and $f(x)$ is the candidate that x voted for)

The denotations of the pronouns in (26) and (27) are completely parallel: it refers to a plurality X, a (restricted) choice function h bound by the distributivity operator and an additional functional component f. Given that the paycheck pronoun in (26) is realized as singular, the pronoun in (27) should come out as singular as well. However, this is not the case. Thus, as soon as a functional account of paycheck pronouns is adopted—which I believe is well justified—we will need an

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[11]However, the semantics of number features being a highly controversial issue (see Sauerland 2003, Spector 2007, Farkas & de Swart 2010 for competing views), I cannot do full justice to this assumption in this paper.

explanation for the lack of the dependent reading in (24).[12]

Elbourne (2005) provides an analysis of paycheck pronouns that is useful for our purposes here. He claims that paycheck pronouns are essentially disguised definite descriptions, and furthermore that they involve NP-ellipsis in syntax (cf. Heim 1990; see Cooper 1979, Jacobson 2000 for a different view). That is, paycheck pronouns are generated at the beginning of the derivation as *bona fide* definite descriptions, but their NP part gets elided in syntax, and consequently the morphophonological component of the grammar spells them out as pronouns.

What is crucial for our purposes is the uncontroversial assumption that NP-ellipsis requires a linguistic antecedent (but see Hankamer & Sag 1976 for some potential exceptions, and Jacobson 2000 for similar observations specifically for paycheck pronouns). This will make a difference between (24) and (25). According to Elbourne's analysis, the paycheck pronoun in (25) is a disguised definite description *their paycheck* with its NP *paycheck* (and part of the possessive pronoun) elided. This NP ellipsis is licensed by the antecedent *his paycheck* in the first sentence. On the other hand, for (24), there is no explicit antecedent of the form *the candidate they voted for* anywhere. Therefore, a paycheck pronoun is not available in this sentence.

As expected from this account, moreover, when an appropriate antecedent is available, a dependent reading becomes available in a sentence analogous to (24). Consider (28), for instance.

(28) The people who voted for the first male candidate on their ballot thought **he** would win.

Assume that different ballots have different orders of candidates (in order to efface the effect of order, as is often done), and that the relevant voters voted for different candidates. In this context *he* can have a reading that is dependent on the subject. This is expected under Elbourne's (2005) analysis of paycheck pronouns that we adopt here.[13] Specifically, *he* is analyzed as being derived from the definite description *the first male candidate on their ballot* from deleting its NP *first male candidate on their ballot*, in relation to the identical noun phrase in the relative clause.

It should be mentioned that for (28), the choice-functional strategy is not fully felicitous. Thus, if the singular pronoun is replaced with a plural pronoun, it loses the dependent reading we are after. In order to see this concretely, the singular *they* reading needs to be excluded. To this end, let us use an inanimate antecedent (cf. fn.1). Suppose that there was a voting to decide the best city in the world, in which people from many different countries participated.

(29) a. The people who voted for the capital of their home country all said that **it** is the most

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[12]If an identity map *id* such that $id(x) = x$ for all $x \in D_e$ is available, (23) will also wrongly be given a dependent reading, for the same reason.

[13](28) looks structurally similar to *donkey pronouns*, another type of functional reading of pronouns. Elbourne (2005) proposes to account for donkey pronouns and paycheck pronouns on a par, i.e. donkey pronouns are also disguised definite descriptions with elided NPs. However, it is not necessary for us to endorse his analysis of donkey pronouns, even if we adopt his analysis of paycheck pronouns. For reasons that will be explained below, I take the position that donkey pronouns involve straightforward dynamic binding with a simple index. Empirical support of this view comes from the fact that there is an interesting asymmetry between paycheck pronouns and donkey pronouns, as pointed out to me by Patrick D. Elliott (p.c.). That is, a donkey pronoun requires the antecedent to be in the same sentence, while a paycheck does not, as expected from our analysis, unlike in Elbourne's.

(i) a. These people voted for a French city. #They said that **it** is the most beautiful city in the world.
     b. These people voted for the capital of their home country. They said that **it** is the most beautiful city in the world.

beautiful city in the world.

    b. ??The people who voted for the capital of their home country all said that **they** are the most beautiful city in the world.

Just in the case of (28), the singular pronoun *it* can be read as dependent on the subject *the people who voted for the capital of their home country*. This is explained by analyzing *it* as a paycheck pronoun derived from *the capital of their home country*. On the other hand, the plural pronoun in (29b) does not readily admit a dependent reading. I argue that this reading of (29b) itself is not excluded by the grammar, but is harder to access for contextual reasons. That is, in order to derive it, one would have to use a Skolemized choice function, but its range argument is a free index denoting a plurality of capitals of different countries. In the given context, this plurality is not linguistically expressed (unlike in (5) where the relative clause contains a coreferential term *John and Bill*). Hence, its value needs to be inferred from the context, which I assume degrades the acceptability of the dependent reading, if not completely ungrammatical. More specifically, the degree of acceptability of (29b) under the dependent reading should be similar to that of a discourse like (30), under the reading where *they* refers to a plurality consisting of the relevant capitals.

(30)   ??These people voted for the capital of their home country. **They** turn out to be European cities.

    To sum up the discussion so far, the reasons why dependent plural pronouns are plural are two fold. For cases that involve c-command like (23), there is simply nothing that can bind the singular pronoun (for semantic reasons). For cases without c-command like (24), the singular pronoun would be a paycheck pronoun, but given the independently motivated constraints on paycheck pronouns that they require linguistic antecedents (Elbourne 2005), the pronoun simply cannot be construed as a paycheck pronoun in (24).

    Before moving on, the following sentence should also be discussed, which is provided by an anonymous reviewer.

(31)   The people who voted for **a man** thought that **he** would win.

That this sentence has a dependent reading with a singular pronoun, unlike (5), is not very surprising, given that in this configuration, an indefinite like *a man* can bind the pronoun in the main clause, a phenomenon known as *donkey binding*. The best discussed example of donkey binding is (32), where *a donkey* in the relative clause on the subject binds *it* in the main clause.

(32)   Every farmer who owns a donkey beats it.

I assume that the singular pronoun in (31) is donkey-bound in the same way as (32). This can be achieved by dynamicizing the underlying semantics, and nothing in the present analysis resists this modification. Since dynamicization is a routine and would also complicate the rest of the exposition, I would like to omit the dynamic version of the present account here. Yet, it is not hard to see that the dynamicization will also explain (33), which is provided by the same anonymous reviewer.

(33)   The people who voted for **John or Bill** thought that **he** would win.

This sentence also has a dependent reading, which can be analyzed in the same fashion using dynamic binding. That is, as is well known, a disjunctive phrase has the same quantificational properties as indefinites and so should be able to dynamically bind *he* in the main clause. On the other hand, when the conjunctive phrase *John and Bill* is used as in (5), the dynamic binding is simply unavailable due to its quantificational properties that are similar to those of universal quantifiers. It is known that universal quantifiers do not license donkey binding in this configuration, as demonstrated by the lack of a dependent reading of *it* in (34).

(34)   Every farmer who vaccinated every donkey beats it.

However, there is still an overgeneration problem lurking here: The current explanation does not yet exclude the use of a plural pronoun in these examples with indefinite antecedents. We observe that the following sentences do not admit dependent readings.[14] Again, in order to avoid the singular *they* readings, we use inanimate antecedents.

(35)   a.   The people who voted for a European city all said that **they** are the most beautiful city.
         b.   The people who voted for London or Paris all said that **they** are the most beautiful city.
         c.   The people who voted for one of the French cities all said that **they** are the most beautiful city.

This needs to be explained. To this end, I will introduce a general constraint on the distribution of choice-functional indices in the following subsection, which I argue is independently needed.

3.2   Economy Condition

If pronouns with (Skolemized) choice functions are available in matrix clauses, a sentence like (2), repeated here, should in principle be given a felicitous interpretation in an appropriate context, contrary to fact.

(2)   **#They** are the smartest student.

More specifically, if *they* in this sentence could have a complex index like $8[\langle e, e \rangle](3[e])$ and denote an atomic individual, there should be no reason why (35) cannot receive a coherent interpretation. Although the choice-functional index $8[\langle e, e \rangle]$ would not be bound by a distributivity operator in this structure, a given assignment function should be able to assign it a value in an appropriate context. In order to rule out sentences like (35), I postulate the following economy condition:

(36)   *Economy Condition on Complex Indices*
         An index with a choice-functional component is anti-licensed if a structurally simpler index can be used to derive the same reading.

For instance, in a simple sentence like (36), the choice-functional component of the complex index will be unbound, and hence the values of $8[\langle e, e \rangle]$ and $3[e]$ must be contextually determined. If so, it should also be able to contextually determine the value of $8[\langle e, e \rangle](3[e])$ as a whole, i.e. it

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[14]I thank an anonymous reviewer for directing my attention to these examples, and Ezra Keshet (p.c.) for reminding me that Heim (1990:168) discusses similar examples, although she does not give an analysis.

is possible to denote it using a simpler index like $15[e]$ such that $g(8[\langle e, e \rangle])(g(3[e])) = g(15[e])$. As a consequence, the complex index is prohibited.

More generally, a complex index involving a choice-functional index as part of it is licensed in contexts where at least one of its choice functional indices gets bound by a distributivity operator. Given that a distributivity operator always appears with a plural argument, which will act as the range argument of the choice function, it follows that dependent plural pronouns can only be found under a plural noun phrase.[15]

Now, coming back to the examples discussed at the end of the previous subsection, repeated in (37), I claim that the same economy condition prohibits the use of structurally complex indices, because in these sentences, structurally simple indices can be used instead to derive the same readings, with indefinite antecedents dynamically binding them.

(37)   a.   The people who voted for **a man** thought that **they** would win.
       b.   The people who voted for **John or Bill** thought that **they** would win.
       c.   The people who voted for **one of John and Bill** thought that **they** would win.

On the other hand, this dynamic binding is not a possibility in (5), and hence the use of the structurally complex index is licensed.

(5)   The people who voted for *John and Bill* thought that **they** would win.

So far so good, but there is one empirical shortcoming of the present analysis, which I would like to leave open here.[16] We have so far used Skolemized choice functions of type e^2 for sentences with non-c-commanding antecedents, but there is nothing that prevents them from appearing with a c-commanding antecedent. However, if this is allowed, the present analysis predicts a reading that does not exist.

Firstly, with the Skolemized choice function h that is an identity map with respect to the second argument, i.e. $h(X, y) = y$ for any $y \subseteq X$, the interpretation is indistinguishable from what we derive with a choice function of type e^1, so this is harmless. However, if $h(X, y) \neq y$, we run into a problem. Suppose that John and Bill are playing a card game with each other.

(38)   John and Bill thought that they had the ace of spades.

This sentence does not have a reciprocal reading that John thought that Bill had the ace of spades, and Bill thought that John had the ace of spades, but our analysis generates this reading with a

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[15]As pointed out to me by Ezra Keshet (p.c.), a very similar constraint seems to be necessary to regulate the distribution of paycheck pronouns. Suppose that John is married to Mary, and Bill is married to Sue.

(i)   a.   John kissed his wife, but no other man kissed her.
       b.   John kissed his wife, but Bill didn't kiss her.

The singular pronoun *her* in (ia) can be construed as a paycheck pronoun dependent on *no other man*. On the other hand, *her* in (ib) has to denote John's wife and cannot denote Bill's wife, showing that it cannot be a paycheck pronoun. One could take this as showing that the use of a paycheck pronoun is blocked in a context where a simple non-paycheck pronoun could be used to derive the same reading. In (ib), the paycheck interpretation is ruled out because the same could be achieved by a referential pronoun, although since Sue is not particularly contextually salient, it fails to refer to her, and must refer to the more salient female individual, Mary. On the other hand, the paycheck pronoun in (ia) is licensed because a referential pronoun would not yield the same reading.

[16]I thank an anonymous reviewer for raising this question.

Skolemized choice function h such that $h(X, y)$ is the person among X that y plays the game with. I do not have a solution to this important problem, but I suspect that it has to do with restrictions on reciprocal readings (cf. Dimitriadis 2000 and references therein). I would like to leave this problem open for future research.

3.3 Lack of Formal Link Condition

Lastly, let us address the issue of how the Skolemized choice function in (5) is contextually picked out. Recall that under our analysis of (5), there is a Skolemized choice function of type e^2, as illustrated by (21)

(21)   For each $f \in \mathrm{RelCF}(A)$, $f(A)$ thought that $h(j \oplus b, f(A))$ would win.
       I.e. for each atomic part a of A, a thought that the person among $j \oplus b$ that a voted for
       would win.

We simply assume that h is contextually recovered in some manner. Although it is beyond the scope of this paper to elucidate how exactly this is done, there is one concern that needs to be addressed, especially given that we adopt Elbourne's (2005) analysis of paycheck pronouns.

Elbourne's (2005) NP-deletion analysis is partly motivated by the so-called 'formal link condition' (cf. Heim 1982, 1990, Kadmon 1987, 2001). That is, such functional pronouns require a linguistic antecedent:

(39)   a.   John is sitting in front of his wife. Most other married men are sitting next to **her**.
       b.   (John and Mary are married) John is sitting next to Mary. Most other married men
            are sitting next to **her**.

In (39a) the pronoun *her* can be construed as dependent on the quantifier *Most other married men*, but not in (39b). Under Elbourne's (2005) analysis of paycheck pronouns, this contrast is expected. That is, in (39a), the deletion of the NP-part of *his wife* is licensed, turning this NP to *her*, due to the presence of an appropriate linguistic antecedent, while this deletion is not licensed in (39b). To put this differently, if one assumes that the functional part of the denotation of the pronoun in (39a) is determined just contextually (see Cooper 1979 for such an analysis, and see Jacobson 2000 for a similar analysis for paycheck pronouns), the contrast between these sentence will not be accounted for.

Notice that an analogous concern arises with our analysis of sentences like (5) that postulates free Skolemized choice-functional indices, assuming that the value of h is retrieved from the context, and need not be linguistically expressed. If this is correct, then a contrast like (39) should *not* arise for the Skolem choice functions of dependent plural pronouns. In order to test this prediction, consider the following examples.[17] A lead-in sentence is added here in order to introduce an appropriate antecedent for the range argument of the Skolemized choice function, which is also free (cf. the discussion in Section 3.1 above).

(40)   a.   The Ivy League is composed of eight universities. The undergraduates who study at
            these universities all think that they are the best university.
       b.   The Ivy League is composed of eight universities. The undergraduates there all think

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[17]I thank Philippe Schlenker (p.c.) for bringing this issue into my attention and for detailed discussion on it.

that they are the best university.

Both of these sentences do have dependent plural pronoun readings, and hence a contrast similar to (39) is not observed.[18] This observation suggests that unlike functional readings of paycheck pronouns, Skolemized choice functional pronouns do not require a linguistically expressed antecedent for their choice-functional component, which is in accordance with our analysis.

4 The Semantic Effects of Phi-Features on Pronouns

Let us now be clear about how the pronominal phi-features on dependent plural pronouns are interpreted. As repeatedly mentioned above, the main idea is that the phi-features of a pronoun reflect the range of values it takes. For dependent plural pronouns, the range is encoded in the first argument of the Skolemized choice function (unlike in Dimitriadis' 2000 analysis which uses non-choice-functional functions). Thus, in order to know which phi-features the pronoun should have, all one has to do is look at the range argument of the (topmost) Skolemized choice function. If the range argument is a plural individual, then the pronoun is realized as plural. If the plurality includes the current speaker, it will be realized as first person; if it doesn't contain the current speaker, but contains the hearer, it will be second person; and otherwise it will be third person.

   Here is a more explicit version of these rules. The keystone is to identify the part of a given index i that indicates the range of values it will take, which will be denoted by **range**(i). In order to state the rules in a form that is applicable to pronouns with simple indices, I will henceforth regard type e elements as Skolemized choice functions of type e^0 whose range arguments are the Skolemized choice functions themselves.

(41)   For any index i,
   a.   if i is simple (i.e. i is of the form $n[e]$ for some $n \in \mathbb{N}$), then **range**$(i) = i$;
   b.   otherwise, **range**$(i) = $ **range**(j) where j is the range argument (i.e. the first argument) of the topmost functional index of i.[19]

Recall that indices are assumed to be internally structured and they specify the function-argument structures of their choice-functional components. This assumption is necessary to define crucial notions such as the topmost functional index of i, and its first argument mentioned here.

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[18]According to one of the informants I consulted with, neither sentences have the dependent reading (and hence are infelicitous), but crucially none of them reported that (40a), but not (40b), allows the relevant reading.

[19]We have not seen a case that involves a second level of complexity that requires two applications of (41b), but such a case is not hard to construct, e.g.:

(i)   Several professors from different universities told me that the Ph.D. students supervised by the professors in their department all think that they are the nastiest advisor in the world.

The intended reading of the pronoun *they* is dependent on the subject of *told* and the subject of *think* in the following way:

(ii)   Each x of the professors told me that each y of the students that was supervised by x or x's colleagues thinks that **the professor among x and x's colleagues that supervised** y was the nastiest advisor in the world.

Here, the range part of the pronoun's index denotes the plurality consisting of all the professors and their colleagues, and as a consequence the pronoun is third person plural.

In order to determine the form of a given pronoun with an index i with respect to an arbitrary assignment function g, we apply the following rules to the value of **range**(i) (these rules will later be modified to incorporate partial binding in Section 5).

(42)   *Spell-Out Rules* (version 1 of 2)

   a.   Person Rules:

   - if $g(\textbf{range}(i))$ includes a_c, the pronoun must be first person,
   - if $g(\textbf{range}(i))$ does not include a_c but includes h_c, the pronoun must be second person;
   - otherwise, the pronoun must be third person

   b.   Number Rules:

   - if $g(\textbf{range}(i))$ is an atomic individual, the pronoun must be singular,
   - otherwise, the pronoun must be plural

It should be stressed that these are semantically natural rules that can be semantically derived from the meanings of phi-features, and hence are dispensable, once a proper semantics of phi-features is given. Although we will not be committed to a particular view of the semantics of phi-features in this paper, it is worthwhile demonstrating this more concretely, adopting one particular analysis. Let us tentatively assume that pronominal phi-features are presupposition triggers (Heim & Kratzer 1998, Heim 2008, Schlenker 2003, Sauerland 2003, 2008a; but see Stokke 2010, Sudo 2013 for criticisms). For expository purposes, we assume that pronouns have internal structures as illustrated by (43) for 'her' with index i:

(43)

$$
\left[\begin{array}{c} \text{singular} \\ \text{3rd} \\ \text{feminine} \end{array} \right] \quad i
$$
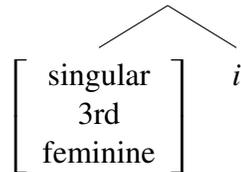
We can analyze the meanings of phi-features as partial functions from indices to their denotations. Disregarding the issue of semantically vacuous phi-features (see Percus 2006, Heim 2008, Sauerland 2003, 2008a, Spector 2007), the features in (43) can be given the following meanings.

(44)   a. $[\![\text{singular}]\!]^{c,g} = [\lambda i\colon\ g(\textbf{range}(i))\text{ is atomic. }g(i)]$
   b. $[\![\text{3rd}]\!]^{c,g} = [\lambda i\colon\ a_c\text{ and }h_c\text{ are not part of }g(\textbf{range}(i)).\ g(i)]$
   c. $[\![\text{feminine}]\!]^{c,g} = [\lambda i\colon\ \text{each member of }g(\textbf{range}(i))\text{ is feminine. }g(i)]$

Here, $g(i)$ is defined as follows:

(45)   For any index i

   a.   if i is simple, then $g(i) = g(i)$;
   b.   if $i = h(j_1, \ldots, j_n)$, $g(i) = g(h)(g(j_1), \ldots, g(j_n))$

We assume that feature bundles like [feminine, 3rd, singular] put a conjunctive restriction on i:

(46)   For any phi-features $\phi_1, \ldots, \phi_n$,
$$[\![\phi_1, \ldots, \phi_n]\!]^{c,g} = \lambda i : i \in \mathbf{dom}([\![\phi_1]\!]^{c,g}) \wedge \cdots \wedge i \in \mathbf{dom}([\![\phi_n]\!]^{c,g}).\, g(i)$$

Thus, for (43), the restriction is that $\mathbf{range}(i)$ denotes a female atomic individual distinct from the speaker or hearer, which is the desired result. Other phi-features can be analyzed in a similar manner.

It should be emphasized again that there is no need for us to assume the presuppositional analysis of phi-features. What is important is that given the semantic naturalness of the spell-out rules in (42), any analysis of phi-features could in principle be married with our analysis of dependent plural pronouns in order to make the spell-out rules theoretically unnecessary. This is an advantage over Heim's (2008) minimal pronoun approach, according to which such spell-out rules are indispensable. We will come back to this in Section 6.

5   Partial Binding

In this section, the analysis of dependent plural pronouns proposed above will be extended to account for partial binding and its interaction with dependent plural pronouns. As we will see, the structure of indices needs to be a bit more complex than we have been assuming, and consequently we will also need to modify the spell-out rules proposed in the previous section. However, necessary modifications are minimal, and the core of the analysis of dependent plural pronouns will stay intact.

As we already saw at the beginning of the paper, partial binding is a phenomenon where a single pronoun is bound by more than one quantifier, as illustrated by (4), repeated below.

(4)   No student asked any professor if **they** can work together.

This sentence has a reading paraphrased by (47).

(47)   No student x asked any professor y if $x \oplus y$ can work together.

As mentioned in Section 1, the fact that pronouns with partial binding are plural is not so hard to explain in a 'semantic approach' of phi-features like the current one where the effects of phi-features are (more or less) semantically transparent, unlike in the minimal pronoun approach. That is, partially bound pronouns like *they* in (4) are plural, because they denote a non-atomic individual. That said, when we consider more complex cases that involve partially dependent plurals and first and second persons, the spell-out rules will have to be non-trivially modified.

This section will proceeds as follows. In Section 5.1, I will introduce a way to account for basic cases like (4), i.e. set indices. This is a standard mechanism in dealing with partial binding, and this paper has nothing new to add to it. Section 5.2 will give an analysis of cases involving both dependent plural pronouns and partial binding. Then in Section 5.3, the spell-out rules will be modified to incorporate set indices.

5.1   Set Indices

The basic case of partial binding in (4) can be accounted for straightforwardly by allowing pronouns to bear sets of indices (Higginbotham 1983, Sportiche 1985, Rullmann 2003, Büring 2005, Heim 2008). The idea is that if a pronoun has two or more indices, its denotation will be the sum

of the values of these indices.

(48) $[\![\text{pronoun}_I]\!]^g = \bigoplus_{i \in I} g(i)$

For the sake of simplicity, I assume that non-set indices i are equivalent to singleton indices $\{i\}$. Thus, from now on all pronouns are assumed to have a set of indices, and everything stated before this section should be understood as about singleton indices.

Now, we can account for the intended reading of (4) with an LF structure like the following where the quantifiers have been QRed.

(49)
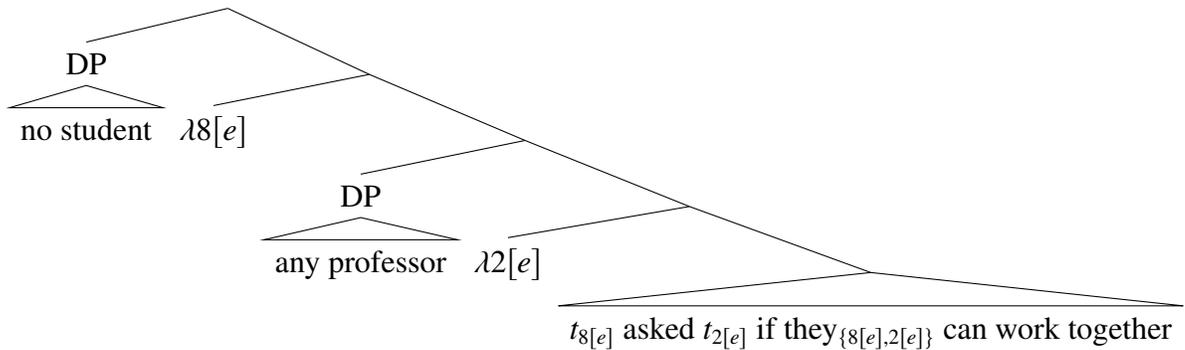
The denotation of *they* is $g(8[e]) \oplus g(2[e])$, and each of these components co-vary with either of the quantifiers, which captures the intended reading.

5.2   Dependent Plurality and Partial Binding

The following sentence has an additional complication.

(50)   The boys all told Mary that **they** will make a good couple.

This sentence can be read as (51).

(51)   Each boy x told m that $x \oplus m$ will make a good couple.

Notice that x here is a 'dependent plural' in the sense that it denotes a single boy at a time and its value co-varies with the subject of *told*. As this is essentially a combination of dependent plurality and partial binding, our theory is already equipped with enough machinery to deal with it. That is, what we need is a choice function that applies to one of the indices. More concretely, the reading in (51) is captured by the following LF.

(52)

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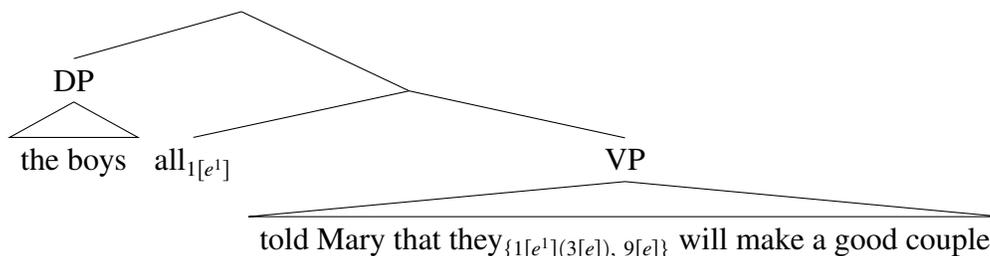
Suppose that $g(3[e])$ is the boys, and $g(9[e])$ is Mary. These indices do not have to be semantically bound in this structure (although they can well be). Crucially, $g(1[e^1])$ is bound by the distributivity operator *all*. As a result, we obtain the following reading, as desired.

(53)   For each $f \in \mathrm{RelCF}(\textbf{the.boys})$, $f(\textbf{the.boys})$ told m that $f(\textbf{the.boys}) \oplus m$ will make a good couple.

Furthermore, since *the boys* in (50) does not have to semantically bind the plural pronoun, it is predicted that it is possible to construct a dependent plural pronoun combined with partial binding in the configuration like Dimitriadis' example (5). Consider (54), for instance.

(54)   The professors who supervised these students told Mary that **they** should work together.

This sentence has a reading paraphrased in (55).

(55)   Each x of the professors who supervised these students told Mary that **the student that** x **supervised** and Mary should work together.

We can account for this reading with a Skolemized choice function h of type e^2 such that $h(X, y)$ is the student among X that y supervised. I assume the following LF structure.

(56)   the professors who supervised the students D_1 Mary that **they**$_{\{5[e^2](2[e],1[e^1](9[e])),3[e]\}}$ should work together.

The intended reading is captured by the following assignment function g (with respect to which the pronoun is interpreted): $g(5[e^2])$ is the Skolemized choice function h, $g(2[e])$ is the relevant students, $1[e^1]$ is the choice function that the distributivity operator binds, $g(9[e])$ is the professors, and $g(3[e])$ is Mary.

5.3   Person Features and Spell-Out Rules

We have just seen how our theory augmented with set indices accounts for simple cases of partial binding, and interactions between partial binding and dependent plural pronouns. Let us now consider the effects of phi-features.

As Rullmann (2004) discusses in detail, partial binding is possible with plural pronouns of other persons (see also Heim 2008). Let us first consider a case where a pronoun has a two-membered set index $\{i, j\}$ such that i is bound by a third person quantifier like *each of NP*, and j denotes the speaker. An example of such a case is given in (57).

(57)   Each of the students asked me if **we** can work together.

The intended reading is paraphrased by (58).

(58)   Each student x asked a_c if $x \oplus a_c$ can work together.

The LF structure necessary to derive this reading will be essentially the same as the one in (49) for (4). The question to consider is why the pronoun is first person plural in (57).

Recall the underlying idea of our analysis: the spell-out rules should be driven by semantic considerations, which is desirable given the semantic naturalness of the present phenomenon. Ac-

cording to this, the pronoun in (57) is plural because it functions as a variable ranging over pairs of individuals, rather than an atomic individual. Also it is first person because its denotation includes the current speaker. I will be more explicit about this immediately below.

Incidentally, it is not hard to construct a case that is similar to (57) but additionally involves a dependent plural component.

(59)   The boys all told me that **we** will make a good couple.

The intended reading is represented in (60).

(60)   Each x of the boys told a_c that $x \oplus a_c$ will make a good couple.

This reading is accounted for in parallel to (50) whose LF is given in (52) above. What is important now is the phi-features of the pronoun, but it poses no challenge for the present semantic account: it is plural since it denotes a pair of individuals, and is first person because its denotation includes a_c.

In the above two examples, the first person component is unbound. The situation becomes more complex when the first person component is part of the bound index whose value co-varies with some other phrase. Consider, for instance, (61) which involves a dependent plural.

(61)   John and I both told Mary that **we** will make a good couple.

The intended reading of this sentence is:

(62)   For each x of $j \oplus a_c$, x told m that $x \oplus m$ will make a good couple.

Again, this dependency is captured with an LF structure analogous to the one in (52). The reason why the pronoun is first person might at first sight seem less clear, since when $x = j$, $j \oplus m$ does not include a_c. However, notice that the range of values the pronoun takes in (61), namely $j \oplus m$ and $a_c \oplus m$, contains more than one individual and includes the speaker a_c. Thus, this example actually is not problematic for our analysis.

Let us now be more specific about the spell-out rules. As has just been suggested, the rule of thumb is that the form of the pronoun is determined by the spell-out rules in (42) applied to *the sum of the range arguments of the indices*, where the 'range argument' of an index is defined as before:

(41)   For any index i,
        a.   if i is simple, i.e. i is of the form $n[e]$ for some $n \in \mathbb{N}$, then **range**$(i) = i$;
        b.   otherwise, **range**$(i) = $ **range**(j) where j is the range argument (i.e. the first argument) of the topmost functional index of i.[20]

Since we are dealing with sets of indices rather than single indices, I will make the following modification: Instead of applying the rules to $g(\textbf{range}(i))$, we now apply them to, $\bigoplus_{i \in I} g(\textbf{range}(i))$ for a set I of indices (which can be a singleton). Thus, our spell-out rules now look as follows.

(63)   *Spell-Out Rules* (version 2 of 2)
        a.   Person Rules:

                •if $\bigoplus_{i \in I} g(\textbf{range}(i))$ includes a_c, the pronoun must be first person,

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> > •if $\bigoplus_{i\in I} g(\textbf{range}(i))$ does not include a_c but includes h_c, the pronoun must be second person;
>
> > •otherwise, the pronoun must be third person
>
> b.   Number Rules:
>
> > •if $\bigoplus_{i\in I} g(\textbf{range}(i))$ is an atomic individual, the pronoun must be singular,
>
> > •otherwise, the pronoun must be plural

By way of illustration, consider (61) again. The pronoun should have a two-membered set of indices, $I = \{i_1, i_2\}$, where i_1 is a 'dependent plural index' dependent on $j \oplus a_c$ and i_2 denotes m. Then $g(\textbf{range}(i_1)) = j \oplus a_c$ and $g(\textbf{range}(i_2)) = m$, and thus $\bigoplus_{i\in I} g(\textbf{range}(i)) = j \oplus a_c \oplus m$. Therefore, the pronoun should be first person plural. As the reader can easily varify, the forms of the pronouns in other examples discussed in this section are accounted for by the same rules given here.

It should again be stressed at this point that the spell-out rules in (63) become redundant and can be completely dispensed with, once an adequate semantic analysis of phi-features is assumed, as concretely shown in Section 4. For instance, the presuppositional analysis presented there can be minimally modified to accommodate set indices by referencing $\bigoplus_{i\in I} g(\textbf{range}(i))$, instead of $g(\textbf{range}(i))$, in the presuppositions of phi-features.

6   Comparison with Heim's Minimal Pronoun Account

Let us now summarize the important assumptions made by our theory of phi-features on plural pronouns:

- Each pronoun has a set of indices.

- Atomic indices may have function-argument structures.

- Phi-features put semantic constraints on the 'range' argument of the topmost Skolemized choice function.

As mentioned in the previous section, the first point is standardly assumed by probably all accounts of partial binding. The second assumption is a crucial part of our analysis of dependent plural pronouns, and together with the third assumption, it accounts for the effects of phi-features, as demonstrated above. The purpose of this section is to compare this theory with the most successful of its alternatives, namely Heim's (2008) minimal pronoun account.

Being a minimal pronoun account, Heim (2008) posits the following morphosyntactic operation that applies at PF.

(64)   *Feature Transmission under Semantic Binding* (version 1 of 2)
        When a DP semantically bounds a pronoun, DP's phi-features are obligatorily transmitted to the pronoun at PF.

As discussed in Section 1, dependent plural pronouns with c-commanding antecedents are easy to account for with this rule. For example, take (1a) repeated below.

(1a)   The first-years all think that **they** are the smartest student.

Assuming that the subject *the first-years* semantically binds *they*, the latter acquires [plural, 3rd] at PF and is pronounced as such. To be more precise about the distributive meaning, Heim assumes a structure where a trace of the subject and the distributivity operator *all* form a constituent, which binds the pronoun. This complex DP [[the first-years] all] is assumed to have the same phi-features as *the first-years*, which get transmitted onto the pronoun by Feature Transmission.

The innovative aspect of Heim's minimal pronoun theory consists in her analysis of partial binding. In order to account for the multiple binding, she assumes set indices. Again, as mentioned in Section 1, the main problem to account for is the fact that the pronoun comes out as plural, even if its binders have [singular], as in (4), repeated here:

(4)   No student asked any professor if **they** can work together

In order to explain this, Heim proposes that phi-features that Feature Transmission targets reside on the indices rather than on the pronoun as a whole. Accordingly, the definition of Feature Transmission is modified as follows.

(65)   *Feature Transmission under Semantic Binding* (version 2 of 2)
         When a DP semantically bounds an **index**, DP's phi-features are obligatorily transmitted to the **index** at PF.

In (4), for instance, the pronoun is assumed to bear a set of indices $\{i, j\}$. Each of these indices is bound by a quantifier, so both of them acquire [3rd, singular]. Now Heim postulates a spell-out rule that demands that when a pronoun has a set index of the form $\{i, j\}$, the pronoun take a plural form, no matter which number features i and j have, and a third person form when both of i and j have [3rd].[21] This accounts for the form of the pronoun in (4). Similarly, cases involving [1st] like (66) can be analyzed with a spell-out rule:

(57)   Each of the students asked me if **we** can work together.

The pronoun *we* bears a set of indices $\{i, j\}$, where i is partially bound by the singular third person quantifier *each of the students* and j denotes the speaker. Because the index i is bound, i inherits [singular, 3rd] from its binder. Assuming that j denotes the speaker by virtue of having [1st] (which could be transmitted from *me* when it is bound, but also can originate in this index), Heim postulates a spell-out rule requiring the pronoun to be first person, when either one of the indices in $\{i, j\}$ has [1st]. In (66) is the full set of spell-out rules that Heim proposes for person features.

(66)   A pronoun with a set index I is

         a.   a first person pronoun, if some $i \in I$ is first person;
         b.   a second person pronoun, if no $i \in I$ is first person and some $i \in I$ is second person;
         c.   a third person pronoun, otherwise.

---

[21]Heim actually suggests two ways of accounting for number features, one of which is semantic. The non-semantic way is by a spell-out rule that demands the pronoun to be plural when its index has more than one member. The semantic way is that the number features simply restrict the denotations of pronouns (rather than those of indices). She remarks that the latter option is more appealing but it would be more attractive to be able to do similar analyses for all features, not just for person features (cf. Kratzer's 2009 treatment of number features). This relates to the unattractive feature of her account discussed below.

Crucially, Heim's account is a 'non-semantic' account of pronominal phi-features in the sense that some occurrences of phi-features have no semantic import on the denotation of the pronoun. Rather, they are copied from the binder(s) at PF and only feed purely morphological spell-out rules like (66). For this reason, these spell-out rules are indispensable for Heim, unlike our spell-out rules that follow from the semantics of phi-features. As the end of her paper, Heim herself remarks that this is an unsatisfactory feature of her account, as it fails to capture the semantic naturalness of the spell-out rules:

> The main message, however, is that we cannot be satisfied with this story. The burden that we have ended up putting on the PF derivation is very likely misdescribed or misplaced. The operation we had to posit in the end for the person features in split-bound pronouns was especially impalatable. But it may well be said that this only vindicates the suspicions that some have already had about the Feature Transmission rule, a PF operation which relies on a syntactic definition of semantic binding. It would certainly be desirable if we could preserve the more natural ideas in the present package (the semantics of features, the existence of underspecified pronouns at LF) and explain away the apparent need for feature-copying operations in the syntax or morphology, unless these can be reduced to independently known syntactic and morphological mechanisms. (Heim 2008:55)

Another undesirable feature of Heim's account is that it cannot be easily extended to plural dependent pronouns without c-commanding antecedents like (5), where the plural DP that the pronoun is dependent on is in a structural configuration where semantic binding cannot be established. Her account, therefore, needs a separate explanation for sentences like (5) and for sentences like (1). In my opinion, however, it is undesirable to give separate explanations to these two cases. Rather, it seems to me that whatever accounts for the former more complex cases should be able to account for the latter simpler cases.

The account put forward in this paper is an attempt to make all the phi-features semantically relevant, obviating the need for Feature Transmission (as far as dependent plural pronouns and partial binding are concerned; see the discussion in the next section), while placing the main theoretical burden on syntax and semantics. Specifically, the crucial non-standard assumptions include the structurally complex indices that refer to Skolemized choice functions, and the way phi-features refer to the range arguments of such complex indices. As demonstrated by the preceding sections, our analysis achieves a unified account of dependent plural pronouns with and without c-commanding antecedents, so the empirical coverage of the present theory is broader than its predecessors including Heim (2008). In addition, it allows for a semantically natural account of partial binding that makes no recourse to purely morphological spell-out rules like Heim's. Rather, the spell-out rules we have postulated are semantically very natural, and as demonstrated in Section 4, when augmented with a semantics of pronominal phi-features, e.g. the presuppositional analysis (Heim & Kratzer 1998, Heim 2008, Sauerland 2003, 2008a, Schlenker 2003), the spell-out rules become comnpletely redundant and can be totally dispensed with.

7   Conclusions and Further Prospects

To summarize, I proposed a new account of dependent plural pronouns that makes an extensive use of Skolemized choice functions. I argued that it is more appealing than its predecessors in that it

accounts for the effects of phi-features including person features in sentences where the antecedent does not c-command the dependent plural pronoun (Dimitriadis 2000). I also demonstrated that the resulting account can be extended to cover partial binding and its interaction with dependent plural pronouns by incorporating set indices. One crucial aspect of my proposal is that all occurrences of phi-features are semantically interpreted, and in this sense, the proposed analysis is semantic, as opposed to a morphosyntactic account like Heim's (2008) minimal pronoun account, and it has several conceptual advantages, as claimed in the previous section.

One such conceptual advantage of our accountis that it dispenses with minimal pronouns and the mechanism of Feature Transmission, which opens up the possibility that all occurrences of phi-features on plural pronouns are semantically relevant. This is a welcome result, as it leads to a purely semantic explanation of pronominal phi-features that reconciles the semantic naturalness of partial binding and the seemingly puzzling phi-features of dependent plural pronouns.

To be fair, it should be mentioned that the minimal pronoun account is also intended to account for other occurrences of seemingly semantically inert phi-features, such as the first person features of the following sentences.

(67)   a.   Only I did **my** homework.
       b.   I am the only person who did **my** homework.

Although I need to leave detailed discussion of such sentences in this paper, I would like to mention that recent studies such as Cable (2005), Spathas (2010), Jacobson (2012), Sauerland (2013) and Sudo (2012) demonstrate that these sentences are amenable to alternative accounts that do not postulate minimal pronouns and Feature Transmission (see also Maier 2009). Together with the consequences of the present paper, therefore, these theories might provide us with a different, semantically more transparent way of looking at the semantics of phi-features than the minimal pronoun analysis.

Before closing the paper, I would like to mention three relevant open issues. Firstly, one conceptual drawback of the present account is the postulation of a mechanism that is more complex than standardly assumed, namely structurally complex indices with a function-argument structure. This move goes directly against the idea entertained by many syntacticians today that indices are theoretical artifacts that should ultimately be eliminated from the theory (e.g. Chomsky 1995). Although I agree with their conceptual concerns, I do not see at this moment how to account for various interpretive effects of semantic binding, completely without indices (but see Sauerland 2008b for a possibility). For this reason, I leave this issue for future research.

Another open issue has to do with the recent attempts to analyze all occurrences of pronouns as disguised definite descriptions (Elbourne 2005, Schlenker 2005). According to them, all pronouns are in fact definite descriptions with a 'minimal' restrictor, i.e. their NP-part is reduced and only the definite article (with the phi-features) is pronounced. However, with respect to dependent plural pronouns, it is not clear whether such a move is on the right track, as pronouns and definite descriptions seem to behave differently, as Dimitriadis (2000) points out. Consider the following examples (modeled after Dimitriadis' 2000:91).

(68)   a.   The people who voted for John and Bill all told the reporters that **they** would win the election.
       b.   #The people who voted for John and Bill all told the reporters that **John and Bill** would win the election.

    c. ??The people who voted for John and Bill all told the reporters that **these candidates** would win the election.

    d. ?The people who voted for John and Bill all told the reporters that **the former governors** would win the election.

Among these sentences, (68a) clearly has a dependent plural reading, and (68b) with proper names does not. Furthermore, it appears that (68c) with a demonstrative NP also does not readily permit a dependent plural reading, but its status seems to fall between (68a) and (68b). With a definite description as in (68d), furthermore, the sentence appears to become more felicitous, but not as felicitous as (68a). To complicate the picture further, it seems that certain definite descriptions such as epithets more readily allow dependent plural readings, as demonstrated by (69).

(69)   The people who voted for John and Bill each thought that **these idiots** would win the election.

Since the empirical status of sentences like (68c) and (68d) are not so clear at this moment, I will leave this discussion for another occasion.

    A third issue is about phi-features on other exponents. Recall that according to my analysis, phi-features target a specific part of a pronoun's index, namely the range argument of the index. This leads naturally to the question of how phi-features on other items, especially nouns and adjectives, are interpreted.[22] Nouns and adjectives presumably do not have indices that are interpreted in the same way as indices of pronouns. As the claim of the present paper is exclusively about how pronominal phi-features are interpreted at the syntax-semantics interface, and it has nothing insightful to offer regarding the semantics of phi-features *per se*, this question needs to be left open here. Needless to say, however, a uniform analysis of phi-features is desirable, and it is ultimately expected that the present analysis becomes part of a more comprehensive theory of phi-features.

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[22]I am indebted to an anonymous reviewer for raising this question and for their insightful suggestions.

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