1 Introduction

When a quantifier or a phrase containing a quantifier c-commands a pronoun that agrees with it in person, gender and number, it can bind that pronoun, as illustrated in (1).

(1) a. Every boy loves his mother.
    b. Every boy’s mother loves his father.
    c. Most boys love {their / *his} mother.

Typically, plural quantifiers can only bind plural pronouns as shown in (1c).

Contrary to this standard generalization, we have found that in examples like the following, a bound variable interpretation for a singular pronoun is surprisingly

\[1\]

While singular quantifiers standardly bind singular pronouns, they can also bind plural pronouns, especially in colloquial English. Here is a relevant example from Rullmann (2003), who attributes it to Sarah Cummins (p.c.):

(i) Someone left their jockstrap in the locker room.

This kind of binding is best when the gender of the binder is unknown or purposely left unspecified, or when the antecedent ranges over mixed genders, as seen below:

(ii) a. ?Some guy left their jockstrap in the locker room.
    b. ?Every boy loves their mother.
    c. ?John left their jockstrap in the locker room.
    d. Each of John and Mary left their uniform in their locker.
    e. Every child loves their mother.

We will not address this issue in the present paper.
possible with a plural quantifier.\textsuperscript{2,3}

\begin{enumerate}
\item a. His acne bothers most school boys.
\item b. Mary introduced his new teacher to most students.
\item c. His mother most boys love.
\item d. His parents are ashamed of few people who succeed in life.
\item e. Few people who succeed in life are his parents ashamed of.
\item f. The sentence “He loves his mother” is true of most boys.
\item g. Which of his relatives do most men love the most?
\item h. It’s his mother that most men love the most.
\end{enumerate}

The aim of this paper is twofold. First, we will address the question of under what circumstances a singular pronoun may be bound by a plural quantifier. To answer this question, we will examine various licensing constructions in section 2. Second, we will outline a semantics of number interpretation that allows for the kind of binding exemplified in (2). Rullmann (2003) argues that while singular pronouns range only over singular entities, plural pronouns can range over plural entities. Since singular pronouns are bound by plural quantifiers in (2), one may naturally wonder whether the bound pronouns in such examples are semantically singular or plural. In section 3, we will show that such pronouns are unambiguously semantically singular, corroborating Rullmann’s thesis. However, this makes it necessary to develop a theory that allows plural quantifiers like most boys to bind semantically singular pronouns as well as semantically plural ones. To achieve this, in section 4, we propose to modify Winter’s (2001, 2002) and Rullman’s (2003) theories, where singular and plural entities are distinguished as individuals and sets of individuals, by analyzing singular entities as singleton sets of individuals rather than individuals themselves. Finally, section 5 concludes the paper.

\textsuperscript{2}Here and throughout, unless otherwise specified, the judgments given are for a bound variable interpretation of the pronouns.

\textsuperscript{3}It should be noted that the phenomenon examined in this paper is not uniformly accepted by all native speakers of English. In particular we have encountered British speakers who uniformly reject all of the cases of binding of a singular pronoun by a plural quantifier. Since British and American English exhibit other differences in number agreement this is perhaps not too surprising, though we make no attempt in this paper to relate number (non-)agreement in the binding cases considered here to the different agreement patterns between subjects and predicates in the two dialects.
2 Licensing Constructions

In this section we go through a systematic examination of data involving singular and plural quantifiers combined with singular and plural pronouns. We divide the data into two parts. The first part consists of what we take to be the core data, where a single difference separates occurrences of he that cannot be bound by a plural quantifier from those that can be. These data conform to the following generalization:

(3) Generalization 1: Whenever a singular quantifier with a determiner such as every can bind an occurrence of a singular pronoun to its left, so can a plural quantifier with a determiner such as most.

The second part consists of extensions of various sorts that do not directly fall under Generalization 1, but which can for the most part be related to sentences that do fall under this generalization.

2.1 Core Data

2.1.1 Psych Predicates

As discussed in Belletti and Rizzi (1988), psych predicates allow for a reversal in typical binding relations. For a standard agentive predicate, it is possible for an antecedent in the subject to bind a pronoun in the object, but the reverse is not possible:

(4) a. Every boy’s mother scolded him.
   b. *His mother scolded every boy.

For a psych predicate, in contrast, binding is possible in both directions:

(5) a. Every boy’s acne bothered him.
   b. His acne bothered every boy.

While these examples use singular quantifiers, the same pattern holds with plural quantifiers with determiners such as most, all, no, many, ten and few binding morphologically plural pronouns:

4Even with psych predicates, the bound pronoun cannot be the subject itself, presumably due to strong crossover:

*{He / Himself} bothered every boy.
With plural quantifiers binding singular pronouns, however, the range of acceptable examples is much more limited: of the four types of examples examined in (6) and (7), only the type in (7b) allows the binding in question, as seen in (8) and (9) below:⁵

(8)  
   a. *Most children’s mother(s) scolded him.
   b. *His mother(s) scolded most children.

(9)  
   b. His acne bothered most children.

These data conform to Generalization 1: the singular pronoun can only be bound by the plural quantifier in the one case in which the pronoun precedes the quantifier and is in a position where it could be bound by a singular quantifier, namely (9b).

2.1.2 Three-Argument Verbs

In this section we show that Generalization 1 captures the behavior of pronouns and quantifiers occurring in internal argument positions of verbs taking multiple internal arguments. While there is some variation in the overall acceptability of binding in these cases, the general pattern holds throughout: a singular pronoun cannot be bound by a plural quantifier that precedes it, but it can be bound by one that follows it provided that it can be bound by a singular quantifier occupying that same position.

For a predicate like *introduce* that takes one accusative and one dative internal argument, it is possible for a quantifier in either argument to bind a pronoun in the other, as in the (a) through (d) examples below.

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⁵Here and for the rest of the paper we will use the quantifier *most* to illustrate binding possibilities. In all cases, however, the behavior illustrated carries over to the other plural quantifiers found in (6) and (7).
(10) **DO + IO**
 a. Mary introduced every student to his new teacher.
 b. Mary introduced his new teacher to every student.
 c. Mary introduced most students to {their / *his} new teacher.
 d. Mary introduced {their / his} new teacher to most students.

As seen in (c) and (d), binding of a singular pronoun by a plural quantifier is only possible when the pronoun precedes the quantifier. This same pattern of binding is seen when the two arguments are reversed, as occurs with heavy NP shift.

(11) **IO + DO**
 a. Mary introduced to every student his new teacher.
 b. Mary introduced to his new teacher every student.
 c. Mary introduced to most students {their / *his} new teacher.
 d. Mary introduced to {their / his} new teacher most students.

As with all examples of heavy NP shift, these improve in acceptability when the shifted NP is heavier, as in the following examples.

(12) **Heavy NP shift**
 a. Mary introduced to {their / his} new teacher most boys who were found wandering the halls looking lost on the first day of classes.
 b. Mary introduced to most students problems she thought would be difficult for {them / *him}.

However, even with this improvement the binding possibilities for the pronouns do not change.

Like the verb *introduce*, the verb *send* takes one accusative and one dative argument in its basic configuration, and the binding behavior is the same as with *introduce*.

(13) **DO + IO**
 a. Mary sent every lost notebook to the person it belongs to.
 b. Mary sent his report card to every student.
 c. Mary sent most lost notebooks to the person {they / *it} belong(s) to
 d. Mary sent {their / his} report card(s) to most students.

When the arguments are reversed, however, *send* marks both internal arguments
as accusative objects. In this construction backward binding is only marginal at best even with a singular quantifier as seen in (b) below. That same marginality carries over to binding by a plural quantifier as seen in (d). Importantly, even in this case the forward binding of a singular pronoun by a plural quantifier in (c) is clearly worse than the backward binding in (d).

(14) Double object
a. Mary sent every student his report card.
b. ??Mary sent the person it belongs to every lost notebook.
c. Mary sent most students {their / *his} report card.
d. ??Mary sent the person {they / it} belong(s) to most lost notebooks.

A similar pattern can be observed with verbs that take multiple preposition phrases, like talk. The acceptability of both forward and backward binding varies subtly with choice of preposition and ordering of the preposition phrases, but once again we observe that backward binding of a singular pronoun is possible with a plural quantifier to the same degree to which it is possible with a singular quantifier, while forward binding of a singular pronoun by a plural quantifier is uniformly unacceptable.

(15) to-PP + about-PP
a. Mary talked to every student about his new teacher.
b. ??Mary talked to his new teacher about every student.
c. Mary talked to most students about {their / *his} new teacher(s).
d. ??Mary talked to {their / his} new teacher(s) about most students.

(16) about-PP + to-PP
a. ??Mary talked about every student to his new teacher.
b. Mary talked about his new teacher to every student.
c. ??Mary talked about most students to {their / *his} new teacher(s).
d. Mary talked about {their / his} new teacher(s) to most students.

(17) with-PP + about-PP
a. Mary talked with every student about his new teacher.
b. Mary talked with his new teacher about every student.
c. Mary talked with most students about {their / *his} new teacher(s).
d. Mary talked with {their / his} new teacher(s) about most students.

(18) about-PP + with-PP
a. ??Mary talked about every student with his new teacher.
2.1.3 Topicalization

The pattern of binding that we saw above also shows up in cases of topicalization, as well as in limited cases of negative inversion. Topicalization can move an NP containing a bound pronoun to a position preceding the quantifier that binds it. Binding that is possible in a non-topicalized version of the sentence is also possible in the topicalized version, as seen by comparing the (a–b) examples in (19) with those in (20) below.

(19)  a. Every boy loves his mother.
     b. Most boys love their mother(s).
     c. *Most boys love his mother(s).

(20)  a. His mother every boy loves.
     b. Their mother(s) most boys love.
     c. His mother(*s) most boys love.

In the (c) examples we see that a singular pronoun occurring in a topicalized phrase can also be bound by a plural quantifier, despite the fact that such binding is not possible in the corresponding non-topicalized sentence.

2.1.4 Negative Inversion

Like topicalization, negative inversion involves moving some expression to the front of a sentence. However, negative inversion is more limited than topicalization, applying only to non-upward entailing quantifiers and operators and triggering subject-aux inversion. While topicalization allows for flexibility in the scope of a topicalized quantifier phrase, negative inversion generally results in the fronted quantifier phrase taking obligatory wide scope, as can be seen in the following examples.6

(21)  a. Some woman, every man loves. (some > every, every > some)
     b. No woman does every man love. (no > every, *every > no)

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6The reconstructed scope option becomes much more readily available when the subject QP binds a pronoun contained within the topicalized QP:
   i. Some woman he knows, every man loves.
Because of the obligatory wide scope interpretation of the fronted QP in negative inversion, it is generally impossible for a pronoun contained in such a QP to be bound by a subject quantifier, regardless of whether the pronouns and quantifiers are singular or plural:

(22)  
  a. *Few of his friends does every boy despise.
  b. *Few of {their / his} friends do most boys despise.

The one exception to this behavior is when the subject QP is headed by the negative polarity item *any*. In such a case it is possible for the subject QP to bind an occurrence of a pronoun contained in the fronted QP, as can be seen below.

(23)  
  a. Few of his friends does any boy despise.
  b. Few of {their / his} friends do any boys despise.

In this case a singular pronoun can be bound by either a singular or a plural QP headed by *any*, in conformity with Generalization 1.

**2.1.5 Wh-movement**

Like topicalization, *wh*-movement can also make it possible for a plural quantifier to bind a singular pronoun. As we can see in the following in-situ *wh*-questions, binding of a pronoun contained in an in-situ *wh*-phrase by a subject quantifier is only possible with number-agreeing pronouns.

(24)  
  a. Every man loves which of his relatives the most?
  b. Most men love which of {their / *his} relatives the most?

When the *wh*-phrase is fronted, however, binding of *his* by *most* becomes possible, in conformity to Generalization 1.

(25)  
  a. Which of his relatives does every man love the most?
  b. Which of {their / his} relatives do most men love the most?

**2.1.6 Clefting**

Clefting can also make it possible for a singular pronoun to be bound by a plural quantifier. In the unclesed sentences below, binding of a singular pronoun is only possible with a number-agreeing quantifier.

(26)  
  a. Every man loves his mother the most.
b. Most men love {their / *his} mother the most.

Clefting of the object, however, makes it possible for either a singular or a plural quantifier to bind the singular pronoun.

(27) a. It’s his mother that every man loves the most.
    b. It’s {their / his} mother that most men love the most.

Interestingly, clefting differs from pseudo-clefting in this regard, the latter resulting in no improvement in the relevant binding.

(28) a. Who every man loves the most is his mother.
    b. Who most men love the most is {their / *his} mother.

Here once again the facts conform to Generalization 1: the relevant binding is only possible when the pronoun precedes the quantifier, despite the fact that binding in general is possible in a much wider range of cases.

2.2 Extensions

2.2.1 Contrasting Clauses

Although somewhat marginal, it is possible to extend a binding relation from one clause to another that is being contrasted with it. Thus in the following sentences the pronoun in the second clause has a bound-variable like interpretation, with the binder being the QP in the initial clause.

(29) a. Every boy loves his mother, but he doesn’t (necessarily) love his younger sister.
    b. His acne bothers every school boy, but his popularity never bothers him.

We saw in section 2.1.1 that with psych predicates it is possible for a plural quantifier to bind a singular pronoun that precedes it within a single clause. Here we see that this possibility can be extended to pronouns in a contrasting clause. When forward binding of a singular pronoun is impossible as in (a) below, using a singular pronoun for the contrasting sentence is also impossible.

(30) a. Most boys love {their / *his} mother, but {they don’t / *he doesn’t} (necessarily) love {their / *his} younger sister.
b. His acne bothers most school boys, but his popularity never bothers him.

With the backward binding of a singular pronoun made possible by a psych predicate as in the first clause of (b), however, it is possible to use a singular pronoun in the contrasting clause as well. This example does not conform to Generalization 1 since the singular pronouns in question follow the plural quantifier and yet are still capable of being given a bound variable interpretation. Their bound variable interpretation is clearly parasitic on the availability of a bound reading in the initial clause, however, making Generalization 1 at least partially relevant here as well.

2.2.2 Undoing Weak Crossover

A pronoun contained in a subject bound by an object QP typically gives rise to weak crossover effects, as in the following examples.

(31)  a. *His parents criticized every man who failed in life.
     b. *His parents criticized no man who succeeded in life.
     c. *{Their / His} parents criticized most men who failed in life.
     d. *{Their / His} parents criticized few men who succeeded in life.

When the quantifier undergoes topicalization or negative inversion to a position preceding the pronoun that it binds, however, the weak crossover effect is obviated.

(32)  a. Every man who failed in life his parents criticized.
     b. No man who succeeded in life did his parents criticize.
     c. Most men who failed in life {their / his} parents criticized.
     d. Few men who succeeded in life did {their / his} parents criticize.

As seen in the topicalization case in (c) and the negative inversion case in (d) above, this is an additional case in which it is possible for a plural quantifier to bind a singular pronoun that follows it. This case thus stands as another exception to Generalization 1. However, once again Generalization 1 appears to be at least partly relevant. While the examples in (31) are all marginal at best, the examples with a singular pronoun bound by a plural quantifier are no worse than those in which the binding shows number agreement between pronoun and quantifier. Furthermore, when the weak crossover effect is made weaker, the acceptability of
the examples with a singular pronoun bound by a plural quantifier that follows it goes up along with that of the rest of the examples.

(33)  
   a.  ?His parents are ashamed of every person who fails in life.  
   b.  ?His parents are ashamed of no person who succeeds in life.  
   c.  {?[Their / His] parents are ashamed of most people who fail in life.  
   d.  {?[Their / His] parents are ashamed of few people who succeed in life. 

So here once again we see a case in which forward binding of a singular pronoun by a plural quantifier appears to be parasitic on backward binding of the pronoun elsewhere.

2.2.3 True of

In talking about sentences it is not uncommon to say of a sentence containing a pronoun that it is true of an individual. The sentence “He loves his mother”, for example, can be claimed to be true (or false) of John. This way of talking can also be extended with the use of quantifiers, giving rise to what looks like a bound variable interpretation of a pronoun in a quotation context, as in (a) and (b) below.

(34)  
   a.  (The sentence) “He loves his mother” is true of {every boy / most boys}.  
   b.  For {every boy / most boys}. “He loves his mother” is true.  
   c.  Consider the sentence “He loves his mother”. That sentence is true of {every boy / most boys}. 

While the binding in (a) conforms to Generalization 1, that in (b) clearly does not. In this case, however, it is less plausible to assume that the topicalization is a result of movement, meaning it is difficult to see how this example can even be related to Generalization 1. That something different is going on in general with this construction, however, is strongly suggested by the example in (c). Here we see that the backward binding of he/his by most boys can cross a sentence boundary. No other cases we know of, however, allow such long distance backward binding, not even cases in which long distance forward binding is possible.

(35)  
   a.  *He loves his mother, but every boy doesn’t (necessarily) love his younger sister. 
   b.  *His acne bothers him, but his popularity never bothers every boy.
While the phenomenon of binding into quotation is interesting in its own right, we will ignore these kinds of examples in the remainder of the paper.

3 Bound Singular Pronouns are Semantically Singular

In the previous section, we have seen many cases where a singular pronoun is bound by a plural quantifier. In all those cases, the corresponding plural pronouns are admitted as well (and are presumably more standard) where singular pronouns are found. A question then naturally arises as to whether the use of a singular pronoun instead of a plural pronoun gives rise to any semantic difference.

Based on data like the following example by Rullmann (2003), plural bound pronouns were often assumed to be semantically singular:

(36) All candidates thought they could win the presidential election.

This example is understood as asserting that each candidate thought that he could be the sole winner of the election, so the bound pronoun *they* was taken to in effect range only over singular candidates, despite its plural appearance. As we will see shortly, however, Rullmann convincingly argues that plural bound pronouns can range over pluralities of individuals and shows that the above example can be accounted for even if morphologically plural pronouns are restricted to having a plural interpretation.\(^7\) Given this thesis of Rullmann’s, our question can now be rendered as follows: is it possible for a singular pronoun bound by a plural quantifier to range over pluralities? If the singular bound pronoun in question were only a surface variant of the corresponding plural pronoun, this should be possible. In this section, however, we will argue that morphologically singular pronouns bound by a plural quantifier are unambiguously singular semantically as well.

\(^7\)For Rullmann, pluralities of individuals are represented by sets of individuals, and the fact that a plural bound pronoun often appears to range over singular entities is accounted for by assuming its range to contain singleton sets. See section 4 for details.
3.1 Atom Predicates, Set Predicates, and the Semantic Number of Pronouns

English has pairs of quantifiers that appear to have more or less the same meaning but differ in morphological number. For instance, *all (the) students* and *every student* form such a pair, as do *no students* and *no student*, *two or more students* and *more than one student,* and *many students* and *many a student*. In each pair, the first is morphologically plural and the second is morphologically singular. Winter (2001, 2002) classifies predicates into atom predicates and set predicates according to whether the choice of a singular or plural quantifier in such a pair alters the interpretation or acceptability of sentences the quantifier is the subject of. When the change makes no difference the predicate is classified as an atom predicate. When it does make a difference the predicate is classified as a set predicate. In (37), we see that plural quantifier subjects in (a) can be replaced with their corresponding singular quantifiers without affecting the interpretation or acceptability as seen in (b), making *be at the party* qualify as an atom predicate.

(37) a. {All (the) / No / Two or more / Many} students were at the party.
    b. {Every / No / More than one / Many a} student was at the party.

In contrast, in (38), replacing the plural quantifier subjects in the grammatical (a) sentences with their corresponding singular quantifiers in (b) results in unaccept-able sentences, making *meet* a set predicate.

(38) a. {All (the) / No / Two or more / Many} students met.
    b. *

The idea underlying this division of predicates is that atom predicates take only semantically singular individuals as their subject, while set predicates take pluralities of individuals as their subject. Singular quantifiers like *every* are taken to quantify exclusively over singular individuals, making them incompatible with set predicates. Plural quantifiers like *all*, in contrast, can effectively quantify over either singular or plural individuals, making them compatible with either set or atom predicates.

With the distinction between atom and set predicates as background, Rullmann (2003) argues that it is possible not only to quantify over pluralities, but also for

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8Rather than *two or more*, Winter originally contrasts *at least two* with *more than one*. Here, we avoid using *at least two*, which is argued to have an epistemic modal interpretation unlike *more than one* and *two or more* (Geurts and Nouwen 2007, Nouwen 2010).
such quantification to bind plural pronouns interpreted as plural variables. He gives the following example to support these claims:

(39) Most people who think they have common interests become friends.

In this example there are two predicates that qualify as set predicates and that hence require semantically plural subjects: the main predicate become friends and the subordinated predicate have common interests. To see this, we need only apply Winter’s test. The fact that the following sentences are acceptable with a plural quantifier but not with a singular one shows clearly that the relevant predicates are set predicates, not atom predicates:

(40) a. {All (the) / No / Two or more / Many} boys have common interests.
    b. *{Every / No / More than one / Many a} boy has common interests.

(41) a. {All (the) / No / Two or more / Many} boys become friends.
    b. *{Every / No / More than one / Many a} boy becomes friends.

Given that these predicates are set predicates, it has to be concluded that the occurrence of they in (39) is plural not only morphologically but semantically as well. Furthermore, they in (39) is bound by the plural quantifier subject, since its value covaries with the subject quantifier as it picks different groups of people with common interests. Thus, (39) is understood as asserting that for everyone $x$ of the majority of the people who share interests with someone else, $x$ belongs to a group of people with common interests whose members all become friends. This shows that it is possible for a pronoun to be semantically plural and bound at the same time.

We now turn to the interpretation of morphologically singular pronouns bound by plural quantifiers.

### 3.2 Evidence for Semantic Singularity

This subsection presents three arguments that singular pronouns bound by plural quantifiers are semantically unambiguously singular, unlike in the case of bound plural pronouns as seen above.

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9The predicate have common interests has an irrelevant reading in which common is taken as the opposite of uncommon. The interpretation of interest here is not that one but rather the interpretation the predicate shares with have interests in common. Below we will use this latter predicate in constructing our own examples in order to avoid the irrelevant interpretation.
3.2.1 Bound Singular Pronouns as Subjects of Set Predicates

Our first argument that singular pronouns bound by plural quantifiers are semantically singular comes from attempts to place them in the subject position of a set predicate. If the pronoun can be given a plural interpretation, then the resulting sentence should be acceptable. If, on the other hand, the pronoun can only be given a singular interpretation, then the resulting sentence should be ill-formed. As we can see from the examples below, in all of the types of examples considered in section 2 in which a morphologically singular pronoun can be bound by a plural quantifier, the bound pronoun cannot be the subject of a set predicate. Since the examples given here differ structurally from those given in section 2, we give minimal pairs for each type of example, with the first sentence containing an atom predicate and the second a set predicate. We will illustrate the contrasts only with the quantifier most, though the same contrasts obtain for other plural quantifiers as well.

(42) a. (i) The fact that {they are / he is} unique pleases most boys.
   (ii) The fact that {they have / *he has} interests in common pleases most boys.

b. (i) Mary introduced the idea that {they are / he is} unique to most students.
   (ii) Mary introduced the idea that {they have / *he has} interests in common to most students.

c. (i) The thought that {they are / he is} unique most boys cherish.
   (ii) The thought that {they have / *he has} interests in common most boys cherish.

d. (i) Whose claim that {they are / he is} unique did most men appreciate the most?
   (ii) Whose claim that {they have / *he has} interests in common did most men appreciate the most?

e. (i) It’s the thought that {they are / he is} unique that most boys cherish the most.
   (ii) It’s the thought that {they have / *he has} interests in common that most boys cherish the most.

f. (i) Few men who succeed in life does the thought that {they are / he is} unique bother.
   (ii) Few men who succeed in life does the thought that {they have / *he has} interests in common bother.
3.2.2 Bound Singular Possessive Pronouns in Subjects of Set Predicates

In this and the next subsections, we will consider examples closer to those examined in section 2, in which the relevant bound pronoun is a possessor, as in *their / his* mother(s). Since it is not possible to predicate anything directly of a possessive pronoun we cannot directly apply a set predicate to these pronouns. Our arguments using these examples will thus be indirect.

In a noun phrase with a possessive pronoun, the number of the possessive pronoun and that of the head noun can vary independently. When the possessive pronoun is not bound but referential, the morphological number of these expressions corresponds with their semantic number. This is illustrated by the following examples, where the possessive pronoun is taken to refer to some contextually salient boy(s):

(43)  
a. His mother loves Mary.  
(one boy, one mother)  
b. His mothers love Mary.  
(one boy, multiple mothers)  
c. Their mother loves Mary.  
(multiple boys, one mother)  
d. Their mothers love Mary.  
(multiple boys, multiple mothers)

Binding of the possessive pronouns adds a new dimension to the interpretation, however, one which can create an ambiguity when the pronoun is plural:

(44)  
a. Every boy loves his mother.  
(one mother per boy)  
b. Every boy loves his mothers.  
(multiple mothers per boy)  
c. Most boys love their mother.  
(one mother per boy OR one mother per group of boys)  
d. Most boys love their mothers.  
(multiple mothers per boy OR multiple mothers per group of boys)

The singular pronoun *his* bound by the singular quantifier *every boy* in the (a) and (b) examples gives rise to only one interpretation, exactly as would be expected from the interpretation of the corresponding example in (43). Binding of the plural pronoun *their* by the plural quantifier *most boys* in (c) and (d), however, gives rise
to a range of different instantiations of the possibilities seen in (43). In (c), if the quantification is taken to be over individual boys, the plural pronoun *their* will in effect behave like a singular bound variable, giving rise to a one-mother-per-boy interpretation. If, on the other hand, the quantification is understood to be over groups of boys, we obtain a one-mother-per-group-of-boys interpretation. This latter interpretation is available most easily if all the boys in the context are presupposed to have the same mother, but is also available if the context provides some salient grouping of boys where the boys in each group are brothers. In (d) we see a similar range of interpretations. The singular-bound-variable reading requires each one of the majority of the boys to have multiple mothers and to love those multiple mothers. The plural-bound-variable reading requires there to be multiple mothers per group of boys, but does not restrict the relation between mothers and boys beyond that. Thus, this reading allows the possibility that each boy has only one mother, as well as the (unrealistic) possibility of there being some boy who has multiple mothers.\(^{10}\)

With this as background, consider (45), where the relative clause with a set predicate restricting the subject quantifier strongly favors an interpretation with quantification over groups of boys, making the pronoun range over pluralities:

\[
(45) \quad \begin{align*}
   a. \text{ Most boys who have interests in common hide their interests from their mothers. } \\
   b. \text{ Most boys who have interests in common analyzed their genomes. }
\end{align*}
\]

The example (45a) can describe a situation where for every individual \(x\) in the majority of the boys sharing interests with other boys, \(x\) belongs to a group of boys with shared interests such that each member of the group hides the shared interests from the mothers of each member of the group. Similarly, (45b) can describe a situation where for every individual \(x\) in the majority of the boys sharing interests with other boys, \(x\) belongs to a group of boys with shared interests such that every member of the group analyzed the genome of each member of the group.\(^{13}\)

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\(^{10}\)Additionally, the pronoun *their* can be interpreted as simply referring to the group of all the boys in the context, who are somehow presupposed to be brothers. This is not a bound-variable interpretation, however.

\(^{11}\)Again, *their* can be interpreted as referring to the group of all the boys in the context, in which case the sentence is true just in case the number of boys who love all of the mothers adds up to a majority of the boys. This is not a bound-variable interpretation.

\(^{12}\)(44d) also allows a dependent plural reading. See subsection 3.2.3.

\(^{13}\)The plural nouns *mothers* and *genomes* may be construed as dependent plurals as well. See the next subsection.
in (a), each relevant boy hides his interests from multiple mothers including his own mother, and in (b), each relevant boy analyzed multiple genomes including his own. These readings can be accounted for by assuming that *their* in (45) ranges over pluralities of boys with shared interests. Since each boy has only one mother and only one genome, the fact the the plural forms *mothers* and *genomes* appear in (45) can be seen as evidence for the semantic plurality of the pronoun *their*. This point can be further confirmed by the following examples:

(46)  

a. Most boys who have exactly the same ancestors love their {mother / ??mothers}.

b. Most boys who are identical twins analyzed their {genome / ?genomes}.

Here, the boys in each relevant group have the same mother or genome, so for each group, there is only one mother or genome possessed by the boys in the group. As a result, the singular forms *mother* and *genome* become appropriate, and the plural forms become correspondingly less acceptable.

We can now examine sentences with singular bound pronouns. Consider the following sentences:

(47)  

a. {Their / #His} mothers frighten {all (the) / no / two or more / many / most} boys who have interests in common.

b. {Their / #His} genomes intrigue {all (the) / no / two or more / many / most} boys who have interests in common.

Here, the possessive bound pronoun is in a position where we have seen that a singular form is generally licensed. Yet, in these sentences, the singular pronoun

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14 The singular forms *mother* and *genome* are also acceptable, but only with distributive readings. Thus, in (ia), each relevant boy hides his interests only from his own mother, and in (iib), each relevant boy analyzed only his own genome.

(i)  

a. Most boys who have interests in common hide their interests from their mother.

b. Most boys who have interests in common analyzed their genome.

---

15 With predicates of identity such as *be the same*, *be identical* and *be different*, only the plural form *mothers* sounds natural.

(i)  

a. Most boys who have exactly the same ancestors think that their {*mother is / mothers are} {the same / identical / different}.

b. Most boys who are identical twins think that their {*genome is / genomes are} {the same / identical / different}.

We suspect that this has to do with the nature of such predicates and will leave this issue aside.
results in unacceptability. A straightforward explanation can be given for these observations if we assume that singular pronouns can range only over singular individuals. With the plural pronoun *their*, these sentences make sense. For instance, (47a) with *most* means that for every individual *x* in the majority of the boys sharing interests with other boys, *x* belongs to a group of boys with shared interests such that each member of the group is frightened by the mother of each member of the group. In a nutshell, the plural form *mothers* is used because for each relevant group of boys, there are multiple women who gave birth to a boy in the group. If *his* could range over pluralities just like *their*, the sentences in (47) should make sense with *his* as well. The fact that they do not indicates that *his* cannot range over pluralities. Indeed, the apparent reason that *his* does not work in these sentences is that its use would imply that each boy has multiple mothers or multiple genomes, which conflicts with our world knowledge. This is exactly what is predicted if *his* is only capable of ranging over singular individuals.

In the above discussion, the relative clause with a set predicate restricting the domain of quantification helps bring out (but probably does not enforce) readings where the quantification is over pluralities of individuals rather than over singular individuals. By placing a set predicate in the nuclear scope of the quantification, it becomes possible to not only allow but to enforce quantification over pluralities. To create such an example, imagine that a ball for children was held somewhere in the People’s Republic of China, where only the children’s parents were admitted as spectators. Because of the PRC’s longstanding one-child policy, each spectator had only one child. As is typically the case in a ball, the children formed pairs to dance. Now, consider the following sentences:

(48) a. *{Their / His} child dancing together pleased {all (the) / no / two or more / many / most} men.  
   b. {Their / #His} children dancing together pleased {all (the) / no / two or more / many / most} men.

The unacceptability of (48a) is expected, since a singular term *{their / his} child* is illicitly predicated of by a set predicate *dance together*. The fact that (48b) is good with *their* shows that *their children* is semantically plural. As each man had only one child, this semantic plurality entails semantic plurality of the pronoun *their* as well. So the sentence *Their children dancing together pleased most men* means that for every individual *x* in a majority of the men, *x* belongs to a group of men such that those men’s children dancing together pleased each man in the group. Again, if *his* could range over pluralities, it should be able to replace *their* in
However, (48b) is illegitimate with his, since each man would have to have more than one child for it to be true, contra the one-child per family limitation in the context. Thus, the data in (48) provide further evidence that singular pronouns bound by a plural quantifier range only over singular individuals.

### 3.2.3 Dependent Plurals

De Mey (1981) notes that (49a) has the same interpretation as the bound variable reading of (49b), that is, the interpretation that each boy brings along his own father and not necessarily other boys’ fathers.

(49)  
\begin{align*}
\text{a. } & \text{All the boys bring their fathers along.} \\
\text{b. } & \text{All the boys bring their father along.}
\end{align*}

What is interesting is that fathers in (a) is in the plural form even though each boy presumably has only one father. Since this plural form seems to be licensed by the plural subject all the boys, de Mey calls such plural nouns dependent plurals.

Given that the dependent plural interpretation of (49a) is truth conditionally indistinguishable from the bound variable interpretation of (49b), one might suspect that the plural morphology of fathers in (49a) is semantically vacuous. That this suspicion is not correct becomes clear when one considers (50)–(51). If Adam and Bill are not brothers, (50a) can be used on its dependent plural interpretation when Adam loves Adam’s mother and Bill loves Bill’s mother, a situation in which the bound variable interpretation of (50b) is also true. However, if Adam and Bill are known to be brothers, only (50b) and not (50a) can be used in the same situation. Similarly, if it is known that the boys in the discourse are all brothers, it will be quite odd to use (51a) on its dependent plural interpretation. (51b) should be used instead, even though (51a) with a dependent plural interpretation would be otherwise perfectly acceptable.

(50)  
\begin{align*}
\text{a. } & \text{Adam and Bill love their mothers.} \\
\text{b. } & \text{Adam and Bill love their mother.}
\end{align*}

(51)  
\begin{align*}
\text{a. } & \text{Most boys love their mothers.} \\
\text{b. } & \text{Most boys love their mother.}
\end{align*}

These observations tell us that the dependent plural mothers is licensed only if there is more than one relevant mother, and in this sense, the plural morphology cannot be ignored semantically, even if it is true that every boy has only one
Now consider (52):

(52) a. #Every boy loves his mothers.
   b. Every boy loves his mother.

Suppose that there are multiple boys none of whom are brothers. In that situation, there clearly is more than one mother, but nevertheless, (52a) cannot be used felicitously, as it would imply that each boy potentially has more than one mother. This shows us that there being more than one relevant mother is, albeit necessary, not sufficient for licensing the dependent plural *mothers*.

Data on singular and plural bound pronouns with plural quantifiers reveal that a sufficient condition for licensing a dependent plural in this type of sentence is the use of a plural possessive pronoun. Now observe (53):

(53) a. {Their / His} genome intrigues most boys.
   b. {Their / #His} genomes intrigue most boys.

While both the plural possessive pronoun *their* and the singular possessive pronoun *his* are allowed with the singular *genome* as seen in (53a), the dependent plural reading is possible only with *their* as demonstrated in (53b). When the singular *his* is combined with the plural *genomes*, the sentence implies that each boy has more than one genome, which would be an anomaly. Again, the contrast between *their* and *his* in (53b) can be accounted for by assuming that while *their* can range over pluralities of individuals, *his* ranges only over singular individuals.

4 Semantic Analysis

This section sketches a semantic analysis of singular pronouns bound by plural quantifiers. After reviewing Winter’s (2001, 2002) and Rullmann’s (2003) work, we will modify this Winter–Rullmann theory so that singular denotations are singleton sets rather than individuals. As we will see, this makes binding of singular pronouns by plural quantifiers semantically possible.

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16We remain agnostic as to how exactly the dependent plural reading is analyzed semantically. For de Mey (1981), it is expressed as a relation between pluralities of individuals, and the bound-variable-like interpretation is derived via a meaning postulate.
4.1 Winter’s Semantic Theory

In order to capture the distinction between atom predicates and set predicates, Winter (2002) proposes the following:

(54) Principle 1
When uninflected for number, atom predicates denote sets of atomic entities. Uninflected set predicates denote sets of sets of atomic entities.

For instance, since the nominal predicate *candidate* and the verbal predicate *be at the party* are atom predicates, the uninflected forms of these predicates denote sets of individuals. Thus, if Al, George and Ralph are the only candidates in an election, and if Al and George are the only people at the party, we have the following extensions:

(55) a. $\llbracket \text{candidate}(\text{uninflected}) \rrbracket = \{a, g, r\}$
    b. $\llbracket \text{be-at-the-party}(\text{uninflected}) \rrbracket = \{a, g\}$

By contrast, since meet is a set predicate, its uninflected form denotes a set of sets. For instance, if there was a meeting of John, Mary and Sue, a joint meeting of Committee A and Committee B, a separate meeting of Committee B alone and a meeting of Committee C, and no other meetings took place, then we have the following extension:

(56) $\llbracket \text{meet}(\text{uninflected}) \rrbracket = \{\{j, m, s\}, \{c_A, c_B\}, \{c_B\}, \{c_C\}\}$

Winter takes the number morphology to make a semantic contribution, proposing the following additional principle:

(57) Principle 2
Number features change the semantic number of predicates so that all singular predicates denote sets of atoms whereas all plural predicates denote sets of sets.

The extension of the singular inflected form of atom predicates remains the same as that of the uninflected form and is hence a set of individuals:

(58) a. $\llbracket \text{candidate}(\text{sg.}) \rrbracket = \llbracket \text{candidate}(\text{uninflected}) \rrbracket = \{a, g, r\}$
    b. $\llbracket \text{is-at-the-party}(\text{sg.}) \rrbracket = \llbracket \text{be-at-the-party}(\text{uninflected}) \rrbracket = \{a, g\}$
On the other hand, the plural inflected form of atom predicates must denote a set of sets according to Principle 2. Winter (2001) proposes that this change is made via a distributivity operator \( pdist \), which creates the set of all non-empty subsets of a given set. These assumptions generate the following inflected plural extensions:

\[
\begin{align*}
\text{(59) a. } & \quad \text{candidates(pl.)} = \text{pdist(\text{candidate(uninflected)})} \\
& = \{\{a\}, \{g\}, \{r\}, \{a, g\}, \{a, r\}, \{g, r\}, \{a, g, r\}\} \\
\text{b. } & \quad \text{are-at-the-party(pl.)} = \text{pdist(\text{be-at-the-party(uninflected)})} \\
& = \{\{a\}, \{g\}, \{a, g\}\}
\end{align*}
\]

For set predicates, their plural inflected form has the same extension as the uninflected form, which is a set of sets, but singular inflection turns their extension into a set of individuals by the operator \( sg \), which when applied to a predicate extension gives the set of individuals whose singleton sets appear in that extension. Thus, the extensions of the number-inflected forms of \textit{meet} are as follows:

\[
\begin{align*}
\text{(60) a. } & \quad \text{meet(pl.)} = \text{meet(uninflected)} = \{\{j, m, s\}, \{c_A, c_B\}, \{c_B\}, \{c_C\}\} \\
\text{b. } & \quad \text{meets(sg.)} = \text{sg(\text{meet(uninflected)})} = \{c_B, c_C\}
\end{align*}
\]

For the semantics of singular quantifiers such as \textit{every candidate}, Winter adopts the standard generalized quantifier meanings proposed in Barwise and Cooper (1981), so singular quantifiers denote binary relations between sets of individuals. Plural quantifiers such as \textit{all candidates}, on the other hand, denote binary relations between sets of pluralities, i.e., between sets of sets of individuals. Their meanings are generally expressed in terms of the corresponding (singular) generalized quantifiers, as in the following, where \( \mathcal{A} \) and \( \mathcal{B} \) are variables over sets of sets of individuals:

\[
\text{(61) } \text{\lbrack all\rbrack} (\mathcal{A}, \mathcal{B}) = 1 \\
\text{iff } \text{\lbrack every\rbrack} (\bigcup \mathcal{A}, \bigcup (\mathcal{A} \cap \mathcal{B})) = 1 \\
\text{iff } \bigcup \mathcal{A} \subseteq \bigcup (\mathcal{A} \cap \mathcal{B})
\]

For instance, sentence (62a) is analyzed as in (62b), and with (59) and (61), this reduces to the false (62c), which represents the correct truth conditions of (62a).

\[
\begin{align*}
\text{(62) a. } & \quad \text{All candidates are at the party.} \\
\text{b. } & \quad \text{\lbrack all\rbrack (\text{\lbrack candidates(pl.)\rbrack}) (\text{\lbrack are-at-the-party(pl.)\rbrack})} \\
\text{c. } & \quad \{a, g, r\} \subseteq \{a, g\}
\end{align*}
\]
4.1.1 Quantifiers in Non-subject Positions

Winter (2001, 2002) only analyzes sentences where quantifiers are subjects. However, quantifiers need not be subjects, as seen in the following examples:

(63) a. Sue kissed all men.
    b. All men’s kidneys are functional.

A natural analysis of (63a) that suggests itself is the following:

(64) \[
\text{⟦}\text{all}⟧ (\text{⟦men⟧} (\lambda X. \text{⟦kissed⟧} (X)(\text{⟦Sue⟧)}))
\]

Here, \(\lambda X. \text{⟦kissed⟧} (X)(\text{⟦Sue⟧)\rangle\) must be of type \(\langle\langle e,t \rangle,t\rangle\), since it is an argument of the plural quantifying determiner \text{all}. This means that the first argument of \(\text{⟦kissed⟧}\) is of type \(\langle e,t \rangle\). On the other hand, since (63a) is paraphrasable as \text{Sue kissed every man}, we would like to say that the predicate \text{kiss} is an atom predicate with respect to its object argument, which should mean that its uninflected form expects an object of type \(e\). Applying Principle 2 of Winter to the present case suggests that \text{kissed} in (63a) has been inflected for number for the object argument. Thus, we hypothesize that a predicate always gets inflected for number for each of its arguments. This means that transitive verbs get doubly inflected for number, both for the object and for the subject. Number inflections for predicates are often invisible in English, however, simply because English predicates only have overt morphological agreement with subjects. Since \text{pdist} gets inserted whenever an atom predicate is inflected for plural in Winter’s theory, we first have:

(65) \[
\text{⟦kiss(pl.-obj)⟧} = \lambda X.\lambda y. \text{pdist(\lambda x. \text{⟦kiss(uninflected)⟧} (x)(y))(X)}
\]

Since \text{kiss} is an atom predicate with respect to the subject argument (for example, \text{All men kissed Sue} and \text{Every man kissed Sue} have the same meaning), the singular inflection for the subject makes no semantic change:

(66) \[
\text{⟦kissed(pl.-obj, sg.-subj)⟧} = \text{⟦kiss(pl.-obj)⟧} = \lambda X.\lambda y. \text{pdist(\lambda x. \text{⟦kiss(uninflected)⟧} (x)(y))(X)}
\]

Now, suppose that only Sue kissed anybody at all, and she kissed only George and Ralph. Then,\footnote{In the notation \(\langle s,g \rangle\), the first coordinate \(s\) corresponds to the second argument of \(\text{⟦kiss(uninflected)⟧}\), i.e. the subject, and the second coordinate \(g\) corresponds to the first argument, i.e. the object.}
(67)  
   a. \[
   \llbracket \text{kiss(uninflected)} \rrbracket = \{\langle s, g \rangle, \langle s, r \rangle\}
   \]
   b. \[
   \llbracket \text{kissed(pl.-obj, sg.-subj)} \rrbracket = \{\langle s, \{g\} \rangle, \langle s, \{r\} \rangle, \langle s, \{g, r\} \rangle\}
   \]

and hence,

(68) \[
\lambda X. \llbracket \text{kissed(pl.-obj, sg.-subj)} \rrbracket (X)(\llbracket \text{Sue} \rrbracket) = \{\{g\}, \{r\}, \{g, r\}\}
\]

With this, we can derive the correct truth conditions for (63a).

Let us turn to (63b). Since this sentence is paraphrasable as *Every man’s kidneys are functional*, it is natural to think that the “uninflected” form of the predicate of which the quantifier is an argument is an atom predicate. In this case, that predicate is the possessive marker ‘s. Then, the fact that (63b) is fine with the plural quantifier implies that the possessive marker ‘s has been (covertly) inflected for its plural possessor argument. Given this, the sentence can be analyzed as something like the following:

(69) \[
\llbracket \text{all} \rrbracket (\llbracket \text{men} \rrbracket)
\]
   \[\lambda Y. \llbracket \text{are-functional} \rrbracket (\lambda X. \llbracket \text{kidneys} \rrbracket (X) \land \llbracket \text{’s(inflected)} \rrbracket (X)(Y))\]

Here, \(\iota\) is the description operator, and we assume that it gives the supremum of a given set of sets.

(70) For any \(P\) of type \(\langle\langle\langle e, t\rangle, t\rangle, t\rangle\), \(\iota X. P(X) = \bigcup \{X \mid P(X)\}\)

In \(\llbracket \text{’s(inflected)} \rrbracket (X)(Y)\), \(X\) is meant to be the possessee and \(Y\) the possessor. (We have arbitrarily decided that the possessive marker takes the possessee as its first argument.) In (63b), both the possessor and the possessee arguments are plural, so ‘s must have been doubly inflected for plural. Since it is not clear which of the two number inflections occurs first, we can think of the following two possibilities:

(71) \[
\llbracket \text{’s(inflected)} \rrbracket =
   \begin{align*}
   &a. &\lambda X.\lambda Y. \text{pdist}(\lambda x. \text{pdist}(\lambda y. \llbracket \text{’s(uninflected)} \rrbracket (x)(y))(Y))(X) \\
   &b. &\lambda X.\lambda Y. \text{pdist}(\lambda y. \text{pdist}(\lambda x. \llbracket \text{’s(uninflected)} \rrbracket (x)(y))(Y))(X)
   \end{align*}
\]

Now, suppose that \(m_1\) possesses \(k_1\) and \(k_2\) and \(m_2\) possesses \(k_3\) and \(k_4\). Then, each of the above two possibilities produces the following extension:

(72) \[
\llbracket \text{’s(inflected)} \rrbracket = \{\{m_1\}, \{k_1\}\}, \{\{m_1\}, \{k_2\}\}, \{\{m_1\}, \{k_1, k_2\}\}, \{\{m_2\}, \{k_3\}\}, \{\{m_2\}, \{k_4\}\}, \{\{m_1\}, \{k_3, k_4\}\}\}
\]
Using (70), we end up with the following extension for the second argument of \([all]\) in (69):

\[(73) \quad \lambda Y. [\text{are-functional}] (\iota X. [\text{kidneys}] (X) \land [	ext{'s}(inflected)] (X)(Y)) = \{[m_1], [m_2]\}\]

It is now routine to check that the desired truth conditions for (63b) can be derived with this.

### 4.2 Rullmann’s Treatment of Bound Plural Pronouns

Rullmann (2003), who bases his theory on Winter’s, treats bound plural pronouns as bound variables ranging over sets of individuals. To see how Rullmann’s theory works, consider (36) in section 3, repeated below:

(36) All candidates thought they could win the election.

Using (61), Rullmann translates this sentence as follows, where \(X\) is a variable over sets of individuals:

\[(74) \quad \bigcup [\text{candidates}] \subseteq \bigcup([\text{candidates}] \cap [\lambda X. X \text{ thought } X \text{ could win the election}])\]

The \(\lambda\) expression on the right-hand side, which is the second argument of \(\text{all}\), denotes a set of sets of individuals. Assume that the extension of \(\text{candidates}\) is as in (59a). Considering a scenario where each candidate thought he could be the sole winner, Rullmann takes the above \(\lambda\) expression to have the following extension:

\[(75) \quad [\lambda X. X \text{ thought } X \text{ could win the election}] = \{[a], [g], [r]\}\]

Rullmann argues that the bound plural pronoun \(\text{they}\) in (36) appears as if it were quantifying over singular individuals because the above extension contains only singleton sets. Now, by plugging (59a) and (75) into (74), the truth conditions for (36) are calculated as follows:

\[(76) \quad \bigcup\{[a], [g], [r], [a, g], [a, r], [g, r], [a, g, r]\} \subseteq \bigcup(\bigcup\{[a], [g], [r], [a, g], [a, r], [g, r], [a, g, r]\} \cap \{[a], [g], [r]\})\]

iff \([a, g, r] \subseteq \bigcup\{[a], [g], [r]\}\)

iff \([a, g, r] \subseteq [a, g, r]\)
Since the formula in the last line holds true, the sentence is predicted to be true, as desired.

In the above analysis, it is important that the main predicate \textit{thought they could win the election} be analyzed as denoting a set of sets of individuals. For Rullmann, individuals and singleton sets are strictly distinguished, so if it denoted a set of individuals rather than a set of sets of individuals, the union operation would not apply to it, making it impossible to compute the truth conditions of the sentence.

Rullmann does not give the details of how the extension in (75) can be arrived at, so let us try to make it explicit. As a start, focus on Al’s thought worlds. In those worlds, only Al could win. For any variable assignment \( g \), we thus have the following, where \( w_{\text{Al}} \) is any of Al’s thought worlds:

\[ (77) \begin{align*}
\text{a. } \mathcal{L}\text{can-win-the-election(uninflected)}_{w_{\text{Al}},g} &= \{ a \} \\
\text{b. } \mathcal{L}\text{could-win-the-election(pl.)}_{w_{\text{Al}},g} &= \{ \{ a \} \}
\end{align*} \]

Similarly for George and Ralph. Now, suppose that only Al and Bill thought only Al could win, only George and Henry thought only George could win, and only Ralph and Sam thought only Ralph could win. For simplicity, suppose that nobody thought two or more candidates had a chance of winning. Furthermore, since Al, George and Ralph were the only candidates, nobody thought someone other than these three could win. We then have the following, where \( w_{\text{@}} \) denotes the actual world:

\[ (78) \begin{align*}
\text{a. } \mathcal{L}\text{think(uninflected)} X \text{ could-win-the-election}_{w_{\text{@}},g} &= \\
&= \begin{cases} 
\{ a, b \} & \text{if } g(X) = \{ a \} \\
\{ g, h \} & \text{if } g(X) = \{ g \} \\
\{ r, s \} & \text{if } g(X) = \{ r \} \\
\emptyset & \text{otherwise}
\end{cases} \\
\text{b. } \mathcal{L}\text{thought(pl.) } X \text{ could-win-the-election}_{w_{\text{@}},g} &= \\
&= \begin{cases} 
\{ \{ a \}, \{ b \}, \{ a, b \} \} & \text{if } g(X) = \{ a \} \\
\{ \{ g \}, \{ h \}, \{ g, h \} \} & \text{if } g(X) = \{ g \} \\
\{ \{ r \}, \{ s \}, \{ r, s \} \} & \text{if } g(X) = \{ r \} \\
\emptyset & \text{otherwise}
\end{cases}
\end{align*} \]

From this, we can see that (75) is indeed obtained.
4.3 Singular Denotations as Singleton Sets

For Rullmann (2003), the assumption that singular predicates denote sets of individuals rather than sets of sets of individuals, and singular pronouns range over individuals rather than singleton sets is responsible for the ill-formedness of sentences like the following:

(79)  a. All men was at the party.
     b. All men bring his wife.

In (79a), since the verb is morphologically singular, the predicate was at the party denotes a set of individuals. The determiner all, however, denotes a binary relation between sets of sets, resulting in a type mismatch. In (79b), the verb bring is morphologically plural. In order for the pronoun his to be bound, it must be coindexed with the subject, so that (79b) is analyzed like the following:

(80)  \[[\text{all}] (\langle\text{men}\rangle) (\lambda x. \langle\text{bring(pl.)} x\text{'s wife}\rangle (x))\]

However, \(x\) must be a variable ranging over individuals, rather than singletons, and so cannot be an argument to the predicate \(\text{bring(pl.)} x\text{'s wife}\).

Unfortunately, the exact same mechanism appealed to above rules out binding of his in His acne bothers most school boys. In order to treat this sentence, the most obvious thing to do within the broad framework of Rullmann (2003) is to let his in sentences like this range over singleton sets. This leaves us with two choices: either we treat singular pronouns bound by plural quantifiers differently from other occurrences of singular pronouns, or else we revise Rullmann’s (2003) semantics of singular pronouns so that they always range over singleton sets, rather than individuals. The former approach treats singular pronouns as systematically ambiguous, while the latter entails abandoning Rullman’s semantic explanation of the ill-formedness of sentences like those in (79), relegating their explanation to the realm of syntax. Here, we opt for the latter. Under this modification, singular predicates denote sets of singleton sets, rather than sets of individuals, and plural predicates denote sets of (singleton or non-sigleton) sets, as before.

We assume that an \(n\)-place predicate, number-inflected or not, always has a type of the form

\[
\langle\langle e, t\rangle, \langle e, t\rangle, \ldots, \langle e, t\rangle, t \ldots \rangle. \quad n \text{ times}
\]

We thus have to revise the definitions of \(sg\) and \(pdist\) accordingly:
Also, singular quantifiers now denote binary relations between sets of singleton sets rather than between sets of individuals, and the semantics of plural quantifiers, which was given in (61), is revised accordingly. If $Q_{PL}$ is the denotation of a plural quantifying determiner, its semantics is now defined in terms of the corresponding singular quantifier $Q_{SG}$ as follows:

\[(82)\quad Q_{PL}(A, B) = Q_{SG}(AT(\bigcup A), AT(\bigcup (A \cap B)))\]

Here, $AT$ is an operator that takes a set of individuals $A$ and gives back the set of singleton sets whose sole elements are members of $A$:

\[(83)\quad AT = \lambda A \in D_{(e,t)}. \lambda X \in D_{(e,t)}. \exists x \in D_e[X = \{x\} \land x \in A]\]

For example, in our earlier scenario where Sue kissed George and Ralph and no other kissing took place, we now have

\[(84)\quad \begin{align*}
\&\quad \llbracket \text{kiss(uninflected)} \rrbracket = \{\langle \{s\}, \{g\}, \{s\}, \{r\} \rangle \} \\
\&\quad \llbracket \text{kissed(pl.-obj, sg.-subj)} \rrbracket = \{\langle \{s\}, \{g\}, \{s\}, \{r\}, \{s\}, \{g, r\} \rangle \} \\
\&\quad \llbracket \text{Sue} \rrbracket = \{s\}
\end{align*}\]

The second argument of all in (63a) remains

\[(85)\quad \lambda X. \llbracket \text{kissed(pl.-obj, sg.-subj)} \rrbracket (X)(\llbracket \text{Sue} \rrbracket) = \{\{g\}, \{r\}, \{g, r\}\}
\]

as before, and we continue to obtain the correct truth conditions for (63a).

### 4.3.1 Consequences

For Winter, whenever a singular quantifier is the subject of a set predicate as in (86a) and whenever a plural quantifier is the subject of an atom predicate as in (86b), a type mismatch occurs between the quantifier and the uninflected form of the predicate.

\[(86)\quad \begin{align*}
\&\quad \text{a. Every committee met.} \\
\&\quad \text{b. All men sneezed.}
\end{align*}\]

In Winter’s original theory, $sg$ and $pdist$ change the type of the predicate to one that fits with the type of the quantifier in such cases: in (86a), $sg$ will modify the deno-
tation of the uninflected set predicate meet into a set of individuals, and in (86b), pdist will modify the denotation of the uninflected atom predicate sneeze into a set of sets. In the modified framework presented above, however, there is no type distinc-
tion between atom predicates and set predicates, or between morphologically
singular predicates and morphologically plural predicates. Accordingly, sg and
pdist are no longer type-shifters; they are now both of type \langle\langle e, t\rangle, \langle e, t\rangle\rangle.

A question then arises whether we really need sg and pdist. Consider sg first. Let QSG be the denotation of a singular quantifying determiner such as every, A be the denotation of the nominal following the singular quantifying determiner, and B be the denotation of an uninflected set predicate acting as the main verb. Since the nominal is in the singular form, A is a set of singleton sets. Then, given that (singular) generalized quantifiers are conservative (Barwise and Cooper 1981, Keenan and Stavi 1986), one can see that the following equivalence holds:

\[
Q_{SG}(A, sg(B)) = Q_{SG}(A, A \cap sg(B)) = Q_{SG}(A, A \cap B) = Q_{SG}(A, B)
\]

This shows that the addition of sg has no semantic effect, and therefore that sg is unnecessary.

What about pdist? We know that pdist is needed for nouns (see (59a)), so the real question is whether pdist is needed for non-nominal predicates as well. In Winter’s original theory, when a plural quantifier combines with an atom predicate as in (86b), pdist is required to apply to the atom predicate. It turns out that in the case of (86b), this is no longer necessary in our modified framework. Let QPL be the denotation of a plural quantifying determiner, and A and B be sets of singleton sets. Then, since \(\bigcup (pdist(A)) \cap pdist(B)\) = \(\bigcup (pdist(A) \cap B)\), by

\[\text{This can be verified as follows. For all } x \text{ of type } e,\]

\[
x \in \bigcup (pdist(A) \cap pdist(B))
\]

iff \(x \in \bigcup (pdist(A) \cap B)\)

iff for some \(S\) such that \(S \in pdist(A) \cap B, x \in S\)

iff \(\{x\} \in A \cap B\)

iff \(\{x\} \in A\) and \(\{x\} \in B\)

iff \(\{x\} \in pdist(A)\) and \(\{x\} \in B\)

iff for some \(S\) such that \(S \in pdist(A)\) and \(S \in B, x \in S\)

iff for some \(S\) such that \(S \in pdist(A) \cap B, x \in S\)

iff \(x \in \bigcup (pdist(A) \cap B)\).

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(82), we have

\[ Q_{PL}(\text{pdist}(A), \text{pdist}(B)) = Q_{SG}(\text{AT}(\bigcup \text{pdist}(A)), \text{AT}(\bigcup (\text{pdist}(A) \cap \text{pdist}(B)))) = Q_{SG}(\text{AT}(\bigcup \text{pdist}(A)), \text{AT}(\bigcup (\text{pdist}(A) \cap B))) = Q_{PL}(\text{pdist}(A), B) \]

So, generally, when the first argument of a plural quantifying determiner can be expressed as \( \text{pdist}(A) \) for some set \( A \) of singleton sets (and when the main verb is an atom predicate), applying \( \text{pdist} \) to the second argument has no overall semantic effect. This is why it is redundant to apply \( \text{pdist} \) to \( \llbracket \text{sneezed} \rrbracket \) in (86b), since \( \llbracket \text{men} \rrbracket = \text{pdist}(\llbracket \text{man} \rrbracket) \).

However, when the first argument of a plural quantifying determiner cannot be expressed as \( \text{pdist}(A) \) for some set \( A \) of singleton sets, as in the following example, it is necessary to insert \( \text{pdist} \) for the second argument:

(89) All men who have interests in common sneezed.

We can thus conclude that while \( sg \) is now completely redundant, \( \text{pdist} \) is still required in some places. A natural idea may now occur that non-nominal predicates do not actually change in meaning according to their morphological number, and \( \text{pdist} \) is by default inserted at an argument position of a non-nominal predicate whenever that predicate behaves as an atom predicate with respect to that argument, irrespective of the morphological number of that predicate. This might lead to a simpler semantic theory, but we will not go deeper into this matter and leave it for future research.

### 4.4 Bound Singular Pronouns

Consider now the following sentences discussed in subsection 3.2.2:

(90) a. Their children dancing together pleased most men.
    b. His children dancing together pleased most men.

Recall that on the scenario considered, where each man has only one child, (90a) is appropriate and (90b) is not. In the modified framework of the Winter–Rullmann theory, (90a) can be analyzed as in (91a), which, taking \( \llbracket \text{most} \rrbracket \) to be as defined in (91b), translates to the truth conditions in (91c).
(91) a. \[
\left[\text{most}\right] (\left[\text{men}\right])
\]
\[
\left(\forall Y. (\forall Z. \left[ Z \text{ dancing together pleased } Y \right]) \left(\left[ Y \text{’s children}\right]\right)\right)
\]
b. \[
\left[\text{most}\right] (\mathcal{A}, \mathcal{B}) = 1 \iff \left|\text{AT}(\bigcup (\mathcal{A} \cap \mathcal{B}))\right| > \frac{1}{2} \left|\text{AT}(\bigcup \mathcal{A})\right|
\]
c. \[
\left|\text{AT}(\bigcup (\left[\text{men}\right] \cap \{Y \mid (\forall Z. \left[ Z \text{ dancing together pleased } Y \right]) \left(\left[ Y \text{’s children}\right]\right)\})\right| > \frac{1}{2} \left|\text{AT}(\bigcup \left[\text{men}\right])\right|
\]

Here, we assume\(^{19}\)

(92) \[
\left[ Y \text{’s children}\right] = \{x \in D_e \mid \exists y \in D_e [y \in Y \land x \text{ is a child of } y]\}.
\]

In words, the possessive form \(Y \text{’s children}\) denotes the set of the children of all the elements of \(Y\). In the current case, \(Y\) ranges over sets of men who each have one and only one child. \(\left[ Y \text{’s children}\right]\) therefore denotes a non-singleton, nonempty set and the plurality requirement of the predicate \(\text{dance together}\) is satisfied, if and only if \(Y\) itself is a non-singleton, nonempty set. Thus, provided that the relevant groups of men all contain more than one man, the sentence will make sense as a whole. With (91c) as its interpretation, (90a) is predicted to be true when everyone in a majority of the men belongs to a group of men who were pleased by their children (i.e. all the children of the men in the group) dancing together, as desired.

Now, how can we analyze (90b)? To account for the observation that bound singular pronouns range exclusively over singular entities, we analyze the singularity of a pronoun as a presupposition that it denote a singleton set. Combined with the semantics for \(\text{most}\), this gives us the following:

(93) \[
\left[\text{(90b)}\right] = 1 \iff
\left|\text{AT}(\bigcup (\left[\text{men}\right] \cap \{Y \mid (\forall Z. \left[ Z \text{ dancing together pleased } Y \right]) \left(\left[ Y \text{’s children}\right]\right)\})\right| > \frac{1}{2} \left|\text{AT}(\bigcup \left[\text{men}\right])\right|
\]

This interpretation makes (90b) true whenever everyone in a majority of the men belongs to a group of men each of whom was pleased by his own children dancing together. In contrast to (90a), here the variable ranging over men is restricted to singletons. This makes the possessive form \(Y \text{’s children}\) denote the set of all the children of the unique element of \(Y\). This will only satisfy the plurality requirement of the predicate \(\text{dance together}\) if each relevant value of \(Y\) is such

---

\(^{19}\)This denotation cannot be obtained by applying the operator \(\text{pdist}\) to \(\left[\text{’s}\right]\) or to \(\left[\text{child}\right]\) (assuming that \(\text{child}\) is a relational noun). We have to assume that either \(\text{’s}\) or \(\text{child}\) is behaving as a collective predicate with respect to the relevant argument. We will not give a detailed analysis here.
that its unique element has more than one child. We thus predict that the sentence should only be acceptable when there is a majority of men each of whom has multiple children and each of whom is pleased by his own multiple children dancing together. This prediction appears to be correct.

The analysis just given of (90b) takes the implication that each of the relevant men has multiple children to derive from two separate sources: the singularity of the variable \( Y \) and the plurality requirement of the predicate *dance together*. No role was given to the NP internal relation between the singular variable \( Y \) and the plural noun *children*. In particular, it was not assumed that the overt plurality of *children* presupposed a one-to-many relation between the values of \( Y \) and of \( Y \)’s (unique element’s) children. While we take this to be correct, it is far from obviously so. We therefore examine the semantics of possessive NPs more closely below to justify our analysis.\(^\text{20}\)

To show that there is no presupposition of a one-to-many relation between a singular possessor and a plural possessed noun, consider the following sentence:

(94) Every man brought his children.

This sentence can be true and appropriate in a context in which at least some of the men being quantified over have only a single child. If there were a one-to-many presupposition in the sentence, however, such a context should result in the sentence generating a presupposition failure, contrary to fact. The case can be strengthened even further by noting that the sentence remains true and appropriate in a situation where each man has only one child, provided that the speaker does not know this to be the case. With presuppositions, the speaker’s incomplete or incorrect knowledge cannot by itself overcome presupposition failure. A person who is convinced that France is a monarchy, for example, still generates a presupposition failure when uttering *The King of France is bald*.

In contrast to cases with a quantifier bound pronoun, sentences with a referentially bound pronoun or with a singular name in the possessor position give a clear and strong implication of a one-to-many relation between the possessor and his children in the following examples, at least out of the blue:

(95) a. John brought his children.

b. Mary brought John’s children.

\(^\text{20}\)While there are a wide range of cases in which an implication can arise from the choice of a singular or a plural expression, we limit our focus here to the case of a possessive NP with a singular pronoun as the possessor and number variation on the possessee. For a more detailed and general analysis of number implications cf. Sauerland et al. (2005) and Zweig (2008).
The difference between these cases and the case of (94) is sharp. Clearly it would not do, however, to give the sentences in (95) a presuppositional analysis of this implication when such an analysis so clearly fails for the quantified case in (94). We analyze these facts as cases of quantity implicatures. In particular, we analyze child as denoting a set of singleton sets and take children to denote \( \text{pdist}(\text{⟦child⟧}) \), i.e. the closure of this set under union.

Given the proposed distinction between the denotations of child and children, any set falling under the former denotation will also fall under the latter, though the reverse will fail to hold. In such situations, when a speaker chooses to use the more general term rather than the more specific one, here children instead of child, it gives rise to the implication that the more specific term was inappropriate. There are many ways a singular form could be inappropriate in sentences like (95), including the case where the number of John’s children is unknown as well as that in which John is known to have more than one child. To the extent to which the context suggests that the speaker knows how many children John has, then, the implication that John has multiple children is predicted to be strong, which is just what we find. This differs from the quantificational binding case in (94). In that case, the singular pronoun would only be appropriate if the speaker knew that every man under discussion has a single child. Any deviation from this case would be cause for employing the plural children instead of the singular child. This includes cases in which each of the men does have a unique child but the speaker is unaware of this fact, as well as cases in which at least one of the men is known by the speaker to have more than one child. These were the very cases that were seen to allow (94) in the first place and to argue against a presuppositional analysis of the number relation between possessor and possessed noun. The fact that (94) is predicted to be allowed in these cases is thus strong support for the quantity implicature analysis of that relation.

We are now ready to return to our original example in (90b). We have just argued that the relation between a possessor and a possessed noun gives rise to a quantity implicature. What is this implicature predicted to look like in (90b)? We can best answer this question by eliminating the stronger plurality presupposition induced by the predicate dance together as in (96).

\[(96) \quad \text{His children dancing pleased most men.}\]

This example differs from (90b) only in containing the atom predicate dance in place of the plural predicate dance together. We observe that this difference makes for a subtle but clear difference in the number-related implications of the sentence.
Where (90b) implies that each man in some majority of the men has multiple children, (96) allows for the same kinds of possibilities that we saw earlier with (94). In particular, the sentence is acceptable when the speaker fails to know the number of children that each man has, even if it turns out that each man has exactly one child. It is also acceptable when the speaker knows the exact number of children that each man has, provided that at least one of the men has more than one child. The quantity implicature in (96) is clearly much weaker than the presupposition induced by the plural predicate in (90b), making the quantity implicature difficult to detect in the latter example. If our assumptions are correct, however, then even in the latter case there is a quantity implicature.

5 Consequences and Conclusions

We saw in section 2 that binding of a singular pronoun by a plural quantifier is possible whenever the pronoun precedes the quantifier and is in a position where it could be bound if the plural quantifier were replaced by a singular quantifier as well. We also saw several cases in which such a binding relation can be extended, either through movement or through contrast. Without giving a formal characterization of the exact conditions in which such binding is possible, we argued that the fact that it is possible suggests that plural quantifiers must be able to semantically bind singular pronouns. We showed in section 4 that this suggestion is incompatible with the analyses of Winter and Rullmann, who posit a semantic difference between singular and plural interpretations that makes such binding impossible. We proposed what we take to be the minimal modifications needed to these theories to allow for such binding.

The most far-reaching change proposed was to analyze singular denotations as based on singleton sets of individuals rather than on individuals. While this simplifies the types of expressions since singular denotations are now of the same semantic type (and sort) as plural denotations, it also requires making additional changes in the semantics of singular quantifiers as well as of several covert operators posited by Winter. We gave concrete re-analyses of \textit{pdist}, \textit{sg} and singular quantifiers, and showed that in the resulting semantics the \textit{sg} operator can be dispensed with. We also suggested that \textit{pdist} might apply by default to all non-nominal argument positions of a predicate that act as atom predicates with respect to that position, though we left the consequences of such a suggestion unexplored in this paper.

The semantics of plurality that was developed in section 4 allows for unre-
stricted binding of singular pronouns in the scope of a plural quantifier. The many cases seen in which such binding was impossible, however, present clear evidence that restrictions are needed. If the semantics given is on the right track, these restrictions cannot be reduced to a semantic type / sort distinction between singular pronouns and plural quantifiers. This in turn suggests that the restrictions are not semantic in origin. We suspect that the restrictions observed are ultimately syntactic in nature. The core data examined in section 2.1 as well as the generalization these data were taken to support suggest that the restrictions are connected with the phenomenon of cataphora, i.e. anaphoric dependence of a pronoun on something that follows it. The limited cases examined in section 2.2 in which a singular pronoun can be bound by a plural quantifier to its left, however, show that the dependences in question cannot be characterized in simple terms of surface linear order. Ultimately we hope to be able to derive the restrictions observed as consequences of the normal operation of mechanisms of anaphora. At present, however, we do not have such an analysis that accounts for the full range of binding facts found in section 2, and put off the development of such an analysis to future work.

References


