PREDICATE-ARGUMENT MISMATCHES
AND THE ADJECTIVAL THEORY OF INDEFINITES

Fred Landman
Tel Aviv University

1. TWO THEORIES OF ARGUMENTS AND PREDICATES

In her influential paper Partee 1987, Barbara Partee introduced the notions of argument type and predicate type for the interpretation of noun phrases, and she proposed that the types available for the interpretation of noun phrases in argument position (like *three girls* in (1a)) are type d of (singular (= atomic) and plural) individuals and <<d,t>,t> of generalized quantifiers, while the type available for the interpretation of noun phrases in predicative position (like *three girls* in (1b)) is type <d,t> of sets of individuals.

(1) a. *Three girls* walked
  b. The guests were *three girls*.

In this paper, I will adopt this proposal and discuss the relative merits of two alternative ways of giving content to it.

The first theory I call Montague-Partee: it is (the core of) the proposal in Partee 1987, which consists of Partee's theory of predication, combined with the generalized quantifier theory of determiners, both of which ultimately derive from Montague 1970, 1973 (the second through Barwise and Cooper 1981).

The other theory I call the Adjectival Theory of indefinite determiners. My causal chain for this name goes back to what I expect to be an initial baptism by Barbara Partee in her marginalia to a first draft of a paper by Godehard Link in the mid eighties. I mention this, because the unpublished debate between Partee and Link forms, as will become clear, the most direct inspiration for this paper. In published work, versions or traces of the Adjectival Theory can be found in Bartsch 1973, Bowers 1987, and, most explicitly, Bittner 1994.

Both theories consist of a theory of determiners (A), and a type shifting theory (B).

MONTAGUE-PARTEE (MP)

MP PRINCIPLE A: THE GENERALIZED QUANTIFIER THEORY OF DETERMINERS

All noun phrase interpretations are born at argument types.

The type of **quantificational** and **indefinite** determiners is the type of relations between sets of individuals: <<d,t>,<<d,t>,t>>.

every → $\lambda Q \lambda P.\forall x \in Q$: ATOM(x) $\wedge$ P(x)

The relation that holds between two sets Q and P iff every element of Q is an atomic individual that has P.

three $\rightarrow$ $\lambda Q \lambda P\ \exists x \in Q\colon\ |x|=3\ \wedge\ P(x)$

The relation that holds between two sets Q and P iff some element of Q is a sum of three individuals having P. This means that quantificational and indefinite noun phrases are generated at the argument type <<d,t>,t>.

A large part of Partee's paper is concerned with the interpretation of the definite article. Since in the present paper that will only be of marginal interest, I will assume only the lowest interpretation that Partee considers: the **definite** determiner is the sum operation of type <<d,t>,d>:

the $\rightarrow$ $\lambda Q.\sigma(Q)$

The function that maps Q onto the sum of its elements if that is in Q, and is undefined if not. This means that definite noun phrases are generated at the argument type of individuals, d.

MP PRINCIPLE B: THE PARTEE TRIANGLE:

Predicate interpretations of noun phrases are derived from argument interpretations with type lowering operation BE.

ARGUMENTS PREDICATES

$$\begin{tikzcd}
\mathbf{<<d,t>,t>} \arrow[dr, "\mathbf{BE}"] & \\
& \mathbf{<d,t>} \\
\mathbf{d} \arrow[uu, "\text{LIFT}"] \arrow[ur, "\text{IDENT}"'] &
\end{tikzcd}$$

$\text{LIFT}[\alpha]\ = \lambda P..P(\alpha)$
$\text{IDENT}[\alpha] = \{\alpha\}$

$\text{BE}[\alpha] = \{x \in D\colon \alpha(\{x\})\}$

(The logical language used here is the Language of Plurality from Landman 2000, without distinguishing properly between function types and set types: e.g. Partee's $\lambda x.x=\alpha$ is written as $\{\alpha\}$.) The type shifting operation BE takes a generalized quantifier and maps it onto the set of individuals for which the property of being that individual is in that generalized quantifier.

THE ADJECTIVAL THEORY (AT):

AT PRINCIPLE A: ADJECTIVAL SEMANTICS OF INDEFINITES

Indefinite noun phrases are born at the predicate type.

Quantificational and **definite** determiners are interpreted as in MP as relations between sets. But **indefinite** determiners are interpreted at type <d,t>, the type of sets of individuals. This is the same type as that of adjectives, and semantically indefinite determiners combine with the noun through **intersection**:

three → {x∈D: |x|=3}   of type <d,t>

The set of plural individuals consisting of three atoms.

girls → *GIRL   of type <d,t>

The set of all plural individuals that consist solely of girls. (* is the pluralization operation, it maps the set of individual girls onto the set of sums of individual girls.)

three girls → {x∈D: |x|=3} ∩ *GIRL

The set of all sums of girls each consisting of three individuals.

This means that quantificational and definite noun phrases are born at argument types, but that indefinite noun phrases are born at the predicate type <d,t>.

AT PRINCIPLE B: THE EXISTENTIAL CLOSURE TRIANGLE

> **Argument interpretations of indefinite noun phrases are derived from predicative interpretations through type lifting with Existential Closure.**

ARGUMENTS   PREDICATES

$$\begin{tikzcd} \langle\langle d,t\rangle,t\rangle & \\ & \langle d,t\rangle \arrow[ul, "EC"'] \\ d \arrow[uu, "LIFT"] \arrow[ur, "IDENT"'] & \end{tikzcd}$$

LIFT,IDENT as above

$EC[\alpha] = \lambda P.\exists x \in (\alpha \cap P)$

The type shifting operation EC takes a set α of individuals and maps it onto a generalized quantifier: the set of all sets that have a non-empty intersection with α.

The comparison between MP and AT will take the form of two matches and a play-off. The first match is a match played at high speed in the next section.

2. THE FIRST MATCH

2.1. THE INFELICITY OF QUANTIFICATIONAL PREDICATES

As is well-known, quantificational noun phrases in predicate position are infelicitous:

(2) #Nirit is *every semantics professor at the party.*

This is a point in favor of the Adjectival Theory, because it predicts this: since in AT there is only **type lifting** and no **type lowering** and quantificational noun phrases start out at type <<d,t>,t>, they cannot be shifted to the predicate type.

SCOREBOARD	**MP**	**AT**
MATCH ONE	**0**	**1**

However, Partee 1987 gives a semantic argument explaining why quantificational noun phrases are infelicitous as predicates (in terms of their meanings, rather than their type). I will discuss this argument below. For the moment, I will assume that the possibility of such a semantic explanation equals the score:

SCOREBOARD	**MP**	**AT**
MATCH ONE	**1**	**1**

2.2. THE FIRST MISMATCH: *AT LEAST* AND *EXACTLY* INTERPRETATIONS

As is well known (see Horn 1972), in **argument position** numerical noun phrases like *three girls* have an *at least* interpretation, and an *exactly* implicature (which is shown by the felicity of (3a), where the *exactly* effect is canceled). As mentioned in Partee 1987, it has been observed that in **predicate position** these numerical noun phrases have an *exactly* interpretation (as shown by the infelicity of (3b), where the *exactly* effect cannot be canceled). (This observation seems to be due to Barbara Partee or Nirit Kadmon, or both.)

(3) a. Three girls came in, in fact, four girls came in.
b. #The guests are three girls, in fact, they are four girls.

In Montague-Partee this can be readily accounted for. You generate at the argument type <<d,t>,t> distinct interpretations for *three girls* and *exactly three girls*, and make sure to choose them in such a way that type lowering operation BE maps them onto the very same set of individuals.

These facts are a problem, however, for the Adjectival Theory. In AT, indefinite noun phrases start out at the predicate type. But what the facts show is that at that type *three girls* and *exactly three girls* denote the same set $\{x \in {}^*GIRL: |x|=3\}$. Since the type lifting operation EC is a function, it cannot map this onto the two argument interpretations we want:

three girls $\rightarrow$ $\lambda P.\exists x \in {}^*GIRL: |x|=3 \wedge P(x)$
exactly three girls $\rightarrow$: $\lambda P.\exists x \in {}^*GIRL: |x|=3 \wedge P(x) \wedge \forall y \in {}^*GIRL \cap P: y \sqsubseteq x$

The conclusion is that AT must replace type shifting operation EC by an operation that is sensitive to more than just the predicate meaning. This is, of course, a disadvantage.

SCOREBOARD	**MP**	**AT**
MATCH ONE	**2**	**1**

2.3. DOWNWARD ENTAILING NOUN PHRASES: *AT MOST THREE GIRLS*

The Adjectival Theory predicts the wrong entailments for downward entailing noun phrases like *at most three girls*:

$EC[\ \{x \in {}^*GIRL: |x| \leq 3\}\ ] = \lambda P.\exists x \in {}^*GIRL: |x| \leq 3 \wedge P(x)$.

With this interpretation, (4a) means: there is some sum of girls, consisting of at most three individuals, each of which walk. It can readily be seen that, on this interpretation, (4a) incorrectly entails (4b), and incorrectly does not entail (4c):

(4) a. At most three girls walked.
b. Some girl walked.
c. Not more than three girls walked.

SCOREBOARD	MP	AT
MATCH ONE	3	1

2.4. NEGATIVE NOUN PHRASES: *NO GIRL*

The Adjectival Theory predicts the wrong meaning for negative noun phrases like *no girl*. As Partee 1987 points out, if, following MP, you take the standard (singular) interpretation of *no girl* at type <<d,t>,t>, and lower it to a predicate with BE, you get what seems to be the correct predicate interpretation:

$BE[\ \lambda P.\neg\exists x \in GIRL: P(x)\ ] = ATOM\text{-}GIRL$

The set of singular individuals which are not girls. On the other hand, if, in AT, you start out with that set as the interpretation for *no girl* at type <d,t>, and you lift it with EC to <<d,t>,t>, you obviously get the wrong interpretation:

$EC[\ ATOM\text{-}GIRL\ ] = \lambda P.\exists x \in ATOM\text{-}GIRL{:}P(x)$

The set of properties that some non-girl has.

SCOREBOARD	MP	AT
MATCH ONE	4	1
WINNER: MONTAGUE-PARTEE		

3. WHITHER THE ADJECTIVAL THEORY

If the prospective for the Adjectival Theory is this bad, one can well wonder why anyone would be attracted to this theory in the first place, and why with rather great regularity it keeps being proposed as an alternative to Montague-Partee. The answer to this lies in the syntax and semantics of numeral phrases in nominals (like *three girls* in the noun phrase *the three girls*) and their relation to predicates. In this section I will point out why the Adjectival Theory **is** attractive, without, unfortunately having the space to belabor any of the points I will make (though some of the points made will be illustrated later in this paper).

ATTRACTION 1: The most persuasive thing about the Adjectival Theory is that it fits naturally with the theory of plural nouns and determiners developed by Link 1983 and others, and that the combination of the two is very successful in effortlessly, and without stipulation, predicting the correct semantics for nominal numerical phrases. To say it the other way round: there are many arguments to show that inside a noun phrase like *the NUMERICAL PHRASE girls*, numerical phrases like *three*, *exactly three*, *at least three*, *at most three*, etc. behave semantically like intersective adjectives, intersecting with the interpretation of the plural head noun *girls*.

ATTRACTION 2: There are many arguments that the semantics of numerical predicates (i.e. *three girls* in (1b)), and numerical nominals (i.e. *three girls* in *the three girls*) is exactly the same. (For instance, *the three girls* means *the exactly three girls*, and not *the at least three girls*.) This is, of course, directly predicted by the Adjectival Theory, which assigns the numerical nominal and the numerical predicate the same semantics at type <d,t>.

ATTRACTION 3. The only difference between numerical nominals and numerical predicates seems to be syntactic: in the numerical nominal, numeral phrases can mingle with adjectives (as shown in (5)), while numerical predicates pattern with numerical argument in that for them the numeral phrase must be initial (as shown in (4)).

(4) a. The animals in the shipment were *fifty ferocious lions*.
b. *The animals in the shipment were *ferocious fifty lions*.
(5) a. We shipped the *fifty ferocious lions* to Blijdorp, and the *thirty meek lions* to Artis.
b. We shipped the *ferocious fifty lions* to Blijdorp, and the *meek thirty lions* to Artis.

Of course, there are subtle and hard to pinpoint interpretation differences between the (5a) and (5b) cases. However, it seems that most of these can be attributed to contextual interpretation factors that we know are operative in the adjectival domain anyway, like focus, contrast, comparison set, etc. That is, we find such interpretation differences also when we consider strings of normal adjectives. The point about (4) and (5) is the contrast: (4b) is crashingly bad, while (5b) is not.

The facts in (5b) form an argument in favor of the AT analysis for numerical nominals ([*the* [*three girls*]]) and against the analysis of the numerical as part of a complex determiner ([[*the three*] *girls*]) (e.g. Barwise and Cooper 1981, Keenan 1987): the complex determiner analysis does not predict the felicity of the order in (5b).

(There is one exceptional case here: there are solid syntactic and semantic arguments for assuming that *every three* in *every three lions* patterns both syntactically and semantically as a complex determiner.)

ATTRACTION 4. The difference between (4) and (5) is a left-periphery effect and can be accounted for syntactically very easily in terms of the NP/DP distinction. We only need to make three simple assumptions, of which the first is in essence AT:

ASSUMPTION 1: *three girls* in *the three girls* is an NP, with *three* a numerical adjective. This predicts that inside the NP mingling with other adjectives is possible.

ASSUMPTION 2: The predicate *three girls* has a DP-layer with an empty determiner D. This tells you that predicate and argument noun phrases are DPs and not NPs.

ASSUMPTION 3: In the DP with empty D, the numerical adjective must move into the DP-layer. This assumption basically says that there is a left-periphery effect in noun phrases where the determiner is not lexically realized: movement is triggered from the NP-layer into the DP-layer.

For my purposes here, I can leave the actual syntax to be assumed here very much underspecified. I am not taking a stand on where the numerical lands in the DP-layer. This means that the assumption is still compatible with a wide range of syntactic implementations. It is worthwhile pointing out, though, that an account along these lines is syntactically rather 'mainstream': it is obviously inspired by the pretty much standard account of left-periphery effects in the verbal domain in Dutch and German (the verb second effect).

With this assumption, the ordering facts about numerical predicate and argument noun phrases follow straightforwardly: if the numerical is in the DP-layer in those noun phrases, it cannot mingle with adjectives which are in the NP-layer.

(This account assumes that *every* and *the* are D-elements. It assumes an intersective semantics for the indefinite article *a* (e.g. $a \rightarrow$ ATOM). It does not take a stand on the syntax of *a*, i.e. on the question of whether or not it is a determiner.)

CONCLUSION: The Adjectival Theory with a little bit of syntax predicts the right syntax and semantics for numerical nominals and numerical predicates, without the stipulations that we commonly find in Generalized Quantifier Theory (and hence its descendant Montague-Partee).

It seems that these considerations are strong enough to modify the score a bit: one more point for the Adjectival Theory:

SCOREBOARD	**MP**	**AT**
INTERMISSION	**4**	**2**

In the next two sections the second match is played. This match consists of playing the first match over, but more slowly now. The game is to re-evaluate the points assigned in the first match. For that reason, while in the first match we handed out points, in the second match we are going to take points away.

4. THE SECOND MATCH: PREDICATE-ARGUMENT MISMATCHES

4.1. MISMATCHES FOR QUANTIFICATIONAL PREDICATES

We come back to the infelicity of sentence (2):

(2) #Nirit is every semantics professor at the party.

Partee 1987 points out the following fact about her type shifting operation BE: if you have a noun phrase of the form *every NOUN*, then applying BE to its generalized quantifier interpretation will give you a trivial interpretation (the empty set), unless the interpretation of the noun is a singleton set.

Partee argues that, while the determiner *every* does not contribute as part of its truth conditional semantics a restriction to non-singletons on its complement noun, there is reason to consider the possibility that the determiner *every* contributes a **presupposition** that its complement noun is restricted to non-singleton sets.

If so, we can explain why quantificational predicates like the one in (2) are infelicitous: *every* presupposes that *semantics professor at the party* is a non-singleton. Lowering this interpretation with BE to a predicate either violates the presupposition (leading to infelicity), or yields a systematically trivial predicate (which is also assumed to be infelicitous).

The problem with this account lies in the assumption that the restriction to non-singletons is a presupposition. Standardly, the restriction of the quantifier *every* on its complement noun is regarded as an implicature rather than a presupposition (e.g. a standard introduction text like Chierchia and McConnell-Ginet 1990). Winter 1998 discusses Partee's account directly, and provides strong evidence that the account doesn't work. Example (6) is modeled on Winter's example. A standard argument about canceling of implicatures shows that, when the quantificational noun phrase is in argument position, the non-singleton condition cannot be more than an implicature: (6a) is felicitous, showing that the effect gets canceled. On the other hand - and this is the strength of Winter's argument - Winter shows that in the very same canceling context the quantificational predicate stays infelicitous: (6b) is infelicitous:

(6) a. If Fred and Tanya weren't at the party, and Nirit was, then every semantics professor at the party danced.
b. #If Fred and Tanya weren't at the party, and Nirit was, then Nirit was every semantics professor at the party.

(6a) shows that the effect can be canceled, when the noun phrase is in argument position, arguing strongly that it is an implicature. But then, if in (6b) we lower the interpretation of the quantificational noun phrase to a predicate, the result should not be infelicity, but merely canceling of the implicature: that is, (6b) should be felicitous and should not have the implicature that there is more than one semantics professor at the party. But that prediction is wrong: (6b) is infelicitous.

What we see here is that we find a **mismatch** between the argument and the predicate interpretation of the quantificational noun phrase *every semantics professor at the party*: the argument interpretation is felicitous, but the predicate interpretation is not. This mismatch is not explained by Montague-Partee. In the Adjectival Theory there is no lowering operation from <<d,t>,t> to <d,t>, and hence (2) and (6b) are infelicitous. Thus, we take back the point that we assigned for this in match one to Montague-Partee:

SCOREBOARD	**MP**	**AT**
MATCH TWO	**3**	**2**

4.2. MISMATCHES FOR DOWNWARD ENTAILING NUMERICAL NOUN PHRASES.
For noun phrases like *at most three girls* we find a mismatch not of felicity, but of interpretation. The crucial mismatch that I want to draw attention to here is that while these noun phrases are (of course) downward entailing in **argument** position, they are not downward entailing in **predicate** position.

This can be seen by looking at the distribution of polarity sensitivity items. (7a), where the numerical noun phrase is in argument position, shows the standard fact about *at most three*: the polarity item *ever* is only felicitous in a downward entailing context; since (7a) is felicitous, this shows that the numerical noun phrase in argument position is downward entailing.

But in (7b) the numerical noun phrase is in predicate position, and (7b) is infelicitous. This shows that the numerical noun phrase in predicate position is not downward entailing:

(7) a. At most three scientists who ever got the Nobel Price were at the party.
b. #The guests were at most three scientists who ever got the Nobel Price.

The observation can be shown directly as well. *At most three girls* in argument position, of course, passes the standard tests for downward entailingness. But in predicate position it behaves like an intersective predicate, and that means that it is not downward entailing. Look at the examples in (8):

(8) a. The congregants are at most seven Jewish men.
b. The congregants are men.

Suppose the congregants are 7 men and 15 women. An orthodox rabbi checks whether there is a minyan (for him, 10 Jewish men, for others, 10 Jewish persons), and sneeringly he says (8a). The reaction of my women informants to this set up is outrage, but importantly, **not** because the rabbi refuses to recognize non-orthodox minyans, **but** because he fails to count the presence of the women among the congregants in the first place: in the situation sketched (8a) is false, because the congregants actually include 15 women, and that shows that (8a) entails (8b). But this is an **upward** entailment, showing that *at most seven Jewish men* is not downward entailing in (8b).

The same facts can be replicated for numerical nominals as well: *at most three girls* in *the at most three girls* is not downward entailing, but is an intersective predicate (it denotes the set of sums of girls that consist of at most three atoms). These facts illustrate that indeed the adjectival semantics is correct for numerical predicates and numerical nominals. We see then that we have the following two interpretations:

at most three girls :
ARGUMENT INTERPRETATION: $\lambda P.\neg\exists x \in {}^*\text{GIRL}: |x|>3 \wedge P(x)$
The set of properties that no sum of more than three girls has (downward entailing).
PREDICATE INTERPRETATION: $\{x \in {}^*\text{GIRL}: |x|\leq 3\}$
The set of sums of girls consisting of at most three singular individuals (intersective).

The problem for Montague-Partee is the following logical fact:

There is no type shifting operation which derives the correct predicate interpretation from the argument interpretation in all relevant cases.

This means that Partee's type shifting operation BE doesn't do it. It also means that the alternative operation MIN proposed in Winter 1998 doesn't do it either.

The problem is a problem of **mismatch** in polarity: because the argument interpretation is downward entailing and the predicate interpretation is not, there will be contexts where the argument interpretation is trivial, but the predicate interpretation is not trivial. But it is a fact of logic that you cannot derive with a type shifting operation a non-trivial predicate interpretation from a trivial argument interpretation. Look at (9):

(9) a. At most 50 girls were at the party.
b. The guests were at most 50 girls.
c. The guests were girls.

Suppose that there are 20 girls. In that case, the downward entailing argument interpretation of *at most 50 girls* is trivial (the set of all sets). This predicts correctly that (9a) is trivially true. However, the predicate interpretation of *at most 50 girls* is *GIRL. This predicts correctly that (9b) is not trivial: in such contexts (9b) is equivalent to (9c).

There is a illuminating reformulation of the problem. Suppose that there are 20 girls and 20 boys. In that case, the **argument** interpretations of *at most 50 boys* and *at most 50 girls* are the same (the set of all sets), but the **predicate** interpretations are not (the set of all sums of boys and the set of all sums of girls respectively). But, of course, no **function** can map the same input onto two outputs, and since the type lowering operation is assumed to be a function, no type shifting operation can.

There is a solution readily available to Montague-Partee. Instead of assuming a simple type shifting operation, we can assume an only slightly more complex operation of Predicate Formation which takes as input the argument interpretation at type <<d,t>,t> **and the noun interpretation that the argument is based on:**

Let α = (DET(NOUN)) of type <<d,t>,t>
PRED[α] = NOUN ∩ BE(α)

If α is *at most fifty girls* then its <<d,t>,t> interpretation is, in the context given, the set of all sets, and BE[α] is D. Then PRED[α] = *GIRL ∩ D = *GIRL.

This works, but now we have equaled this particular score with the Adjectival Theory: we gave Montague-Partee a point because the mismatch between *at least* and *exactly* interpretations forces the Adjectival Theory to make the type shifting operation sensitive to aspects of the interpretation not accessible to a standard type shifting operation (like the noun interpretation). We see now that we have to make exactly the same assumption, if we adopt Montague-Partee. We take back the point:

SCOREBOARD	MP	AT
MATCH TWO	2	2

4.3. MISMATCHES FOR NEGATIVE NOUN PHRASES.

There is a further problem for this reformulation of Montague-Partee. As argued above, for the generalized quantifier interpretation of *no girl*, Partee's operation BE gives an acceptable result. However, the new operation PRED does not give an acceptable result for *no girl*: the intersection of the set of non-girls with the interpretation of *girl* is, of course, empty. This means that, like the Adjectival Theory, Montague-Partee is forced into a theory which gives a **non-unified** account to different indefinite noun phrases (i.e. some shift with PRED and some shift with BE). Hence, Montague-Partee is not a more unified theory than the Adjectival Theory.

When it comes to negative noun phrases, I think that every theory will have to do something special. And this doesn't bother me much, because I think there is a lot of evidence that they actually **are** special. Let me in the briefest of ways sketch how the Adjectival Theory can deal with negative noun phrases.

NEGATIVE NOUN PHRASES IN THE ADJECTIVAL THEORY:

ASSUMPTION 1: The interpretation of *no* is negation: $\neg$. The interpretation of the predicate *no girl* at type <d,t> is formed through **composition**: $\neg$ o GIRL, the set of non-girls.

ASSUMPTION 2: The grammar treats the nominal negation as being **semantically separable**. This point has been made many times in the literature. Landman ms. a 1998 discusses lots of evidence from Dutch, but also from English, which shows that the nominal negation can take higher (often auxiliary) scope, while the remaining noun phrase material remains interpreted in situ.

ASSUMPTION 3: This semantic separation takes place in the process that lifts the predicate interpretation to the argument interpretation: the type lifting operation does not apply to the composition of $\neg$ and the indefinite noun phrase; instead, the negation is separated: the type lifting operation applies to the interpretation of the indefinite noun phrase, and the negation is composed with the result; the argument interpretation is: $\neg$ o EC[GIRL]. This, of course, gives the correct argument interpretation for *no girl.*

The conclusion is: everybody needs to do something special for negative predicates, the Montague-Partee theory is not more unified here than the Adjectival Theory. Moreover, what the Adjectival Theory can do fits with a battery of facts about semantic separability of nominal negation. This means that one more Montague-Partee point goes:

SCOREBOARD	**MP**	**AT**
MATCH TWO	**1**	**2**

5. THE TYPE SHIFTING THEORY OF EXISTENTIAL CLOSURE, MAXIMALIZATION, AND THE NULL-OBJECT.

Let us now come to the mismatch in *exactly* effects and to the problems in getting the interpretation of *at most three girls* right.

The very same problems have been discussed in Landman 1998, 2000 in the context of the operation of Existential Closure over the event argument in neo-Davidsonian theories of events and plurality. What I claim is that these problems are **general** problems of existential closure operations, and the techniques developed in Landman 2000 can be adapted to the present case. In fact, the analysis here will be simpler than that in Landman 2000 for two reasons.

In the first place, I will be using a 0-object here, which allows me to simplify the general maximalization operation from Landman 2000 (but if you don't like the 0-object, you can take the more complex operation of Landman 2000 and get the correct semantics too).

Secondly, in this paper I am only concerned with the problem of getting the meanings right in shifting from <d,t> to <<d,t>,t>. This means that I am ignoring the complicated interactions between multiple noun phrase arguments of a verb that the theory in Landman 2000 addresses. Since it seemed didactic overkill to expose the reader to the ins and outs of the complex operation when only using it in a simple case, I have simplified it to fit the present case. The resulting simplification is close to a proposal in Kadmon 1987 (which derives partially from suggestions by Barbara Partee and Hans Kamp). This similarity is not surprising, because Kadmon 1987 was one of the main inspirations for my own work on maximalization. But the general theory is less similar to Kadmon 1987, and, as discussed in Landman 2000, more similar to work on maximalization in Krifka 1989, ms. 1989 and Bonomi and Casalegno 1993.

ASSUMPTIONS ABOUT PLURALITY

The plurality structures I will assume are complete atomic Boolean algebras **including a 0-object**. Singular nouns denote sets of atomic individuals. Pluralization is closure under sum:

$*GIRL = \{x \in D: \exists Y \subseteq GIRL: x{=}\sqcup Y\}$

This means that the 0-object is an element of the denotation of the plural noun. It will be eliminated from the denotation when later we intersect the noun with the denotation of *three*, but not when we intersect with the denotation of *at most three*.

For simplicity, I will restrict myself to distributive cases: thus, in my expressions, λP will range over plural verbal interpretations (which will include the 0-object). Of course, I owe the reader an account of how the 0-object interacts with collectivity, and in general, how the 0-object affects interpretation. I assume minimally that contextual restriction on predicates can exclude the 0-object from denotations. A more general approach, which allows pragmatic manipulation of the 0-object under a pragmatic principle of Avoid Triviality, has very interesting and surprising consequences for the analysis of presuppositions (in particular, problems of local accommodation). I have no space here to go into any of this.

THE GRAMMAR OF NUMERICAL NOMINALS AND PREDICATES

I assume that the semantics of numerical noun phrases is based on a **numerical relation**, a relation between numbers, which is lexically realized by *at least*, *at most*, *exactly*, etc., and which is semantically present, but not lexically realized in *three girls* (for simplicity, I assume that *three girls* is generated as *Ø three girls*):

at least $\rightarrow \geq$; *at most* $\rightarrow \leq$; *exactly* $\rightarrow =$; *Ø* $\rightarrow =$

Secondly, I assume that these phrases are marked in the grammar by a feature +R or -R, indicating whether or not the numerical relation is lexically realized. I assume further that this feature percolates up in the grammar.

+R: the numerical relation is **lexically realized**.
-R: the numerical relation is **not lexically realized**.

NUMERICAL MODIFIERS:

[SYNTAX ,	SEMANTICS,	FEATURE]
[Ø	, =	, -R]
[*exactly*	, =	, +R]
[*at least*	,≥	, +R]
[*at most*	, ≤	, +R]

A numerical modifier (NM) expressing numerical relation r forms with a number expression (N) a numerical adjective phrase (AP[+NUM]), with interpretation: the set of sums whose cardinality stands in relation r to the denotation of the number expression.

The realization feature R inherits up:

NM	+	N $\rightarrow$	AP[+NUM]
$[\alpha$,r,R]	+	$[n$,n] $\rightarrow$	$[\,[\alpha\ \mathrm{n}], \{x \in D: |x|\ r\ n\}\ ,R]$

A numerical adjective phrase combines with a noun phrase in the normal way. Semantically the denotations intersect. The realization feature R inherits up. At this point, we have formed the **numerical nominal**: an NP with set interpretation, which can be the complement of a determiner. We form the **numerical predicate** by forming a DP with an empty determiner D and our numerical NP, and moving the AP[+NUM] into the DP-layer. I assume that this does not change the interpretation. The realization feature R inherits up. This gives us the following predicative DPs:

[Ø	*three girls,*	$\{x \in *GIRL: \lvert x \rvert = 3\}$,	-R]
[*exactly*	*three girls,*	$\{x \in *GIRL: \lvert x \rvert = 3\}$,	+R]
[*at least*	*three girls,*	$\{x \in *GIRL: \lvert x \rvert \geq 3\}$,	+R]
[*at most*	*three girls,*	$\{x \in *GIRL: \lvert x \rvert \leq 3\}$,	+R]

Of these, only the last one contains the 0-object in its denotation.

I assume that **argument DPs** have the same syntax as predicate DPs. We form the argument interpretation from the predicate semantics **and realization feature R**. I replace the type shifting operation of existential closure by an operation of **argument formation** which is the result of integrating two operations: **existential closure** and **maximalization.** Both operations turn a set expression into a statement:

EXISTENTIAL CLOSURE: EC: $<d,t> \rightarrow t$
EC[X] $= \exists x \in X$ Something is in X
MAXIMALIZATION: MAX: $<d,t> \rightarrow t$
MAX[X] $= \sqcup X \in X$ The sum of X is in X

The idea of **argument formation** is the following. It maps the interpretation of the predicate noun phrase and its realization feature onto a pair of generalized quantifiers. The first element of this pair is the argument interpretation (and that is the only one we will be concerned with), the other element is what I call the implicature-core, the information that can form the basis for an exactly implicature.

What argument formation does depends on the realization feature:

-if the realization feature is +R, the numerical relation that the numerical DP is based on is lexically realized, and then argument formation forms a generalized quantifier through existential closure **and** maximalization. (In this case the implicature core is trivial.)

-if the realization feature is -R, the numerical relation that the numerical DP is based on is not lexically realized, and then argument formation forms a generalized quantifier through existential closure only, storing the maximalization information as an implicature core.

In general, the idea is that both existential closure and maximalization are part of the semantics of indefinite argument DPs, unless the numerical relation is not lexically realized (in which case maximalization is only an implicature).

ARGUMENT FORMATION

ARG: $<d,t> \times \{+R,-R\} \rightarrow <<d,t>,t> \times <<d,t>,t>$

$$\mathrm{ARG}[\alpha,+R] = \ <\lambda P.EC[\alpha \cap P] \wedge MAX[\alpha \cap P], \quad \lambda P.P=P \quad >$$
$$\mathrm{ARG}[\alpha,-R] = \ <\lambda P.EC[\alpha \cap P], \quad \lambda P.MAX[\alpha \cap P]>$$

Two more remarks about the simplification. In the first place, in the present theory MAX entails EC. This is due to the 0-object, and it is precisely where the operation in Landman 2000 (which does without the 0-object) differs. Secondly, the general operation of maximalization in Landman 2000 is more to the point, in that you can show that in the general case you must maximalize **relative to the numerical relation**. Thus, the general operation makes sense of the dependency of the operation on the realization feature R, in a way that the present simpler implementation does not. Thus, indeed, I am using the simplification because it suffices to make my point, but I am really assuming the general operation.

This gives the following argument DPs:

1. *at least three girls*:
$\geq$ is upward entailing. Hence EC($\alpha \cap$ P) entails MAX($\alpha \cap$ P). We get, after simplification:
at least three girls $\rightarrow \lambda P.\exists x \in *GIRL: |x| \geq 3 \wedge P(x)$
The set of properties that some sum of at least three girls has.
2. *three girls*:
= is not lexically realized: maximalization is an implicature.
three girls $\rightarrow \lambda P.\exists x \in *GIRL: |x|=3 \wedge P(x)$
The set of properties that some sum of three girls has. Since this is compatible with a sum of more girls having those properties, we get an *at least* reading (and an *exactly* implicature).
3. *exactly three girls*:
= is lexically realized: maximalization is part of the meaning.
exactly three girls $\rightarrow \lambda P.\exists x \in *GIRL:|x|=3 \wedge P(x) \wedge$
$\sqcup\{x \in *GIRL:|x|=3 \wedge P(x)\} \in \{x \in *GIRL:|x|=3 \wedge P(x)\}$
This means:
exactly three girls $\rightarrow \lambda P.| \sqcup (*GIRL \cap P)|=3$
The set of all properties for which there are exactly three girls having that property.
4. *at most three girls*:
$\leq$ is downward entailing. Since the 0-object 0 is in $\alpha \cap$ P, the statement EC($\alpha \cap$ P), which is $\exists x \in (\alpha \cap P)$, is a tautology (because obviously there is something, namely 0, in that set). Hence, we correctly predict that we do not get an existence entailment: we get only a maximalization meaning:
at most three girls $\rightarrow \lambda P.| \sqcup (*GIRL \cap P)| \leq 3$
The set of all properties for which there are at most three girls having that property (and this includes properties that zero girls have).

CONCLUSION: Argument shift integrates existential closure and maximalization.

Maximalization of the numerical relation is made part of the meaning if this relation is lexically realized. What we see is that while the Adjectival Theory runs into serious technical problems if it assumes Existential Closure as its type lifting operation, these problems are resolved if we replace existential closure by Argument Formation. This means that we take back the last point from Montague-Partee:

SCOREBOARD	**MP**	**AT**
MATCH TWO	**0**	**2**

WINNER: ADJECTIVAL THEORY + MAXIMALIZATION

6. SLUGGING IT OUT: CONJUNCTIVE PREDICATES

We are now concerned with conjunctive predicates, as in (10):

(10) The guests are *three boys and four girls*.

While we are assuming that *three boys* and *four girls* denote sets at type <d,t>, it is quite clear that the predicate conjunction in (10) cannot be analyzed as intersection at the type of sets, because that obviously gives you only the empty set. In various papers, Peter Lasersohn has discussed this problem in the context of verb phrase conjunction in a theory where the verb phrases denote sets of sums of events (e.g. Lasersohn 1995), and he proposes an operation for conjoining sets of pluralities, which I will call **Lasersohn Summing**:

$\alpha \wedge \beta = \{x \in D: \exists a \in \alpha: \exists b \in \beta: x = a \sqcup b\}$

Lasersohn Summing gives the right interpretation for the predicate in (10).

(Note: if we replace in (10) *four girls* by *at most four girls*, we notice another argument for the 0-object: with a 0-object Lasersohn Summing will give automatically the correct interpretation; without a 0-object we have to complicate Lasersohn Summing considerably.)

As I have formulated it here, Lasersohn Summing involves Existential Closure on the conjuncts. If, as I have been arguing, maximalization effects are a general property of Existential Closure, then we might expect maximalization effects (which means, *at least* interpretations) here, **not** on the whole conjunctive noun phrase - that is just a predicate - **but** inside the conjunction on the conjuncts.

First we check that we do not find an *at least* interpretation for the whole predicate. Look at the board and example (11):

7,11,16,18,20,22

(11) The numbers on the board are two prime numbers and three even numbers. FALSE
(#for that matter, four even numbers)

My informants judge that (11) is false, and they judge the continuation infelicitous. This shows that indeed we find normal *exactly* effects for the whole predicate: the predicate needs to cover the whole set of numbers on the board.

Now look at the next board and examples (12) and (13):

2,3,4,6,8

(12) a. The numbers on the board are exactly two prime numbers and exactly four even numbers. TRUE
b. The numbers on the board are exactly two prime numbers and exactly three even numbers. FALSE

(13) a. The numbers on the board are two prime numbers and four even numbers. TRUE
b. The numbers on the board are two prime numbers and three even numbers. TRUE
(for that matter, four even numbers)

Unsurprisingly, my informants judge (12a) and (13a) true in this context (which shows that there is no semantic requirement that the conjuncts should be disjoint). The interesting thing is the contrast between (12b) and (13b). (12b), with *exactly* lexically realized, is judged false, because there are actually four even numbers. But my informants judge (13b) true, and find the continuation felicitous.

Thus, to be in the conjoined predicate denotation a sum must be a sum of two prime numbers and four even numbers and nothing else (that is the normal *exactly* effect on the whole predicate). But if one of the numbers is **both** prime and even, this sum **cannot** be described as a sum of exactly two prime numbers and exactly three even numbers, but it **can** be described as a sum of two prime numbers and three even numbers. This means that indeed we find maximalization effects on the conjuncts in Lasersohn summing: inside the conjunction, *two prime numbers* and *three even numbers* have an *at least* reading.

These facts can be incorporated into Lasersohn Summing straightforwardly in analogy to maximalization in Argument Formation:

LASERSOHN SUMMING WITH MAXIMALIZATION:

$$
\begin{aligned}
\langle\alpha,-R\rangle \wedge \langle\beta,-R\rangle &= \{x: \exists a \in \alpha: \exists b \in \beta: x=a\sqcup b\} \\
\langle\alpha,+R\rangle \wedge \langle\beta,-R]\rangle &= \{x: \exists a \in \alpha: \exists b \in \beta: x=a\sqcup b \wedge a = \sqcup(\{a \in \alpha: a \sqsubseteq x\})\} \\
\langle\alpha,-R\rangle \wedge \langle\beta,+R\rangle &= \{x: \exists a \in \alpha: \exists b \in \beta: x=a\sqcup b \wedge b = \sqcup(\{b \in \beta: b \sqsubseteq x\})\} \\
\langle\alpha,+R\rangle \wedge \langle\beta,+R\rangle &= \{x: \exists a \in \alpha: \exists b \in \beta: x=a\sqcup b \wedge a = \sqcup(\{a \in \alpha: a \sqsubseteq x\}) \wedge \\
&\qquad b = \sqcup(\{b \in \beta: b \sqsubseteq x\})\ \}
\end{aligned}
$$

These facts are a problem for Montague-Partee. Montague-Partee distinguishes *exactly three girls* and *three girls* at the argument type, but **not** at the predicate type. Lasersohn summing requires access to this very distinction at the predicate type. But if we access that distinction in a maximalization operation at the predicate type in Lasersohn Summing, we can just as well access it for maximalization in Argument Formation, and Montague-Partee becomes superfluous.

Have we clinched the case against Montague-Partee? Not yet. The rebuttal might go as follows: Montague-Partee can try to explain the maximalization effects in Lasersohn summing by assuming that Lasersohn Summing involves not the predicate interpretation of the conjuncts, but the argument interpretations. In that case, you would expect maximalization effects. And this can be done easily: conjoin two **argument** DPs with conjunction at the type of generalized quantifiers, and lower the **complex** DP to a predicate. If that is the derivation, then indeed, you may well expect maximalization effects.

However, now look at (14)-(16):

(14) The mingling ferocious three tigers and meek four panthers were giving us hair-raising problems.

(15) a. The exactly two prime numbers and exactly four even numbers on the board illustrate a semantics problem.
 b. #The exactly two prime numbers and exactly three even numbers on the board illustrate a semantics problem.

(16) a. The two prime number and four even numbers on the board illustrate a semantics problem.
 b. The two prime numbers and three even numbers on the board illustrate a semantics problem.

(14) shows that we are dealing with NP-conjunction: the numerical can mingle with the adjectives, and, importantly, the adjective *mingling* can naturally be interpreted as taking scope over the whole conjunctive NP, arguing against an account where a determiner *the* is deleted before the second conjunct.

(15) and (16) show that, as expected, we find **exactly the same** maximalization facts inside the noun phrase here as in the predicative case in (12)-(13): (15b) is infelicitous, but (16b) is not, showing that *three even numbers* in (16b) has an *at least* interpretation.

Now, in order to deal with this, Montague-Partee would have to argue that in (16b) the the interpretation of the **nominal**, the **NP** *two prime numbers and three even numbers*, **inside the DP** in (16b), is itself derived from the interpretation of the **argument DP** *two prime numbers and three even numbers*. This is unreasonable.

As argued, the Adjectival Theory with Maximalization can deal with all these facts unproblematically.

SCOREBOARD	**MP**	**AT**
FINAL SCORE	**0**	**3**

WINNER: ADJECTIVAL THEORY + MAXIMALIZATION

7. SYNTAX-SEMANTICS MISMATCHES

In the syntax of noun phrases, the central distinction that syntactic phenomena make reference to seems to be the NP/DP distinction. In the semantics of noun phrases, the central distinction seems to be the set/non-set distinction. Since I have argued that predicate noun phrases are DPs with a set interpretation, we see that there is a **mismatch** between the syntax and the semantics:

The syntax clusters arguments and predicates together.
The semantics clusters predicates and nominals together.

What are the arguments that predicate noun phrases are DPs, and not NPs? I have two major arguments for that. The first argument concerns, of course, the mentioned difference in syntax between nominals and predicates, which is easily explained if nominals are NPs and predicates DPs.

The second argument concerns the existence of exceptional cases where quantificational noun phrases are reinterpreted at the set type, and hence can occur as predicates. (This fits with the central idea that type shifting is a mechanism that is available at no cost, but that the grammar may contain special mechanisms that provide something that the type shifting theory doesn't give you.) I am thinking here of two kinds of examples.

1. I argue in Landman ms. a 1998 that noun phrases in *there* insertion contexts are semantic adjuncts with a set interpretation (involving a shift which is accessed from the predicate interpretation, and which can involve only noun phrases born at the predicate type.) I show how this accounts for the standard definiteness effects. But, as is well known, there are exceptional cases, where quantificational noun phrases **can** occur in *there* insertion contexts:

(17) There is *every reason* to distrust him.

I argue that it is plausible to assume that what is involved here is a special **semantic reinterpretation** strategy which gives the quantificational noun phrase a set interpretation. But there is no evidence whatsoever for **syntactic restructuring** of a DP as an NP in cases like (17), and that is what a matching between the syntactic and the semantic distinctions would require. (I owe this argument to John Bowers, who convinced me of it.)

2. I argued in Landman 1985, 2000 that quantificational noun phrase like *every girl*, but not *each girl*, can shift from a quantificational interpretation (at type <<d,t>,t>) to a collective definite (at type d, and hence shiftable into <d,t>). *Combine* in (18) is collective on its second argument: (18a) is felicitous, while (18b) is not:

(18) a. In this class I try to combine *every theory of plurality.*
b.#In this class I try to combine *each theory of plurality.*

A quantificational noun phrase that has undergone collective shift has a collective interpretation at type d, from which it can lift with IDENT into the predicate type. Thus we predict that, on the collective shifted interpretation, these noun phrases can occur in predicative position, and that is indeed the case:

(19) a. The press is *every person who writes about the news.*
b. #The press is *each person who writes about the news.*

Here again, we find under special circumstances a semantic shift from <<d,t>,t> to a type from which we can form a predicate. And again, it is completely implausible to assume that this must involve syntactic restructuring of a DP as an NP.

MORAL

The assumption of the Perfect Matching between syntax and semantics derives, originally, from Montague's fixed type assumption. This assumption has frequently tempted both semanticists and syntacticians into imperialism (use the perfect match to import as much syntax as you can into the semantics, versus import as much semantics into the syntax as you can, presumably in the hope that the other will go away). But, as I have argued here for noun phrases, syntax and semantics are mismatched. The mismatch makes syntactic and semantic argumentation harder, because you actually need to determine very carefully which distinction (the syntactic or the semantic) your arguments apply to. It makes it also more interesting, because:

All perfect matchings are alike, each mismatch is interesting in its own way.

ACKNOWLEDGEMENTS

In the academic year 1998/99 I taught a year-long seminar at Tel Aviv University on my recent work on definiteness effects, which, though presented at various conferences, is still unpublished (Landman ms. a,b 1998). The present paper took shape in the course of that seminar as a conceptual prehistory of the other work.

As such, the paper and me owe a great debt to the penetrating comments, skepticism, and encouragement of my students Victoria Barabash, Shai Cohen, Gabi Danon, Yael Greenberg, Daphna Heller, Aldo Sevi and Galit Sassoon.

This paper was presented at the NP/DP conference at the University of Antwerpen in February 2000, and I thank the participants for their comments and discussion, and in general for the stimulating atmosphere at the conference.

Similar thanks are due to my 'home audience' in the Interdisciplinary Thursday Colloquium at Tel Aviv University, where the paper was presented a few weeks later.

The work for this paper was partially supported by the grant *A Tripartite Typology of Relative Clause Constructions* from the Israel Science Foundation to Alex Grosu and me, which is gratefully acknowledged.

My greatest debts are to Susan Rothstein, with whom I battled through each and every bit of this paper many times over, and who still loves me, and to Barbara Partee, whose work inspired it all.

Finally I owe a thank to everybody that I will thank in the acknowledgements to the work to which this paper is a prelude.

REFERENCES

Bartsch, Renate, 1973, 'The semantics and syntax of numbers,' in: J. Kimball (ed.), *Syntax and Semantics 2*, Academic Press, New York.

Barwise, Jon and Robin Cooper, 1981, 'Generalized quantifiers and natural language,' in: *Linguistics and Philosophy* 4.

Bittner, Maria, 1994, 'Cross-linguistic semantics,' in: *Linguistics and Philosophy* 17,1.

Bonomi, Andrea and Paolo Casalegno, 1993, ''Only': association with focus in event semantics,' in: *Natural Language Semantics* 2.1.

Bowers, John, 1987, 'The syntax and semantics of nominals,' in: S. Moore and A. Wyner (eds.), *Proceedings of SALT 1*, distributed by: Cornell Linguistics Circle, Ithaca.

Chierchia, Gennaro and Sally McConnell-Ginet, 1990, *Meaning and Grammar*, MIT Press, Cambridge, MA.

Horn, Laurence, 1972, *On the Semantic Properties of Logical Operators in English*, Ph.D. dissertation, UCLA. Reprinted 1976, IULC, Indiana University, Bloomington.

Kadmon, Nirit, 1987, *On Unique and Non-Unique Reference and Asymmetric Quantification*, Ph.D. dissertation, UMass, Amherst. Published 1993, Garland, New York.

Keenan, Edward, 1987, 'A semantic definition of 'indefinite NP'', in: E. Reuland and A. ter Meulen (eds.), *The Representation of (In)definiteness*, MIT Press, Cambridge, MA.

Krifka, Manfred, 1989, 'Nominal reference, temporal constitution and quantification in event semantics,' in: R. Bartsch, J. van Benthem and P. van Emde Boas (eds.), *Semantics and Contextual Expression*, Foris, Dordrecht.

Krifka, Manfred, ms. 1989, 'Boolean and non-Boolean 'and',' ms. University of Texas, Austin.

Landman, Fred, 1995, 'Plurality,' in: S. Lappin (ed.), *Handbook of Contemporary Semantics*, Blackwell, London.

Landman, Fred, 1998, 'Plurals and maximalization,' in: S. Rothstein (ed.), *Events and Grammar*, Kluwer, Dordrecht.

Landman, Fred, 2000, *Events and Plurality. The Jerusalem Lectures*, Kluwer, Dordrecht.

Landman, Fred, ms. 1998a, 'Parallels between the nominal and the verbal domain: the case of definiteness effects,' ms. Tel Aviv University.

Landman, Fred, ms. 1998b, 'Individual level predicated and state level predicates: predication and adjunction,' manuscript, Tel Aviv University.

Lasersohn, Peter, 1995, *Plurality, Conjunction and Events*, Kluwer, Dordrecht.

Link, Godehard, 1983, 'The logical analysis of plurals and mass terms: a lattice-theoretic approach,' in: R. Bauerle, Ch. Schwarze and A. von Stechow (eds.), *Meaning, Use, and the Interpretation of Language*, de Gruyter, Berlin.

Montague, Richard, 1970, 'English as a formal language,' in; B. Visentini et. al. (eds.), *Linguaggi nella Societa e nella Technica*, Edizione di Communita, Milan. Reprinted in: R. Thomason (ed.), 1974, *Formal Philosophy*, Yale University Press, New Haven.

Montague, Richard, 1973, 'The proper treatment of quantification in ordinary English,' in: J. Hintikka, J. Moravcsik and P. Suppes (eds.), *Approaches to Natural Language*, Kluwer, Dordrecht. Reprinted in: R. Thomason (ed.), 1974, *Formal Philosophy*, Yale University Press, New Haven.

Partee, Barbara, 1987, 'Noun phrase interpretation and type shifting principles,' in: J. Groenendijk, D. de Jongh and M. Stokhof (eds.), *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*, Foris, Dordrecht.

Winter, Yoad, 1998, *Flexible Boolean Semantics*, Ph.D Dissertation, Universiteit Utrecht.