Cross-categorial plurality and plural composition *

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VERSION 1

Abstract

This paper proposes an extension of the class of plural expressions, a generalized analysis of the denotations of such expressions and a novel account of how they semantically combine with other elements in the sentence. The point of departure is the observation that definite plural DPs and *and*–coordinations with coordinates of several semantic categories share (at least) two features: Cumulativity in the context of another definite plural or *and*–coordination, and polarity under negation. I argue that existing analyses of conjunction fail to derive these parallels and that *and*–coordinations should be analyzed as denoting pluralities (of whatever kind of semantic object their conjuncts denote). This, in turn, raises the question of how pluralities combine with other material in the sentence. I show that a simple expansion of the standard analysis of plurals and plural predication, which puts the workload onto the predicate, is insufficient and subsequently propose an alternative analysis, which is based on the idea that all semantic domains contain pluralities and can be intuitively viewed as 'plural projection': The particular truth-conditions of sentences containing plurality-denoting expressions are not due to the semantic expansion of the predicate (as in existing analyses), but the result of a step-by-step process, where once a plurality enters the derivation, the node immediately dominating it will also denote a plurality, namely of the values obtained by a particular combination of the plurality and the denotation of its sister.

1 Introduction

We usually assume that definite plural DPs such as *the cats* denote special objects, namely pluralities of individuals, because their behavior differs from that of singular (non-collective) proper names and from the behavior of expressions involving universal quantification over atomic individuals. The most obvious of these symptoms of plurality is collectivity, i.e. the

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fact that some predicates such as *gather* express properties of denotations of plural DPs, but not of the denotations of singular proper names, as witnessed by the contrast in (1) (cf. Link 1983, but cf. Dowty 1987 for further discussion).

(1) a. *The cats gathered.*
    b. *# Carl gathered.*

For the purposes of this paper, however, two other symptoms of plurality will be relevant: cumulativity, which will be my main focus, and homogeneity. The former refers to the observation that a plurality can be attributed a property if that property is the result of 'adding up', so to speak, the properties of the plurality's parts (cf. Link 1983, Krifka 1986 a.o.): If the two sentences in (2-b) are true – and Abe and Bert are the only salient boys and Carl and Dido are the only salient cats – then (2-a) is true, albeit neither Abe nor Carl individually fed the two cats. Note that the plural DP differs from the universal quantifier *every NP*, as the truth of (2-c) does not follow from the truth of the two sentences in (2-b).

(2) a. *The two boys fed the two cats.*
    b. *Abe fed Carl. Bert fed Dido .*
    c. *Every boy fed the two cats.*

Homogeneity, on the other hand, refers to the fact that we witness a 'grey area' in terms of truth-value judgements when considering sentences with plural DPs and their negation (cf. Fodor 1970, Löbner 1987, 2000, Schwarzschild 1994 a.o.). While (3-a) conveys that Abe fed all of the salient cats, (3-b) conveys that he fed none of them; hence neither of the two sentences adequately describes scenarios where he fed some but not all of the cats. Again, this contrasts with universal quantification over atoms (4), where we find no such grey area.

(3) a. *Abe fed the cats.*
    b. *Abe didn't feed the cats.*

(4) a. *Abe fed each cat.*
    b. *Abe didn't feed each cat.*

If cumulativity and homogeneity are distinctive traits of plurality in the individual domain, we can use them as a diagnostic for analogous denotations (pluralities) in other domains. Taking this rationale as my point of departure, I will make two claims: I submit that the class of expressions denoting pluralities is much bigger than usually assumed and that in fact any semantic domain contains a proper subdomain of pluralities. I then argue that if we admit these new pluralities to our system, we can formulate a new analysis of the symptoms of plurality, in particular, cumulativity. Both claims are briefly outlined in the following.

1.1 Claim 1: Expanding the class of pluralities

Following Schmitt 2013, I will first show that cumulativity, and to a certain extent also homogeneity, can be observed for English *and*-coordinations (henceforth 'conjunctions') with conjuncts of several semantic categories. I argue that therefore *all* conjunctions – e.g. conjunctions with individual-denoting conjuncts as in (5-a) (cf. Link 1983, Schwarzschild 1996 a.o.), predicate conjunctions, (5-b), and sentential conjunctions, (5-c) – denote pluralities (of individuals, predicates of individuals and propositions, respectively). Hence the relation between ⟦*dance and smoke*⟧ and ⟦*dance*⟧ is analogous to that between ⟦*the two boys*⟧ and ⟦*Abe*⟧ etc.

(5) a. *Abe and Bert*
b. *dance and smoke*
c. *(that) Abe is in jail and (that) Bert is in rehab*

I implement this claim by proposing that natural language ontology does not only contain pluralities of individuals (cf. Link 1983) or other primitives such as events (cf. e.g. Landman 2000) or worlds (cf. Schlenker 2004) but that any semantic domain D_a (where a ranges over semantic types) includes a set of pluralities made up from objects of D_a. This means that there are pluralities of functions (cf. Gawron and Kehler 2004 for a similar claim) and also pluralities of sentence denotations (cf. Beck and Sharvit 2002 for a related proposal concerning pluralities of questions). I will model this by assuming that all semantic domains D_a are enriched by two kinds of sets: a set $\mathbf{PL}_a$ of pluralities, which is isomorphic to $\wp(D_a) \setminus \{\emptyset\}$ and a set $\underline{\mathbf{S}}_a = \wp(\mathbf{PL}_a)$. A plural expression of type a will denote a singleton from $\underline{\mathbf{S}}_a$, containing an object from $\mathbf{PL}_a$ which is the 'sum' (represented by '+' below) of the denotations of the individual conjuncts, as illustrated in (6) for the examples in (5).

(6) a. $\{ [\![Abe]\!] + [\![Bert]\!] \}$
b. $\{ [\![dance]\!] + [\![smoke]\!] \}$
c. $\{ [\![Abe\ is\ in\ jail]\!] + [\![Bert\ is\ in\ rehab]\!] \}$

The reason why we need *two* sets (**PL** and $\underline{\mathbf{S}}$) is connected to the particular way in which plurality-denoting expressions combine with their sisters, which comprises the second claim of this paper – namely, that adding new pluralities will give us a new perspective on how to derive the cross-categorial 'symptoms' of plurality, in particular, cumulativity.

1.2 Claim 2: Cumulativity and plural projection

Sentences like (2-a) above (repeated in (7)), which contain two or more plural expressions (where 'plural expression' stands for any expression denoting a plurality given claim 1) exhibit particular weak truth-conditions (cf. Langendoen 1978 a.o.). I here refer to them as 'cumulative truth-conditions': (7) is true iff each of the two boys fed at least one of the two cats and each of the two cats was fed by at least one of the two boys.

(7) *[$_{plural1}$ The two boys] fed [$_{plural2}$ the two cats].*

Theories that only consider pluralities of individuals or other primitives derive those truth-conditions by what I will call the 'predicate analysis', namely, by positing cumulation operations on predicate denotations (cf. Link 1983, Krifka 1986, Sternefeld 1998). For (7), this means that the primitive extension of the predicate *feed*– a set of pairs of individuals – is enriched by all pairs of individuals that we can form by simultaneously adding up feeders and their respective feedees: (8) then comes out as true iff each of the two boys fed at least one of the two cats and each of the two cats was fed by at least one of the two boys.

My point of departure is that the predicate analysis faces (at least) two problems (cf. Schmitt 2013). The first problem is of a syntactic nature and rooted in the predicate analysis' prediction that since cumulation targets predicates (such as *feed* above), we will only find cumulative truth-conditions if the object language provides an adequate predicate that can act as the input to cumulation. Beck and Sauerland (2000) argue that this predicate must sometimes be syntactically derived, because we find instances of cumulative truth-conditions where the required predicate is not a surface constituent. I will show, however, that the syntactic operations we would require to form this predicate do not always correspond to those independently attested, i.e. that we find examples where the required predicate cannot be derived by movement.

The second problem concerns configurations like (8), where, according to the view taken here, one plural expression (*plural 2*) contains another (*plural 3*). We will see that the predicate analysis doesn't consistently derive the correct truth-conditions for such configurations.

(8) *[$_{plural1}$ The boys] [$_{plural2}$ fed [$_{plural3}$ the two cats] and watched TV]*

Given these two problems of the predicate analysis, I propose an alternative way of deriving cumulative truth-conditions, which originated in joint ongoing work with Nina Haslinger, and is intuitively linked to my first claim, namely, that we find pluralities of objects from any semantic domain. The basic idea is that once a plural enters the derivation, every node above it will also denote a plurality (hence 'plural projection', a name I owe to Manuel Križ (pc)). Broadly speaking, if a plural such as *the two cats* combines with its syntactic sister (e.g. *fed*), the result is a particular subset of the set of those pluralities we would obtain by applying the parts of the function plurality to the parts of the argument plurality. More precisely, for any function plurality F with parts $f_{\langle a,b\rangle}$, argument plurality X with parts x_a, it gives us the set of the pluralities created by applying each F-part to some X-part and each X-part being the argument of some F-part. (So in effect, our notion of cumulation from above is now part of a compositional rule and concerns function-argument pairs). Of course, this still requires an adequate notion of 'part' and a more careful phrasing w.r.t the different sets employed here, but in essence, this means that for (9-a) we obtain the denotation in (9-b) – which is analogous to the denotation of predicate conjunctions like *dance and smoke* sketched in the previous paragraph.

(9) a. *fed the two cats*
b. {$\lambda x.x$ fed Carl + $\lambda x.x$ fed Dido }

If the VP in (9-a) combines with a plural subject, as in (10-a), we get a plurality of propositions, (10-b). The final step in the matrix case will be the application of an abstract singular operator, which yields us true iff at least one element of the set is true. (10-a) thus comes out as true if Abe fed Carl and Bert fed Dido or Abe fed Dido and Bert fed Carl and as false otherwise.

(10) a. *The two boys fed the two cats.*
b. { Abe fed Carl + Bert fed Dido, Abe fed Dido + Bert fed Carl }

This illustrates, if somewhat sketchily, that the system I propose here can derive the correct cumulative truth-conditions for simple sentences like (11-a). I will show that it can also capture the truth-conditions of sentences with more than two plurals as well as, crucially for my line of argument here, those of sentences involving 'plural-within-plural' configurations such as (8) above, which the predicate analysis struggles with. Since no movement is involved in the derivation, the system, as presented here, is not constrained by locality at all and thus circumvents the syntactic problem encountered by the predicate analysis.

Building on these basic components of plural projection, I will expand the system so as to capture the truth-conditions of sentences where a plural is embedded under a quantificational determiner as in (11) (cf. Bergmann 1982, Partee and Rooth 1983, Heycock and Zamparelli 2005, Champollion 2015 a.o. for a discussion of such cases under a different heading). Determiners will be shown to act as 'interveners' to plural projection and will be analyzed as a form of collective predicate, which takes pluralities of predicate-denotations as their arguments.

(11) *Abe fed every [$_{plural2}$ dog and cat] in this town.*

1.3 Structure of the paper

The paper is structured as follows: Section 2 presents the empirical parallels between conjunctions and DP-plurals and shows that existing theories of conjunction fail to capture these observations. In section 3, I introduce the predicate analysis and show how we could expand it to explain the empirical facts from section 2. I will then argue that such an expansion is on the wrong track because the predicate analysis itself is faced with serious problems. Section 4 presents the proposal that was sketched in the previous paragraphs, and section 5 extends it to instances of restrictor conjunction like (11). Section 6 concludes the paper.

2 The empirical motivation for cross-categorial plurality

Examples like (12-a) might suggest that the denotations of plural DPs are reducible to universal quantification over atomic individuals, since the truth-conditions of (12-a) and (12-b) are very similar (cf. Winter 2001a for a discussion of analogous examples).

(12) a. *These ten boys are wearing a dress.*
b. *Every boy is wearing a dress.*

In analogy, examples like (13) could suggest that conjunction is 'intersective', (14), i.e. involves universal quantification over the individual conjuncts, as it is true iff Abe has every property denoted by the individual conjuncts.

(13) *Abe smoked and danced.*

(14) $[\![\textit{smoke and dance}]\!] = \lambda x_e.\text{smoke}(x) \wedge \text{dance}(x)$

But once we consider a wider range of contexts, identifying the semantic impact of plural DPs with simple universal quantification becomes untenable. Two semantic effects in particular rule out such a treatment: Cumulativity and homogeneity. In the following, I will show that the same contexts where we witness these effects for plural DPs also reveal analogous effects for conjunctions. Accordingly, conjunctions cannot be analysed in terms of universal quantification, either – rather, their behavior mimics that of plural DPs.

The first part of the claim, i.e. that conjunction is not intersective, is not new. It has been made by various authors arguing for 'non-intersective' (or 'non-Boolean') accounts of conjunction (cf. e.g. Link 1983, 1984, Krifka 1990, Heycock and Zamparelli 2005) and many of the examples discussed in the following are modelled on examples from this literature. Yet, what I show here goes beyond these proposals: The observation that the behavior of conjunctions is parallel to that of plural DPs will turn out to be incompatible with their basic assumptions.

2.1 Cumulativity

The first set of contexts where we witness 'symptoms' of plurality are sentences containing more than one plural DP. For the moment, I will focus on examples such as the sentence marked by $[_S ...]$ (15), where two plural DPs occur as co-arguments of a transitive predicate. (Note: I will frequently give larger chunks of discourse, where the relevant sentence is indicated by $[_S ...]$. Whenever I write 'the sentence in (n)', this will refer to the bracketed sentence in (n).)

(15) *I walked the dog. $[_S$ The two boys fed the two cats].*

Such sentences give rise to very peculiar truth-conditions (cf. Langendoen 1978, Scha 1981), which I here refer to as '**cumulative truth-conditions**' (for a proper discussion of cumulativity, see section 3.1 below). The sentence in (15) is true, for instance, in a scenario where there are two cats – Carl and Dido – and my brother Abe fed Carl and my other brother Bert fed Dido.

Generalizing over the verifying scenarios (but maintaining that Abe and Bert are the only salient boys and Carl and Dido the only salient cats), the truth-conditions of the sentence are those in (16-a). They are much weaker than those in (16-b), which we would expect, if *the two boys* and *the two cats*) denoted the universal quantifier.

(16) $[\![$*The two boys fed the two cats*$]\!] = 1$ iff

a. $\forall x \in \{a,b\}\,(\exists y \in \{c,d\}(x \text{ fed } y)) \wedge \forall y \in \{c,d\}(\exists x \in \{a,b\}(x \text{ fed } y))$

b. $\forall x \in \{a,b\}(\forall y \in \{c,d\}(x \text{ fed } y))$

In the following, I will look for expressions that display a parallel behavior, i.e. strings like the one schematised in (17-a) with the truth-conditions in (17-b). (If the string has these truth-conditions, I will say that *A* and *B* 'display cumulativity'.) For the time being, I won't specify the denotations of *A*, *B*, but I will appeal to an intuitive relation 'consist-of' in the meta-language. This should be sufficient for our present purposes, a proper discussion will follow in section 3.1. Furthermore, I discuss only a limited range of data, omitting collective construals of predicates and restricting the examples to cases where R is a binary relation.

(17) a. *A R B*

b. 1 iff $\forall x \in S_A(\exists y \in S_B(\mathrm{R}(y)(x) = 1)) \wedge \forall y \in S_B(\exists x \in S_A(\mathrm{R}(y)(x) = 1))$
where S_A, S_B are sets of objects that $[\![A]\!]$ and $[\![B]\!]$ consist of intuitively

Conjunctions with individual-denoting conjuncts are known to display cumulativity (as well as all other hallmarks of plurality, cf. Link 1983, Schwarzschild 1994 a.o.): If Abe and Bert are the only boys, the truth-conditions of (18) and of (15) above are identical.[1]

(18) *Abe and Bert fed the two cats.*

The subsequent paragraphs will discuss cumulativity of conjunctions whose conjuncts denote more complex objects, namely, predicates of individuals and propositions.

2.1.1 Cumulativity with predicate conjunctions

(19) shows that predicate conjunctions of syntactic category VP can display cumulativity.

(19) *What the hell is going on? The farm is on fire,*$[_S\ [_A$*the ten animals*$]$ *are* $[_B\ [$*crowing*$]_P$ *and* $[$*barking*$]_Q$*!*$]$ *And the farmer is singing* Auld Lang Syne!

adapted from Krifka 1990

The sentence in (19) is true, for instance, in a scenario with 10 animals, five roosters and five dogs, where the dogs are barking and the roosters are crowing. In fact, it is true in any scenario where all of the farm animals are crowing or barking and some are crowing and some are

[1]Based on a sample of 16 languages from 8 major language families, Flor et al. (2017) show that even though languages may have strategies for individual conjunction that only allow for a distributive (i.e. 'universal') construal, every language in the sample has a least one strategy for individual conjunction that displays the 'plural' behavior sketched here for English *Abe and Bert*.

barking – which means that it has the cumulative truth-conditions in (20).[2]

(20) $1 \text{ iff } \forall x \in S_A(\exists Y \in \{P, Q\}\, (Y(x) = 1)) \wedge \forall Y \in \{P,Q\}(\exists x \in S_A\, (Y(x) = 1))$

Contrary to Winter (2001b), who essentially claims that such cumulative truth-conditions for VP-conjunctions are only observable if the denotations of the conjuncts are disjoint as in (19),[3] (21) shows that non-disjointness of the conjuncts' denotations does not block cumulativity: The denotations of *smoking* and *dancing* are not disjoint, as an atomic individual can easily smoke and dance at the same time, but the truth-conditions of (21) are analogous to those of (19): The sentence is true, for instance, if four of the children are smoking, while the other six are dancing.

(21) *What a party! [$_S$ [$_A$ The ten children I invited] are [$_B$ [smoking]$_P$ and [dancing]$_Q$] in the street] and the adults are getting drunk in the living room.*

Accordingly VP-predicate conjunctions display cumulativity,[4] just like plural DPs or individual-conjunctions.

2.1.2 Cumulativity with propositional conjunctions

Propositional conjunctions also exhibit cumulativity. Consider first the example in (22).

(22) *The agency from Chechnya called and the one from the Philippines did, too. The conversations were useless. [$_S$ [$_A$ The agencies] claimed [$_B$ [that Kadyrov had acquired WMD]$_p$ and [(that) Duterte had hired a new death squad]$_q$]], but neither of them had anything to say about Trump's alleged interactions with Putin.*

In a scenario where the agency from Chechnya made the claim about Kadyrov and the one from the Philippines the claim about Duterte, the sentence is true. Generalizing over such verifying scenarios, we obtain the cumulative truth-conditions in (23).

(23) $1 \text{ iff } \forall x \in S_A(\exists r \in \{p,q\}\, (\text{claim}(r)(x) = 1)) \wedge \forall r \in \{p,q\}(\exists x \in S_A\, (\text{claim}(r)(x) = 1))$

[2]The examples given here might suggest that cumulative truth-conditions are tied to progressive aspect. This is not the case, as witnessed by (i-a), which is true if half of the children in my class are blond and the other half are brunette, or (i-b), which is true if half of the villagers are smokers and the other half drinkers.

(i) a. *[$_A$ The children in my class] are [$_B$ [blond]$_P$ and [brunette]$_Q$], but the ones in Sue's class all have black hair! That's kind of weird....*
b. *How absurd! [$_A$ The people in this village] [$_B$ [smoke]$_P$ and [drink]$_Q$], but none of them has ever eaten a fucking steak!*

[3]'disjoint', in Winter's sense, means that it is impossible or highly unlikely given our world-knowledge that an atomic individual has both properties expressed by the conjuncts simultaneously. While his claims are too strong,Poortman's 2014 work might be on the right track: She provides experimental evidence for the claim that in conjunctions *P and Q*, the availability of cumulativity of the conjunctions decreases with the level of 'typicality' that speakers assign to co-occurrence of P and Q in an atomic individual (e.g. *drink and smoke* might be more 'typical' than *run and smoke*). Given the parallels between plurals and conjunctions, I wonder whether analogous factors govern the availability of cumulativity with individual conjunctions and plural DPs.

[4]There is no cross-linguistic survey on this matter, but all the languages I found informants for or for which the relevant data are available behave exactly the same: German, Dutch (Hilda Koopman, pc), French (Dominique Sportiche, pc), Italian (Silvio Cruschina, pc), Greek (Maria Barouni, pc), Albanian (Dalina Kallulli, pc) Armenian (Nelly Matevosyan, pc) Hebrew (Yael Sharvit, pc), Iraqi Arabic (Yusuf Al-Tamimi, pc), Hungarian (Edgar Onea, pc), Jacaltec (Craig 1977)) and Iraqw (Mous 2004).

Cumulativity of propositional conjunctions is also found with other sentence-embedding predicates, including attitude verbs such as *believe*. The sentence in (24) is true in a scenario where Abe holds the belief about cats but has no opinions about lizards, whereas Bert is certain that Trump is a lizard but agnostic w.r.t. the role of cats in the world, which means that it has cumulative truth-conditions.

(24) *Abe may be the head of the cat cult and Bert a member of the reptile cult, but they are not as bad as you think – okay, [$_S$ [$_A$ they] believe$_R$ [$_B$ [that cats rule the world]$_p$ and [(that) the US president is a monitor lizard]$_q$]], but neither of them would maintain that aliens run the* NYT *– as your 'sane' friend Gina does.*

These data thus suggest that not only predicate conjunctions, but also clausal conjunctions, mimick the behavior of plural DPs w.r.t. cumulativity.

But is this really the correct description of the data? Couldn't we say that Abe and Bert hold the collective belief $[\![p]\!] \cap [\![q]\!]$ – and that thus *p and q* simply denotes $[\![\mathrm{p}]\!] \cap [\![\mathrm{q}]\!]$? In the verifying scenario I gave, Abe is agnostic w.r.t. $[\![q]\!]$ and Bert $[\![p]\!]$, but maybe the content of collective belief can be described in terms of what Abe and Bert agree on, in the sense that it simply gives us the intersection of Abe's and Bert's belief worlds. This would only require $[\![q]\!]$ to be compatible with Abe's beliefs, and $[\![p]\!]$ to be compatible with Bert's beliefs.

I think we can rule out this possibility by looking at examples like (25), which would involve conflicting beliefs. The sentence in (25) is true if Abe believes the next president to be a cat and Bert believes the next president to be a lizard. Hence, in all of Abe's belief worlds, $[\![q]\!]$ is false, and *vice versa* for Bert and $[\![p]\!]$. (And we don't get the feeling that (25) attributes inconsistent beliefs to Abe or Bert.) This means that (25) is incompatible with *p and q* denoting the set of worlds that Abe and Bert agree on.[5]

(25) *Abe may be the head of the cat cult and Bert a member of the reptile cult, but they are not as bad as you think – okay, [$_S$[$_A$ they] believe$_R$ [$_B$ [that the next president will be a cat]$_p$ and [(that) the next president will be a lizard]$_q$]], but neither of them would maintain that the next president will be an alien- as your 'sane' friend Gina does.*

2.2 Homogeneity

We have just seen that conjunctions (of individuals, VP-predicates and propositions) behave like plural DPs w.r.t. cumulativity. In the following, we will look at another symptom of plurality, homogeneity. It won't feature prominently in my analysis later on, but I think it bears on my argument that plural DPs and conjunctions show a parallel behavior.

Homogeneity, just as cumulativity, sets plural DPs apart from universal quantification. To understand this phenomenon, it is best to compare sentences with their negated counterparts. Consider first the behavior of *every boy* in (26). It behaves as we would expect a universal

[5]A different way to make the same point, brought to my attention by Lucas Champollion (pc), goes as follows: If $[\![$*p and q*$]\!]$ were p ∩ q then, if (i-a) and (i-b) are true, it should follow, that (i-c) is also true (because r holds in all worlds where p ∩ q). However, this is not a valid inference. On the other hand, we can infer (i-d) on the basis of (i-a) and (i-b) – which shows again that *p and q* is not reducible to p ∩ q.

(i) a. *Sue believes [that Peter is a sailor]$_p$.*
b. *John believes [that all sailors are criminals]$_q$.*
c. *Sue and John believe [that Peter is a criminal]$_r$.*
d. *Sue and John believe [that Peter is a sailor]$_p$ and [(that) all sailors are criminals]$_q$.*

quantifier to behave: Whereas (26-a) is true iff every boy was bitten by Dido, its negation in (26-b) is true in all situations where (26-a) is false – including situations where Dido bit some, but not all boys. I call this the 'NOT-ALL' -pattern.

(26) a. *Dido bit every boy.*
 b. *Dido didn't bite every boy.* NOT-ALL

Fodor (1970) observed that plural DPs behave differently. Compare (26) to (27): (27-a), just as (26-a), expresses that Dido bit both (i.e. all) of the boys, but (27-b) conveys that she bit neither. Thus, if the truth-conditions of a negated sentence are equivalent to the falsity conditions of its non-negated counterpart, there will be 'in between' scenarios – where Dido bit only one of the two boys – in which neither sentence is true or false. I refer to this as the 'NONE'-pattern.

(27) a. *Dido bit the two boys.*
 b. *Dido didn't bite the two boys.* NONE

In other words, sentences with a plural DP *A* and a distributive predicate *P* are only judged true or false if P holds of all or none of the atomic individuals A consists of – a phenomenon that has been termed **'homogeneity'**. (cf. Löbner (1987, 2000), Schwarzschild (1994) a.o.).[6]

The line between judgements corresponding to 'false' and those corresponding to 'no truth-value' is, of course, often blurry, (Chemla and Križ 2015), but we can employ discourse effects as an additional indicator of homogeneity (but cf. Chemla and Križ 2015 on the complications of such tests). For instance, there is a clear contrast between the discourse in (28-a) with a plural DP and the one in (28-b) with *every NP*: (28-a) suggests that once we have a sentence *not (the As are P)*, we cannot simply follow it up with a sentence that would be true only in an 'in between' scenario (i.e. *some, but not all, As are P*). There is no problem with this type of continuation in the case of (28-b) on the other hand, which does not involve any 'in between' scenarios.

(28) *Abe, Bert and Fred were petting Dido, Eric was feeding her . . .*
 a. *She didn't bite the boys that touched her. ??She bit (only) Abe.*
 b. *She didn't bite every boy that touched her. She bit (only) Abe.*

Further, sentences which exhibit the NONE-pattern can be followed up by relativizing continuations introduced by *I mean* or *well* which introduce sentences with the NOT-ALL-pattern, as in (29-a). Relativizing a sentence that has the NOT-ALL pattern in the same way sounds odd, (29-b), presumably, because there is nothing to relativize in the first place.

(29) a. *Dido didn't bite the three boys that touched her. I mean/well, not ALL of them, just Abe.*
 b. *Dido didn't bite all of the boys that touched her?/??I mean/well, she didn't bite ALL of them, just Abe.*

[6]Homogeneity also interacts with non-maximality, i.e. the phenomenon that sentences with a distributive predicate and a plural DP argument are sometimes judged true even if the predicate does not hold of all the atomic individuals in the plural DP's denotation (cf. Brisson 1998, Malamud 2012, Križ 2015 a.o.): (i) can be true if uttered in the context of a birthday party by an exasperated parent, even if only half of the children are crying.

(i) *The children are crying.*

This interference does not concern us, because I only consider examples where non-maximality and homogeneity are dissociated: I stick to plural DPs with numeral modifiers, which block non-maximality (cf. Križ 2015).

I will employ these tests in addition to the basic diagnostic of homogeneity, namely, that a string like with a universal, i.e. ALL-construal in the non-negated case, exhibits the NONE-pattern when affixed with negation. (Whenever a particular expression *A* gives rise to this behavior of strings, I will say that ‘ *A* displays homogeneity’.)

Just as in the case of cumulativity, individual conjunctions have been known to behave parallel to plural DPs when it comes to homogeneity (cf. Schwarzschild 1994, Szabolcsi and Haddican 2004, Križ 2015, but cf. also Crain 2012 for data from language acquisition that might be related to the phenomenon): Whereas (30-a) conveys that Dido bit both Abe and Bert, (30-b) conveys that she bit neither. Note that it is crucial in these cases (as well as in all the examples discussed below) that *and* is unstressed (cf. in particular Szabolcsi and Haddican 2004 for the effects of stress on *and*) and that the conjunction as a whole is not contrastively stressed either (with pitch accent on the last conjunct).

(30) a. *Dido bit Abe and Bert.*
b. *Dido didn't bite Abe and Bert.* NONE

Given these constraints, the following shows predicate conjunction and propositional conjunctions also exhibit the NONE-pattern and, therefore, homogeneity.

2.2.1 Homogeneity with predicate conjunctions

Consider the two sentences in (31-a) and (31-b). (31-a) clearly expresses that ‘Varg’ was both P and Q, but (31-b) conveys that he was neither (cf. Geurts (2005) for similar data and judgements). (32) is analogous: (31-a) expresses that Bert did both P and Q, but according to (31-b), he did neither. I.e. just as with plural DPs, we witness the NONE-pattern.[7]

(31) *Well, I went on a blind data last with ‘Varg’ night.....*
a. *[$_S$ He was [kind]$_P$ and [handsome]$_Q$]. But he's wanted by the police.*
b. *[$_S$ He wasn't [kind]$_P$ and [handsome]$_Q$]. But at least he isn't wanted by the police.*

(32) *The party had already been going on for a couple of hours, when Bert arrived.*
a. *[$_S$ He [danced]$_P$ and [smoked]$_Q$]. But he didn't look high.*
b. *[$_S$ He didn't [$_A$ [dance]$_P$ and [smoke]$_Q$]. But he looked high.*

The intuition that *not P and Q* shows the NONE-pattern rather than the NOT-ALL-pattern is corroborated by the contrasts in (33) and by (34), both of which repeat discourse diagnostics for homogeneity that I discussed w.r.t. plural DPs above. The gist of (33), which relates to the examples in (28) above, is that bare predicate conjunction *P and Q* behaves analogously to plural DPs, whereas *both P and Q* behaves analogous to quantified DPs: A continuation that appeals to an ‘in-between scenario’ – where Bert is P, but not Q – and that is not introduced by discourse markers such as *well* or *I mean* – is odd with *P and Q*, but fine with *both P and Q*.

[7] Contrasting simple conjunctions like those in (30) with conjunctions including *both* might corroborate this point: With *e*-conjunctions (or plural DPs), homogeneity vanishes if the conjunction is affixed with *both*: (i-b), as opposed to (30-b) above, is an instance of the NOT-ALL-, rather than the NONE-pattern. In analogy, there is a clear contrast between (32-b) and (i-a): As opposed to (32-b), (i-c) exhibits the NOT-ALL-pattern.

(i) a. *Dido bit both Abe and Bert].*
b. *Dido didn't bite both Abe and Bert.*
c. *He didn't both [dance]$_P$ and [smoke]$_Q$.*

(33) *The party had already been going on for a couple of hours, when Bert arrived.*
   a. *He didn't [dance]$_P$ and [smoke]$_Q$. ?/?? He only smoked.*
   b. *He didn't both [dance]$_P$ and [smoke]$_Q$. He only smoked.*

(34), which is parallel to (29), shows that with relativizing *I mean* we can introduce a continuation with the NOT-ALL pattern, again in analogy to what we observe for plural DPs.

(34) *[$_S$ He didn't [dance]$_P$ and [smoke]$_Q$]]. I mean, he didnt' BOTH dance and smoke.*

2.2.2 Homogeneity with propositional conjunction

The reasoning for homogeneity of sentential conjunction is parallel. While (35-a) conveys that Abe claimed both p and q, (35-b) conveys that he claimed neither, i.e. we again find the NONE-pattern, rather than the NOT-ALL pattern.

(35) *I just talked to old chatterbox Abe. We discussed his old enemies, Bert, Gina and Joe...*
   a. *He claimed [$_p$ that Bert is in jail] and [$_q$ (that) Gina is in rehab. But he didn't say anything about Joe being in hiding.*
   b. *He didn't claim [$_p$ that Bert is in jail] and [$_q$ (that) Gina is in rehab. But he did say something about Joe being in hiding.*

Again, the NOT-ALL pattern can be introduced in a continuation introduced by relativizing *I mean*, in analogy to what we observed for plural DPs and predicate conjunction, (36).

(36) *He didn't claim [$_p$ that Bert is in jail] and [$_q$ (that) Gina is in rehab]. I mean he didn't claim BOTH.*

We might even witness symptoms of homogeneity in unembedded sentential conjunctions as in (37).[8] *C*'s reply in (37-a) seems to indicate they *C* believes both *p* and *q* to be false. If *C* believes only one of the conjuncts to be false it seems that *no* must be followed up by the explicit negation of that conjunct, as in (37-b). Furthermore, we observe an asymmetry with*well*-answers, that wouldn't be expected if the NONE-scenarios and the NOT-ALL-scenarios had the same status: A *well*-reply is appropriate if *C* believes only one of the conjuncts to be false, (37-c), but completely inappropriate if she believes both of them to be false.

(37) *A*: *Bert is in jail and Gina is in rehab.*
   a. *C*: *No, that's bullshit.*
   b. *C*: *No, Bert isn't in jail.*
   c. *C*: *Well, Bert is in jail, but Gina isn't in rehab.*
   d. *C*: *# Well, Bert isn't in jail and Gina isn't in rehab.*

2.3 Claims of this paper and the meaning of *and*

The previous paragraphs have shown that individual conjunctions, predicate conjunctions (of VP) and propositional conjunctions display cumulativity and also, at least to a certain extent, homogeneity. Their behavior thus mimics that of plural DPs.

Conjunctions have been extensively discussed in the semantic literature, so it stands to reason that some existing account should derive these observations. In the following, I argue

[8]These observations arose from joint, unpublished work with Manuel Križ.

that this is not the case, despite first appearances. To keep the discussion simple, I will focus on the cumulativity of conjunctions and ignore homogeneity.

2.3.1 Intersective and non-intersective *and*

Concerning the underlying meaning of English *and* and analogous expressions in other languages, we can distinguish two positions: Those that take the meaning of *and* to be uniformly intersective ('distributive', 'Boolean') and those that view it as uniformly non-intersective ('collective', 'non-Boolean').[9]

Intersective theories (cf. von Stechow 1974, Partee and Rooth 1983, Gazdar 1980, Keenan and Faltz 1985, Winter 2001a, Champollion 2015 a.o.) all start off with the assumption that *and* in sentential conjunction is analogous to the operation '$\wedge$' on truth-values in classical propositional logic: Accordingly, (38) is said to be true iff both p and q are true and false otherwise (but see my discussion above concerning homogeneity).

(38) *[$_p$ Abe went to the office] and [$_q$ Bert went to the gym].*

The general idea of most such proposals (cf. Keenan and Faltz 1985 for a slightly different approach) is to 'retrieve' the semantic impact of *and* on D_t in other semantic domains for *t*-conjoinable types (types ending in *t*) and thus to account for the fact that *and* does not only conjoin sentences but expressions of various semantic types.[10] The meaning of *and* is defined as the type-polymorphous operation '$\sqcap$' which is recursively expanded from D_t, (39):

(39) $$X \sqcap Y = \begin{cases} X \wedge Y & \text{if } X, Y \in D_t \\ \lambda Z_a.X(Z) \sqcap Y(Z) & \text{if } X, Y \in D_{\langle a,b\rangle} \text{ and } \langle a, b\rangle \text{ is t-conjoinable} \end{cases}$$

To see the point, take the predicate conjunction in (40): According to (39), conjoining two elements from $D_{\langle e,t\rangle}$ gives us another element of $D_{\langle e,t\rangle}$, namely that function which maps any individual x to 1 iff x both dances and smokes.

(40) $[\![$*smoke and dance*$]\!] = \lambda x_e.\ \text{smoke}(x) \wedge \text{dance}(x)$.

It should be clear that without any additional assumptions (such as those in Winter 2001a, Champollion 2015, which I briefly address in section 5 below) the intersective theory is incompatible with the data discussed in paragraph 2.1. (40) gives us a distributive predicate of individuals (distributive because one of its conjuncts, 'smoke' is distributive). Accordingly, its truth-conditions in sentences with a plural subject should be analogous to those of sentences with non-conjoined distributive predicates such as (41).

(41) *The ten children are smoking.*

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[9] The hypothesis that English *and* is ambiguous between an intersective and a non-intersective meaning is unattractive for two reasons (cf. in particular Krifka 1990, Schein 1997, Winter 2001a, Heycock and Zamparelli 2005, Champollion 2015 for similar arguments): On the one hand, in a number of typologically unrelated languages the same formal strategy can seemingly express both meanings, at least for some categories (cf. Flor et al. 2017 a.o. for discussion). On the other hand, even in English, a single conjunction token can simulatenously exhibit what would count as an intersective reading and a non-intersective reading: (i), modelled after examples by Dowty (1987), is true in a scenario where Abe and Bert met and had ten beers each.

(i) *Abe and Bert met in the park and drank exactly 10 beers.*

[10] Cf. Geach 1970 and van Benthem 1991 for the syntactic prerequisites of such a 'retrieval'.

As (41) is true iff each of the ten children are smoking, the example from (21) above, repeated in (42), should be true iff each of the ten children is both smoking and dancing.

(42) *The ten children are smoking and dancing.*

We saw above that the actual truth-conditions of (42) are much weaker: The sentence is true iff each of the ten children is smoking or dancing and there are both smokers and dancers among the children. In other words, the intersective theory of *and*, in the 'bare' version I reproduced here, cannot account for cumulativity of predicate conjunctions.

In fact it was data like those in (42) which, among other observations, motivated an alternative treatment of the lexical meaning of *and*, namely, the non-intersective theory (cf. Link 1983, 1984, Krifka 1990, Heycock and Zamparelli 2005). The gist of such theories is, in a sense, the inverse of intersective theories: Rather than considering the semantic impact of *and* in propositional conjunction as basic, they take its role in individual conjunction, such as (43), as the point of departure.

(43) *Abe and Bert*

The assumption is that in contexts such as (43), *and* denotes the operation that forms pluralities of individuals from (pluralities of) individuals (cf. Link 1983). I have not defined this operation yet, so I will simply represent it here by '+' – it will be sufficient to say that $[\![Abe]\!] + [\![Bert]\!]$ is identical to $[\![\textit{the two boys}]\!]$, if $[\![boy]\!] = \{$ Abe, Bert $\}$. The idea is to recursively define the denotation of *and* for all conjuncts of e-conjoinable types – defined in (44)– on the basis of '+' , as in (45), where $\sqcup$ represents the (type-polymorphous) denotation of *and*:[11]

(44) e is an e-conjoinable type and if $a_1, ..., a_n$ are e-conjoinable types, then $((a_1)...(a_n)t)$ is an e-conjoinable type.

(45)
$$X \sqcup Y = \begin{cases} X \cup Y & \text{if } X, Y \in D_e \\ \lambda Z_a.\exists Z_1, Z_2\, [\, Z = Z_1 \sqcup Z_2 \wedge X(Z_1) \wedge Y(Z_2)\,] & \\ \quad \text{if } X, Y \in D_{\langle a,t\rangle} \text{ and } \langle a, t\rangle \text{ is } e\text{-conjoinable} & \\ \lambda Z^1_{a1}, \ldots, Z^n_{an}.\exists Z^1_1, Z^1_2, \ldots Z^n_1, Z^n_2 & \\ [Z^1_1 \sqcup Z^1_2 = Z^1 \wedge \ldots \wedge Z^n_1 \sqcup Z^n_2 = Z^n \wedge X(Z^1_1)\ldots(Z^n_1) \wedge Y(Z^1_2)\ldots(Z^n_2)] & \\ \quad \text{if } X, Y \in D_{\langle a_1\langle \ldots\langle a_n,t\rangle\ldots\rangle\rangle} \text{ and } \langle a_1, \langle \ldots, \langle a_n, t\rangle \ldots\rangle\rangle \text{ is } e\text{-conjoinable} & \end{cases}$$

For the predicate conjunction in (46), this yields that function that maps any (plurality of) individuals to 1, just in case it exclusively consists of 'parts' that smoke and 'parts' that dance – the characteristic function of the set of those (pluralities of) individuals that are the result of adding up smokers and dancers.

(46) $[\![\textit{smoke and dance}]\!] = \lambda x_e.\exists y, z[y + z = x \wedge \text{smoke}(y) \wedge \text{dance}(z)]$

Glossing over the problems resulting from my informal treatment (the predicate extension itself in (47) is not 'cumulated', see section 3.1), (45) thus derives the correct truth-conditions for our sentence in (21) above, repeated again in (47): (47) is predicted true iff we can split up the group of ten children completely into smokers and dancers (and it doesn't exclude the possibility that there are children that do both).

(47) *The ten children are smoking and dancing.*

[11] t still represents a special case.

In other words, non-intersective theories of conjunction derive cumulativity for predicate conjunction – so why not simply use such an analysis to account for the data above?

2.3.2 Why existing non-intersective analyses of *and* are insufficient

Ignoring all other potential problems for non-intersective theories (e.g. the question of how they deal with cumulativity of propositional conjunction, but also the problems brought up by Krifka (1990) and most recently by Champollion (2015)), such theories include one component that makes them unfit to explain cumulativity of conjunctions: They require what I will henceforth call 'semantic locality'. This means that these proposals essentially capture the impact of *and* in conjunctions with functional denotations (such as predicate conjunction) in terms of its impact on the arguments of that function (the same holds for intersective theories, of course). As a result, the 'cumulative relation' we observed above is predicted to only hold between conjunctions and those elements that either denote an argument of the conjunction or themselves take that conjunction as an argument.

Crucially, this predicts that we should never find cumulative truth-conditions for sentences with an plural DP (or an individual conjunction) *A* and a predicate conjunction *B* where *A* is not an argument of *B* – and this prediction is false. It is falsified by sentences like that in (48), which contains predicate conjunction in the embedded clause and a plural DP (*the ambassadors*) as the subject of the matrix clause. Importantly, this plural DP is *not* an argument of the predicate conjunction in the embedded clause – the subject of the latter is *Trump*.

(48) *Diplomacy is useless! The Georgian ambassador called this morning and the Russian one this afternoon.* $[_S$ $[_A$ *The ambassadors] kept insisting that* **Trump** *must* $[_B$ *take a walk with Putin and build a golf club in Tbilisi]], but neither of them said anything about the really pressing issue – the Caucasian conflict.*

Nevertheless, the sentence has cumulative truth-conditions and the cumulative relation – if I may put it like this – holds between the matrix subject and the embedded predicate conjunction. Namely, the sentence is true in a scenario where the Georgian ambassador insists that the president do *P* and the Russian one insists that he do *Q* – or, more generally, if (49) holds.

(49) $\forall x \in S_A\,(\exists Y \in \{\text{P,Q}\}(x \text{ kept insisting that the president must } Y)) \wedge \forall Y \in \{\text{P,Q}\}\,(\exists x \in S_A(x \text{ kept insisting that the president must } Y))$

(50-a) and (50-b) are analogous to to (49) in the relevant sense and again we find cumulative truth-conditions. The sentences is true if some of the villagers believe that Abe is a murderer, some believe he is a fraud, some believe he is a gambler, some believe he is a hedonist and all of them believe at least one of these things. Crucially, the cumulative relation holds between the subject of the matrix clause and the predicate conjunction in the predicate of the embedded clause, but neither is an argument of the other- rather, the conjunction's argument is **he**.[12]

(50) *The people in this village are not as bad as you think. They each have their idiosyncratic theories about Abe, of course...*

[12] As we find the same facts with predicate-topicalization as in (i), which shows that the conjunction forms a constituent, such examples are not (necessarily) reducible to propositional conjunction (at the level of the embedded clause) plus subsequent ellipsis.

(i) *A murderer, a fraud, a gambler and a hedonist, they believe he is – but none of them has ever claimed that he is an actual witch.*

a. *$[_S [_A$ they$]$ believe that* **he** *is $[_B$ a murderer, a fraud, a gambler and a hedonist$]]$– but none of them has ever claimed that he is an actual witch.*
b. *$[_S [_A$ they$]$ consider* **him** *(to be) $[_B$ a murderer, a fraud, a gambler and a hedonist$]]$– but none of them has ever claimed that he is an actual witch.*

In sum, what these data show is that semantic locality is not a prerequisite for cumulativity of a predicate conjunction. What we find, once again, is that conjunctions (in this case predicate conjunctions), pattern with DP-plurals which also don't require semantic locality in order to give rise to cumulative truth-conditions (quite obviously so, since one DP-plural cannot function as the argument of another). Existing non-intersective (and, of course, also intersective) theories cannot account for this observation, as semantic locality is built into these theories. (The same holds for all existing theories of conjunction that work with events, rather than individuals, e.g. Lasersohn 1995, Landman 2000.) Accordingly, we must look for a new explanation for these facts, which I will do in the following. I should note, however, that as opposed to the intersective and the non-intersective theories, my proposal is not a proposal about the lexical meaning of *and* (even though it is currently phrased like this) but rather about the denotations of conjunctions, i.e. the entire coordinate structure.

2.4 Summary: Parallels between plural DPs and conjunctions

The preceding paragraphs have shown that conjunctions behave analogously to plural DPs in terms of cumulativity and homogeneity – and that no existing account derives these parallels. Before I try to provide such an account, let me point to some additional indications that conjunctions and plural DPs form a natural class of expressions.

First, a number of lexical elements don't distinguish between plural DPs and conjunctions in general – neither w.r.t. their selectional restrictions nor concerning their semantic impact in the respective context. *both*, for instance, combines with plural DPs, (51-a), and individual conjunctions, (51-b), but also with other conjunctions, e.g. predicate conjunctions, (51-c) (cf. Schwarzschild 1996), and, in each case, seems to add a distributive flavor.

(51) a. *Both the boys went to jail.*
b. *Both Abe and Bert went to jail.*
c. *Abe both drank and smoked.*

The adverb *respectively* exhibits an analogous behaviour, combining with plural DPs, (52-a), as well as with conjunctions in general – e.g. individual conjunctions, (52-b) or predicate conjunctions, (52-c). (Cf. in particular McCawley 1988, Gawron and Kehler 2004.)

(52) a. *The two first amendments refer to the first two commandments, respectively.* (adapted from Munn 1993:(17c))
b. *Abe and Bert fed Carl and Dido, respectively.*
c. *Abe and Bert smoked and danced, respectively.*

Furthermore, certain grammatical features seem to have the same effect with individual conjunctions and other conjunctions: Winter (2007) and Wagner (2010) both note that individual conjunctions can give rise to a semantic 'grouping' of some conjuncts to the exclusion of others, which Wagner (2010) relates to the relative strength of the prosodic boundaries between the conjuncts (here indicated by iteration of '|'). The most prominent reading of (53-a), for instance, is one where Abe and Bert performed a song together and Gina performed a song on her own. As opposed to this, (53-b), which differs from (53-a) only w.r.t. the relative strength of the prosodic boundaries, prominently conveys that it was Bert and Gina who collaborated. As noted by Winter (2007), we find similar 'grouping' effects for other kinds of conjunction, such as predicate conjunction: The most salient construal of (53-c) is one where Abe danced and smoked and Bert drank, whereas (53-d) – again, this example only differs from (53-c) w.r.t. the relative strength of the boundaries – conveys that Abe danced and Bert smoked and drank.

(53) a. *Abe | and Bert || and Gina performed a song.*
b. *Abe || and Bert | and Gina performed a song.*
c. *Abe and Bert danced and smoked | and drank (,respectively).*
d. *Abe and Bert danced | and smoked and drank (,respectively).*

I offer no analysis of these phenomena, but they suggest to me that a uniform treatment of plural DPs and conjunctions in general could be on the right track.

3 Pluralities, the predicate analysis and its expansion

Here is what we need to explain: Conjunctions with conjuncts denoting individuals, predicates of individuals (in VP) and propositions show a parallel behavior to plural DPs. In particular, they exhibit two of the properties that, in the case of plural DPs, lead us to assume that they denote special objects, namely, pluralities. So – how do these parallels come about?

In the following, I will propose a very straightforward answer: Conjunctions behave like plural DPs because they, too, denote pluralities – pluralities of those kinds of objects that the conjuncts denote – individuals, predicates of individuals, propositions etc. In other words, I will argue that pluralities – objects that are isomorphic to non-empty subsets of the respective domain – exist in any semantic domain.

Implementing this very simple claim, however, will immediately bring me to a more complex issue: Plural composition. In particular, when considering these 'new pluralities', we will also have to consider how they semantically combine with other elements of the sentence. At first sight, there seems to be an easy way out: We could just take the standard story for the denotation of plural DPs and the way *they* combine with other elements – the 'predicate analysis' which I lay out in paragraph 3.1 – and expand it so that it includes pluralities of functions etc. This is sketched in paragraph 3.2. However, closer scrutiny (applied in paragraph 3.3) reveals that the predicate analysis itself is not without problems. Some of them are observable even in simple cases, i.e. when only dealing with plural DPs, but others become evident once we add our 'new' pluralities. Accordingly, a simple expansion of it seems to be on the wrong track.

3.1 Pluralities and the predicate theory

Let us start with the most basic questions: What is the denotation of plural DPs such as *the boys* and how does it relate to the denotations of singular DPs, such as *Abe* or *the boy*? And how exactly do we derive the truth-conditions of sentences containing plural DPs? In the following, I outline a version of what I call the 'predicate analysis': Link's 1983 proposal, which I here sketch using a set-based ontology. [13]

[13] Even though accounts such as Van der Does 1992 and Winter 2001a differ from the one presented here in a number of ways, they still maintain those insights of Link's 1983 original paper that will be relevant for me, in particular, the basic idea of predicate cumulation (although they implement this idea in different ways).

3.1.1 The denotations of plural DPs and *e*-conjunctions

The basic idea is that the domain of individuals D_e does not only contain 'atomic' individuals, i.e. objects that have no parts but themselves, but also complex objects that *do* have individuals as their proper parts. In order to capture this idea, we replace the 'traditional' domain of individuals, A, by the set of all non-empty subsets of A, (54).

(54) $\mathrm{D}_e := \wp(A) \setminus \{\emptyset\}$, where A is the non-empty set of individuals.

I will introduce a simplifying step here and assume, as in (55) that singulars enter the derivation as singletons (but cf. Schwarzschild 1996 and also Van der Does 1992 for discussion).[14] As a consequence, I will now treat every function that standardly would have D_e has its domain is a partial function with PL as its domain, i.e. is a function that takes sets of individuals as its arguments (these sets can, of course, be singletons). Hence, an expression like *Abe* will have its denotation in $\{x : x \in \mathrm{PL} \,\&\, |x| = 1\}$. Plural DPs like *the boys* will have their denotations in PL.(55) gives some terminology conventions that I will adhere to in the following:

(55) a. I write 'A is a part of B' iff $\mathrm{A} \subseteq \mathrm{B}$
 b. I write that 'A is an atomic part of B' or write '$\mathrm{A} \subseteq_{AT} \mathrm{B}$' iff $\mathrm{A} \subseteq \mathrm{B}$ & $|\mathrm{A}| = 1$.
 c. Finally, I will write that 'C is the sum of A and B', iff $\mathrm{A} \cup \mathrm{B} = \mathrm{C}$.

Given the parallels between plural DPs and individual conjunctions, Link (1983) assumes that *and* in individual conjunctions is the operation that forms pluralities of individuals from other individuals (atomic or pluralities), (56): It takes any two individuals (atoms or pluralities) and gives us another individual, as illustrated in (57).

(56) $[\![and]\!]_{\langle e\langle ee\rangle\rangle} = \lambda x_e.\lambda y_e.x \cup y.$

(57) $[\![\textit{Abe and Bert}]\!] = [\![\textit{Abe}]\!] \cup [\![\textit{Bert}]\!] = \{\text{Abe}\} \cup \{\text{Bert}\} = \{\text{Abe, Bert}\}$.

Simpifying greatly, a plural DP denotes the sum of the elements in the NP-denotation, as exemplified by (58).

(58) $[\![\textit{the boys}]\!] = \bigcup([\![\textit{boys}]\!])$

3.1.2 Cumulation

But when does a predicate hold of a plurality? Ignoring cases where it can do so primitively, i.e. collective predicates, the task is to ensure that 'cumulative inferences' are adequately captured by the theory: If both (59-a) and (59-b) are true, then so is (59-c). *blond* intuitively expresses a property of atomic individuals (but cf. Schwarzschild 1994 for more discussion) – a trait I here take to be lexically specified (but cf. Link 1983). Accordingly, we require a mechanism where the predicate in (59-a) will hold of the plurality { Abe, Bert } in virtue of holding of its atoms, i.e. a mechanism that will allow for a plurality to inherit the properties of its parts.

(59) a. *Abe is blond.*
 b. *Bert is blond.*
 c. *Abe and Bert are blond.*

Link (1983) identifies this mechanism with the cumulation-operation '*' on the extension of intransitive predicates, (60). It expands the basic extension of the predicate – i.e. the set of

[14] I will not address cases where lexical elements of type *e* are non-atomic.

objects it primitively holds of – by closure under set-union.

(60) For any $P \in D_{\langle e,t\rangle}$, $*P$ is the smallest function f s.th. for all $x \in D_e$, if $P(x) = 1$, then $f(x) = 1$ and for any $S \subseteq D_e$ s.th. for all $y \in S$, $f(y) = 1$, $f(\bigcup S) = 1$.

In the following, I assume that '*' is introduced in the object language by a (silent) morpheme $\textsc{cum}^1$. Accordingly, (61-a) is the LF for (59-c), and (61-b) shows that the sentence is true iff both Abe and Bert are in the primitive extension of *blond* – i.e. iff both Abe and Bert are blond.

(61) a. [[*Abe and Bert*] [$\textsc{cum}^1$ *blond*]]
b. $*[\![blond]\!]$ ($[\![Abe\ and\ Bert]\!]$) = 1 iff $\exists x, y(x \cup y = \{\text{Abe, Bert}\} \& *[\![blond]\!](x) = 1 \& *[\![blond]\!](y) = 1)$

Our main focus in section 2, however, was on transitive structures. Crucially, the latter also license cumulative inferences – if both (62-a) and (62-b) are true, so is (62-c) – and accordingly we require a mechanism that derives such cumulative inferences.

(62) a. *Abe fed Carl.*
b. *Bert fed Dido.*
c. *Abe and Bert fed Carl and Dido.*

It should be evident that we cannot simply reduce the transitive structure to a structure with two intransitives and iterate application of $\textsc{cum}^1$, as in (63) (cf. in particular Sternefeld 1998 for discussion): The truth-conditions assigned to (63) are much too strong, requiring that each of the two boys fed each of the two cats.

(63) *[[Abe and Carl]*$_1$ $\textsc{cum}^1$ *[1 [Dido and Carl] [* $\textsc{cum}^1$ *[2 [t1 fed t2]]]]]*

Nevertheless, we can make use of the essential idea of cumulation – if not the operation itself. The input, this time, is a transitive predicate, i.e. a function representing a set of pairs of individuals – e.g. the pair of actual feeders and feedees in the case of *feed*. The cumulation operation ** (for which I assume the object language representation $\textsc{cum}^2$), defined in (64), now 'passes on' this property to pairs of pluralities as follows: It expands the original extension of the predicate by adding together feeders while simultaneously adding together their respective feedees (and *vice versa*). Accordingly, the cumulated extension of *feed* will hold of a pair of individuals $\langle a, b\rangle$ iff a exclusively consists of individuals that feed a part of b and b exclusively consists of individuals that were fed by a part of a (cf. Krifka 1986, Sternefeld 1998).

(64) For any $P \in D_{\langle e,\langle e,t\rangle\rangle}$, $**P$ is the smallest function f s.th. for all $x, y \in D_e$, if $P(x)(y) = 1$, then $f(x)(y) = 1$ and for all $S, S' \subseteq D_e$, s.th for every $x' \in S$ there is an $y' \in S'$ and $f(x')(y') = 1$ and for every $y' \in S'$ there is an $x' \in S$ and $f(x')(y') = 1$, $f(\bigcup(S))(\bigcup(S')) = 1$.

(65-a) gives the LF for (62-c), and (65-b) a sketch of the semantic derivation. Note that the result is exactly what we require: The sentence has the 'cumulative' truth-conditions observed in the preceding chapter. Analogous operations can be defined for n-transitive predicates with $n > 2$ (cf. Sternefeld 1998).

(65) a. *[[Abe and Carl] [[*$\textsc{cum}^2$ *fed] [Carl and Dido]]]*
b. $[\![[\textsc{cum}^2\ fed]]\!]$ ($[\![Carl\ and\ Dido]\!]$) ($[\![Abe\ and\ Bert]\!]$)
$= **\ [\![fed]\!]$ ($[\![Carl\ and\ Dido]\!]$) ($[\![Abe\ and\ Bert]\!]$)
$= 1$ iff $\exists x, x', y, y'(x \cup x' = \{\text{ Carl, Dido }\} \wedge y \cup y' = \{\text{ Abe, Bert }\} \wedge **\ [\![\text{fed}]\!](x)(y)\ \&$

$**[\![\text{fed}]\!](x')(y'))$

The assumption that cumulation operations are realised by actual morphemes $\textsc{cum}^n$ in the syntactic structure – rather than being (exclusively) a lexical property of predicates (as argued by Krifka (1986), cf. also Champollion 2010b) – is motivated by Beck and Sauerland's 2000 observation that the predicate targeted by cumulation does not have to be a lexical element. Consider their example in (66): It has cumulative truth-conditions, namely, the sentence is true iff it is the case that of each of the two women wanted to marry at least one of the two men and it holds for each of the two men that at least one of the two women wanted to marry him.

(66) *The two women wanted to marry the two men.* Beck and Sauerland 2000:356 (19c)

As cumulative truth-conditions, in the theory laid out here, are the result of operations on predicate extensions, it will be the predicate in (67) that has to undergo cumulation. However, none of the lexical elements in (66) corresponds to (67), nor any of the surface constituents.

(67) $\lambda x_e.\lambda y_e.y$ wanted to marry x

Beck and Sauerland (2000) argue that (67) is syntactically derived by covert 'tucking-in' movement, (Richards 1997), resulting in (68), where $\textsc{cum}^2$ is affixed to the constituent denoting (67).

(68) *[[the two women] [[the two men] [*$\textsc{cum}^2$ *[2 [1 [*t_1 *wanted to marry* t_2 *]]]]]]*

We end up with the following picture: individual conjunctions have their denotations in an identifiable subset of D_e. Their denotations differ from those of singular DPs only in that they have non-trivial parts, i.e. parts other than themselves. Pluralities inherit properties of their parts *qua* predicate cumulation – operations on the predicate's extension, which, in the case of transitive predicates, derive us the cumulative truth-conditions witnessed in section 2. The predicates targeted by these operations can be syntactically derived.

3.2 Expanding the predicate analysis

In section 2 above I argued that the behavior of predicate and sentential conjunctions mimics the behavior of plural DPs. I will propose a straightforward explanation of these facts: Conjunctions with conjuncts of type a behave analogously to plurals because they, too, denote pluralities – namely, pluralities from objects in D_a.

In what follows, I sketch the most salient implementation of this idea, which essentially generalizes the predicate analysis to all semantic domains (cf. also Schmitt 2013). I then show (in paragraph 3.3) why this account, straightforward as it may be, is insufficient. Because it will eventually be discarded and replaced by an alternative system (in section 4), I keep my sketch of this preliminary analysis as simple as possible: My implementation ignores collective predication (i.e. predicates that primitively hold of pluralities), will use extensions wherever possible and omits any discussion of homogeneity.[15]

3.2.1 Ontology

I assume that all well-formed expressions (LFs) are semantically categorized, i.e. are assigned a logical type. Here and also in my final proposal in section 4 I will work with the standard set

[15] For the same reason, I don't address disjunction here. See 4 below.

of extensional types in (69). This means I won't introduce special types for plural expressions. Doing so would be more elegant in terms of the syntax and the assignment of denotations, but would add to notational complexity, which I try to keep at a minimum.

(69) The set T is smallest set S s.th. $e \in S, t \in S$ and if $a \in S, b \in S, \langle a, b\rangle \in S$.

As a first step, I add pluralities to all semantic domains. Note that my treatment of pluralities here deviates slightly (but not in any deep sense) from the story for individuals I gave in the preceding section, owing to the fact that working with simple power sets might lead to confusion when dealing with pluralities of functions to D_t , but also because I will recycle some of the notions from this current, preliminary version in my final treatment in section 4. That being said, we start off with the 'atomic' domains in (70-a), which only contain 'atomic' objects, i.e. no pluralities of primitives or any other object. We then add, for each domain D_a the set of pluralities $\mathbf{PL}_a$ (so we have two sets per type).

(70) a. **atomic domains (containing atoms)**
  (i) D_e := the domain of all atomic individuals
  (ii) D_s := the set of all atomic possible worlds
  (iii) D_t := the domain of truth-values
  (iv) $D_{\langle a,b\rangle}$:= the set of all atomic functions from D_e

 b. **plural domains (containing pluralities)**
  For any domain D_a, there is a set $\mathbf{PL}_a$ and a bijection $pl_a : (\mathcal{P}(D_a) \setminus \{\emptyset\}) \to \mathbf{PL}_a$

For the purposes of readability, I will use the notational conventions in (71):

(71) a. (i) I use $\mathbf{a}, \mathbf{b}, \mathbf{c}$ for elements of $\mathbf{PL}_e$, $\mathbf{P}, \mathbf{Q}$ etc. for elements of $\mathbf{PL}_{\bar{e},t}$, and $\mathbf{p}, \mathbf{q}$ etc. for elements of $\mathbf{PL}_t$ and
  (ii) a, b, c for elements of D_e, P, Q etc. for elements of $D_{\bar{e},t}$, and p, q etc. for elements of D_t.

 b. **'sums'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \oplus \mathbf{b} = pl_a(pl_a^{-1}(\mathbf{a}) \cup pl_a^{-1}(\mathbf{b}))$.

 c. **'part-of'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \leq \mathbf{b}$ iff $pl_a^{-1}(\mathbf{a}) \subseteq pl_a^{-1}(\mathbf{b})$.

 d. **'atomic-part-of'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \leq_{AT} \mathbf{b}$ iff $pl_a^{-1}(\mathbf{a}) \subseteq pl_a^{-1}(\mathbf{b})$ and $|pl_a^{-1}(\mathbf{a})| = 1$.

Lexical meanings are assigned by the function $\mathcal{L}$, which maps any lexical element of primitive type a to an element in D_a, and lexical elements of functional types to elements in $D \cup \mathbf{PL} \cup \{f : D \to \mathbf{PL}\} \cup \{f : \mathbf{PL} \to \mathbf{PL}\} \cup \{f : \mathbf{PL} \to D\}$, where D and $\mathbf{PL}$ stand for $\bigcup D_{a:a \in T}$ and $\bigcup \mathbf{PL}_{a:a \in T}$, respectively (this simply means that there will be expressions which denote functions from atomic domains to plural domains, from plural domains to plural domains etc.).[16]

I furthermore introduce two operations that 'shift' the denotations of expressions from one set to another. '$\downarrow$' in (72-a) takes elements from $\mathbf{PL}_a$ to D_a. It is only defined if the set-correlate of its argument is a singleton. (72-b) on the other hand gives a *quasi*-trivial 'shift'-morpheme: For any atomic domain D_a, $\textsc{pl}_a$ denotes a function from D_a to $\mathbf{PL}_a$.

(72) a. for any type a, $\downarrow_a$ is a function from $\mathbf{PL}_a$ to D_a. For any $X \in \mathbf{PL}_a$, $\downarrow(X)$ is defined iff $|pl^{-1}(X)| = 1$. If defined $\downarrow(X)$ = the unique $Y \in pl^{-1}(X)$.

 b. $[\![\textsc{pl}_a]\!] = \uparrow_a = \lambda X \in D_a.pl(\{X\})$

[16]For example, an expression of type $\langle a, b\rangle$ will have its denotation in $\{f : D_a \to D_b\} \cup \{f : \mathbf{PL}_a \to \mathbf{PL}_b\} \cup \{f : D_a \to \mathbf{PL}_b\} \cup \{f : \mathbf{PL}_a \to D_b\}$.

In order to keep the derivations readable, I will simplify them as follows: Unless it could lead to confusion, I drop the type-subscript on functions defined for each semantic domain, leave out the 'trivial' morpheme in (72-b) in the syntactic derivation and drop the correlating operators from the meta-language. This means e.g. that I write $P(\mathbf{a})$ instead of $P(\downarrow(\mathbf{a}))$ for some $P \in D_{\langle a,t\rangle}$, $\mathbf{a} \in \mathbf{PL}_a$ if it follows from the context that $|pl^{-1}(\mathbf{a})| = 1$.As a final notational simplification, I replace characteristic functions of sets of individuals by upper-case words, e.g. 'CAT' stands for '$\lambda x_e.x$ is a cat' and accordingly '**CAT**' for '$pl(\lambda x_e.x$ is a cat)'. For the denotations of object-language declaratives, the meta-linguistic sentence will stand for the proposition the object-language sentence expresses, i.e. if, for the object language sentence *Abe fed Carl* I write 'Abe fed Carl' in the meta-language, this will stand for λw. Abe fed Carl in w.

3.2.2 Plural denotations

Both definite plurals and conjunctions with conjuncts of any category will denote pluralities. Concerning definite plurals, I assume that the definite determiner denotes the function in (73-a): It takes a predicate extension and gives us the sum of all the individuals in that extension – if that extension is non-empty.

(73) a. $[\![the]\!] = \lambda P_{\langle et\rangle} : \{y : P(y) = 1\} \neq \emptyset. \bigoplus(\{pl(y) : P(\downarrow(y)) = 1\})$
b. $[\![the\ cats]\!]$ is defined if $\{x : x$ is a cat $\} \neq \emptyset$.
If defined, $[\![the\ cats]\!] = \bigoplus(\{pl(y)$: $\downarrow(y)$ is a cat $\}$

Conjunctions with conjuncts of any any type *a* will denote the sum of all of the conjuncts' denotations. For this to work, I have to assume that all conjuncts that don't have their denotations in **PL** are affixed with PL (cf. Schmitt (2013) for potential typological correlates of this operation). I.e. the LF of *Abe and Bert* is the one given in (74).

(74) [PL *Abe* [*and* [PL *Bert*]]]

I assume the meaning in (75-a) for *and* in (75), some examples of its effect are given in (76): A conjunction of with conjuncts of type *e* gives us a plurality of individuals, (76-a), a conjunction with conjuncts with functional types, such as $\langle et\rangle$, denotes a plurality of the corresponding functions, (76-b), and a conjunction of declaratives gives us a plurality of propositions, (76-c).

(75) $[\![\ and_{\langle a,\langle a,a\rangle\rangle}]\!] = \lambda X \in \mathbf{PL}_a.\lambda Y \in \mathbf{PL}_a.\mathbf{X} \oplus \mathbf{Y}$.

(76) a. $[\![$*[PL Abe] and [PL Bert]* $]\!] = [\![and]\!]$(**Abe**)(**Bert**) = **Abe** $\oplus$ **Bert**
b. $[\![$*[PL smoke] and [PL dance]*$]\!] = [\![and]\!]$(**SMOKE**)(**DANCE**) = **SMOKE** $\oplus$ **DANCE**
c. $[\![$*[PL [that Kadyrov acquired WMD]] and [PL [(that) Duterte has hired a death squad]]*$]\!]$
= $[\![$and$]\!]$(**Kadyrov acquired WMD**)(**Duterte has hired a death squad**) =
Kadyrov acquired WMD $\oplus$ **Duterte has hired a death squad**

3.2.3 Generalized Cumulation

The next step is to let these pluralities (of individuals, functions etc.) combine with other material in the clause. First, we need a default rule for matrix pluralities, i.e. conjunction of sentences as in (77). According to (78), (77), which denotes a plurality of propositions, is true in *w* iff both conjuncts are true in *w*.

(77) *Abe smoked and Bert danced.*

(78) $p \in \mathbf{PL}_{\langle s,t\rangle}$ is true in w iff $\forall \mathbf{q} \leq_{AT} \mathbf{p}, (\downarrow(\mathbf{q}))(w) = 1$.

For all other cases, we simply generalise the cumulation rules taken from above, for all t-conjoinable types a. In order to avoid any confusion with the operators discussion in section 3.1, I use a new set of symbols, '+, ++, ...' etc, which expand '*, **, ...' above.

(79) a. $[\![\mathbf{cum}^1]\!] = +$, where, for any $P \in D_{\langle bt\rangle}, +P = \lambda \mathbf{X} \in \mathbf{PL}_b.P(\downarrow(\mathbf{X})) = 1 \vee \exists \mathbf{X^1}, ..., \mathbf{X^n}(\mathbf{X^1} \oplus ... \oplus \mathbf{X^n} = \mathbf{X} \wedge +P(\mathbf{X^1}) = 1 \wedge .... \wedge +P(\mathbf{X^n}) = 1)$.

b. $[\![\mathbf{cum}^2]\!] = ++$, where, for any $P \in D_{\langle b\langle at\rangle\rangle}, + + P = \lambda \mathbf{X} \in \mathbf{PL}_b.\lambda \mathbf{Y} \in \mathbf{PL}_a.P(\downarrow(\mathbf{X}))(\downarrow(\mathbf{Y})) = 1 \vee \exists \mathbf{X^1}, ..., \mathbf{X^n}, \mathbf{Y^1}, ..., \mathbf{Y^n}(\mathbf{X^1} \oplus ... \oplus \mathbf{X^n} = \mathbf{X} \wedge \mathbf{Y^1} \oplus ... \oplus \mathbf{Y^n} = \mathbf{Y} \wedge + + P(\mathbf{X^1})(\mathbf{Y^n}) = 1 \wedge ... \wedge + + P(\mathbf{X^n})(\mathbf{Y^n}) = 1)$

Finally, we need syntactic rules that generate the right LFs. For this purpose, I adapt Beck and Sauerland's 2000 syntax to all plural expressions, using covert movement of all expressions with denotations in **PL** and which will be *tucking in*-movement in all those cases where the sentence contains more than one plural expression. The resulting predicates are then affixed with +, ++ etc.[17]

This correctly yields 'distributive' truth-conditions for sentences with one plural expression, e.g. an individual conjunction, (80-a), or a predicate conjunction, (81-a). The LFs are given in (80-b) and (81-b), respectively, and the (simplified) semantic derivations in (80-c) and (81-c).

(80) a. *Abe and Bert slept.*

b. [[*Abe and Bert*] CUM^1[1 [$t_{1,e}$ *slept*]]]

c. $[\lambda \mathbf{x} \in \mathbf{PL}_e.\forall \mathbf{y} \leq_{AT} \mathbf{x}\ (\text{slept}\ (\mathbf{y}))](\mathbf{Abe} \oplus \mathbf{Bert}) = 1$ iff Abe slept $\wedge$ Bert slept

(81) a. *Abe smoked and drank.*

b. [[*smoked and drank* CUM^1 1 [*Abe* [$t_{1,\langle et\rangle}$]]]

c. $[\lambda \mathbf{P} \in \mathbf{PL}_{\langle e,t\rangle}.\forall \mathbf{Q} \leq_{AT} \mathbf{P}\ (\mathbf{Q}(\text{Abe}))]\ (\mathbf{SMOKED} \oplus \mathbf{DRANK}) = 1$ iff Abe smoked $\wedge$ Abe drank

For structures with two (or more) plural expressions, e.g. two individual conjunctions, (82-a), or an individual and a predicate conjunction, (83-a), we obtain the LFs in (82-b) and (83-b), repespectively. As shown in (82-c) and (83-c), which give the the (simplified) semantic derivations, we obtain the correct cumulative truth-conditions.

(82) a. *Abe and Bert fed Carl and Dido.*

b. *[[Abe and Bert] [Carl and Dido]* CUM^2 *[2 [1 [t_1 fed t_2]]]]*

c. $\lambda \mathbf{x} \in \mathbf{PL}_e.\lambda \mathbf{y} \in \mathbf{PL}_e.\exists \mathbf{x}', \mathbf{x}'', \mathbf{y}', \mathbf{y}''(\mathbf{x}' \oplus \mathbf{x}'' = \mathbf{x} \wedge \mathbf{y}' \oplus \mathbf{y}'' = \mathbf{y} \wedge \text{fed}(\mathbf{x}')(\mathbf{y}') \wedge \text{fed}(\mathbf{x}'')(\mathbf{y}''))$ $(\mathbf{C} \oplus \mathbf{D})(\mathbf{A} \oplus \mathbf{B})$
$= 1$ iff $\exists \mathbf{x}', \mathbf{x}'', \mathbf{y}', \mathbf{y}''(\mathbf{x}' \oplus \mathbf{x}'' = \mathbf{C} \oplus \mathbf{D} \wedge \mathbf{y}' \oplus \mathbf{y}'' = \mathbf{A} \oplus \mathbf{B} \wedge \text{fed}(\mathbf{x}')(\mathbf{y}') \wedge \text{fed}(\mathbf{x}'')(\mathbf{y}''))$

(83) a. *Abe and Bert smoked and drank.*

[17] Here is an inelegant, possibly too restrictive set of syntactic rules:

(i) a. If α has its denotation in $\mathbf{PL}_a$ and α moves from its position β to some c-commanding position γ, replace α with a trace with index i, where i ranges over D_a.

b. If α has its denotation in $\mathbf{PL}_a$, adjoin α to the lowest position γ that is immediately dominated by by a node δ that also immediately dominates an expression with denotation in **PL** or, if there is no such position, adjoin α to the highest node in the sentence. Strand an index co-indexed with the trace of α in the position right below α.

c. If α, β are expressions with denotations in **PL** and α c-commands β at surface structure, move α before you move β.

b. *[[Abe and Bert] [smoke and drank]* CUM^2 *[2 [1 [t_1 t_2]]]]*

c. $\lambda\mathbf{P} \in \mathbf{PL}_{\langle et\rangle}.\lambda\mathbf{x} \in \mathbf{PL}_e.\exists\mathbf{P}',\mathbf{P}'',\mathbf{x}',\mathbf{x}''(\mathbf{P}' \oplus \mathbf{P}'' = \mathbf{P} \wedge \mathbf{x}' \oplus \mathbf{x}'' = \mathbf{x} \wedge \mathbf{P}'(\mathbf{x}') \wedge (\mathbf{P}'')(\mathbf{x}''))(\mathbf{SMOKED} \oplus \mathbf{DRANK})(\mathbf{A} \oplus \mathbf{B})$
$= 1$ iff $\exists\mathbf{P}',\mathbf{P}'',\mathbf{x}',\mathbf{x}''(\mathbf{P}' \oplus \mathbf{P}'' = (\mathbf{SMOKED} \oplus \mathbf{DRANK}) \wedge \mathbf{x}' \oplus \mathbf{x}'' = (\mathbf{A} \oplus \mathbf{B}) \wedge \mathbf{P}'(\mathbf{x}') \wedge \mathbf{P}''(\mathbf{x}'')]$

Since the present system is simply an expansion of the predicate analysis, we don't require semantic locality w.r.t. the predicate conjunction and the individual plural (as was the case in the non-intersective treatments of conjunction discussed in section 2.3 above). For instance, in (84-a), adapted from (48) above, both expressions are simply treated as plural expressions and we use syntactic movement as in (84-b) to create a relation that can subsequently be cumulated and take the two plurals as its arguments.[18]

(84) a. *Abe and Bert insist that the president must take a walk with Putin and build a golf club in Tbilisi.*

b. *[[Abe and Bert] [take a walk with Putin and build a golf club in Tbilisi]* CUM^2 *[2 [1 [t_1 insist that the president must t_2]]]]*

3.3 Why the predicate analysis is insufficient

While this expanded system derives the correct truth-conditions for the sentences considered so far (*modulo* the simplifications I introduced), it cannot be the solution to our problem. The reason for this doesn't lie in the expansion (even though this expansion will add a number of problems which I here simply gloss over) – rather, I will argue, it is the predicate analysis itself that is flawed. Since these flaws will turn out to be connected to its core assumption, namely, that cumulative truth-conditions are the result of operations targeting the predicate that the plurals occur as (LF)-arguments of, any expansion of this theory, such as the one presented in the preceding paragraph, will face the same problems.

3.3.1 The syntactic problem for the predicate theory

The first problem, which I term 'the syntactic problem', concerns the question of how the relation targeted by ++ is derived when its object language correlate is not a surface constituent. The data presented in the following show that it cannot be formed by any of the 'standard' syntactic operations of LF-displacement, as its formation is not constrained by any of the independently attested restrictions on these operations.

Recall that (85), repeated from (66) above, was supposed to show that cumulativity is not (exclusively) a property of lexical predicates but also of syntactically derived expressions – including those that do not correspond to surface constituents. The sentence has cumulative truth-conditions (see above) and the relation *R* that must hold between each of the two women and at least one of the two men and each of the two men and one of the two women is the one in (86)– which is not expressed by any surface constituent.

(85) *The two women wanted to marry the two men* (Beck and Sauerland 2000:356 (19c))

(86) $R = \lambda x_e.\lambda y_e.y$ wanted to marry x

[18] Note that this analysis, just as the standard predicate analysis, will always predict a *de re* reading for the lower plural if it shows up under an intensional operator at surface structure. See section 6.

As described above, Beck and Sauerland (2000) (henceforth B&S) argue that the input to ++ is derived by covert tucking-in movement, so we obtain (87) for as the structure for (85).

(87) *[[the two women] [[the two men] [*CUM^2 *[2 [1 [*t_1 *wanted to marry* t_2 *]]]]]]*

If the input to cumulation – the required relation – is derived by covert movement, it should be subject to the constraints that are independently attested for this operation – and this exactly is B&S's point: They submit that cumulative truth-conditions of the form in (88-b) are only available for a string like (88-a) if the syntactic correlate of R in (88-b) obeys the constraints on covert movement. This they they take as evidence that the input to cumulation is derived by standard syntactic operations.

(88) a. [...*A* .. [...*B*....]]
b. $\forall x \leq_{AT} \mathrm{A}(\exists y \leq_{AT} B\,(R(y)(x))) \wedge \forall y \leq_{AT} \mathrm{B}(\exists x \leq_{AT} \mathrm{A}\,(R(y)(x)))$

In order to motivate this argument, B&S consider configurations where covert movement of quantifiers is blocked.[19] As discussed by Reinhart (1997) a.o., a non-symmetric quantifier that occurs inside a finite embedded clause cannot take scope over a quantifier in the matrix clause. This is shown in (89-a), which lacks the reading paraphrased in (89-b).[20]

(89) a. *At least one lawyer pronounced that every proposal is against the law.*
b. For every proposal x, there is at least one lawyer y, s.th. y pronounced x to be against the law.

[19]B&S also discuss English double-object constructions as in (i-a) in support of their hypothesis. These constructions disallow a quantifier in the second (direct) object position out-scoping a quantifier in the first (indirect) object position (cf. Barss and Lasnik (1986) a.o.): (i-a) lacks the reading paraphrased in (i-b). Bruening (2001) takes this to suggest that covert movement of the second object across the first is blocked.

(i) a. *I gave a boy every cookie.* (Beck and Sauerland 2000:366(52))
b. For every cookie, there is a boy that I gave this cookie to.

B&S point out that (ii-a) lacks a cumulative construal in which the indefinite has narrow scope: (ii-a) is not true in the scenario in (ii-b). This is expected given their assumptions: This reading could only be derived if the predicate in (ii-c) were cumulated, but since covert movement from the second object position across the quantifier in the first object position is blocked, the predicate cannot be formed.

(ii) a. *The two girls gave a boy the two cookies.* (Beck and Sauerland 2000:367(54))
b. Sue gave Abe one cookie, Mary gave Bert the other one.
c. $\lambda x.\lambda y.\exists z[\text{ boy}(z)\ \&\ x \text{ gave } y \text{ to } z]$

I am uncertain, however, how strong this argument actually is, because inverse scope of the direct object over the indirect object and the availability of cumulative construals don't always seem to go hand in hand: The sentence in (iii-a) for instance, clearly has the cumulative construal that is lacking in (ii-a), while the sentence (iii-b) still does not allow for *every museum* to take scope over the indefinite.

(iii) a. *What did the boys do in Paris?... Well, Abe and Bert showed a friend the Louvre and the Museé d'Orsay (respectively) – Abe took his friend George from Belgium and Bert his Spanish friend Guadeloupe – and Peter went to the Eiffel tower.*
b. *What did the boys do in Paris ?.... Well, Abe showed a friend every art museum and Peter went to the Eiffel tower.*

[20]I leave open whether covert movement of non-symmetric quantifiers across clause-boundaries is generally impossible. The view that it is has recently been challenged, cf. a.o. Syrett 2015, Wurmbrand to appear. Crucially, the empirical answer – and also its explanation – does not matter for my purposes, because I here only look at configurations where inverse scope is impossible or at least very hard to get and contrast them with analogous sentences that exhibit a cumulative construal.

Accordingly, B&S predict – correctly, as they argue – that (90-a) should lack the reading in (90-b): They could only be obtained by cumulating the predicate in (90-c), however, this predicate cannot be derived by covert movement of the object, as this movement would have to cross a clause-boundary, which (89-a) shows to be impossible.

(90) a. *[$_A$ The two lawyers] have pronounced that [$_B$ the two proposals] are against the law.* (Beck and Sauerland 2000:(43b))
b. $\forall x \leq_{AT} [\![A]\!](\exists y \leq_{AT} [\![B]\!]$ (x pronounced that y is against the law)) $\wedge$ $\forall y \leq_{AT}$ $[\![A]\!](\exists y \leq_{AT} [\![B]\!]$ (, x pronounced that y is against the law))
c. $\lambda x.\lambda y.y$ pronounced that x is against the law

But the empirical claim that cumulative construals are subject to the same constraints as QR is not correct. On the one hand, contrary to what B&S claim, clause-boundedness does not generally block cumulative construals in those configurations where it blocks inverse scope. Consider for instance the sentence in (90-a), which allegedly lacks the construal in (90-b), in the scenario and with the context provided in (91). Here, the construal in (90-b) is clearly available – the sentence is true in the scenario given.

(91) SCENARIO The chair of the linguistics department, Dr. Abe, and the chair of the musicology department, Dr. Bert keep coming up with crazy proposals. Last week, Dr. Abe proposed to expel all teachers that didn't speak Esperanto and Dr. Bert brought forth a motion that would exclude any student that didn't play an instrument. This morning, there was a meeting with the university lawyers, Dr. Kern, who specialises in the rights of faculty members, and Dr. Marten, who acts as the legal representative of the student body. Dr. Kern immediately dismissed Dr. Abe's proposition, and Dr. Marten declared Dr. Bert's proposal to be untenable, but both said that the chairs could not be fired on the basis of the behavior.
Well, the two lawyers have pronounced that the two proposals are against the law (as was kind of expected) but neither of them supported the dean's motion to fire Dr. Abe and Dr. Bert immediately.

(92-a) and (93-a) make the same point (they only differ from (91) w.r.t. the matrix predicate): The sentence in (92-a) is true in a scenario where the Grosny agency insists that Trump should call Kadyrov and the Manila agency insist that she should call Duterte, which means it has a cumulative construal which would require the predicate in (92-b) to be in input for cumulation. Analogously, (93-a) is true in a scenario where Current 93 fan Abe made the claim about me and David Tibet, while cult-member Bert claimed that I was in love with Yasmuheen, which means that the predicate in (93-b) would have to be cumulated. In each case, the required predicate is such that its syntactic derivation would involve the crossing of a clause-boundary.[21]

(92) a. *This morning, our two intelligence agencies called in. First, I spoke to the one from Grosny about Kadyrov, then I talked to the Manila agents about Duterte. Both agencies had quite an agenda, and I have no clue how to proceed now.*

[21] Uli Sauerland (pc) points out the possibility that the reason why sentences like (89-a) lack an inverse reading could also be captured in terms of a ban of the embedded quantifier to move covertly across the matrix *subject* rather than generally being prevented from crossing a clause-boundary. As covert movement of lower plural in (92-a) – (93-a) never has to cross the matrix subject in order to derive the required predicate, the possibility to form this predicate – and thus the availability of the cumulative construals we witness – would thus be expected under a theory positing QR of the lower plural. However, this approach does not cover the data in (94) and (95-a), which show that covert movement would not only have to cross clause-boundaries, but also islands for overt movement.

Namely, the two agencies insisted that Trump should call the {*two madmen / Kadyrov and Duterte*}*, but I know that he won't talk to anyone but Theresa May.*

b. $\lambda x.\lambda y.y$ insists that Trump should call x

(93) a. *Well, ok, I see why you think my two best friends – Abe and Bert – don't really know me.... but you see, while they might claim that I am in love with* {*the two craziest people on earth / Yasmuheen and David Tibet*}*, neither of them would go so far and assume that I married to a reptile - as you just did!*

b. $\lambda x.\lambda y.y$ claims that I am in love with x

What is more, we even find cases where the derivation of the required predicate would have to involve movement of the lower plural out of an island for (seemingly much more liberal) overt movement. Consider first the sentence in (94). Assuming a similar context as the one in (92-a), the sentence is true in the scenario described right above (92)– accordingly it exhibits cumulative truth-conditions, which means we would require the predicate in (92-b) to be cumulated. However, deriving this predicate syntactically would involve movement of the lower plural out of the topicalized clause - a well-known island for movement (cf. Ross 1967).

(94) *Well, the two agencies' plans for Trump were not as horrible as you make it sound. That he should call the two dictators, the agencies insisted, but neither of them said anything about a 'dictators' summit' in the near future.*

Analogously, deriving the correct truth-conditions for the sentence in (95-a) would mean that the lower plural would have to move out of an adjunct, namely, the antecedent of the conditional: The sentence is true in the scenario given, accordingly, the predicate in (95-b) would have to undergo cumulation.

(95) a. SCENARIO: An experiment on human-cat interaction: In room 1, Abe is watching a video of Carl sleeping, in room 2, Bert is watching a video of Dido sleeping. Whenever Carl moves, Abe must press a button. Whenever Dido moves, Bert has to press a button.

If { *the two cats / Carl and Dido* } *move, the two boys have to press a button.*

adapted from an example by Manuel Križ (pc)

b. $\lambda x.\lambda y.y$ has to press a button if x moves

While all of this runs contrary to the argument given by B&S – that the syntactic derivation of predicates targeted by cumulation is constrained by the independently attested restrictions on covert movement – it does not, as such, falsify the idea that the required predicate is derived by *some* syntactic mechanism. In particular, it has long been observed that indefinites, as opposed to other non-referential expressions, can take scope in positions they could not 'reach' if the standard restrictions on movement applied to them (cf. e.g. Ruys 1992, Abusch 1994, Reinhart 1997, Winter 2001a a.o., but cf. also Heim 1982). This is witnessed by the fact that (96-a) has the reading in (96-c).

(96) a. *If some building in Washington is attacked by terrorists then US security will be threatened.* (Winter 2001a:85 (28))

b. If it is the case that there is a building in Washington that is attacked by terrorists, then US security will be threatened.

c. There is a building in Washington, such that if this building is attacked by terrorists, US security will be threatened.

One could argue, therefore, that definite plurals are as unconstrained as singular indefinites (cf. Winter (2001a) for a parallel treatment of definite and indefinite plurals): Simplifying greatly, they can be interpreted (and accordingly strand the index that will give rise to abstraction over the variable in their surface position) in any position.[22] However, as pointed out to me by Yoad Winter (pc), this would predict that those plural expressions that usually resist such exceptional scope taking, should not partake in cumulative construals of sentences where the required relation cannot be derived by standard movement. In particular, Winter (2001a) (a.o.) argues on the basis of contrasts like (97) that while indefinites with bare numerals can take exceptional scope (just as *some building* in (96-a)), those with modified numerals cannot do so: According to Winter, (97-a) has the plausible reading paraphrased below, but (97-b) doesn't.

(97) a. *If two people I know are John's parents then he is lucky.* (Winter 2001a:108 (105a))
available: There are two people I know, such that if they are John's parents, he is lucky.
b. # *If exactly two people I know are John's parents then he is lucky.* (Winter 2001a:108 (105b))
not available: There are exactly two people I know, such that if they are John's parents, he is lucky.

If exceptional scope taking is not available for modified numerals, and exceptional scope taking is the mechanism behind the cumulative construals of all those examples where a syntactic derivation of the relation would violate a syntactic island (e.g. (91)–(95-a)), then we would expect cumulative construals to be unavailable in those configurations if we replace the definite plural by a modified numeral. But this expectation is not born out: (98-a), where the lower plural is a modified numeral, is perfectly fine in the context given. Hence, a cumulative construal is available, and in order to derive this construal, we would need to cumulate the predicate in (98-b) – the derivation of which would involve movement out of a tensed clause.

(98) a. *My friends Abe and Bert are members of different esoteric health cults. So I was quite hopeful when I consulted each of them on my health problems - I expected at least ten recommendations regarding my diet, work-out schedules etc. from each of them. The outcome was disappointing. (Between them) They told me that I should contact exactly two gurus....and that was it! When I talked to Abe, he said I should talk to Yasmuheen and when I called Bert, he insisted I should get in touch with the one and only Mr. Leadbeater.*
b. $\lambda x.\lambda y.y$ said I that should contact x

In summary, we have found cumulative construals for sentences where the relation that should form the input to cumulation is not a surface constituent and thus has to be derived syntactically.

[22]One question within this view arises from observations concerning the scope of distributivity operators – i.e. a version of CUM^1. Ruys (1992) claims that if plural indefinites are contained in a syntactic island, as in (i-a), the existential can have wide scope, but the scope of the distributivity operator is confined by the island: (i-a) only has the reading in (i-b), but not the one in (i-c). This raises the question why the behavior of CUM^2 should be so different from that of CUM^1 – after all, CUM2 would have to apply *above* the conditional in order to yield the correct reading for (95-a) above.

(i) a. *If three relatives of mine die, I will inherit a house.* (Winter 2001a:94(50))
b. I have three relatives such that if they all die, i will inherit a house.
c. I have three relatives such that for each of them, if he/she dies, I will inherit a house.

This derivation, however, cannot generally be the result of covert movement, since we saw a number of cases where movement would have to be out of syntactic islands. Furthermore, since at least some of the plural expressions that partake in these cumulative construals are such that they do not license 'exceptional scope-taking' in other contexts, we cannot simply assume that the mechanism responsible for this exceptional scope taking in other contexts is the one that will derive us the required relation in the case of cumulative construals. Accordingly, we don't have a mechanism that derives us the predicates that form the input to cumulation by ++.

3.3.2 The projection problem for the predicate analysis

The second problem for the predicate analysis – the 'projection problem' – arises in configurations where one plural expression is contained within another one, as in the examples in (99-b) and (100-b). (This characterisation presupposes the extended view of 'plural expression' pursued in this paper.) Crucially for my purposes below, (99-b) is true in the scenario in (99-a), and (100-b) is true in the scenario in (100-a).[23] Generalizing over verifying scenarios, the truth-conditions of (99-b) and (100-b) are those informally paraphrased in (99-c) and (100-c).

(99) a. SCENARIO: Abe fed Carl. Bert fed Dido. Bert brushed golden retriever Eric. Neither Abe nor Bert fed hamster Harry. Harry is dead.
b. *Abe and Bert fed Dido and Carl and brushed Eric, but none of them took care of the hamster! (It's dead!)*
c. Abe and Bert each did one of the following: feed Carl, feed Dido, brush Eric & Carl and Dido were each fed by Abe or Bert & Eric was brushed by Abe or Bert.

(100) a. SCENARIO: Abe made Gina feed his cat Carl, Bert made Gina feed his cat Dido and brush his dog Eric.
b. *Abe and Bert made Gina feed Carl and Dido and brush Eric, when all she wanted to do was take care of poor hamster Harry.*
c. Abe and Bert each did one of the following: make Gina feed Carl make Gina feed Dido, make Gina brush Eric & Abe or Bert made Gina feed Carl & Abe or Bert made Gina feed Dido & Abe or Bert made Gina brush Eric.

Informally, the embedded plural expression seems to 'project' to the embedding plural expression: The VP-conjunctions in (99-b) and (100-b), in which the first conjunct itself embeds an individual conjunction, i.e. (101-a), behaves like the VP-conjunction in (101-b) w.r.t. the cumulative truth-conditions observed above – i.e. each member of the subject plurality has to be in the relevant relation with at least one of the conjuncts in (101-b) and *vice versa*).

(101) a. *[fed [Carl and Dido] and brush Eric]*
b. *[[fed Carl] and [fed Dido] and [brush Eric]]*

We will see that none of the proposals considered so far – including the expanded predicate analysis – consistently derives us this equivalence. The problem, broadly speaking, is that the embedded plural expression will be inaccessible for any form of cumulated relation with the subject plurality in configurations like (100-b).

Let us first consider why we cannot consistently derive the correct truth-conditions *without* assuming the expanded predicate theory, namely, by appealing to the non-intersective analysis

[23] Examples like (i) with DP-plurals instead of individual conjunctions are completely parallel.

(i) *The two boys fed the two cats and brushed the dog, but none of them took care of the hamster! (It's dead!)*

of conjunction discussed in section 2.3.[24] Recall that under this analysis, a conjunction of predicates P, Q has the denotation in (102-a) – a predicate that holds of all those individuals that have a P-part and a Q-part. If we furthermore assume that the relation expressed by *fed* in the first conjunct is cumulated via ++, as schematized in (102-b), the conjunction in (99-b) will have the denotation in (102-c). If we apply this function to the subject's denotation, the sentence is correctly predicted to be true in our scenario in (99-a) (just replace x' by $\mathbf{A}\oplus\mathbf{B}$ and x'' by $\mathbf{B}$).

(102) a. $[\![P\ and\ Q]\!] = \lambda\mathbf{x}_e.\exists\mathbf{x}',\mathbf{x}''(\mathbf{x}'\oplus\mathbf{x}'' = \mathbf{x} \wedge P(\mathbf{x}') \wedge Q(\mathbf{x}''))$
b. *[Abe and Bert [[*CUM^2 *fed] C and D and brushed E]]*
c. $\lambda\mathbf{x}_e.\exists\mathbf{x}',\mathbf{x}''(\mathbf{x}'\oplus\mathbf{x}'' = \mathbf{x} \wedge ++[\![fed]\!](\mathbf{x}')([\![C\ and\ D]\!]) \wedge \mathbf{x}''$ brushed E)
d. Abe and Bert each did one of the following: feed Carl, feed Dido, brush Eric & Carl and Dido were each fed by Abe or Bert & Eric was brushed by Abe or Bert.

The problem with non-intersective theories of conjunction, however, was semantic locality- they only predict cumulative truth-conditions w.r.t. a predicate conjunction *P and Q* and some other element X if X is an argument of the conjunction or *vice versa*. In section 2.3 above, I showed this prediction to be false. In analogy, semantic locality gets into the way of providing a general story for the examples under discussion: The sentence in (100-b) is parallel to (99-b) except that *Abe and Bert* does not denote an argument of the predicate conjunction (nor *vice versa*). The non-intersective analysis of predicate conjunction, therefore, gives us the (simplified) semantic derivation in (103)– the resulting truth-conditions are clearly too strong.

(103) a. $[\![(100\text{-b})]\!] = +[\![made]\!]([\![feed\ C\ and\ D\ and\ brush\ E]\!]$ (G)) ({A,B}) =
$= +[\![made]\!](\lambda x_e.\exists\mathbf{x}',\mathbf{x}''(\mathbf{x}'\oplus\mathbf{x}'' = \mathbf{x}\wedge++[\![feed]\!](\mathbf{C}\oplus\mathbf{D})(\mathbf{x}')\wedge\mathbf{x}''$ brush E)(G))($\mathbf{A}\oplus$ $\mathbf{B}$) = $+[\![made]\!]$ (G feed C $\wedge$ G feed D $\wedge$ G brush E)($\mathbf{A}\oplus\mathbf{B}$)
b. Abe and Bert each did all of the following: make Gina feed Carl, make Gina feed Dido, make Gina brush Eric.

Accordingly, previous proposals do not derive the correct truth-conditions for all the sentences under consideration. But how does the expanded predicate analysis fare? Let us first consider the simpler sentence in (99-b). The most plausible analysis on the basis of the expanded predicate analysis starts off with the LF in (104-a). This yields us the semantic derivation in (104-b), which, in fact, delivers the correct truth-conditions ($\mathbf{A}\oplus\mathbf{B}$ cumulatively have the property expressed by the first conjunct, $\mathbf{B}$ the property expressed by the second conjunct).

(104) a. *[A and B] [[*CUM^2 *fed] C and D and brushed E]* CUM^2 *[1 [2 [t_1 t_2]]]*
b. $\lambda\mathbf{P}_{\langle e,t\rangle}.\lambda\mathbf{x}_e.\exists\mathbf{P}',\mathbf{P}'',\mathbf{x}',\mathbf{x}''(\mathbf{P}'\oplus\mathbf{P}'' = \mathbf{P}\wedge\mathbf{x}'\oplus\mathbf{x}'' = \mathbf{x}\wedge\mathbf{P}'(\mathbf{x}')\wedge\mathbf{P}''(\mathbf{x}''))(pl(\lambda y_e. +$ $+[\![\text{fed}]\!])(\mathbf{C}\oplus\mathbf{D})(y))\oplus pl(\lambda y_e.y$ brushed E)) ($\mathbf{A}\oplus\mathbf{B}$)
c. Abe and Bert each did one of the following: feed Carl, feed Dido, brush Eric & Carl and Dido were each fed by Abe or Bert & Eric was brushed by Abe or Bert.

But this proposal, too, runs into problems with (100-b). At LF the embedding plural expression is moved according to the rules specified in the previous paragraph, (105-a). The truth-conditions resulting from the (again simplified) derivation in (105-b) are those paraphrased in (105-c) and they turn out to be too strong – (100-b) is incorrectly predicted false in the scenario in (100-a).

(105) a. *[A and B] [[*CUM^2*] fed C and D and brushed E]* CUM^2 *[1 [2 [t_1 made G t_2]]]*

[24] Note that I still use the notational devices introduced for pluralities in the previous paragraphs.

b. $\lambda \mathbf{P}_{\langle e,t\rangle}.\lambda \mathbf{x}_e.\exists \mathbf{P}', \mathbf{P}'', \mathbf{x}', \mathbf{x}''(\mathbf{P}' \oplus \mathbf{P}'' = \mathbf{P} \wedge \mathbf{x}' \oplus \mathbf{x}'' = \mathbf{x} \wedge\ \mathbf{x}'$ made G $P' \wedge x''$ made G $P'')(pl(\lambda y_e. + +[\![\text{fed}]\!](\mathbf{C} \oplus \mathbf{D})(y)) \oplus pl(\lambda y_e.y$ brushed E)) $(\mathbf{A} \oplus \mathbf{B})$

c. Abe and Bert each did one of the following: make Gina feed both Carl and Dido, brush Eric & Abe or Bert made Gina feed Carl & Abe or Bert made Gina feed Dido & Abe or Bert made Gina brush Eric.

This means that even though the expanded predicate analysis was tailored to overcome semantic locality, the system breaks down in those cases where one plural expression is embedded in another one. In other words, since the expanded predicate analysis, just as the standard one, derives cumulative truth-conditions by cumulating relations between pluralities, it fails in all those cases, where we cannot form a such a relation directly, because of syntactic embedding.

3.4 Summary: The predicate analysis and its expansion

In the previous paragraphs, I outlined the predicate analysis, which derives cumulative truth-conditions by enriching the predicates: For any structure as in (106-a), where A and B denote pluralities from D_a, and R has its denotation in $D_{\langle a,\langle a,t\rangle\rangle}$, cumulative truth-conditions result from a cumulation operation on R.

(106) $R(A)(B)$

Using this system as a background, I tried to come to terms with our data from section 2 by assuming that all conjunctions denote pluralities of the kind of objects their conjuncts denote and by expanding the predicate theory so as to allow for cumulation operations that will expand relations between any two (or more) objects from any semantic domain (excluding D_t).

This expanded version of the predicate analysis – and the predicate analysis in general – ran into two problems. First, when forming the relation R that represents the input to the cumulation operation, we will have to violate various constraints on syntactic movement that are observable otherwise ('syntactic problem'). Second, the system won't derive the correct truth-conditions if one plural expression is embedded in another one ('projection problem').

4 An alternative proposal: Pluralities and plural projection

In the following, I propose an alternative analysis for conjunctions and plural composition, which I refer as the 'plural projection analysis' ('PPA').[25] In the current section, I focus on the constructions considered so far: individual, VP-predicate and propositional conjunctions. The interaction of conjunction and quantificational material will be addressed in section 5. Since my main aim is to give a plausible account of conjunction denotations and cumulative truth-conditions, homogeneity will only surface as side issue: Albeit it is encoded in the analysis here, this treatment doesn't add much in terms of a general understanding of the phenomenon, nor does it generalize to the constructions considered in section 5.

In section 2, conjunctions with conjuncts of various semantic categories were shown to exhibit clear parallels to plural DPs in terms of cumulativity and also homogeneity. As in section 3.3 above, I will take these parallels at face value, assuming that all semantic domains contain a subdomain of pluralities (of the relevant kind of semantic object) and that conjunctions with conjuncts of type a denote pluralities of the conjuncts' denotations. The modelling of these pluralities will be slightly more complex than in section 3.3, for reasons having to do with how

[25]The proposal here is an adaptation of a system developed in joint, ongoing work with Nina Haslinger.

these pluralities combine with their sisters. In particular, I argued in section 3 that expanding the predicate analysis to other kinds of pluralities is inadequate. The syntactic problem and the projection problem suggest that rather than forming relations between the pluralities and affixing these relations with cumulation operators, we should look for a system that lets us 'project' pluralities bottom up. Again, I will take these facts at face value, proposing a system where once a plurality *a* enters the semantic derivation, the node immediately dominating it will also denote a plurality, namely, a plurality of values obtained by combining *a* with its sister. I.e. argument pluralities will 'project' in the sense that once they combine with a function the result will be pluralities of those values that the function yields for the different 'parts' of the argument, function pluralities 'project' in the sense that once they combine with an argument we will obtain a plurality of the values the function 'parts' yield for that argument. I schematize this in (107), where f, g stand for functions that have a, b in their domains, and '+' represents plurality-formation. Note that the actual implemention will again be slightly more complex in order to let us deal with structures containing more than two pluralities.

(107)

f(a)+f(b)		f(a)+g(a)	
f	a+b	f+g	a

The general idea of projection is, of course, strongly reminiscent of focus projection (cf. Rooth (1985) a.o.) or other systems working with a Hamblin-style alternative semantics (cf. e.g. Simons (2005) for disjunctions). The difference to such systems will lie in how exactly projection is defined, i.e. how exactly we go from an argument/function plurality to a plurality of values. The idea is that projection essentially encodes cumulation: Rather than assuming an operator that modifies predicate extensions, cumulation is part of the compositional system itself.

4.1 Plural denotations

As a first step, I enrich the ontology by pluralities and sets thereof and will then introduce the denotations of conjunctions. For the moment, I keep the system completely extensional, which means that I don't introduce any parametrization w.r.t. worlds or times, and also distributive, meaning that I don't include collective predicates (see again section 5).

4.1.1 Ontology

The ontology will look similar to that in section 3.2.1 above, except that the set of possible denotations for every type *a* is expanded not only by the set $\mathbf{PL}_a$ of pluralities, but also by the 'plural set' $\underline{\mathbf{S}}_a$, which contains all subsets of $\mathbf{PL}_a$. We thus end up with three 'levels' of complexity for any domain. (I will write D for the union of all atomic domains, $\mathbf{PL}$ for the union of all plural domains, and $\underline{\mathbf{S}}$ for that of all plural sets.)

(108) a. **atomic domains (containing atoms)**
  (i) D_e := the domain of all atomic individuals
  (ii) D_t := the domain of truth-values
  (iii) D_s := the set of all atomic possible worlds
  (iv) $D_{\langle a,b\rangle}$:= the set of all atomic functions from D_e
b. **plural domains (containing pluralities)**
  For any domain D_a, there is a set $\mathbf{PL}_a$ and a bijection $pl_a : (\mathcal{P}(D_a) \setminus \{\emptyset\}) \rightarrow \mathbf{PL}_a$
c. **plural sets (containing sets of pluralities)**
  For any domain D_a, there is a set $\underline{\mathbf{S}}_a = \wp(\mathbf{PL}_a)$

(109) repeats the notational conventions from section 3.2.1 and adds the shorthand in (109-a-i) relating to our 'new' level of plural sets.

(109) a. (i) I use $\underline{\mathbf{a}}, \underline{\mathbf{b}}, \underline{\mathbf{c}}$ for elements of $\underline{\mathbf{S}}_e$, $\underline{\mathbf{P}}, \underline{\mathbf{Q}}$ etc. for elements of $\underline{\mathbf{S}}_{\bar{e},t}$, and $\underline{\mathbf{p}}, \underline{\mathbf{q}}$ etc. for elements of $\underline{\mathbf{S}}_t$ and
(ii) $\mathbf{a}, \mathbf{b}, \mathbf{c}$ for elements of $\mathbf{PL}_e$, $\mathbf{P}, \mathbf{Q}$ etc. for elements of $\mathbf{PL}_{\bar{e},t}$, and $\mathbf{p}, \mathbf{q}$ etc. for elements of $\mathbf{PL}_t$ and
(iii) a, b, c for elements of D_e, P, Q etc. for elements of $D_{\bar{e},t}$, and p, q etc. for elements of D_t.

b. **'sums'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \oplus \mathbf{b} = pl_a(pl_a^{-1}(\mathbf{a}) \cup pl_a^{-1}(\mathbf{b}))$.

c. **'part-of'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \leq \mathbf{b}$ iff $pl_a^{-1}(\mathbf{a}) \subseteq pl_a^{-1}(\mathbf{b})$.

d. **'atomic-part-of'**: For any $\mathbf{a}, \mathbf{b} \in \mathbf{PL}_a$, $\mathbf{a} \leq_{AT} \mathbf{b}$ iff $pl_a^{-1}(\mathbf{a}) \subseteq pl_a^{-1}(\mathbf{b})$ and $|pl_a^{-1}(\mathbf{a})| = 1$.

I also keep the 'shifts' introduced in section 3.2.1, repeated, in (110-a,b) and add the operation $\underline{\mathbf{pl}}_a$ in (110-c), which takes elements from $\mathbf{PL}_a$ to $\underline{\mathbf{S}}_a$.

(110) a. for any type $a, \downarrow_a$ is a function from $\mathbf{PL}_a$ to D_a. For any $X \in \mathbf{PL}_a, \downarrow(X)$ is defined iff $|pl^{-1}(X)| = 1$. If defined $\downarrow(X)$ = the unique $Y \in pl^{-1}(X)$.

b. $[\![\text{PL}_a]\!] = \uparrow_a = \lambda X \in D_a.pl(\{X\})$

c. $[\![\underline{\text{PL}}_a]\!] = \Uparrow_a = \lambda \mathbf{X} \in \mathbf{PL}_a.\{\mathbf{X}\}$

Again, just as in section 3.2.1 I will often simplify the derivations to keep them readable: Unless it would lead to confusion, I will drop the type-subscript on functions defined for each semantic domain, leave out the 'trivial' morphemes in (110-b,c) in the syntactic derivation and furthermore drop the correlating operators from the meta-language.

Lexical meanings are assigned by the function $\mathcal{L}$, which maps any lexical element of primitive type a to an element in D_a, and any lexical element of type $\langle a, b\rangle$ to elements in $D \cup \{f : D \rightarrow \mathbf{PL}\} \cup \{f : \mathbf{PL} \rightarrow \underline{\mathbf{S}}\} \cup \{f : \underline{\mathbf{S}} \rightarrow \underline{\mathbf{S}}\}\}$. In this new proposal, I add a basic assumption about the correlation of syntactic categories and denotations, namely, that all open class-elements are assigned a denotation in D, (111). [26]

(111) a. For any lexical element of syntactic category V, A or N, $\mathcal{L}(\alpha) \in D$.

b. If α is a terminal node, then $[\![\alpha]\!] = \mathcal{L}(\alpha)$

I furthermore make two basic syntactic assumptions, namely, that all expressions with a denotation in D must be affixed with PL, and all expression with a denotation in **PL** affixed with $\underline{\text{PL}}$ – which essentially means that open-class elements will always be 'carried' to a denotation in $\underline{\mathbf{S}}$. This is stated in the (simplified) syntactic rules in (112) and illustrated for the noun *cat* in (113), which also gives the denotations of each node. Regarding closed-class (functional) elements, I will address those later.

(112) a. If α is a terminal node with a denotation in D, and β immediately dominates α, then β is a well-formed expression iff β also immediately dominates PL.

b. If α is a node with a denotation in **PL**, and β immediately dominates α, then β is a well-formed expression iff β also immediately dominates $\underline{\text{PL}}$.

[26] Note that collective predicates, briefly discussed in section 5, are incompatible with this assumption, unless they are assumed to be syntactically complex (cf. e.g. Hackl 2002). In order to embed them into the system, I would have to expand the type-system or change the make-up of the semantic domains.

(113) $\{pl(\lambda x_e.x \text{ is a cat})\}$

$\underline{\text{PL}}$ $\Uparrow$ — $pl(\lambda x_e.x \text{ is a cat})$

PL $\uparrow$ — *cat* $\lambda x_e.x$ is a cat

I will again replace characteristic functions of individuals by upper-case words ('CAT' stands for '$\lambda x_e.x$ is a cat', '**CAT**' for '$pl(\lambda x_e.x$ is a cat)'). For the denotations of object-language declaratives, the meta-linguistic sentence will (for the moment) stand for the truth-value of the object-language sentence, i.e. if, for the object language sentence *Abe fed Carl* I write 'Abe fed Carl' in the meta-language, this will stand for '1' iff Abe fed Carl and for '0' otherwise.

4.1.2 Denotations for conjunctions

We can now introduce plural denotations for conjunctions (I put off the treatment of definite plurals to section 5). For the sake of simplicity, but without any syntactic commitment, I assume a binary-branching structure for coordination. For any type *a*, the meaning of *and* is given in (114)[27]: It takes the conjuncts' denotations (plural sets) and yields a plural set containing all those pluralities that we get by adding elements (i.e. pluralities) from one the conjuncts' denotations to elements (i.e. pluralities) of the other. (115) gives some examples.

(114) $[\![\text{and}_{\langle a\langle aa\rangle\rangle}]\!] = \lambda \underline{\mathbf{X}}_a.\lambda \underline{\mathbf{Y}}_a.\{\mathbf{X}' \oplus \mathbf{Y}' : \mathbf{X}' \in \mathbf{X}, \mathbf{Y}' \in \mathbf{Y}\}$

(115) a. $[\![\textit{Abe and Bert}]\!] = [\![\textit{and}_{\langle e\langle ee\rangle\rangle}]\!]\ (\underline{\mathbf{Abe}})\ (\underline{\mathbf{Bert}}) = \{\mathbf{Abe} \oplus \mathbf{Bert}\}$

b. $[\![\textit{smoke and dance}]\!] = \{\ \mathbf{SMOKE} \oplus \mathbf{DANCE}\ \}$

c. $[\![\textit{Abe fed Carl and Bert fed Dido}]\!] = \{\mathbf{Abe\ fed\ Carl} \oplus \mathbf{Bert\ fed\ Dido}\}$

For the sake of completeness – and to show that we don't inadvertently collapse the meanings of conjunction and disjunction – (116) gives the meaning of *or*, for any type *a*. It takes the disjuncts' denotations (plural sets) and yields us their union. (117) gives some examples.

(116) $[\![\text{or}_{\langle a\langle aa\rangle\rangle}]\!] = \lambda \underline{\mathbf{X}}_a.\lambda \underline{\mathbf{Y}}_a.\underline{\mathbf{X}} \cup \underline{\mathbf{Y}}$

(117) a. $[\![\textit{Abe or Bert}]\!] = [\![\textit{or}_{\langle e\langle ee\rangle\rangle}]\!]\ (\underline{\mathbf{Abe}})\ (\underline{\mathbf{Bert}}) = \{\mathbf{Abe}, \mathbf{Bert}\}$

b. $[\![\textit{smoke or dance}]\!] = \{\ \mathbf{SMOKE}, \mathbf{DANCE}\ \}$

c. $[\![\textit{Abe fed Carl or Bert fed Dido}]\!] = \{\mathbf{Abe\ fed\ Carl}, \mathbf{Bert\ fed\ Dido}\}$

4.2 Plural composition

The final step is to lay out how plural sets combine with the other elements in the clause.

As a first step, let us consider what happens with matrix-clause conjunction, i.e. cases like (115-c), where we end up with a plural set. We still have to determine how such sets map to 1 and 0, respectively. I assume a singular morpheme SG, (118), which attaches to any root node (and may optionally attach to other nodes of type *t*). Its denotation is supposed to encode the homogeneity effects observed above, adapting a proposal by Löbner (1987), which views them as an 'all-or-nothing' presupposition. The function takes a set of truth-value pluralities as its argument. It is defined if at least one of these pluralities reducec to 1 or all of them reduce to 0. A plurality of truth-values, given our definitions of the domains above, will be reducible to

[27]This means that the cross-categorial denotation for *and* is not recursively derived from a basic type, as e.g. in Partee and Rooth 1983 (with basic type *t*), but rather that the denotations of *and* form a family of meanings in the sense that they perform the same algebraic operation w.r.t. each domain. In this sense, the current analysis is similar to Keenan and Faltz's 1985 proposal.

1 just in case of all its atomic parts are 1, and to 0, if all of its atomic parts are 0. If defined, it will yield 1 if at least one of the pluralities reduces to 1, and 0 otherwise.

(118) $[\![\text{SG}]\!] = \mathcal{T} = \lambda \underline{\mathbf{p}}_{\mathbf{t}} : \exists \mathbf{q} \in \underline{\mathbf{p}} (\downarrow (\mathbf{q}) = 1) \vee \forall \mathbf{q} \in \underline{\mathbf{p}} (\downarrow (\mathbf{q}) = 0).\exists \mathbf{q} \in \underline{\mathbf{p}} (\downarrow (\mathbf{q}) = 1)$

The full derivation for a matrix-clause conjunction thus looks like (119): (119-a) gives the LF with the singular morpheme attached to the highest node. We get 'true' if all of the conjuncts are true, 'false' if none of them are and 'undefined' otherwise. This means that we obtain the correct truth-conditions, in addition to the homogeneity effects observed in section 2.

(119) a. [SG *Abe fed Carl and Bert fed Dido*]
b. $[\![(119\text{-a})]\!] = \mathcal{T}(\{$**Abe fed Carl** $\oplus$ **Bert fed Dido**$\})$
defined iff $\downarrow$ (**Abe fed Carl**) = $\downarrow$ (**Bert fed Dido**)
if defined, 1 if $\downarrow$ (**Abe fed Carl**) = $\downarrow$ (**Bert fed Dido**) = 1, and 0 otherwise.

Just to make the contrast to disjunction clear, (120) gives a parallel structure with *or*. It will come out as 'true' if at least one of the disjuncts is true, and 'false' otherwise.

(120) a. [SG *Abe fed Carl or Bert fed Dido*]
b. $[\![(120\text{-a})]\!] = \mathcal{T}(\{$**Abe fed Carl**, **Bert fed Dido**$\})$
1 if $\downarrow$ (**Abe fed Carl**) =1 or $\downarrow$ (**Bert fed Dido**) = 1, 0 otherwise.

I assume that negation only applies to elements of D_t – which means that SG must apply before negation can do so. Since negation 'feeds off' the value of SG, it will not be able to yield a value itself if SG is undefined. More specifically, negation takes a truth-value – it can only do so, if $[\![\text{SG}]\!]$ is defined – and returns the plural set of the complement. This latter step might seem unnecessary, but as negation doesn't have to be the highest element in the clause, and the rules of composition given below will operate on the level of plural sets, it is the more plausible option. Accordingly, if a negation combines with a matrix sentence, the result will once again have to be affixed by SG, as illustrated by the simplified LF in (122-b) for (121-a).[28]

(121) $[\![\textit{not}]\!] = \lambda p_t.\{pl(\neg p)\}$

(122) a. *It is not the case that Abe fed Carl and Bert fed Dido*
b. [SG [*not* [SG *Abe fed Carl and Bert fed Dido*]]]

The more interesting cases, of course, are those where the plurality is not formed at the matrix level, but a proper part of the sentence, as in any of the sentences in (123) (all of which are simplified versions of constructions discussed in sections 2 and 3). We want to derive cumulative truth-conditions for all the sentences involving more than one plurality, which, according to the treatment here, are all the sentences in (123-c)–(123-i). We must furthermore be able to deal with the lack of semantic locality, i.e. examples like (123-g,h,i), the lack of syntactic locality, exemplified by (123-i), and the projection problem, illustrated by (123-g,h).

(123) a. *Abe and Bert smoked.*
b. *Abe smoke and drank.*

[28] This predicts – incorrectly for at least some speakers – that sentential negation should act as an intervener for plural projection: I.e. it should be impossible to judge (i-a) true in the scenario in (i-b).

(i) a. *Abe and Carl claimed that Ferdl didn't feed Carl and Dido.*
b. SCENARIO: A claimed that F didn't feed C. B claimed that F didn't feed D.

c. *Abe and Bert smoked and drank.*
d. *Abe and Bert fed Carl and Dido.*
e. *Abe and Bert introduced Carl and Dido to Eric and Ferdl.*
f. *Abe and Bert made Gina smoke and drink.*
g. *Abe and Bert fed Carl and Dido and brushed Eric.*
h. *Abe and Bert made Gina feed Carl and Dido and brush Eric.*
i. *Abe and Bert claimed Eric smoked and danced.*

The basic idea is there are two basic rules of composition: To standard functional application (FA), we add a new rule of composition, cumulative combination (CC), (124). CC will apply in all those cases, where the nodes that are to combine semantically denote plural sets – more specifically, a set $\underline{\mathbf{F}}$ of function pluralities $\mathbf{f}$ and a set $\underline{\mathbf{X}}$ of argument pluralities $\mathbf{x}$. The output of CC will again be a plural set – namely, a set $\underline{\mathbf{V}}$ of value pluralities $\mathbf{V}$. This set is derived via the relation C, which is defined below and essentially encodes cumulation. $\underline{\mathbf{V}}$ will contain all the smallest pluralities $\mathbf{v}$ s.th. there is $\mathbf{f} \in \underline{\mathbf{F}}$ and an $\mathbf{x} \in \underline{\mathbf{x}}$ and $\mathbf{v}$ is the sum of 'cumulatively' applying atomic parts of $\mathbf{f}$ to atomic parts of $\mathbf{x}$: For every atomic part of $\mathbf{f}$, there must be an atomic part of $\mathbf{x}$ that it applies to, and for every atomic part of $\mathbf{x}$ there must be an atomic part of $\mathbf{f}$ that it is an argument of. Note that there is no deeper reason for this set containing only the smallest value-pluralities– this will simply keep the derivations in the following from getting unnecessarily complex.

(124) **Cumulative combination (CC)**
If α is a branching node with daughters β, γ, where $[\![\beta]\!] \in \underline{\mathbf{S}}_{\langle a,b\rangle}$ and $[\![\gamma]\!] \in \underline{\mathbf{S}}_a$, $[\![\alpha]\!] = [\![\beta]\!] \bullet [\![\gamma]\!] = \{\mathbf{C} \in C([\![\beta]\!], [\![\gamma]\!]) \ : \ \neg\exists \mathbf{C}' \in C([\![\beta]\!], [\![\gamma]\!]) (\mathbf{C} \leq \mathbf{C}' \wedge \mathbf{C}' \neq \mathbf{C})\}$

where, for any $\underline{\mathbf{X}} \in \mathbf{S}_{\langle a,b\rangle}, \underline{\mathbf{Y}} \in \mathbf{S}_a, C(\underline{\mathbf{X}})(\underline{\mathbf{Y}}) :=$
$\{\mathbf{C} \in \mathbf{PL}_b \ : \ \exists \mathbf{X} \in \underline{\mathbf{X}}, \mathbf{Y} \in \underline{\mathbf{Y}} : \forall \mathbf{C}' \leq_{AT} \mathbf{C} \, (\exists \mathbf{X}' \leq_{AT} \mathbf{X}, \mathbf{Y}' \leq_{AT} \mathbf{Y} : \mathbf{C}' = \mathbf{X}'(\mathbf{Y}')$
$\wedge \forall \mathbf{X}' \leq_{AT} \mathbf{X} \, (\exists \mathbf{Y}' \leq_{AT} \mathbf{Y}, \mathbf{C}' \leq_{AT} \mathbf{C} \, (\mathbf{C}' = \mathbf{X}'(\mathbf{Y}')))$
$\wedge \ \forall \mathbf{Y}' \leq_{AT} \mathbf{Y} \, (\exists \mathbf{X}' \leq_{AT} \mathbf{X}, \mathbf{C}' \leq_{AT} \mathbf{C} \, (\mathbf{C}' = \mathbf{X}'(\mathbf{Y}')))\}$

The way this new compositional rule works will become clearer if we look at a couple of simple examples from (123) above (where I will take the liberty to represent the proper names by their first letters). Consider first (123-a) and (123-b), which each contain one plural expression. Their derivations are given in (125-a) and (125-b). In both cases – or more generally, whenever the sentence contains no plural expression, or only one such expression – we end up with a singleton at the root node, which contains a propositional plurality. Application of the singular-operator will yield us true in (125-a) if both of Abe and Bert smoked, false if neither smoked and undefined otherwise. (125-b) is analogous: It will be true if Abe both smoked and danced, false if he did neither and undefined otherwise.

(125) a. $[\![\textsc{sg}[\textit{A and B smoked}]]\!] = [\![\textsc{sg}]\!] \, (\, [\![\textit{smoked}]\!] \bullet [\![\textit{Abe and Bert}]\!] \,) =$
$= \mathcal{T}(\{\textbf{SMOKED}\} \bullet \{\textbf{Abe} \oplus \textbf{Bert}\}) = \mathcal{T}(\{\textbf{Abe smoked} \oplus \textbf{Bert smoked}\})$
b. $[\![\textsc{sg}[\textit{Abe smoked and danced}]]\!] = [\![\textsc{sg}]\!] \, ([\![\textit{smoke and dance}]\!] \bullet [\![\textit{Abe}]\!]) =$
$= \mathcal{T}(\{\textbf{SMOKED} \oplus \textbf{DANCED} \} \bullet \{\textbf{Abe}\}) = \mathcal{T}(\{\textbf{Abe smoked} \oplus \textbf{Abe danced}\})$

For the sentences with more than one plural expression, e.g. (123-c) – (123-e), the sentence-level plural set will contain more than one plurality. The derivation for (123-d) is given in (126-a) and that for (123-c) in (126-b). Note that in (126-b), the DP-plurality 'projects' to what is, in fact, a plurality of intransitive predicates. Accordingly, both in (126-a) and in (126-b), we eventually combine the subject plural set with a predicate plural set. In both cases, the singular will map the set to 'true' just in case one of the two propositional pluralities reduces to 'true'. We therefore derive the correct, 'cumulative' truth-conditions for (123-c) and (123-d).

(126) a. $[\![$SG[*A and B smoked and drank*]$]\!] = [\![$SG$]\!]([\![$*smoked and drank*$]\!]\bullet[\![$*A and B*$]\!])$ $= \mathcal{T}(\{\textbf{SMOKED} \oplus \textbf{DRANK}\}\bullet\{\textbf{A} \oplus \textbf{B}\}) = \mathcal{T}(\{\textbf{A smoked} \oplus \textbf{B drank}, \textbf{B smoked} \oplus \textbf{A drank}\})$

b. $[\![$SG[*Abe and Bert fed Carl and Dido*]$]\!] = [\![$SG$]\!]([\![$*fed Carl and Dido*$]\!]\bullet[\![$*Abe and Bert*$]\!])$ $= [\![$SG$]\!](\{pl(\lambda x_e.\lambda y_e.y \text{ fed } x)\} \bullet \{\textbf{C} \oplus \textbf{D}\}) \bullet\{\textbf{A} \oplus \textbf{B}\})$ $= [\![$SG$]\!](\{\textbf{FED C} \oplus \textbf{FED D}\})\bullet\{\textbf{A} \oplus \textbf{B}\})$ $= \mathcal{T}(\{\textbf{A fed C} \oplus \textbf{B fed D}, \textbf{B fed C} \oplus \textbf{A fed D}\}$

(123-e), which contains three plural expression, also ends up with the correct truth-conditions. The VP gets the denotation in (127-a) and the entire sentence with that in (127-b). Again, it will be true of one of elements of the plural set reduces to 'true'.

(127) a. $[\![$*[Dido and Carl [introduced to Eric and Ferdl]]*$]\!] = \{\textbf{INTRODUCE C TO E} \oplus \textbf{INTRODUCE D TO F}, \textbf{INTRODUCE D TO E} \oplus \textbf{INTRODUCE C TO F}\}$

b. $[\![$SG[*Abe and Bert [Dido and Carl [introduced to Eric and Ferdl]]*$]\!]$ $= \{\textbf{A introduced C to E} \oplus \textbf{B introduced D to F}, \textbf{B introduced C to E} \oplus \textbf{A introduced D to F}, \textbf{A introduced D to E} \oplus \textbf{B introduced C to F}, \textbf{B introduced D to E} \oplus \textbf{B introduced D to F}\}$

4.3 Application

Let's turn to the more complex examples in (123-f) – (123-i), each of which played a part in rejecting the various analyses discussed in sections 2 and 3. I first discuss (123-g), which was the simple case of the projection problem addressed in section 3.3. (128) gives all the relevant steps of the derivation (but note that I will henceforth drop the SG-operator, as it should be clear by now when it applies and what it does). For the first conjunct, we derive a set containing a predicate plurality, (128-b). Conjoining this set with the second conjunct gives us again a set containing a predicate plurality, (128-c). Note that we now capture the intuition from paragraph 3.3: *fed Carl and Dido and brushed Eric* will end up being denotationally equivalent to *fed Carl and fed Dido and brushed Eric*. Combining this set with the subject yields us (128-c) – which means, we derive the correct truth-conditions.

(128) a. *Abe and Bert fed Carl and Dido and brushed Eric.*

b. $[\![$*fed C and D*$]\!] = \{\textbf{FED C} \oplus \textbf{FED D}\}$

c. $[\![$*fed C and D and brushed Eric*$]\!] = \{\textbf{FED C} \oplus \textbf{FED D} \oplus \textbf{BRUSHED E}\}$

d. $\{\textbf{A fed C} \oplus \textbf{B fed D} \oplus \textbf{B brushed E}, \textbf{A fed D} \oplus \textbf{B fed C} \oplus \textbf{B brushed E}, \textbf{B fed C} \oplus \textbf{B fed D} \oplus \textbf{A brushed E}, \textbf{B fed C} \oplus \textbf{A fed D} \oplus \textbf{A brushed E}, \textbf{B fed D} \oplus \textbf{A fed C} \oplus \textbf{A brushed E}, \textbf{A fed C} \oplus \textbf{A fed D} \oplus \textbf{B brushed E}\}$

For all the other examples, the extensional system given so far won't suffice. I have nothing deep to say about the expansion to intensions, i.e. world-parametrization, so I chose the most simple variant: I add the type s to our set of types and the set W of all possible worlds to our semantic domains. I then assume that all lexical elements are assigned functions from worlds to extensions in that respective world and add two rules on the combination of meanings from D, which essentially encode extensional and intensional functional application. This means that I don't have to worry with how world-parametrization affects our levels **PL** and $\underline{\textbf{S}}$ – we will simply form pluralities of intensions and sets thereof, as sketched in (130). (This will also mean that the function SG will have to be relativized to worlds, which I omit here.) For the remainder of this section, I modify my notation as follows: I write 'SMOKE', for '$\lambda w.\lambda x_e.x$ smokes in w, and 'Abe smokes', will stand for 'λw. Abe smokes in w'.

(129) a. For any $A \in D_{\langle s\langle a,b\rangle\rangle}$, $B \in D_{\langle s,a\rangle}$, $A(B) = \lambda w.A(w)(B(w))$
b. For any $A \in D_{\langle s\langle\langle sa\rangle b\rangle}$, $B \in D_{\langle s,a\rangle}$, $A(B) = \lambda w.A(B)(w)$

(130) $[\![smoke]\!] \bullet [\![Abe\ and\ Bert]\!] = \{\lambda w.\lambda x_e.x$ smokes in $w\} \bullet \{\lambda w.$ A$\oplus\lambda w.$ B$\} = \{pl(\lambda w.$ A smokes in $w) \oplus pl(\lambda w.$ B smokes in $w)\}$

We can now turn to the more complex example of the projection problem, (123-h), which none of the previous analyses was able to derive. Again, I only give the relevant steps of the derivation in (131), and as it is of no consequence for my purposes, I make the simplifying assumptions that *make* denotes a function which takes a propositional argument, e.g. $\lambda w.\lambda p_{\langle s,t\rangle}.\lambda x_e.x$ does everything to make p true in w. (131-b) shows the denotation of the VP-conjunction (it is identical to what we derived in (128)). (131-c) gives the denotation of the embedded clause, a set containing a plurality of propositions. This projects to a set containing a plurality of predicates, (131-d), and combining the latter with the denotation of the subject in (131-e) yields us a set of propositions analogous to those in (128-d). This means we derive the correct truth-conditions and thus solve the projection problem.

(131) a. *Abe and Bert made Gina feed Carl and Dido and brush Eric.*
b. $[\![$*feed C and D and brush Eric*$]\!]$ = {**FEED C** $\oplus$ **FEED D** $\oplus$ **BRUSH E**}
c. $[\![$*G feed C and D and brush Eric*$]\!]$ = {**G feed C** $\oplus$ **G feed D** $\oplus$ **G brush E**}
d. $[\![$*made G feed C and D and brush Eric*$]\!]$ = {**MADE G FEED C** $\oplus$ **MADE G FEED D** $\oplus$ **MADE G BRUSH E**}
e. {**A made G feed C** $\oplus$ **B made G feed D** $\oplus$ **B made G brush E**, **A made G feed D** $\oplus$ **B made G feed C** $\oplus$ **B made G brush E**, **B made G feed C** $\oplus$ **B made G feed D** $\oplus$ **A made G brush E**, **B made G feed C** $\oplus$ **A made G feed D** $\oplus$ **A made G brush E**, **B made G feed D** $\oplus$ **A made G feed C** $\oplus$ **A made G brush E**, **A made G feed C** $\oplus$ **A made G feed D** $\oplus$ **B made G brush E**}

This example also highlights two other features of the PPA: First, the system does not require semantic locality in order to derive cumulativity for sentences with predicate conjunctions. Once a plurality enters the system, it will project upwards so that any other plurality higher up in the tree will be able to 'enter in a cumulative relation' with it. I.e. sentences like (123-h), but also (123-f), which the non-intersective analysis of conjunction couldn't derive, don't represent a problem for the current system. Furthermore, as pluralities project upwards by a compositional rule that encodes cumulation, we don't require any cumulation operators (i.e. '*, **,...') and therefore also no predicates that these operators can attach to. This, in turn, means that we don't need to derive predicates by covert movement in examples like (123-i) and therefore – correctly – don't predict any constraints by syntactic locality in the first place.

4.4 Interim summary: Plural projection

In the preceeding paragraphs, I outlined an alternative analysis for plural denotations and plural composition that fares much better in all respects than existing proposals: It derives us cumulative truth-conditions, without requiring semantic locality (as non-intersective theories of conjunction do), and without giving rise to either the syntactic or the projection problem (as the predicate analysis does). It comprises three crucial features: First, all semantic domains contain pluralities (actual pluralities and plural sets). This means that in this treatment, there is no difference between a domain of primitives, like the domain of individuals, and a domain of complex objects, like the domain of functions from individuals to truth-values. Second, conjunctions with conjuncts of any semantic category are treated on a par with other plural expressions: They denote sets containing the sum of all the conjuncts' denotations. Third, cumulative truth-conditions are not due to the semantic enrichment of predicates by operators like '**', but rather due to a particular rule of composition that lets pluralities project up to the nodes dominating them.

5 Interveners for plural projection

Widening the empirical scope reveals several constructions where pluralities don't project in the sense above: Some elements seem to 'eat up' plural sets or 'intervene' in plural projection.[29] The most obvious case are collective predicates of individuals, such as the lexically object-collective *compare* in (132-a). Our mechanism fails, as it derives the sentence meaning in (132-b) and accordingly incorrectly predicts that (132-a) can never be true, because *compare* can never be truthfully attributed to atomic objects: (132-c) is essentially uninterpretable.

(132) a. *Abe compared 'The Iliad' and 'War and Peace'*
b. {**A compared I** $\oplus$ **A compared W+P** }
c. # *Abe compared 'War and Peace'.*

Collective predicates are not the only context where pluralities don't project. A number of 'quantificational' expressions also block plural projection from at least some positions. Here, my focus will be on determiners. The lack of plural projection can be observed, for instance, when the determiner has a plural expression in its restrictor: This is particularly obvious in configuations like (133-a), which I will call 'restrictor conjunctions' and where an NP-conjunction occurs in the restrictor of the determiner. Without any further assumptions, the PPA derives (133-b) as the denotation of (133-a) – which essentially means that structures like (133-a) should have the same denotation as structures like (133-c) (where both occurrences of DET stand for the same determiner). This prediction turns out to be wrong in a number of cases.

(133) a. DET $[_{NP}$ *P and Q*$]$
b. { **det** (**P**) $\oplus$ **det** (**Q**))
c. [DET $[_{NP}$ *P*]] *and* [DET $[_{NP}$ *Q*]]

In the following, after laying out the empirical situation, I sketch an expansion of the PPA that can circumvent this problem. The basic idea will be that all 'interveners' for plural projection are similar to collective predicates in that they are lexically specified to take pluralities (or rather, plural sets) as their arguments; hence, determiners will take elements of $\underline{\mathbf{S}}_{\langle et\rangle}$ as their arguments. The result of this expansion is not completely satisfactory, because while it doesn't fare worse than other accounts of restrictor conjunction, it also doesn't do better in any relevant sense. Nevertheless, my main point here is to show that the PPA is not generally doomed whenever plural projection is blocked and to illustrate how it could be expanded to handle such contexts.

[29] Note that here again we have an analogy to focus projection and elements like *only*.

5.1 The empirical situation

In order to understand what the analysis has to achieve, it is important to be clear about the rather complex empirical situation of how determiners interact with pluralities. In the following, I address two aspects thereof: 'Internal distributivity/non-distributivity', which concerns the semantic relation between the determiner and plural expressions in its restrictor – e.g. the relation between *ten* and *cats and dogs* in (134-a) – and 'external distributivity/non-distributivity', which covers the semantic relation between (non-referential) DPs and plural expressions in their scope – e.g. the relation between *ten cats* and *the boys* in (134-b).

(134) a. **Ten** *[$_{PL}$ cats and dogs] attacked Abe.*
b. **Ten cats** *attacked [$_{PL}$ the boys].*

5.1.1 Internally distributive and internally non-distributive readings

The distinction between what I will call (descriptively) 'internally distributive' and 'internally non-distributive' readings can be witnessed with restrictor conjunction as in (134-a) (cf. in particular Heycock and Zamparelli 2005, Champollion 2015 for discussion). 'Internally distributive' readings are those where the determiner essentially 'distributes' over the NP-conjuncts, so that the result is equivalent to applying the determiner separately to each conjunct – (134-a), for instance, has the internally distributive reading in (135-a). 'Internally non-distributive' readings are all those that are not internally distributive, i.e. that are not equivalent to having the determiner apply to each conjunction individually, such as the reading in (135-b) for (134-a).

(135) a. Ten cats and ten dogs attacked Abe. **internally distributive**
b. Ten animals attacked Abe, and this plurality consisted exclusively of cats and dogs. **internally non-distributive**

Not only do we find these two readings, we also observe that determiners differ w.r.t. which readings are accessible.[30] (Modified) Numerals and cardinals as well as *most* generally seem to have both readings, irrespective of their logical properties: (Left-and-right-) Downward-monotone *less than ten* behaves analogously to (left-and-right-) upward-monotone *ten*: (136-a) can be both true and false in a scenario where Abe was attacked by six cats and seven dogs, which means that it has both the internally distributive reading in (136-b) (true in the scenario) and the internally cumulative reading in (136-c) (false in the scenario).

(136) a. *Less than ten cats and dogs attacked Abe.*
b. Less than ten cats and less than ten dogs attacked Abe. **internally distributive**
c. Less than ten animals that were cats or dogs attacked Abe. **internally non-distributive**

Singular and plural universals (*every* and *all*) and plural *no*, on the other hand, seem to be limited to internally distributive readings (cf. Bergmann 1982, Cooper 1983, Partee and Rooth 1983 a.o. for *every*, but cf. Winter (1998) for alternative readings, cf. Heycock and Zamparelli (2005), Champollion (2015) for discussion related to *no*). I.e. (137-a,b) only seem to have the reading in (137-c) and (138-a) only exhibits the reading in (138-b).

[30]Which determiners show up with which readings is also subject to cross-linguistic variation (cf. Heycock and Zamparelli 2005). I here only consider those determiners where the Germanic and Romance languages discussed by Heycock and Zamparelli (2005) behave identically (which is why I omit singular indefinites) and where the judgements reported in the literature are relatively clear (which is why I leave out singular *no*).

(137) a. *Every cat and dog attacked Abe.*
b. *All cats and dogs attacked Abe.*
c. Every cat and every dog attacked Abe. **internally distributive**

(138) a. *No cats and dogs attacked Abe.*
b. No cats and no dogs attacked Abe. **internally distributive**

An additional problem of restrictor conjunctions with quantificational determiners (but not the definite determiner), which is independent of whether we find internally distributive or non-distributive readings, is that as opposed to the conjunctions discussed in section 2, they don't give rise to homogeneity effects. The judgements are subtle, but (139-a) seems simply false, and (139-b) true, if Abe fed all of the cats, but not all of the dogs. In this respect, conjunctions (again) pattern with DP-plurals, which are known not to give rise to homogeneity if they occur in the restrictor of quantificational elements (cf. Brisson 1998, Križ 2015): (140-a) is true whenever (140-b) is false (and *vice versa*). To make matters worse, the restrictor differs from the scope of the determiner, where we *do* observe homogeneity effects for conjunctions and plural DPs (cf. Križ (2015) for the latter): (139-a) doesn't seem false, but rather undefined (in the sense discussed in section 2) if all of my friends danced, but none of them smoked.

(139) a. *Abe fed every cat and dog in this town.*
b. *Abe didn't feed every cat and dog in this town.*

(140) a. *Abe fed all (of) the dogs.*
b. *Abe didn't feed all (of) the dogs.*

(141) *All my friends danced and smoked.*

I note at this point already that I won't have much to say about and won't derive this behavior w.r.t. homogeneity in the following. I consider it a question of future research whether the current system can be combined with recent proposals on the interaction of quantificational elements and homogeneity, such as Križ 2016, 2015, Križ and Spector 2017.

5.1.2 Externally distributive and externally non-distributive readings

The second dichotomy concerns what I will call 'externally distributive' and 'externally non-distributive' readings. In particular, non-referential DPs in English (and several other languages, cf. Gil 2001) can give rise to two different readings when a plural (or degree) expression occurs in their *scope*, as illustrated here on behalf of (142-a) and *ten cats*: Broadly speaking, the 'externally distributive' reading ((142-b) for (142-a)) is one where we consider individuals in the restrictor that *each* have the scope property, whereas for the 'externally non-distributive' reading ((142-c) for (142-a)), we consider plural individuals that have the restrictor property and *cumulatively* have the scope property (cf. Kroch 1974, Scha 1981, Dowty 1987, Link 1987, Krifka 1990, 1999, Sher 1990, Schein 1993, Landman 2000, 2004 a.o.).

(142) a. *Ten cats ate exactly 100 sausages!*
b. Ten cats each ate exactly 100 sausages. **externally distributive**
c. Ten cats ate exactly 100 sausages between them. **externally non-distributive**

Crucially, internal and external (non)-distributivity are independent of each other, as witnessed by the fact that the sentence in (143-a) has four readings:

(143) a. *Ten cats and dogs ate exactly 100 sausages!*

b. Ten cats and ten dogs each ate exactly 100 sausages.
internally distributive, externally distributive

c. Ten animals – all of them either cats or dogs – each ate exactly 100 sausages.
internally non-distributive, externally distributive

d. Ten cats and ten dogs all ate exactly 100 sausages between them.
internally distributive, externally non-distributive

e. Ten animals – all of them either cats or dogs – ate exactly 100 sausages between them. **internally non-distributive, externally non-distributive**

The empirical situation regarding external (non-)distributivity is even more complex than that concerning internal (non-)distributivity: (Modified) Cardinals and numerals such as *ten*, but also *less than 10* in (144) seem to generally allow for both readings, as does *all* (which might, however, exhibit some inter-speaker variation, cf. Dowty 1987, Winter 2001a), (145).

(144) a. *Less than cats ate exactly 100 sauages.*
b. Less than ten cats each ate exactly 100 sausages.
c. Less than ten cats ate exactly 100 sausages between them.

(145) a. *Incredible! All my cats ate exactly 100 sausges.*
b. All my cats each ate exactly 100 sausages.
c. All my cats between them ate exactly 100 sausages.

Other determiners, in particular *every* license externally non-distributive readings only when they occur in certain syntactic positions (cf. Schein 1993, Beghelli and Stowell 1997, Kratzer 2000, 2003, Champollion 2010a), a complication I will gloss over in my analysis in section 5.2. For *no*, an externally non-distributive reading doesn't seem to be available at all: Landman (2000, 2004) points out that if it had an externally non-distributive reading, the sentence in (146) should express that no girl kissed any boy (there are no girls for whom it holds that they kissed a boy, and there are at most six boys for whom it holds that they were kissed by a girl – accordingly, there are no girls that kissed a boy). This reading doesn't seem to be accessible.

(146) *No girls kissed at most six boys* (Landman 2004:172(3a))

I will also gloss over the complicating factor that external distributivity and external non-distributivity might be tied to differences in the readings of certain determiners: For instance, whenever right-non-upward-monotone (complex) determiners like *less than ten* have an externally distributive reading, they impose a so-called 'upper bound': (147-a), under its externally distributive reading, is false if ten or more girls each wore a hat. With the externally non-distributive reading on the other hand, the upper bound may vanish: (147-b), under its externally non-distributive reading, is true if, say, eight girls between them prank called 110 teachers, but an additional five girls also prank called some of these teachers.

(147) a. *Less than ten girls cats wore a hat.*
b. *Less than ten girls prank called more than 100 teachers.*

5.1.3 Analytical options

External (non-)distributivity and internal (non-)distributivity raise different analytical issues and have been tackled by different types of proposals. My aim here is not to provide a survey of all those analyses, but rather to set the stage for the expansion of the PPA. In order to do so, I will on the one hand broadly sketch the analytical options w.r.t. external (non-)distributivity, and on the other hand highlight why all existing theories of conjunction must make additional assumptions to account for internal (non-)distributivity. (Note that I am reverting to the 'classical' notation in the present paragraph, which corresponds to that used in section 3.1).

External (non-)distributivity Existing proposals on external (non-)distributivity fall into two classes (cf. Partee 1989, Kennedy 2015 for general discussion): Proposals that assume the DP is ambiguous, and those that view the VP as ambiguous. One way to implement the first type of proposal is to model the determiner itself as ambiguous (but cf. Szabolcsi 1997 for a different option): For *ten*, for instance, the 'GQ' denotation in (148-a) will give us the externally distributive reading for (142-a), whereas the 'restriction' denotation in (148-b), where the numeral essentially restricts a plural variable, its compatible with its externally non-distributive reading (cf. a.o. Link 1987, Szabolcsi 1997, Krifka 1999).

(148) a. $[\![ten]\!] = \lambda P_{\langle e,t\rangle}.\lambda Q_{\langle e,t\rangle}.|P \cap Q| \geq 10$
b. $[\![ten]\!] = \lambda P_{\langle e,t\rangle}.\lambda Q_{\langle e,t\rangle}.\exists x_e(|x| = 10 \wedge P(x) \wedge Q(x))$

The second type of proposal uses only the restriction denotation in (148-b) and posits an additional distributivity operator, (149), which can optionally adjoin to VP (cf. Link 1987, Roberts 1987): If present, it yields us the externally distributive reading, if not (and we include cumulated predicate extensions as in section 3.1), we obtain the externally non-distributive reading.

(149) $[\![\textsc{dist}]\!] = \lambda P_{\langle et\rangle}.\lambda x_e.\forall y \leq_{AT} x(P(y))$

My expansion of the PPA that below will be related to the second type of approach. This means that it will face similar problems, amongst others that – without any additional assumptions – no upper bound for non-right-upward-monotonous DPs is predicted (this is part of what is known as 'van Benthem's problem', van Benthem 1986): If we model *less than ten* in analogy to *ten* (*modulo* its internal complexity) and assign it the denotation in (150-a), (147-a) with the LF in (150-b) will be true as long as there is a plurality with less than ten atomic parts that each wore a hat – so the sentence is falsely predicted to be true in a scenario where 11 girls are wore a hat.

(150) a. $[\![less\ than\ ten]\!] = \lambda P_{\langle e,t\rangle}.\lambda Q_{\langle e,t\rangle}.\exists x_e(|x| < 10 \wedge P(x) \wedge Q(x))$
b. [[*less than ten*] [DIST [*girls wore a hat*]]]

Several authors, most recently Buccola and Spector (2016) have proposed solutions to this problem. As Buccola and Spector (2016) are well aware (this is essentially the gist of their paper), these solutions are complicated by the fact that we sometimes don't want an upper bound to show up – as, for instance, in (147-b) above. I don't go into these solutions here, as this would warrant too much discussion at this stage (and would also include a decomposition of modified numerals, which I don't provide here) and leave it to future research whether the expanded PPA can be made compatible with them.

Internal (non-)distributivity As shown above, internal (non-)distributivity is symptomatically unrelated to external (non-)distributivity and has thus mainly been addressed from a different perspective than the latter, namely, within analyses of conjunction. It was noted early on that it represents a problem for both the intersective and the non-intersective analysis outlined in section 2.3 (for a very detailed comparison cf. Champollion 2015).

Recall that the intersective analysis gives us (151) for a predicate conjunction like *cats and dogs*. Without further assumptions, it thus predicts that determiners will quantify over the set of all atomic individuals that are both a cat and a dog. Hence the sentences in (135-a), (136-a) (137-a) and (138-a) from section 5.1.1 above should only have the meanings in (152-a) – (152-d), respectively. This prediction is incorrect – none of (151-a)–(151-d) is a reading of the respective sentences.[31]

(151) $[\![$*cats and dogs*$]\!] = \lambda x_e.\text{cat}(x) \wedge \text{dog}(x)$

(152) a. Ten individuals that are each both a cat and a dog attacked Abe.
b. Less than ten individuals that are each both a cat and a dog attacked Abe.
c. Every individual that is both a cat and a dog attacked Abe.
d. No individual that is both a cat and a dog attacked Abe.

Accordingly, we require additional mechanisms for both the internally distributive reading (for universals, *no*, and numerals and cardinals) as well as for the particular instance of the internally cumulative reading found with numerals/cardinals. In the former case, we could assume a silent morpheme or a shift that will let the determiner apply to each conjunct (cf. Cooper 1983, Dowty 1988)[32], alternately, we could posit an ellipsis mechanism that would derive the surface structure of restrictor conjunction from the underlying structure in (153).

(153) [DET [$_{NP}$ *P*]] *and* [~~DET~~ [$_{NP}$ *Q*]]

We will require a different set of additional assumptions, however, to derive the internally cumulative reading for sentences with numerals/cardinals such as (135-a) above, repeated in (154-a) (with the relevant reading in (154-b)). Champollion (2015), based on previous work by Winter (2001a) assumes that a number of silent morphemes attach to the conjunction, which eventually yield us the set of all those plural individuals that consist exclusively of cats and dogs.[33] If we apply *ten* with the denotation of (148-b) to this set, we derive the correct internally

[31]This also holds if *P* and *Q* are not disjoint, as in (i): (i-a) is predicted true (but isn't true) in a scenario where 12 individuals arrived: 5 whose only job is acting, 3 that concentrate exclusively on poetry, and and 4 that are active in both areas. Likewise, (i-b) is predicted true in a scenario where every individual that is both an actor and a poet arrived, but some that are only actors (or only poets) didn't. It is unclear whether this reading actually exists, but cf. Winter (1998) for more discussion. Finally, (i-c) should be true (but isn't) in a scenario where several actors and several poets poets, but noone who is both an actor and a poet.

(i) a. *Less than 5 actors and poets arrived.*
b. *Every actor and poet arrived.*
c. *No actors and poets arrive.*

[32]This 'shift' can be implemented by morpheme *D* in (i-a): : Assuming the denotation for *every* in (i-b) and the LF for the (137-a) above in (i-c), we obtain the correct truth-conditions in (i-d).

(i) a. $[\![D]\!] = [\lambda P_{\langle e,t\rangle}.\lambda Q_{\langle\langle et\rangle\langle\langle et\rangle t\rangle\rangle}.Q(P)]$
b. $[\![every]\!] = \lambda P_{\langle et\rangle}.\lambda Q_{\langle et\rangle}.P \subseteq Q$
c. *[[every [D [cat]] and [D [dog]]] is crazy]*
d. Every cat in crazy ∧ every dog is crazy.

[33](i) is a sketch of Champollion's 2015 treatment by means of a simplified derivation for *ten cats and dogs* under internally non-distributive reading, adapted to the system introduced in section 3.1 (cf. (Champollion 2015:25ff) for the details): The underlying structure of the DP is that in (i-a). A function including a choice function ('CR') applies to each conjunct, picking a (potentially plural) individual *y* and yielding us the set of all individuals that *y* is part of, (i-b). Intersective conjunction can apply to the resulting predicates, so that we obtain the set of all those (plural) individuals, containing both the cat-individual and the dog-individual picked out by the respective choice functions, (i-c). A minimization operation applies to this predicate, picking out its smallest elements, which means it gives us the set of those individuals, that consist exclusively of the cat-individual and the dog-indivdiual picked by the choice functions, (i-d). The next step is existential closure of the choice functions, so that we obtain the set of all individuals that consist exclusively of cats and dogs, (i-e). The last step (which is not part of Champollion's

non-distributive reading.

(154) a. *Ten dogs and cats attacked Abe.*
b. Ten animals attacked Abe, and this plurality consisted exclusively of cats and dogs.

The non-intersective analysis derives the same result without having to posit any additional morphemes (cf. in particular Heycock and Zamparelli 2005): The meaning of *and* itself in this type of analysis (see again section 2.3) gives us the set of all pluralities made up of cats and dogs exclusively as the denotation for *cats and dogs*, (155). Again, applying *ten* with the denotation of (148-b) to this set, we derive the correct internally non-distributive reading.

(155) $[\![\textit{cats and dogs}]\!] = \lambda x_e.\exists y,z[y \oplus z = x \wedge {*}\text{cat}(y) \wedge {*}\text{dog}(z)]$

Yet, the non-intersective analysis also does not generalize to all instances of restrictor conjunction, either: In particular, it does not derive the correct denotations for conjunctions under right-downward-monotone determiners (as noted by Krifka (1990) and Heycock and Zamparelli (2005) themselves, cf. Champollion 2015 for closely related discussion): Take (138-a) above, repeated in (156-a). It only has the internally distributive reading in (156-b). But as the non-intersective analysis has us quantify only over those pluralities that have both a cat-part and a dog-part, individuals consisting exclusively of cats or of dogs won't enter the domain of quantification. Accordingly, we end up with the wrong prediction that (156) is true in a scenario where only cats attacked Abe.

(156) a. *No cats and dogs attacked Abe.*
b. No cats and no dogs attacked Abe.

In sum, no existing analysis of conjunction derives the correct results for all instances of restrictor-conjunction without positing additional operations. Some of them will also feature in my own treatment in the next paragraph.

5.2 Expanding the PPA

The main motivation for the PPA were the data in sections 2 and 3. The expansion I give here simply serves the purpose of illustrating that the PPA can in principle be extended to the data considered in this section. Just like any other theory of external or internal (non-)distibutivity, it will require additional assumptions, and just like most other approaches, it will run into a number of problems, which I will point out along the way.

5.2.1 What we have and what we need

In its current stage, the PPA fails to derive the correct truth-conditions for sentences with restrictor conjunctions: It derives only internally distributive readings, because if (157-a) is the

2015 treatment, but compatible with it) is to combine this set with the denotation in (148-b) above, (i-f).

(i) a. [ER [ten [$\exists_{C,1}$ [$\exists_{C,2}$ [MIN [[CR$_1$ **cats*] *and* [CR$_2$ **dogs*]]]]]
b. $[\![\text{CR}_1 \text{ cats}]\!] = \lambda x_e.f_1([\![\text{cats}]\!]) \leq x$
c. $[\![\text{CR}_1 \text{ cats and CR}_2 \text{ dogs}]\!] = \lambda x_e.f_1([\![\text{cats}]\!]) \leq x \wedge f_2([\![\text{dogs}]\!]) \leq x$
d. $[\![\text{MIN [CR}_1 \text{ cats and CR}_2 \text{ dogs] }]\!] = \lambda x_e.x = f_1([\![\text{cats}]\!]) \cup f_2([\![\text{dogs}]\!])$
e. [[$\exists_{C,1}$ [$\exists_{C,2}$ [MIN [[CR$_1$ *cats*] *and* [CR$_2$ *dogs*]]]]]] = $\lambda x_e.x$ is a cat-dog mixture
f. [[ten [$\exists_{C,1}$ [$\exists_{C,2}$ [MIN [[CR$_1$ *cats*] *and* [CR$_2$ *dogs*]]]]]]] = $\lambda P_{\langle e,t\rangle}.\exists x_e[|x| = 10$ is a cat-dog mixture

general denotation of determiners, with R some relation between the restrictor and the scope, then application of our compositional rule CC produces (157-b), namely, a singleton containing the plurality of the values obtained by applying the determiner-function to each NP-conjunct.

(157) a. $[\![\text{DET}]\!] = \{\lambda \mathbf{P}_{\langle \mathbf{et} \rangle}.\lambda \mathbf{Q}_{\langle \mathbf{et} \rangle}.R(\mathbf{P})(\mathbf{Q})\}$
b. $[\![\ [\text{DET}\ [P\ \mathit{and}\ Q\ ]]\ ]\!] = \{[\![\text{DET}]\!]([\![P]\!]) \oplus [\![\text{DET}]\!]([\![Q]\!])\}$

At first sight, it might seem we should preserve this analysis to derive internally distributive readings in those cases where we find them, and add a mechanism for the internally non-distributive readings of cardinals/numerals, which obviously aren't captured by (157). But this path is blocked: First, (157) incorrectly derives homogeneity effects for restrictor conjunction: (158-a) will have the denotation in (158-b); hence the sentence is incorrectly predicted undefined, rather than false if all the dogs attacked Abe, but only half of the cats.

(158) a. *Every cat and dog in this town attacked Abe.*
b. { **every cat attacked Abe** $\oplus$ **every dog attacked Abe** }

Second, and more importantly, the PPA, *qua* (157), makes absurd predictions for sentences like (159-a), where a plural expressions occurs in the *scope* of a DP with restrictor conjunction: As the subject in (159-a) will have the denotation in (159-b), we derive the sentence meaning in (159-c). Now, (159-a) has both an externally distributive reading, (159-d) and an externally non-distributive reading (159-e), but the meaning (159-c) – which isn't equivalent to either of them – doesn't seem to be available.

(159) a. *All (the) cats and dogs (in my house) attacked Abe and Bert*
b. { **all cats** $\oplus$ **all dogs** }
c. { **all cats attacked Abe** $\oplus$ **all dogs attacked Bert**, **all dogs attacked Abe** $\oplus$ **all cats attacked Bert**}
d. Every cat attacked Abe and Bert and every dog attacked Abe and Bert.
e. Every cat attacked Abe or Bert and every dog attacked Abe or Bert and both Abe and Bert were each attacked by at least one member of that plurality.

As a consequence, we must make sure that we don't derive (157-b) as the denotation for (157-a), which means that determiners cannot combine with pluralities in their restrictor via CC. The general idea will be that determiners are lexically specified to take plural sets of predicates of individuals as their arguments. Accordingly, they will combine with their restrictor via standard functional application rather than CC.[34]

But what do determiners do to the plural sets in their restrictor? In order to model internal (non-)distributivity, I will assume that the effect of determiners on the conjunction *P and Q* in their restrictor, broadly speaking, boils down to quantification over the of set individuals that are *either* P *or* Q. This assumption differs from those of other theories of conjunction, which either assume quantification over the set of all atomic individuals that are *both* P and Q (unmodified intersective analysis) or the set of all plural individuals that consist exclusively of Ps and Qs (modified intersective analysis, non-intersective analysis). The consequences are the following:

[34] The way in which DP-internal plural expressions combine with each other (e.g. *the black and white cats and dogs*) suggests that it might be more adequate to put the semantic workload on (potentially silent) morphemes below D (i.e. right above NP), rather than on the determiner itself (in analogy to the treatment of this silent morphology by Champollion (2015)). The present proposal can be seen as a simplified version thereof, which could easily be reformulated in this respect. An interesting question for future research, raised by Lucas Champollion (pc), is whether we find any cross-linguistic evidence for this 'special status' of NP-conjunctions.

First, we correctly derive the internally distributive reading for universals and plural *no*: *all cats and dogs* essentially expresses 'all individuals that are either a cat or a dog' . Second, we (arguably) obtain the correct internally non-distributive reading for numerals/cardinals. This is evident in the case of *less than ten cats and dogs* which (under this reading) is adequately paraphrased by 'less than ten individuals that each are either a cat or a dog'. It is less obvious for *ten cats and dogs*, for which we now predict the (internally non-distributive) paraphrase 'ten individuals that each are either a cat or a dog' so that (160-a) should be true if ten cats but no dogs attacked Abe. This might seem counterintuitive, but the oddness of using (160-a) in such a scenario could have pragmatic reasons: As pointed out by Nina Haslinger (pc), (160-b) has a reading where it isn't true if someone saw ten cats (and no dogs).[35]

(160) a. *Abe saw ten cats and dogs.*
b. *Nobody saw ten cats and dogs.*

The third consequence of this assumption is that we don't derive the internally distributive reading for cardinals/numerals (just as any of the theories of conjunction discussed in paragraph 5.1.3). Hence I will also have to assume a silent morpheme /a shift or determiner ellipsis as in (153) to account for this reading.

Concerning external (non-)distributivity, I will more or less follow proposals that assume only one lexical entry per determiner – the 'restriction' denotation (see paragraph 5.1.3) – and retrieve the distinction between external distributivity and non-distributivity via the presence/absence of a distributivity operator that attaches to VP. Owing to the pecularities of the PPA, I will model determiners as functions that take a plural set of predicates as their argument (see above) and return a plural set of individuals: E.g. *all P and Q* will give us the set of all maximal pluralities of individuals that are each P or Q, *ten P and Q* will give us the set of all pluralities of individuals that are either P or Q that have cardinality ≥ 10 asf. As already mentioned above, this will get me into the same kind of problems that 'restriction' based proposals encounter with non-right-upward determiners – I don't predict 'upper-bound' readings.

Finally, the implementation below offers no account of the asymmetry w.r.t. homogeneity observed in paragraph 5.1.1 above and falsely derives homogeneity effects across the board. This is a consistent problem with this proposal, and I will only occasionally comment on it.

5.2.2 Implementation

As indicated above, I model external distributivity by assuming the presence of a distributivity operator that adjoins to VP, which can either be silent or realized by *each* (cf. Link 1987, Roberts 1987). For this purpose, I adapt (149) above to the PPA as in (161). Its effect is illustrated for the simple sentence in (162-a) in (162-b): The sentence is true iff Abe fed both Carl and Dido and Bert did, too.

(161) $[\![\text{DIST}]\!] = \lambda \underline{\mathbf{P}}_{\langle et \rangle}.\lambda \underline{\mathbf{x}}_e.\{\mathbf{p}_t : \exists \mathbf{y} \in \underline{\mathbf{x}} \wedge \mathbf{p} = pl(\forall \mathbf{z} \leq_{AT} \mathbf{y}(\exists \mathbf{Q} \in \underline{\mathbf{P}}(\mathcal{T}(C(\{\mathbf{Q}\})(\{\mathbf{z}\}) = 1))))\}$

[35] This assumption essentially predicts there to be no truth-conditional difference between restrictor conjunction, as in (i-a) and restrictor disjunction as in (i-b) (unless we add determiner ellipsis, in which case we will be dealing with conjunction / disjunction of full DPs).(i-a) and (i-b) certainly impose different restrictions on the contexts they may occur in, but I am not sure where this difference is rooted and how to even capture it descriptively. Cf. Champollion (2015) for some aspects of these differences, and cf. Zimmermann (2000) for an interesting reading of restrictor disjunctions that might play a role in the distribution.

(i) a. DET *cats and dogs*
b. DET *cats or dogs*

(162) a. *Abe and Bert each fed Carl and Dido.*

b. $[\![$*Abe and Bert [*DIST *[fed Carl and Dido]]*$]\!]$ =
$[\![\text{DIST}]\!]$ $(\{\mathbf{fed\ C} \oplus \mathbf{fed\ D}\})$ $(\{\mathbf{A} \oplus \mathbf{B}\})$ =
$\{\mathbf{p}_t : \mathbf{p} = pl(\forall \mathbf{z} \leq_{AT} \mathbf{A} \oplus \mathbf{B}(\mathcal{T}(C(\{\mathbf{fed\ C} \oplus \mathbf{fed\ D}\})(\{\mathbf{z}\}) = 1)))\}$

The next step are determiner denotations. As outlined above, they take plural sets of predicates of individuals (elements of $\underline{\mathbf{S}}_{\langle et\rangle}$) as their arguments and return plural sets of individuals (elements of $\underline{\mathbf{S}}_e$). As I will require it for the lexical entries of all determiners, I introduce the shorthand in (163), which encodes a relation between pluralities of individuals and plural sets of predicates of individuals. E.g. $C'(\mathbf{a})(\{\mathbf{CAT} \oplus \mathbf{DOG}\}$ holds iff every atomic part of **a** is either a cat or a dog. (C' is in a sense a weaker version of the cumulativity relation C introduced above, except that is a relation $\mathbf{PL} \times \underline{\mathbf{S}}$ rather than $\underline{\mathbf{S}} \times \underline{\mathbf{S}}$.)

(163) For any $\mathbf{x} \in \mathbf{PL}_e, \underline{\mathbf{P}}_{\langle e,t\rangle}$, $C'(\mathbf{x})(\underline{\mathbf{P}})$ iff $\forall \mathbf{y} \leq_{AT} \mathbf{x}(\exists \mathbf{Q} \in \mathbf{P}(\exists \mathbf{R} \leq_{AT} \mathbf{Q}(\mathbf{Q}(\mathbf{y}) = 1)))$

For universals (*all, every*), I assume the denotation in (164), which takes a plural set of predicates as its argument and yields the (singleton) plural set containing the largest plurality that is such that each of its atomic parts is either a cat or a dog. I furthermore add the (generally assumed) presupposition that the restrictor of the determiner is non-empty.[36] As stated above, I gloss over the differences between *every* and *all* w.r.t. when they license external non-distributivity – those differences are not captured by the current system.

(164) $[\![$*all/every*$]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e : C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge \neg\exists \mathbf{y} > \mathbf{x}(C'(\mathbf{y})(\underline{\mathbf{P}}))\}$

Assuming for the purposes of illustration that there is exactly one cat (Carl) and exactly one dog (Eric), (165-b) gives the relevant steps of the semantic composition of (165-a). The sentence comes out as true iff both Carl and Eric attacked Abe.

(165) a. *All cats and dogs attacked Abe.*

b. $([\![all]\!]\ (\{\mathbf{CAT} \oplus \mathbf{DOG}\})) \bullet (\{\ \mathbf{ATTACK\ A}\ \}) =$
$(\{\mathbf{x}_e : \forall \mathbf{z} \leq_{AT} \mathbf{x}\,(\text{CAT}(\mathbf{z} \vee \text{DOG}(\mathbf{z})) \wedge\neg\exists \mathbf{y} > \mathbf{x}(\forall \mathbf{z} \leq_{AT} \mathbf{y}\,(\text{CAT}(\mathbf{z} \vee \text{DOG}(\mathbf{z}))\}) \bullet$
$(\{\ \mathbf{ATTACK\ A}\ \}) = \{\mathbf{C\ attacked\ A} \oplus \mathbf{E\ attacked\ A}\ \}$

The more interesting case is of course the one where the DP has another plural expression in its scope, as in (166-a) and (167-a). If the structure lacks a distributivity operator, as in (166), we obtain the externally non-distributive reading. As shown in (166-b), (166-a) is predicted true iff each individual that is either a cat or a dog attacked Abe or Bert and Abe and Bert were each attacked by a cat or a dog. (167-a), on the other hand, which contains a distributivity operator, has the externally distributive reading: (167-b) illustrates that the sentences comes out as true iff each individual that is either a cat or a dog attacked both Abe and Bert.

(166) a. *All cats and dogs attacked Abe and Bert.*

b. $([\![all]\!]\ (\{\mathbf{CAT} \oplus \mathbf{DOG}\})) \bullet (\{\mathbf{ATTACK\ A} \oplus \mathbf{ATTACK\ B}\}) =$
$(\{\mathbf{x}_e : \forall \mathbf{z} \leq_{AT} \mathbf{x}\,(\text{CAT}(\mathbf{z} \vee \text{DOG}(\mathbf{z})) \wedge\neg\exists \mathbf{y} > \mathbf{x}(\forall \mathbf{z} \leq_{AT} \mathbf{y}\,(\text{CAT}(\mathbf{z} \vee \text{DOG}(\mathbf{z}))\}) \bullet$
$(\{\mathbf{ATTACK\ A} \oplus \mathbf{ATTACK\ B}\}) =$
$\{\mathbf{C\ attacked\ A} \oplus \mathbf{E\ attacked\ B}, \mathbf{E\ attacked\ A} \oplus \mathbf{C\ attacked\ B}\}$

(167) a. *All cats and dogs* DIST *attacked Abe and Bert.*

[36]More precisely, the present formulation requires that at least one atom of at least one of the pluralities in the restrictor be non-empty. I.e. for *all cats and dogs*, it requires that there are cats or dogs.

b. $[\![\textsc{dist}]\!]$ $(\{\mathbf{ATTACK\ A} \oplus \mathbf{ATTACK\ B}\})$ $([\![all]\!]$ $(\{\mathbf{CAT} \oplus \mathbf{DOG}\})) =$
$\{\mathbf{p}_t : \mathbf{p} = pl(\forall \mathbf{z} \leq_{AT} \mathbf{C} \oplus \mathbf{E}(\mathcal{T}(C(\{\mathbf{attack\ A} \oplus \mathbf{attack\ B}\})(\{\mathbf{z}\}) = 1)))\}$

Here, I assume that the definite determiner *the* has the same denotation as the universal, (168). This clearly cannot be the last word in the matter, given the differences between *all NP* and *the NP* w.r.t. homogeneity and related factors (cf. Brisson 1998, Križ 2016).

(168) $[\![the]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e : C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge \neg\exists \mathbf{y} > \mathbf{x}(C'(\mathbf{y})(\underline{\mathbf{P}}))\}$

The lexical entries for numerals and cardinals differ from universals only in terms of the description of the pluralities of individuals in the plural set they yield as a value, as illustrated by the lexical entry for *three* in (169).

(169) $[\![three]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e : C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge |x| \geq 3\}$

three cats and dogs will thus denote set of all pluralities consisting of at least three individuals that each are either a cat or a dog – as illustrated in (170) for a very small universe with exactly two cats (Carl, Dido) and two dogs (Eric, Ferdl).

(170) $[\![three\ cats\ and\ dogs]\!] =$
$\{\mathbf{C} \oplus \mathbf{D} \oplus \mathbf{E}, \mathbf{C} \oplus \mathbf{D} \oplus \mathbf{F}, \mathbf{C} \oplus \mathbf{E} \oplus \mathbf{F}, \mathbf{D} \oplus \mathbf{E} \oplus \mathbf{F}, \mathbf{C} \oplus \mathbf{D} \oplus \mathbf{E} \oplus \mathbf{F}\}$

(171-a), without DIST, will thus be true if at least one of these pluralities cumulatively attacked Abe and Bert, whereas (171-b), which includes DIST, will come out as true if at least one of these pluralities is such that each of its atoms attacked both Abe and Bert. As stated above, this gives us no handle on the internally distributive reading of numerals / cardinals and an additional shift or determiner ellipsis will have to be posited.

(171) a. *Three cats and dogs attacked Abe and Bert.*
b. *Three cats and dogs* DIST *attacked Abe and Bert.*

As also indicated above, we also run into the problem that we cannot derive the ‘upper-bound’ reading for non-right-upward monotone determiners. If we model *less than three* (*modulo* its internal complexity) as in (172), we predict, in analogy to the example in (171-b) that (173) is true if there is at least one plurality that has less than three atoms, which are each either a cat or a dog, and which each attacked both Abe and Bert. Accordingly, we falsely derive truth in a scenario where, say, two dogs and one cat each attacked both Abe and Bert.[37] I remarked earlier that this tends to be a problem for ‘restriction’-based proposals. There is no principled reason why the PPA should be incompatible with the general strategies that have been put forth as solutions (e.g. Kennedy (2015), Buccola and Spector (2016)), but because it is orthogonal to the core points of this paper I omit any further discussion thereof here.

(172) $[\![less\ than\ three]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e : C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge |x| < 3\}$

(173) *Less than three cats and dogs each attacked Abe and Bert.*

The last case I consider here is plural *no*. We observed above that it is internally distributive, but als that as opposed to all other determiners, DPs headed by *no* never license externally non-distributive readings. At first sight, it seems that we derive these facts – *modulo* wrong predictions about homogeneity – by combining the current ideas with Penka’s 2011 account of

[37]We also incorrectly derive an existence implication, i.e. that there is at least one cat or one dog that attacked Abe. This is the second part of van Benthem’s problem, which is also shared by other ‘restriction’-based accounts.

negative indefinites, where *no* is decomposed into an indefinite (= existential) determiner ('A' below) and a sentential negation ('NEG'). In her treatment, (174-a) is assigned the LF in (174-b).

(174) a. *No cats attacked Abe.*
b. [NEG [[A *cats*] *attacked Abe*]]

Adapting this analysis to our purposes, the first step is to give a lexical entry for A, (175): Just as any determiner, it takes a plural set of predicates as its argument, and it returns the set of all pluralities of individuals that are each either a cat or a dog.

(175) $[\![\text{A}]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e : C'(\mathbf{x})(\underline{\mathbf{P}})\}$

Taking our lexical entry for *not* from section 4 above, (176-a), plus the assumption that it applies to the output of SG, the lexical entry of which is repeated in (176-b), (177-a) would thus have the LF in (177-b). Assuming that there is only cat (Carl) and one dog (Eric), the subject's denotation is (177-c). Applying SG to the combination of the subject and the VP as in (177-d) will return us 1 just in case one of the pluralities in its argument reduces to 1, 0 if none them do, and undefined otherwise. This forms the input to [[NEG]], and accordingly, we get 1 for (177-a) if no cat attacked Abe or Bert and no dog attacked Abe or Bert. The afore-mentioned problem with homogeneity is that the sentence comes out as undefined, rather than false, if only one of Abe and Bert is attacked by a cat or dog. (As stated above, analogous problems arise in my treatment of other determiners.) Hence, *salva* homogeneity, this derives the correct result.

(176) a. $[\![\textit{not}]\!] = [\![\text{NEG}]\!] = \lambda p_t.\{pl(\neg p)\}$
b. $[\![\text{SG}]\!] = \mathcal{T} = \lambda \underline{\mathbf{p}}_{\mathbf{t}} : \exists \mathbf{q} \in \underline{\mathbf{p}}(\downarrow(\mathbf{q}) = 1) \vee \forall \mathbf{q} \in \underline{\mathbf{p}}(\downarrow(\mathbf{q}) = 0).\exists \mathbf{q} \in \underline{\mathbf{p}}(\downarrow(\mathbf{q}) = 1)$

(177) a. *No cats and dogs attacked Abe and Bert.*
b. [NEG [$_S$ SG [[A cats and dogs] [DIST attacked Abe and Bert]]]]
c. $[\![\text{A } \textit{cats and dogs}]\!] = \{\ \mathbf{C}, \mathbf{E}, \mathbf{C} \oplus \mathbf{E}\ \}$
d. $[\![\text{SG}]\!]$({ **C attacked A** $\oplus$ **C attacked B**, **E attacked A** $\oplus$ **E attacked B**, **C attacked A** $\oplus$ **E attacked B**, **E attacked A** $\oplus$ **C attacked B** })

The question is whether Penka's 2011 treatment of negative indefinites generalizes to DP-conjunctions like (178-a). What we would require here is the LF in (178-b): Two occurrences of A, and a *single* sentential negation. The subject would get the denotation in (178-c), which means that application of SG to the output of combining the subject with the VP, (178-d), would give us 1 just in case one of the pluralities in its argument set reduces to 1, 0 if all of them reduce to 0, and undefined otherwise. I.e. once we adjoin NEG, we get roughly the same truth-conditions as in (177) above: For the sentence to be true, it must be the case that no cat attacked Abe or Bert and also that no dog attacked Abe or Bert. The problem with homogeneity remains.

(178) a. *No cats and no dogs attacked Abe and Bert.*
b. [NEG [$_S$ SG [[A cats] and [A dogs]] [DIST attacked Abe and Bert]]]
c. $[\![\text{A } \textit{cats and } \text{A } \textit{dogs}]\!] = \{\ \mathbf{C} \oplus \mathbf{E}, \mathbf{C}, \mathbf{E}\ \}$
d. $[\![\text{SG}]\!]$({ **C attacked A** $\oplus$ **C attacked B**, **E attacked A** $\oplus$ **E attacked B**, **C attacked A** $\oplus$ **E attacked B**, **E attacked A** $\oplus$ **C attacked B** }

One reason, however, *not* to assume such a structure are instances of DP-conjunction like (179). Intuitively, (179) is true iff all dogs attacked Abe, but no cat did – but this is not what we (or in fact any analysis assuming decomposition of *no* into a sentential negation and an existential determiner) derive:[38]: Assuming the LF in (179-b), however, gives us absurd truth-conditions: Assume there is only one cat (Carl) and two dogs (Eric, Ferdl). Then the subject's denotation will be the one in (179-c). In analogy to the (177), (179-a) should then be true only if no cat and no dog attacked Abe – which is clearly not the result we want.

(179) a. *No cats and all (the) dogs attacked Abe.*
b. [not [$_S$ SG [[A cats] and [ALL dogs]] [DIST attacked Abe]]]]]
c. $[\![$A *cats and* ALL *dogs*$]\!] = \{ \mathbf{C} \oplus \mathbf{E} \oplus \mathbf{F} \}$

This suggests that the 'split' analysis of negative indefinites might not be the way to go, after all, which in turn would mean that we would need a proper, quantificational treatment of *no*. One possibility to adapt this to the current system is to let the determiner take a plural set of predicates as its argument (as before) and map it to a plural set of *quantifiers* (elements of $\underline{\mathbf{S}}_{\langle\langle et\rangle t\rangle}$), as sketched for *no* in (180). It is maybe best to explain the effect on behalf of the full DP in (181): The value of the function – assuming there are cats or dogs – will be the set containg that quantifier-plurality, which maps any predicate to 1 just in case it contains no dog or cat.

(180) $[\![no]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle} : \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{pl(\lambda Q_{\langle e,t\rangle}.\exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge \neg\exists y > \mathbf{x}(C'(\mathbf{y})(\underline{\mathbf{P}}) \wedge \forall \mathbf{x}' \leq_{AT} \mathbf{x}\,(Q(\mathbf{x}') = 0))\}$

(181) $[\![no\ cats\ and\ dogs]\!] = \{pl(\lambda Q_{\langle e,t\rangle}.\exists \mathbf{x}_e(C'(\mathbf{x})(\{\mathbf{CAT} \oplus \mathbf{DOG}\}) \wedge \neg\exists y > \mathbf{x}(C'(\mathbf{y})(\{\mathbf{CAT} \oplus \mathbf{DOG}\}) \wedge \forall \mathbf{x}' \leq_{AT} \mathbf{x}\,(Q(\mathbf{x}') = 0))\}$

The downside of this solution is that we either have a lexical entry for *no* that sets it apart from other determiners, or revert to the ambiguity hypothesis for these other determiners, assuming that each has a 'restriction'-type lexical entry (as above), which is required for externally non-distributive readings, and a 'quantificational' lexical entry parallel to that of *no* in (180).

5.3 Interim summary: Restrictor conjunction

In this section, I expanded the PPA to cover some of the contexts where plural projection is blocked: I considered the behavior of determiners, with a special focus on configurations where an NP-conjunction occurs in their restrictor. The basic idea was that determiners act as 'interveners' for plural projection because they are lexically specified to take plural sets as their arguments – and thus combine with their restrictor via functional application, rather than our 'plural composition' rule CC. The results of my implementation were no more satisfactory than most existing treatments on both external and internal (non-)distributivity, but the discussion showed that we can at least derive comparable results, despite the different point of departure.

[38]No matter which denotations we assume for the DP-conjunction, the wide scope negation posited by Penka (2011) will always render an implausible result (even though the predicted truth-conditions differ, depending on the analysis). Consider for instance the predictions for the 'classical' view of non-referential DPs as Generalized Quantifiers, in combination with the intersective analysis of conjunction: The DP in (179-a) will have the denotation in (i-a), accordingly, the sentence in (178-a) will have the truth-conditions paraphrased in (i-b). Hence the sentence should be true, for instance, in a scenario where some cats and half of the dogs attacked Abe.

(i) a. $[\![$A *cats and all dogs*$]\!] = \lambda P_{\langle et\rangle}.\text{CAT} \cap P \neq \emptyset \wedge \text{DOG} \subseteq P$
b. $\neg(\text{CAT} \cap \text{ ATTACK A} \neq \emptyset \wedge \text{DOG} \subseteq \text{ATTACK A})$

6 Discussion and outlook

This paper made two points: First, the class of expressions denoting pluralities is much bigger than previously thought. Namely, conjunctions with conjuncts of several semantic categories also denote pluralities (of the objects their conjuncts denote); therefore, the respective semantic domains must contain pluralities. This point was motivated by clear parallels between plural DPs and conjunctions and by the fact that no existing theory of conjunction can derive them. Second, plural composition – the way in which pluralities combine with other elements in the sentence – does not happen via cumulation operations on predicate denotations, but rather in a step-by-step fashion, via a compositional rule that essentially encodes cumulation and lets pluralities 'project up the tree'. This claim resulted from the observation that alternative theories – theories where predicate denotations are cumulated – run into serious problems of both a syntactic and a semantic nature in a number of configurations.

Apart from the particular problems or questions that I indicated in the text, a number of more general questions arise, four of which I consider particularly relevant for future research.
Q1: Cumulativity and syntactic asymmetry In section 5.1.2, I briefly addressed what I referred to as the 'externally non-distributive' reading of non-referential expressions – which was just a cover term for cumulative construals of non-referential DPs. We saw that these cumulative readings are somehow tied to the syntactic position of the expression: *every NP* does not license cumulative readings in all syntactic positions (see above for references). Yet, syntactic positions might also be relevant in another respect: I mentioned that Buccola and Spector (2016) point out that the difference between cumulative and distributive readings apparently has an impact on the meaning of some non-referential DPs: *less than ten girls* in (147) above always exhibits an 'upper bound' when construed distributively, but can lack an upper bound when construed cumulatively. Both Schmitt (2015) and Buccola and Spector (2016) show there are clear restrictions on this lack of an upper bound even in cumulative readings: *less than ten girls* in (182-a), repeated from (147-b) above, doesn't have to induce an upper bound: The sentence can be true if a group of 110 teachers was called, cumulatively, by 11 girls, and nine of these girls, between them, managed to call all 110 teachers. *less than ten teachers* in (182-b), on the other hand, imposes an upper bound: The sentence is false in a scenario analogous to that which makes (182-a) true, namely, if there are nine teachers that, between them, got called by 110 girls, but these 110 girls called a total of 11 teachers. Buccola and Spector (2016) assume that this interpretative asymmetry is tied to a thematic one, but Schmitt (2015), based on scrambling data from German, argues that it should be tied to a syntactic asymmetry.

(182) a. *Less than ten girls prank called more than 100 teachers.*
b. *More than 100 girls prank called less than ten teachers.*

Accordingly, we have one, possibly two phenomena where aspects of cumulativity are tied to syntactic asymmetry. As opposed to the predicate-cumulation approach, which, without further assumptions, is inherently symmetric, the general idea of plural projection, where plural composition proceeds in a stepwise fashion along the hierarchical structure of the sentence, seems intuitively 'made for' this kind of phenomenon. However, in order to actually capture it, more will have to be said about the denotations of non-quantificational DPs and how they interact with the general system laid out above.[39]
Q2: 'Projection' properties of non-referential DPs In section 3 I argued against a predicate-cumulation account using examples with referential expressions. However, cumulative con-

[39] In fact, this is the goal of ongoing, unpublished joint work with Nina Haslinger.

struals of non-referential expressions can be used to make the same point – while raising yet another question on how to actually model such expressions. Consider (183): (183-b) is true in the scenario in (183-a) and therefore displays a form of cumulativity. But as the belief held by Berta and Carl is *de dicto*, a predicate-cumulation analysis, which would have to assume the LF in (183-c), won't give us the right result: It would construe *four monsters* outside of the scope of the intensional operator. Provided we can rule out collective belief and also argue against a treatment in terms of intentional objects, we would thus want plural projection to derive us this reading – intuitively, *four monsters* should project up to a plurality of propositions believed by either Berta or Carl. However, the treatment of indefinites given above – or any existing treatment of indefinites that I am aware of – won't give us that.

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(183) a. SCENARIO Berta and Carl spent last night at Joe's castle. Berta believes in griffins, Carl in zombies. Around midnight, Berta heard a sound in her bedroom and was certain that it was caused by two griffins fighting with each other. A little later, Carl heard a sound in his bedroom, and took it to be caused by two zombies. In the morning, they each took Joe aside and told him – secretly – what they believed was going on at his castle. Later, Joe, completely exasperated, tells me:
Well, I had invited Berta and Carl to spend the night at the castle. Bad idea! I know, of course, that people find it a little spooky here, but guess what...

b. ***these idiots believed that four monsters (altogether) were roaming the castle!***

c. *[[these idiots][four monsters][*CUM^2*[2[1[1 believes that 2 roamed the castle]]]]]*

Q3: Homogeneity The third question also relates, in a sense, to non-referential expressions, more precisely, to their interaction with homogeneity. In this paper, I used homogeneity as an additional piece of evidence for my claim that plural DPs and conjunctions with conjuncts of various semantic categories display a parallel behavior. My implementation of homogeneity in section 3 was not particularly elegant, and obviously not correct, either, because it made the wrong predictions w.r.t. contexts where we *don't* find homogeneity – such as the restrictor of quantificational determiners. I left open the question whether more recent work on the interaction of quantification and homogeneity (see references above) can be made compatible with the proposal here. However, from the perspective of this paper, one particular question arises, namely: Are the contexts where plural projection is blocked and the contexts from which homogeneity does not project the same? If so, what does this tell us about both plural projection and homogeneity?

Q4: Conjunction and disjunction In this paper, I have proposed a new meaning of conjunctions, which I derived by attributing a new meaning to *and*. I also posited a new meaning for disjunctions – derived via a new meaning for *or* – mainly in order to make sure I didn't inadvertently collapse the two. Both were defined as particular operations forming plural sets. Now, there are a number of phenomena in natural language that are usually explained by appealing to the lexical contrast between *and* and *or* – or more precisely, the lexical contrast between the two under their *Boolean* analysis – most notably scalar implicatures. Haslinger and Schmitt (2017) argue that non-Boolean analyses of *and* usually face a problem when trying to derive the same effects, simply because the meaning they assume for *and* is too weak, compared to the standard Boolean one. Because my analysis here falls into that class of analyses (although it was shown to differ from the more 'traditional' non-Boolean analyses), it will face similar issues. At the moment, I don't really know how to tackle them.

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