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Pluralities across categories and plural projection *

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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 certain features — in particular cumulativity — in the context of other plural expressions. Existing analyses of conjunction fail to derive these parallels and I propose 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 thereof, which puts the workload onto the predicate, is insufficient. I propose an alternative which is based on the idea that all semantic domains contain pluralities and involves *plural projection*. In this system, the 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: 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.

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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. In the following, one of these symptoms of plurality will be particularly relevant: cumulativity. This refers to the observation that a plurality can be attributed a property if that property is the result of ”adding up” the properties of the plurality's parts (see Scha 1981, Link 1983, Krifka 1986 a.o.): If the two sentences in (1b) are true — and Abe and Bert are the only salient boys and Carl and Dido are the only salient cats — then (1a) is true, albeit neither Abe nor Carl individually fed the two cats. The plural DP differs from the universal quantifier *every NP*, as the truth of (1c) does not follow from the truth of the two sentences in (1b).

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

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

1.1 Claim 1: Expanding the class of pluralities

Following Schmitt 2013, I first show that cumulativity (and possibly other symptoms of plurality) can be observed for English *and*-coordinations (henceforth *conjunctions*) with conjuncts of several semantic categories.[1] I argue

1 Unless noted otherwise, the judgements reported in this paper are those of native speakers of English. (They can be reproduced in German, but I omit German examples for reasons of

that therefore all types of conjunctions — e.g., conjunctions with individual-denoting conjuncts as in (2a) (see Link 1983, Schwarzschild 1996 a.o.), predicate conjunctions, (2b), and sentential conjunctions, (2c) — denote pluralities (of individuals, predicates of individuals and propositions, respectively). Thus the relation between ⟦*dance and smoke*⟧ and ⟦*dance*⟧ is analogous to that between ⟦*the two boys*⟧ and ⟦*Abe*⟧, etc.

(2) a. *Abe and Bert*
    b. *dance and smoke*
    c. *(that) Abe went to the office and (that) Bert went to the gym*

I implement this claim by proposing that the ontology does not only contain pluralities of individuals (see Link 1983) or other primitives such as events (see e.g., Landman 2000) or worlds (see Schlenker 2004) but that any semantic domain D_a (where a ranges over semantic types) includes pluralities made up from objects of D_a. This means that there are pluralities of functions (see Gawron & Kehler 2004 for a similar claim) and also pluralities of sentence denotations (see Beck & Sharvit 2002 for a related proposal concerning pluralities of questions). I will model this by enriching the set of denotations for every type a in two respects: First, this set will contain all possible ”sums” (”pluralities”) of objects of the respective domain. Second, it will contain sets of such sums (”plural sets”). A conjunction with conjuncts of type a will then denote a singleton plural set, containing the sum (represented by ”⊕” below) of the denotations of the individual conjuncts, as illustrated in (3) for the examples in (2).

(3) a. {⟦*Abe*⟧ ⊕ ⟦*Bert*⟧}
    b. {⟦*dance*⟧ ⊕ ⟦*smoke*⟧}
    c. {⟦*Abe went to the office*⟧ ⊕ ⟦*Bert went to the gym*⟧}

The reason why I need *two* levels of complexity (pluralities and plural sets) is connected to the 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 cumulativity as a cross-categorial symptom of plurality.

space.) There is slight speaker variation in *all* types of examples, which usually has to do with how much context is needed in order to obtain the relevant construal. The judgements I report are those given relative to the type of context I present.

1.2 Claim 2: Cumulativity and plural projection

Sentences like (1a) above (repeated in (4)), 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 (see Langendoen 1978 a.o.). I here refer to them as *cumulative truth-conditions*: (4) 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.

(4) *[$_{plural\ 1}$ The two boys] fed [$_{plural\ 2}$ the two cats].*

Theories that only consider pluralities of individuals derive these truth-conditions by what I will call the *predicate analysis*, namely, by positing cumulation operations on predicate denotations (see Link 1983, Krifka 1986, Sternefeld 1998). For (4), this means that the primitive extension of the predicate *feed* is enriched by all pairs of individuals that we can form by simultaneously adding up feeders and their respective feedees: (4) 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.

However, the predicate analysis faces two problems (see also Schmitt 2013). The first one is rooted in its prediction that since cumulation targets predicates (like *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 & Sauerland (2000) argue that this predicate must sometimes be syntactically derived, because we find cumulative truth-conditions where the required predicate is not a surface constituent. Yet, I will show that the syntactic operations we would require to form this predicate do not always correspond to those independently attested.

The second, more severe, problem concerns configurations like (5), where, according to the view taken here, one plural expression (*plural 2*) contains another (*plural 3*). I will show that the predicate analysis cannot consistently derive the correct truth-conditions for such configurations.

(5) *[$_{plural\ 1}$ The boys] [$_{plural\ 2}$ fed [$_{plural\ 3}$ the two cats] and watched TV]*

I then propose an alternative way of deriving cumulative truth-conditions, which builds on my claim 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*). Broadly speaking, if a plural like *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: 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). Glossing over the details, this means that for (6a) we obtain the denotation in (6b) — which is analogous to the denotation of predicate conjunctions like *dance and smoke* sketched in the previous paragraph.

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

If the VP in (6a) combines with a plural subject, as in (7a), we get a plurality of propositions, (7b). 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. (7a) thus comes out as true iff Abe and Bert each fed one of the two cats and each cat was fed by Abe or Carl.

(7) a. *The two boys fed the two cats.*
 b. {Abe fed Carl $\oplus$ Bert fed Dido, Abe fed Dido $\oplus$ Bert fed Carl, … }

This illustrates, if somewhat sketchily, that the system I propose derives the correct truth-conditions for simple sentences like (7a). I will show that it also accounts for more complex cases, including ”plural-within-plural” configurations such as (5) above. 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.

What I formulate here is the backbone of a theory of plural composition. A number of configurations — including those with collective predicates and cases where a plural expression is embedded by quantificational material as in (8) — will require an expansion of the system. I believe such an expansion to be possible (see Haslinger & Schmitt 2018), but since a proper account would not only warrant a technical discussion, but also a detailed empirical investigation of the phenomena (see e.g., Heycock & Zamparelli 2005, Champollion 2016), I only give a general indication of what such an expansion could look like.

(8) *Abe fed [every [$_{plural}$ 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 them. In Section 3, I introduce the predicate analysis and sketch how we could use it to explain the facts from Section 2. I then argue that the predicate analysis as such is on the wrong track, based on the problems sketched above. In Section 4, I introduce generalized plural denotations and plural projection and apply the system to the examples discussed up to this point. Section 5 concludes the paper and addresses questions for future research.

2 The empirical motivation for cross-categorial plurality

Since the truth-conditions of (9a) and (9b) are similar, examples like (9a) might suggest that the denotations of plural DPs are reducible to universal quantification over atomic individuals (see Winter 2001a for parallel examples).

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

By analogy, examples like (10a) could suggest that conjunction is intersective as in (10b), since (10a) is true iff Abe has all the properties denoted by the individual conjuncts.

(10) a. *Abe smoked and danced.*
 b. $[\![\textit{smoke and dance}]\!] = \lambda x_e.\ \text{smoke}(x) \wedge \text{dance}(x)$

But once we consider a wider range of contexts, identifying the semantic impact of plural DPs with universal quantification becomes untenable. Cumulativity, in particular, rules out such a treatment. The following will show that the contexts where we witness cumulativity for plural DPs reveal analogous effects for conjunctions with conjuncts of several semantic categories, for instance with predicate conjunction as in (10a). Accordingly, conjunctions cannot be analysed as intersective — rather, their behavior mimics that of plural DPs.[2]

2 This observation is limited to conjunctions with *and*. Conjunctions with *but* and possibly also conjunctions containing *and* plus additional material (like *smoked and also danced*) exhibit a different behavior, which I do not address in this paper.

The first part of the claim, namely that conjunction is not intersective, is not new. Link (1983, 1984), Krifka (1990), and Heycock & Zamparelli (2005) and others argue for non-intersective analyses of conjunction and some of the examples discussed below are modelled on examples from this literature. Nevertheless, the parallelism between conjunctions and plural DPs will actually turn out to be incompatible with their basic assumptions.

2.1 Cumulativity

Sentences containing more than one plural DP are one context that reveals symptoms of plurality. For the moment, I will focus on examples such as the sentence marked by $[_S \ldots]$ in (11), where two plural DPs occur as co-arguments of a transitive predicate. (I will frequently give larger chunks of discourse where the relevant sentence is indicated by $[_S \ldots]$. Whenever I write "the sentence in (n)", this refers to the bracketed sentence in (n).)

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

More precisely, such sentences give rise to peculiar truth-conditions (Langendoen 1978 a.o.), which I refer to as *cumulative truth-conditions*. The sentence in (11) 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.[3]

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 are those in (12a). They are weaker than those in (12b), which we would expect, if *the two boys* and *the two cats* denoted the universal quantifier.

(12) $[\![$*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 consider expressions that display a parallel behavior, namely strings like the one schematised in (13a) with the truth-conditions in (13b). (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 appeal to an intuitive relation *consist-of* in the meta-language. This should be

3 I take cumulative construals to be distinct from collective ones. See Landman 2000 a.o. for discussion.

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.

(13) a. $A \quad R \quad B$
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, see Link 1983, Schwarzschild 1993 a.o.): If Abe and Bert are the only boys, the truth-conditions of (14) and of (11) above are identical.

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

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

2.1.1 Cumulativity with predicate conjunctions

(15) gives two examples which show that predicate conjunctions of syntactic category VP can display cumulativity.[4]

(15) a. *Good Lord! 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)
b. *[$_S$ [$_A$ The children in my class] are [$_B$ [blond]$_P$ and [brunette]$_Q$]], but the ones in Sue's class all have red hair…how strange!*

The sentence in (15a) is true in a scenario with five roosters and five dogs, where the dogs are barking and the roosters are crowing. In fact, it is true in

4 Data contributed to our project *Conjunction and disjunction from a typological perspective* (carried out by Enrico Flor, Nina Haslinger, Eva Rosina, Magdalena Roszskowski, Valerie Wurm and myself) suggest that similar facts are found in several languages, including a number of non-Indo-European ones. The data can be accessed via http://test.terraling.com/groups/8.

any scenario where all of the farm animals are crowing or barking and some are crowing and some are barking — which means that it has the cumulative truth-conditions in (16). (15b) is analogous: It is true in a scenario where half of the children in my class are blond and the other half is brunette.

(16) 1 iff $\forall x \in S_A\, (\exists Y \in \{\mathrm{P,Q}\}\, (\mathrm{Y}(x) = 1)) \wedge \forall Y \in \{\mathrm{P,Q}\}\, (\exists x \in S_A\, (\mathrm{Y}(x) = 1))$

Contrary to Winter (2001b), who essentially claims that cumulative truth-conditions for VP-conjunctions are only observable if the denotations of the conjuncts are disjoint as in (15),[5] The examples in (17) show that non-disjointness of the conjuncts' denotations does not block cumulativity: The denotations of *smoking* and *dancing* in (17a) are not disjoint, but the truth-conditions of the sentence again fit the pattern in (16). It is true, for instance, if four of the teenagers are smoking, while the other six are dancing. Likewise *drink* and *smoke* are not disjoint, but (17b) exhibits cumulative truth-conditions: If 50 villagers are non-smoking drinkers, 20 are smokers that don't drink, and the remaining ones both drink and smoke, the sentence is true.

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

b. *Absurd! [$_S$ [$_A$ The people in this village] [$_B$ [smoke]$_P$ and [drink]$_Q$]], but none of them has ever eaten a steak!*

2.1.2 Cumulativity with propositional conjunctions

Propositional conjunctions also exhibit cumulativity. Consider first the example in (18).

(18) *The agency from Paris called and the one from Berlin. The conversations were useless. [$_S$ [$_A$ The agencies] claimed [$_B$ [that Macron was con-*

5 "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 (2014) 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.

sidering his resignation]$_p$ and [(that) Merkel hired 10 new bodyguards]$_q$]],
but neither of them had anything to say about the Brexit negotiations.

In a scenario where the Paris agency made the claim about Macron and the Berlin agency the claim about Merkel, the sentence is true. Generalizing over such verifying scenarios, we obtain the cumulative truth-conditions in (19).

(19) 1 iff $\forall x \in S_A\, (\exists r \in \{\text{p,q}\}\, (\text{claim}(r)(x) = 1)) \wedge$
$\forall r \in \{\text{p,q}\}\, (\exists x \in S_A\, (\text{claim}(r)(x) = 1))$

Cumulativity of propositional conjunctions is also found when the embedding verb is an attitude predicate like *believe*. The sentence in (20) is true in a scenario where Abe holds the belief about cooked food but has no opinions about antibiotics, whereas Bert is certain that antibiotics are a health hazard but agnostic w.r.t. the effect of cooked food — hence it has cumulative truth-conditions.

(20) *Abe may be into raw food and Bert into homeopathy, but they are not as crazy as you think — okay, [$_S$ [$_A$ they] believe$_R$ [$_B$ [that cooked food causes headaches]$_p$ and [(that) antibiotics will kill you]$_q$]], but neither of them would maintain that all drinking water in the US is poisoned — as your friend Gina does.*

These data thus suggest that propositional conjunctions, too, mimic the behavior of plural DPs w.r.t. cumulativity.

But couldn't we say that Abe and Bert hold the collective belief $[\![p]\!] \cap [\![q]\!]$ — and that thus *p and q* simply denotes $[\![p]\!] \cap [\![q]\!]$? In the scenario I gave, Abe is agnostic w.r.t. $[\![q]\!]$ and Bert w.r.t. $[\![p]\!]$, 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. However, we can rule out this possibility by examples like (21), which would involve conflicting beliefs. The sentence in (21) is true if Abe believes the next president to be a Southern Cardinal and Bert believes the next president to be a Californian Satanist. Thus 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 (21) attributes inconsistent beliefs to

Abe or Bert.) Hence (21) is incompatible with *p and q* denoting the set of worlds that Abe and Bert agree on.[6]

(21) *Abe may be a fervent Catholic and Bert a member of a Satanist cult, but they are not as bad as you think — okay, $[_S[_A$ they$]$ believe$_R$ $[_B$ [that the next president will be a Southern Cardinal$]_p$ and [(that) the next president will be a Californian Satanist$]_q$]], but neither of them would maintain that the next president will be an alien — as your "sane" friend Gina does.*

2.2 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. Their behavior thus mimics that of plural DPs. But since conjunctions have been extensively discussed in the semantic literature, it stands to reason that some existing account should derive these observations. In the following, I argue that this is not the case, despite first appearances.

2.2.1 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").[7]

Intersective theories (von Stechow 1974, Partee & Rooth 1983, Gazdar 1980, Keenan & Faltz 1985, Winter 2001a, Champollion 2016 a.o.) start with

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6 A different way to make this point (due to Lucas Champollion (pc)), goes as follows: If $[\![p \text{ and } q]\!]$ were $p \cap q$ then, if (ia) and (ib) are true, it should follow that (ic) is also true (because r holds in all worlds where $p \cap q$). However, this is not a valid inference. On the other hand, we can infer (id) on the basis of (ia) and (id) — which shows again that *p and q* is not reducible to $p \cap q$. (See Schmitt 2019 for more examples.)

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

7 See Winter 2001a and Flor et al. 2017 for reasons why the hypothesis that English *and* is ambiguous between an intersective and a non-intersective meaning is unattractive.

the assumption that *and* in sentential conjunction is analogous to the operation $\wedge$ on truth-values in classical propositional logic: (22) is true iff both p and q are true and false otherwise (but see Section 2.3).

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

The general idea of such proposals (but see Keenan & Faltz 1985 for a slightly different view) 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.[8] The meaning of *and* is defined as the type-polymorphous operation $\sqcap$ which is recursively expanded from D_t, (23):

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

To see the point, take the predicate conjunction in (24): According to (23), 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.

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

It should be clear that, absent further assumptions (such as those in Winter 2001a, Champollion 2016), the intersective theory is incompatible with the data discussed above. (24) gives us a distributive predicate of individuals (distributive because one of its conjuncts, *smoke*, is distributive). Thus, its truth-conditions in sentences with a plural subject should be analogous to those of sentences with non-conjoined distributive predicates like (25).

(25) *The ten teenagers are smoking.*

As (25) true iff each of the ten children are smoking, the example from (17a) above, repeated in (26), should be true iff each of the ten children is both smoking and dancing.

(26) *The ten teenagers are smoking and dancing.*

We saw above that the actual truth-conditions of (26) 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 inter-

8 See Geach 1970 and van Benthem 1991 for the syntactic prerequisites.

sective 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 (26) which, among other observations, motivated non-intersective theories of *and* (Link 1983, 1984, Krifka 1990, Heycock & 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 (27), as the point of departure.

(27) *Abe and Bert*

The assumption is that in contexts such as (27), *and* denotes the operation that forms pluralities of individuals from (pluralities of) individuals (see Link 1983). I have not defined this operation yet, so I will simply represent it here by "$\oplus$"—it will be sufficient to say that $[\![Abe]\!] \oplus [\![Bert]\!]$ is identical to $[\![\textit{the two boys}]\!]$, if $[\![boy]\!] = \{\text{Abe}, \text{Bert}\}$. The idea is to recursively define the denotation of *and* for all conjuncts of *e*-conjoinable types—defined in (28)—on the basis of $\oplus$.[9] This is done in (29), where $\sqcup$ represents the (type-polymorphous) denotation of *and*.[10] Note that in the third clause I assume that Z^1 has type a_1, Z^2 type a_2 and so forth: Accordingly, this third clause tells us (i) that $\sqcup$ extends to functions of *e*-conjoinable type that take more than one argument, and (ii) that not all of the arguments of these functions need to have the same type.

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

9 As pointed out to me by an anonymous reviewer and Lucas Champollion (pc), Kit Fine's work on truthmaker semantics includes what is, broadly speaking, an expansion of $\oplus$ to propositional conjunction (see e.g., Fine 2012). I don't go into it here, because it would warrant too much discussion of the particular background required.

10 t still represents a special case.

(29) $$X \sqcup Y = \begin{cases} X \oplus Y \quad \text{if } X, Y \in D_e \\[1em] \lambda Z_a.\exists Z', Z'' \,[\, Z = Z' \sqcup Z'' \;\wedge\; X(Z') \wedge Y(Z'') \,] \\ \text{if } X, Y \in D_{\langle a,t\rangle} \text{ and } \langle a, t\rangle \text{ is } e\text{-conjoinable} \\[1em] \lambda Z^1, \dots, Z^n.\exists Z^{1'}, Z^{1''}, \dots, Z^{n'}, Z^{n''} \\ [Z^{1'} \sqcup Z^{1''} = Z^1 \;\wedge\; \cdots \wedge\; Z^{n'} \sqcup Z^{n''} = Z^n \\ \wedge X(Z^{1'}) \dots (Z^{n'}) \wedge Y(Z^{1''}) \dots (Z^{n''})] \\ \;\text{if } X, Y \in D_{\langle a_1 \langle \dots \langle a_n, t\rangle \dots \rangle\rangle} \text{ and } \langle a_1, \langle \dots, \langle a_n, t\rangle \dots \rangle\rangle \text{ is } e\text{-conjoinable} \end{cases}$$

For the predicate conjunction in (30), this yields the 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.

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

Glossing over the problems resulting from my informal treatment, (29) thus derives the correct truth-conditions for our sentence in (17a) above, repeated again in (31): (31) is predicted true iff we can split up the group of ten teenagers completely into smokers and dancers (which doesn't exclude the possibility that some or all teenagers do both).

(31) *The ten teenagers are smoking and dancing.*

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?

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

Ignoring all other problems for non-intersective theories (see Krifka 1990 and most recently Champollion 2016), they 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 a plural DP (or an individual conjunction) A and a predicate conjunction B where A is not (on some level) an argument of B — and this prediction is falsified by sentences like that in (32): It 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 *the president.*[11]

(32) *Diplomacy is useless! The French ambassador called this morning and the German one this afternoon. [$_S$ [$_A$ The ambassadors] think that the president should [$_B$ [$_P$ take a walk in Versailles] and [$_Q$ build a golf club in Bavaria]], but neither of them said anything about the really pressing issue — the trade agreement with the EU.*

Nevertheless, the sentence has cumulative truth-conditions and the cumulative relation, so to speak, holds between the matrix subject and the embedded predicate conjunction: The sentence is true in a scenario where the French ambassador insists that the president do P and the German one insists that he do Q — or, more generally, if (33) holds.

(33) $\forall x \in S_A\,(\exists Y \in \{\text{P,Q}\}\,(x \text{ thinks that the president should } Y)) \;\wedge$
$\forall Y \in \{\text{P,Q}\}\,(\exists x \in S_A(x \text{ thinks that the president should } Y))$

11 Analyses that cumulate relations between individuals and events (e.g., Kratzer 2000, Landman 2000) and include non-intersective predicate conjunction (e.g., Lasersohn 1995, Landman 2000) don't generalize to such examples either, because there is no "chain-of-events", so to speak, connecting the conjunction and the matrix subject. (See Section 3 on a more precise notion of "cumulated relations".) In particular, we argue in Haslinger & Schmitt 2018 that such theories do not account for the fact (observable in examples like (32)) that cumulative relations can reach inside arguments that denote neither individuals nor events, like complements of attitude verbs. One might hold against this that in some analyses, attitude verbs combine with eventualities, such as belief states, rather than propositions (see Kratzer 2006, Moulton 2015, Elliott 2017). However, such accounts still involve an operator within the complement clause that maps propositions to eventualities. Since a purely event-based system cannot reach below this operator, the problem remains.

(34a) and (34b) are analogous to (33) in the relevant sense and again we find cumulative truth-conditions. The sentences are 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 again holds between the subject of the matrix clause and the predicate conjunction in the embedded clause, but neither is an argument of the other- rather, the conjunction's argument is *he*.[12]

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

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 a 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 a witch!*

What these data show is that semantic locality is not a prerequisite for cumulativity of a predicate conjunction. We find, once again, 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). 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.[13]

12 We find analogous facts with predicate-topicalization as in (i), where the conjunction forms a constituent. Accordingly, such examples are not (always) reducible to propositional conjunction (at the level of the embedded clause) plus 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 a witch!*

13 As opposed to the theories discussed above, my proposal below is in fact not about the lexical meaning of *and* (although it is currently phrased like this) but about denotations of entire coordinate structures.

2.3 Discussion: Parallels between plural DPs and conjunctions

The preceding paragraphs have shown that conjunctions of individuals, VP-predicates and propositions behave analogously to plural DPs in terms of cumulativity and that no existing analysis of conjunction derives these parallels. Before we turn to other analytical options, I give some examples showing that the parallels between such conjunctions and plural DPs are not limited to cumulativity — even though my analysis below will only deal with the latter.

Homogeneity Fodor (1970) notes a "grey area" in terms of truth-value judgements when considering sentences with plural DPs and their negation — a phenomenon known as *homogeneity* (Löbner 1987, 2000, Schwarzschild 1993 a.o.). While (35a) conveys that Dido bit all of the boys, (35b) conveys that she bit none of them, so neither sentence adequately describes scenarios where she bit some but not all of the boys. Plural DPs thus differ from universal quantifiers over atoms as in (36), where we find no such grey area.

(35) a. *Dido bit the two boys.*
 b. *Dido didn't bite the two boys.*

(36) a. *Dido bit every boy.*
 b. *Dido didn't bite every boy.*

Judgements relating to homogeneity can be blurry (see Križ & Chemla 2015), but similar effects seem to be observable for conjunctions. For individual conjunctions this has been noted before (Schwarzschild 1993, Szabolcsi & Haddican 2004 a.o.): Whereas (37a) conveys that Dido bit both Abe and Bert, (37b) conveys that she bit neither. (Schwarzschild (1993) and Szabolcsi & Haddican (2004) note that it is crucial that *and* is unstressed. This extends to the examples discussed below.)

(37) a. *Dido bit Abe and Bert.*
 b. *Dido didn't bite Abe and Bert.*

However, the effect can also be witnessed with predicate and propositional conjunction. (38a) expresses that Varg was both P and Q, but (38b) conveys that he was neither (see Geurts 2005 for similar data and judgements).

(38) *Well, I went on a date with Varg last 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.*

This intuition is corroborated by (39): If the predicate conjunction *P and Q* didn't display homogeneity, we shouldn't observe the (slight) contrast in (39) between the "bare" conjunction in (39a) and the conjunction modified by *both* in (39b). In particular, appealing to "in-between-scenarios" without a qualifying *I mean…* or *well* seems worse in the first case. This is analogous to what we find when contrasting plural DPs and universal quantifiers as in (40).

(39) *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.*

(40) a. *Dido didn't bite the two boys. ?/?? She only bit Abe.*
  b. *Dido didn't bite every boy/both the boys. She only bit Abe.*

Propositional conjunction is analogous: While (41a) conveys that Abe claimed both p and q, (41b) seems to prominently convey that he claimed neither.

(41) *I just talked to 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.*

Selectional restrictions A number of lexical elements combine with both plural DPs as well as conjunctions of various categories and seem to "do the same thing" in each case. *respectively* in (42) is one such case (see Gawron & Kehler 2004), illustrated here for plural DPs, (42a), individual conjunction, (42b), and predicate conjunction, (42c).[14]

14 Two more cases deserve mentioning. First, as pointed out to me by Sigrid Beck (pc) and discussed in Beck 2000, the "objects" compared by *different* cannot only be introduced by plural DPs or individual conjunction, but also by conjunctions of VPs, PPs etc. (see also Carlson 1987): (ia) can express that the feeders of Carl are not identical to the feeders of Dido, likewise, (ib) can express that the singers are not identical to dancers.

(42) 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.*

Collective predication Finally, one of the reasons why we assume that plural DPs (and individual conjunctions) have special denotations is that collective predicates like *meet* select for them, but not for singular DPs (with count nouns), Link 1983. The possibility that similar effects can be witnessed for other domains is addressed by von Stechow (1980), with (43a) as a potential case of collective predication with propositional conjunction, and (43b) as a potential case of collectivity with predicate conjunction.

(43) a. *That Major was good minded and that Napoleon was evil-minded are two distinct facts.* (von Stechow 1980: 91(64))
b. *To be drunk and to be sober are incompatible properties.* (von Stechow 1980: 91(65))

3 Pluralities, the predicate analysis and its expansion

So, why do plural DPs and conjunctions with conjuncts of various semantic categories display the parallels observed in the preceding section? Here is a straightforward proposal: Conjunctions behave like plural DPs because they, too, denote pluralities, namely, of the kind of object their conjuncts denote: Individuals, predicates of individuals, propositions etc. In other words, we could argue that pluralities — objects that are isomorphic to non-empty subsets of the respective domain — exist in any semantic domain.

If we make this assumption, however, we must also explain how these new pluralities semantically combine with other elements of the sentence and how we derived cumulative truth-conditions. At first sight, there seems to be an easy solution: 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 Section 3.1 — and expand it so that it includes pluralities

(i) a. *Different people fed Carl and Dido.*
b. *Different people sang and danced.* (Sigrid Beck, pc)

Second, "semantic grouping" effects of prosodic boundaries, which can be observed both in individual and predicate conjunctions (and are discussed by Winter (2007) and Wagner (2010) under different headings) are another cross-categorial effect.

of functions etc. Yet, closer scrutiny (applied in Section 3.2) reveals that the predicate analysis, and thus its expansion, faces problems. At least one of them is so severe that it will lead me to suggest an alternative proposal in Section 4. It will maintain the idea of cross-categorial plurality, but will suggest a very different way in which plurality-denoting expressions combine with other elements and how cumulative truth-conditions are derived.

3.1 Pluralities and the predicate analysis

We will start with the standard view of the denotations of plural DPs and of plural predication, which I outline here roughly following Link 1983.

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, that is objects that have no parts but themselves, but also plural individuals - which are conceived of as sums of individuals. More precisely, D_e is supplemented by all possible sums of individuals so that we end up with a one-to-one correspondence between such sums and non-empty subsets of atomic individuals. Accordingly, we assume that there is a set $A \subseteq D_e$ of atomic individuals, a binary sum operation $\oplus$ on D_e and a function $f\colon (\mathscr{P}(A) \setminus \{\emptyset\}) \to D_e$, such that $f(\{a\}) = a$ for any $a \in A$ and f is an isomorphism between the structures $(\mathscr{P}(A) \setminus \{\emptyset\}, \cup)$ and $(D_e, \oplus)$. Hence, if our set A of atomic individuals is $\{\text{Abe, Bert, Carl}\}$, then our set D_e will be $\{\text{Abe, Bert, Carl, Abe} \oplus \text{Bert, Abe} \oplus \text{Carl, Bert} \oplus \text{Carl, Abe} \oplus \text{Bert} \oplus \text{Carl}\}$. This resulting set differs from the set of atoms in that it involves a more interesting notion of parthood (elements are not only (trivially) part of themselves but can also be proper parts of other elements). In the following, I will use two relations concerning parthood: The *part-of* relation, where $a \leq b$ will stand for "a is a part of b" and the *atomic-part-of*-relation, where $a \leq_{AT} b$ will be used for "a is an atomic part of b".[15]

With this background, we can consider the denotations of plural DPs and individual conjunctions according to Link (1983). Omitting the internal composition, a plural DP will denote the sum of all the elements in the NP-extension, as in (44). ($\bigoplus S$ stands for $f(\bigcup\{f^{-1}(x) \mid x \in S\})$, for any $S \subseteq D_e$.) If Abe and Bert are the only salient boys, then $[\![\textit{the boys}]\!] = \text{Abe} \oplus \text{Bert}$.

15 For any $a, b \in D_e$, $a \leq b \Leftrightarrow a \oplus b = b$ and $a \leq_{AT} b \Leftrightarrow a \leq b \wedge a \in A$.

(44) $[\![\textit{the boys}]\!] = \bigoplus \{x_e.x \text{ is a boy}\}$

Given the parallels between plural DPs and individual conjunctions, Link (1983) assumes that the denotation of an individual conjunction is analogous to that of a plural DP and thus associates *and* with the sum-operation $\oplus$, (45). This means that an individual conjunction as in (46) also denotes a plural individual.

(45) $[\![\textit{and}]\!]_{\langle e,\langle e,e\rangle\rangle} = \lambda x_e.\lambda y_e.x \oplus y.$

(46) $[\![\textit{Abe and Bert}]\!] = \text{Abe} \oplus \text{Bert}$

3.1.2 Cumulation

But when does a predicate hold of a plurality? Ignoring cases where it can do so primitively, namely collective predicates, the task is to ensure that cumulative inferences are adequately captured by the theory: If both (47a) and (47b) are true, then so is (47c). *blond* intuitively expresses a property of atomic individuals (but see Schwarzschild 1993 for more discussion) — a trait I here take to be lexically specified (but see Link 1983). Accordingly, we require a mechanism where the predicate in (47c) will hold of the plurality Abe $\oplus$ Bert in virtue of holding of its atoms, that is, a mechanism that will allow for a plurality to inherit the properties of its parts.

(47) 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, (48). It expands the predicate's basic extension by closure under sum.

(48) 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 $y \in S, f(y) = 1$, $f(\bigoplus S) = 1$.

I assume that * is introduced in the object language by a (silent) morpheme C^1. Accordingly, (49a) is the LF for (47c), and (49b) 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.

(49) a. [[*Abe and Bert*] [C^1 *blond*]]

b. $^*[\![\textit{blond}]\!]$ ($[\![\textit{Abe and Bert}]\!]$) = 1 iff $\exists x, y\, (x \oplus y = \text{Abe} \oplus \text{Bert} \wedge {}^*[\![\textit{blond}]\!](x) = 1 \wedge {}^*[\![\textit{blond}]\!](y) = 1)$

Our main focus in Section 2, however, was on transitive structures. Crucially, the latter also license cumulative inferences — if both (50a) and (50b) are true, so is (50c) — and accordingly we require a mechanism that derives such cumulative inferences.

(50) a. *Abe fed Carl.*

b. *Bert fed Dido.*

c. *Abe and Bert fed Carl and Dido.*

We cannot simply reduce the transitive structure to a structure with two intransitives and iterate application of C^1, as in (51) (see Sternefeld 1998): The truth-conditions assigned to (51) are much too strong, requiring that each of the two boys fed each of the two cats.

(51) *[[Abe and Carl]*$_1$ C^1 *[1 [Dido and Carl] [* C^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, for instance the pair of actual feeders and feedees in the case of *feed*. The cumulation operation ** (for which I assume the object language representation C^2), defined in (52), 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 (see Krifka 1986, Sternefeld 1998).

(52) 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 a $y' \in S'$ and $f(x')(y') = 1$ and for every $y' \in S'$ there is an $x' \in S$ and $f(x')(y') = 1$, $f(\bigoplus(S))(\bigoplus(S')) = 1$.

(53a) gives the LF for (50c), and (53b) a sketch of the semantic derivation. We indeed derive the cumulative truth-conditions observed above. Analogous operations can be defined for n-transitive predicates with $n > 2$ (see Sternefeld 1998).

(53) a. *[[Abe and Carl] [[*C^2 *fed] [Carl and Dido]]]*
b. $[\![[c^2\ \textit{fed}]]\!]$ ($[\![$*Carl and Dido*$]\!]$) ($[\![$*Abe and Bert*$]\!]$)
= ** $[\![$*fed*$]\!]$ ($[\![$*Carl and Dido*$]\!]$) ($[\![$*Abe and Bert*$]\!]$)
$= 1$ iff $\exists x, x', y, y'\ (x \oplus x' = \text{Carl} \oplus \text{Dido} \wedge y \oplus y' = \text{Abe} \oplus \text{Bert} \wedge$
$^{**}[\![\ \textit{fed}]\!](x)(y)\ \wedge {}^{**}[\![\textit{fed}]\!](x')(y'))$

The assumption that cumulation operations are realised by actual morphemes C^n in the syntactic structure — rather than being (exclusively) a lexical property of predicates (as argued by Krifka (1986) a.o.) — is motivated by the observation by Beck & Sauerland (2000) that the predicate targeted by cumulation does not have to be a lexical element. Consider their example in (54): It has cumulative truth-conditions, namely, the sentence is true iff it is the case that 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.

(54) *The two women wanted to marry the two men.* (Beck & 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 (55) that has to undergo cumulation. However, none of the lexical elements in (54) corresponds to (55), nor any of the surface constituents.

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

Beck & Sauerland (2000) argue that (55) is syntactically derived by covert *tucking-in* movement, Richards 1997, resulting in (56), where C^2 is affixed to the constituent denoting (55).

(56) *[[the two women] [[the two men] [*C^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, which means they have 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.

3.1.3 Expanding the predicate analysis

If we want to derive the parallel behavior of predicate / sentential conjunctions and plural DPs by assuming that they denote the same kind of object — i.e., that conjunctions with conjuncts of type a denote pluralities from objects in D_a — then an obvious way to go would be to generalize the predicate analysis to all semantic domains. In Schmitt 2013, I provide such a generalization, with two ingredients: First, an expansion of the notion of plurality, which requires a cross-categorial notion of the sum operation (for expository purposes here simply indicated by "$\oplus$"), so that all semantic domains can be enriched by pluralities of their respective "atoms" (i.e., pluralities of predicates, propositions etc.). Conjunctions with conjuncts of any type can then be analyzed in analogy to Link's individual conjunctions: For instance, *dance and smoke* will denote the predicate sum $\lambda x_e.\text{smoke}(x) \oplus \lambda x_e.\text{dance}(x)$. Second, we must adapt our cumulation operators *, ** etc., so that they can apply to relations with different types of arguments: We define a cross-categorial version of ** (here also simply "**") that does not only modify relations between individuals, but also relations between individuals and predicates, etc.

Even without the actual definitions, it should be clear how such a proposal would work: Examples of the kind discussed in Section 2, like (57a), will now involve two plurality-denoting expressions: *Abe and Bert* will denote a plurality of individuals, and the VP-predicate conjunction *dance and smoke* a plurality of predicates. Accordingly, such sentences can be treated in analogy to (54) above: We syntactically derive an expression that denotes a relation of the adequate type — which, for (57a), will be a relation between predicates and individuals. This relation is affixed by (cross-categorial) C^2, as in (57b). Assuming that the cross-categorial cumulation operator ** preserves the essential traits of its individual counterpart, we obtain the truth-conditions in (57c): (57a) is correctly predicted to be true iff Abe and Bert each smoked or drank and at least one of them smoked and at least one of them danced.[16]

16 Because this proposal assumes that cumulative truth-conditions result from cumulation of a relation between the pluralities, and views all conjunctions as plurality-denoting, it avoids the problem of semantic locality for non-intersective theories of conjunction (see Section 2.3).

(57) a. *Abe and Bert smoked and danced.*

b. *[[Abe and Bert] [smoked and danced]* [C^2 *[2 [1 [t_1 t_2]]]]]*

c. $[\![(57a)]\!] = 1$ iff $\exists P', P'', x', x''$ $(P' \oplus P' = \lambda x.\text{smoked}(x) \oplus \lambda x.\text{danced}(x) \wedge x' \oplus x'' = \text{Abe} \oplus \text{Bert} \wedge (P')(x') = 1 \wedge P''(x'') = 1)$.

So why not simply spell out such a proposal? While my analysis in Section 4 will keep some of the insights (e.g., the cross-categorial notion of plurality), the next section will suggest that the assumptions it is built on — namely, those of the predicate analysis — are flawed. These flaws concern the predicate analysis as such and are independent of the expansion sketched here. Nevertheless, employing some of the concepts that I just introduced informally — in particular, viewing predicate conjunctions as denoting pluralities of predicates and employing generalized version of ** — will come in handy in illustrating these flaws. Thus, I ask the reader to use the intuitive notions I just sketched for the time being.

3.2 Why the predicate analysis is insufficient

Recall that the core idea of the predicate analysis is that cumulative truth-conditions result from cumulation operations like ** targeting relations between the respective pluralities. In cases where there is no adequate surface expression, the required relations are derived via (covert) syntactic operations. Accordingly, the predicate analysis predicts that the following should *not* exist: A sentence with cumulative truth-conditions, which contains no expression (be it derived or not) denoting the relation that needs to be cumulated. In the following, I show that this prediction is wrong. I identify two aspects of this problem. First, the *syntactic locality problem*: We find cumulative truth-conditions for sentences where deriving the adequate relation would violate independently attested constraints on LF-displacement. I consider this the weaker point against the predicate analysis. Even though a solution would seem *ad hoc*, I can at least see what it could look like: We would have to claim that syntactic constraints that are otherwise observable don't apply in the derivation of those relations that will serve as the input for cumulation operators. Second, the *plural projection problem*, which represents a far greater obstacle: Some sentences in which a plural DP is embedded in a predicate conjunction (e.g., *feed the two cats and brush Eric*) display cumulative truth-conditions for which it is simply impossible to (compositionally) derive the adequate input relation. In other words, even if we ignore all constraints on movement, we won't be able to derive a relation that, when cumulated, could give us the correct truth-conditions.

3.2.1 The syntactic locality problem for the predicate theory

Recall that (58), repeated from (54) above, was supposed to show that cumulativity can be a property of predicates derived by (covert) syntactic operations. The sentence has cumulative truth-conditions (see above) and the relation that must be cumulated, namely (59), is not expressed by a surface constituent.

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

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

As described above, Beck & Sauerland (2000) (henceforth B&S) argue that the input to ** is derived by covert tucking-in movement, so we obtain (60) as the structure for (58).

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

If the relation that forms the input to cumulation is derived by covert movement, it should be subject to the constraints independently attested for this operation — and this exactly is B&S's point: They argue that cumulative truth-conditions are only available if the derivation of the syntactic correlate of the relation obeys the constraints on covert movement.

B&S thus consider configurations where covert movement of quantifiers is blocked:[17] For instance, quantifiers occurring in finite embedded clauses cannot scope over a quantifier in the matrix (but see Reinhart (1997)): (61a) lacks the reading paraphrased in (61b).[18]

(61) a. *At least one lawyer pronounced that every proposal is against the law.*

17 See Schmitt 2013 for a discussion of the argument from English double-object constructions given by B&S.

18 It does not matter here whether covert movement of non-symmetric quantifiers across clause-boundaries is generally impossible (see e.g., Wurmbrand 2018 against such a view), since I only consider configurations where inverse scope is impossible and contrast them with analogous sentences that exhibit a cumulative construal.

b. For every proposal x, there is at least one lawyer y, s.th. y pronounced x to be against the law.

B&S predict that (62a) should lack the reading in (62b). This reading would result from cumulating the relation in (62c). However, this relation cannot be derived by covert movement of the object: Movement would have to cross a clause-boundary, but (61a) shows such covert movement to be impossible.

(62) a. *[$_A$ The two lawyers] have pronounced that [$_B$ the two proposals] are against the law.* (Beck & Sauerland 2000: (43b))

b. $\forall x \leq_{AT} [\![A]\!] \, (\exists y \leq_{AT} [\![B]\!] \, (x \text{ pronounced that } y \text{ is against the law})) \wedge$

$\forall y \leq_{AT} [\![A]\!] \, (\exists y \leq_{AT} [\![B]\!] \, (x \text{ pronounced that } y \text{ is against the law}))$

c. $\lambda y.\lambda x.x$ pronounced that y against the law

B & S argue that this prediction is correct. However, I contest their claim that cumulative construals are subject to the same constraints as QR. First, clause-boundedness does not generally block cumulative construals in configurations where it blocks inverse scope. The sentence in (62a) allegedly lacks the construal in (62b), but set within the context in (63), this construal is available — the sentence is true in the scenario given.

(63) 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 know Latin and Dr. Bert brought forth a motion excluding any student that didn't play the piano. Yesterday, there was a meeting with two lawyers, Dr. Kern, who specialises in the rights of faculty members, and Dr. Marten, the legal representative of the student body. Dr. Kern 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 their behavior.
Well, [$_S$ 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.

(64a) makes the same point: The sentence is true in a scenario where the Paris agency insists that Trump should call Macron and the Rome agency that he should call Matarella. Thus, it has a cumulative construal which would require the relation in (64b) to be the input for cumulation — and the syntactic derivation of this relation would involve the crossing of a clause-boundary.

(64) a. *Our two intelligence agencies called in. First, I spoke to the Paris agency, then to the one in Rome. I have no clue how to proceed now: [$_S$ The two agencies insisted that Trump should call the* {*two presidents / Macron and Matarella*}*, but I know that he won't talk to anyone but May.]*

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

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. Assuming a similar context as the one in (64a), the sentence in (65) is true in the scenario described right above (64). Accordingly it exhibits cumulative truth-conditions, which means the relation in (64b) must be cumulated. However, deriving this predicate syntactically would involve movement of the lower plural out of a topicalized clause (Ross 1967).

(65) *Well, the two agencies' plans for Trump were not as horrible as you make it sound. [$_S$ That he should call the two presidents, the agencies insisted], but neither of them said anything about a crisis meeting in the near future.*

Analogously, deriving the correct truth-conditions for the sentence in (66a) would mean that the lower plural would have to move out of an adjunct, the antecedent of the conditional: The sentence is true in the scenario given, thus the relation in (66b) would have to be cumulated.

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

All of this runs contrary to the B&S's point that predicates targeted by cumulation are derived by "standard" covert movement, but does not yet falsify the idea that the required predicate is derived by *some* known syntactic mechanism. In particular, indefinites can take scope in positions they cannot reach if the standard restrictions on movement applied (see e.g., Ruys 1992, Reinhart 1997, Winter 2001a). This is witnessed by the fact that (67a) has (67b) as one of its readings.

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

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

One could thus argue 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 in any position. However, Yoad Winter (pc) points out that this would predict that those plural expressions that resist 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 examples like (68) that while indefinites with bare numerals can take exceptional scope (just as *some building* in (67a)), those with modified numerals can't: According to Winter, (68) lacks the reading paraphrased below.

(68) *If exactly two people I know are John's parents then he is lucky.* (Winter 2001a: 108(105b))

\# There are exactly two people I know, such that if they are John's parents, he is lucky.

If exceptional scope taking is unavailable for modified numerals, but serves as the mechanism behind the cumulative construals of examples where a syntactic derivation of the relation would violate a syntactic island (e.g., (63) - (66)), then cumulative construals should be unavailable in those configurations if we replace the definite plural by a modified numeral. But (69a), where the lower plural is a modified numeral, is 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 (69b) — the derivation of which would involve movement out of a tensed clause.

(69) a. *My friend Abe is a historian, my friend Bert an archeologist. So when I consulted each of them about my research project on the Roman Empire, I expected lots of recommendations. The outcome*

was disappointing. [$_S$ They told me that I should read exactly two books]....and that was it! Abe said I should read SPQR *and Bert insisted I should get* Art and Archeology of Ancient Rome.

b. $\lambda x.\lambda y.y$ told me that I should read x

In summary, we find cumulative construals for sentences where the relation that should form the input to cumulation has to be derived syntactically. This derivation cannot generally be the result of covert movement, as in a number of cases movement would have to be out of syntactic islands. Furthermore, since some of the plural expressions that partake in these cumulative construals do not license exceptional scope-taking in other contexts, we cannot assume that the mechanism responsible for exceptional scope taking in other contexts is the one that derives us the required relation in the case of cumulative construals. Accordingly, if we wanted to maintain the predicate analysis, we would have to assume that the syntactic mechanism deriving us the required relation is unconstrained and thus differs from what we find in other constructions.

3.2.2 The plural projection problem for the predicate analysis

Even if we assume that the input-relations for cumulation are formed by unconstrained syntactic operations, the predicate analysis cannot account for what I call the *plural projection problem*.

The relevant configurations are those where one plural expression is contained within another one, as in the examples in (70b) and (71b). (This characterisation presupposes the extended view of "plural expression" introduced in Section 3.1.3.) (70b) is true in the scenario in (70a), and (71b) is true in the scenario in (71a). Generalizing over verifying scenarios, the truth-conditions of (70b) and (71b) are those informally paraphrased in (70c) and (71c).

(70) a. SCENARIO: Abe fed cat Carl. Bert fed cat Dido. Bert brushed golden retriever Eric. Neither Abe nor Bert fed hamster Harry.

b. *Abe and Bert fed the two cats and brushed Eric, but none of them took care of the poor hamster!*

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.

(71) 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 the two cats 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.

What seems to happen here, descriptively, is that the embedded plural expression ”projects” to the embedding plural expression. Put differently, the VP-conjunctions in (70b) and (71b) seem to preserve the part-structure of the embedded plurality denoted by *the two cats*: The sentence is true if each of Abe and Bert is in the relevant relation with at least one ”atomic part” of the predicate plurality in (72b) and *vice versa*.[19]

(72) a. *[feed [the two cats] and brush Eric]*

b. $\lambda x_e.x$ feed Carl $\oplus\ \lambda x_e.x$ feed Dido $\oplus\ \lambda x_e.x$ brush Eric

None of the proposals considered so far derives 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 (71b).

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 of conjunction discussed in Section 2.2. Recall that under this analysis, a conjunction of predicates P, Q has the denotation in (73a) — it 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 (73b), the conjunction in (70b) will have the denotation in (73c). If we apply this function to the subject's denotation, the sentence is correctly predicted to be true in our scenario in (70a) (just replace x' by A $\oplus$ B and x'' by B).

19 In other words, the VP-conjunction in (70b) and (71b), i.e., (72a), behaves like the VP-conjunction in (i) w.r.t. the cumulative truth-conditions observed above — that is, each member of the subject plurality has to be in the relevant relation with at least one of the conjuncts in (i) and *vice versa*).

(i) *[[feed Carl] and [feed Dido] and [brush Eric]]*

(73) a. $[\![P\ and\ Q]\!] = \lambda x_e.\exists x', x''(x' \oplus x'' = x \wedge P(x') \wedge Q(x''))$

b. *[Abe and Bert [[*C^2 *fed] the two cats and brushed E]]*

c. $\lambda x_e.\exists x', x''(x' \oplus x'' = x \wedge {}^{**}[\![\mathit{fed}]\!](x')([\![\mathit{the\ two\ cats}]\!]) \wedge x''$ 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 2.2.2 above, I showed this prediction to be false. By analogy, semantic locality prevents a general story for the examples under discussion: The sentence in (71b) is parallel to (70b) 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 (74) — the resulting truth-conditions are clearly too strong.

(74) a. $[\![(71b)]\!] = {}^*[\![\mathit{made}]\!]([\![\mathit{feed\ the\ two\ cats\ and\ brush\ E}]\!]\ (\mathrm{G}))\ (\mathrm{A} \oplus \mathrm{B}) =$
$= {}^*[\![\mathit{made}]\!](\lambda x_e.\exists x', x''(x' \oplus x'' = x\ \wedge$
${}^{**}[\![\mathit{feed}]\!](\mathrm{C}{\oplus}\mathrm{D})(x') \wedge x''$ brush E$)(\mathrm{G}))(\mathrm{A}{\oplus}\mathrm{B}) = {}^*[\![\mathit{made}]\!]($G feed C $\wedge$
G feed D, $\wedge$ G brush E$)(\mathrm{A} \oplus \mathrm{B})$

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? Even though I only sketched it informally, we can get an intuitive grasp of its predictions. Consider first the simpler sentence in (70b). The most plausible analysis on the basis of the predicate analysis starts off with the LF in (75a). This yields us the semantic derivation in (75b), which, in fact, delivers the correct truth-conditions (A⊕B cumulatively have the property expressed by the first conjunct, B the property expressed by the second conjunct).

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

b. $\lambda P_{\langle e,t\rangle}.\lambda x_e.\exists P', P'', x', x''\ (P' \oplus P'' = P\ \wedge\ x' \oplus x'' = x\ \wedge P'(x') \wedge P''(x''))$
$(\lambda y_e.y$ cumulatively fed C and D $\oplus\ \lambda y_e.y$ brushed E$)(\text{A} \oplus \text{B})$

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 (71b). At LF, the embedding plural expression moves to form an expression denoting a binary relation, (76a). The truth-conditions resulting from the (again simplified) derivation in (76b) are those paraphrased in (76c) and they turn out to be too strong — (71b) is incorrectly predicted false in the scenario in (71a).

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

b. $\lambda P_{\langle e,t\rangle}.\lambda x_e.\exists P', P'', x', x''\ (P' \oplus P'' = P \wedge x' \oplus x'' = x \wedge x'$ made G $P' \wedge x''$ made G $P'')(\lambda y_e.y$ cumulatively fed C and D $\oplus\ \lambda y_e.y$ brushed E$)(\text{A} \oplus \text{B})$

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.

Accordingly, the predicate analysis (and its expansion) breaks down in cases where one plural expression is embedded in another one: If we try to form a binary relation as the input for cumulation, we don't derive the correct truth-conditions. Moving all three plural expressions, namely *Abe and Bert*, the VP-conjunction and *the two cats* and thus forming a ternary relation which can be affixed by a ternary cumulation operator, won't be of much help, either: The VP-conjunction would contain an unbound trace. This is a general problem for any account that requires syntactically derived relations as the input for cumulation — and a problem for which there is no obvious solution.[20]

20 The event-based analyses mention in fn. 11 could in principle come to terms with examples like (71): In such analyses (see e.g., Lasersohn 1995, Landman 2000, Kratzer 2000) the embedded clause in (71) could be assumed to denote a plural event (consisting of subevents of Gina feeding Carl, Gina feeding Dido and Gina brushing Eric), which in turn would be the goal of an event that Abe and Bert are the cumulative agent of. However, in fn. 11 I concluded that such analyses do not offer a generalized account of the data discussed in this paper, as they cannot deal with the fact that we can form cumulative relations "across" attitude verbs.

3.3 Summary: The predicate analysis and its expansion

In the previous paragraphs I outlined the predicate analysis, which derives cumulative truth-conditions by enriching relations between pluralities: For any structure as in (77), 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. I then gave an informal sketch of how this analysis could be expanded to account for our data from Section 2: Conjunctions are taken to denote pluralities of the kind of objects their conjuncts denote and cumulation operators are generalized to relations between "higher-order" objects.

(77) $R(A)(B)$

I argued that the predicate analysis (and with it, its expansion) runs into two problems. Both concern the question of how exactly we obtain the relation R that forms the input to cumulation. On the one hand, forming the expression denoting R will often violate various constraints on syntactic movement that are observable otherwise (*syntactic locality problem*). Second, and more importantly, in some cases where one plural expression is embedded in another one, we cannot even identify an expression that would give us the right relation (i.e., a relation that we could cumulate in order to obtain the correct truth-conditions). This *plural projection problem* will be the point of departure for the analysis I propose in the following.

This argument can be expanded to the plural projection problem (see also Schmitt 2019): The sentence in (ib) is similar to examples like (71) above in that one plural expression (*the two cats*) is contained in another one (the VP-conjunction). Furthermore, the sentence is true in the scenario in (ia), so we are dealing with an instance of the plural projection problem. Yet, as opposed to the example in (71), the VP-conjunction occurs below an attitude verb (*believe*). Since event-based analyses fail whenever cumulation would have to "cross" such a predicate, they cannot derive the correct truth-conditions for the sentence in (ib).

(i) a. SCENARIO: Abe went on a trip and asked Gina to feed his cat Carl. Bert also went on a trip and and asked Gina to feed his cat Dido and brush his dog Harry. Both Abe and Bert believe that Gina did what they asked her to do.

b. *[$_S$ Abe and Bert believe Gina fed the two cats and brushed Eric] — but all she did was party all week long!*

4 An alternative proposal: Pluralities and plural projection

I now present an alternative analysis for conjunctions and plural composition which derives cumulative truth-conditions for the examples considered in Sections 2 and 3. Before I spell it out, I give an informal overview of its core properties.

As in Section 3.1.3 above, I will take the parallels between plural DPs and conjunctions at face value, assuming that all semantic domains contain *pluralities* (of the relevant kind of semantic objects) and that conjunctions with conjuncts of arbitrary type denote pluralities of the conjuncts' denotations. However, my analysis here will also involve a new proposal regarding how pluralities combine with their sisters and how to derive cumulative truth-conditions. More precisely, I just argued that the predicate analysis (and its expansion) is inadequate: The syntactic locality problem and in particular the plural 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. To see the point, recall the plural projection problem: The truth-conditions of a sentence like (78a) (repeated from (71b)) could be captured intuitively by assuming that Abe and Bert each are in the relevant relation (of making Gina do) with one of the "atomic parts" of the predicate plurality in (78b), and *vice versa*.

(78) a. *Abe and Bert made Gina feed the two cats and brush Eric.*
b. $\lambda x_e.x$ feed Carl $\oplus$ $\lambda x_e.x$ feed Dido $\oplus$ $\lambda x_e.x$ brush Eric

Again, I will take this intuition at face value, proposing a system in which embedding nodes reflect the part structure of embedded pluralities: 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. 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 when they combine with an argument we get a plurality of the values the function parts yield for that argument. I schematize this in (79), where f, g stand for functions that have a, b in their domains, and "$\oplus$" represents plurality-formation. Note that the semantic value of nodes immediately dominating a plurality will preserve the part-structure of that plurality.

(79)
$$\begin{array}{c} f(a) \oplus f(b) \\ \diagup \quad \diagdown \\ f \qquad a \oplus b \end{array} \qquad\qquad \begin{array}{c} f(a) \oplus g(a) \\ \diagup \quad \diagdown \\ f \oplus g \qquad a \end{array}$$

The general idea of projection is, of course, strongly reminiscent of the composition of alternative sets in different applications of Hamblin-style alternative semantics (see e.g., Rooth 1985 for focus, Simons 2005 for disjunctions). The difference to such systems will lie in how exactly projection is defined, that is, how 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. As a consequence, the actual implementation will be more complex than sketched in (79): For sentences with more than one plurality-denoting expression, like (80), working with mere pluralities will be insufficient, as (80) can be true in various ways: If Abe danced and Bert smoked, if Bert danced and Abe smoked, if both of them did both etc. Hence, the result of combining the function plurality (dance ⊕ smoke) with the argument plurality (Abe ⊕ Bert) cannot be a single value plurality. Rather, whenever one plurality combines with another one, we have more than one way of ”matching-up” the respective parts of one plurality with those of the other plurality.

(80) *Abe and Bert danced and smoked.*

To encode this, I add another level of complexity, *plural sets*. For any domain, these sets will contain pluralities of the respective domain. This will allow for a formulation of the projection rule that can encode cumulativity roughly as follows: Whenever a function-plurality combines with an argument-plurality, the result will be a *set* of value pluralities: Each element will be such that every ”atom” of the function plurality occurs at least once and every ”atom” of the argument plurality occurs at least once. This is sketched in (81).

(81)
$$\begin{array}{c} \{f(a) \oplus g(b), f(b) \oplus g(a), f(a) \oplus g(a) \oplus f(b), \ldots, f(a) \oplus g(a) \oplus f(b) \oplus g(b)\} \\ \diagup \quad \diagdown \\ f \oplus g \qquad a \oplus b \end{array}$$

The projection mechanism will apply at every node and the result will be a set of pluralities of propositions. I will assume that such a set is true iff at least one of its elements is such that all of its atomic parts are true.

We will end up with a surface-compositional system that derives cumulative truth-conditions in a step-by-step process, rather than forming a relation syntactically and affixing it with a cumulation operator. It derives the parallels between DP-plurals and conjunctions witnessed in Section 2 and all the data discussed in Section 3, which means it does not run into any of the problems of the theories considered so far.

4.1 Plural denotations

As a first step, I enrich the ontology by pluralities and sets thereof and then introduce the denotations of conjunctions. For the moment, I keep the system extensional, which means that I don't introduce any parametrization w.r.t. worlds or times.

4.1.1 Ontology

I assume that all well-formed expressions (LFs) are semantically categorized, that is, are assigned a logical type. Here I start off with the standard set of extensional types in (82).[21]

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

The ontology deviates from more traditional versions in that the set of possible denotations for every type a is expanded in two respects. As a first step, I add *pluralities* to each domain, generalizing our notion of plurality: The system does not only contain pluralities of individuals, but also pluralities of predicates, propositions etc. The proper definition is given in (83).[22] We start off with a set of atoms, for instance {Abe, Bert} for the domain of individuals, $\{\lambda x_e.x$ smoked, $\lambda x_e.x$ danced $\}$ for the domain of one-place predicates of individuals etc. We then add all possible sums of these atoms, which essentially means that we enrich the domain so that we get a one-to-one correspondence between elements of the domain and non-empty subsets thereof. Thus we obtain {Abe, Bert, Abe ⊕ Bert} as our enriched domain of individuals, $\{\lambda x_e.x$ smoked, $\lambda x_e.x$ danced, $\lambda x_e.x$ smoked $\oplus$ $\lambda x_e.x$ danced$\}$ as our enriched domain of one-place predicates of individuals etc. (See below

21 Introducing special types for plural expressions would be more elegant, but would add notational complexity.

22 I thank an anonymous reviewer, David Beaver and Nina Haslinger for suggestions on how to simplify my original version of this ontology.

for my use of ”⊕”.) This is parallel to what we did when we added pluralities to the individual domain — except that I now apply this expansion to any domain.

(83) Let A be the (nonempty) set of atomic individuals. For each type a, there is an atomic domain $\mathbf{A}_a$ and a plural domain $\mathbf{D}_a$ with the following properties:

a. $\mathbf{D}_a$ is a set s.th. $\mathbf{A}_a \subseteq \mathbf{D}_a$ and there is an operation $\bigoplus_a : \wp(\mathbf{D}_a)\backslash\{\varnothing\} \rightarrow \mathbf{D}_a$.

b. There is a function $pl_a : \wp(\mathbf{A}_a)\backslash\{\varnothing\} \rightarrow \mathbf{D}_a$ s.th.:

(i) $pl_a(\{x\}) = x$ for each $x \in \mathbf{A}_a$ and

(ii) pl_a is an isomorphism from $(\wp(\mathbf{A}_a)\backslash\{\varnothing\}, \bigcup)$ to $(\mathbf{D}_a, \bigoplus)$.

The second step is to expand the set of denotations for any type a even further. Apart from elements in $\mathbf{D}_a$, expressions of type a can also denote *plural sets*, namely elements of $\underline{\mathbf{D}}_a$, (84). This step deviates from a simple generalization of standard plural semantics to all semantic domains. As sketched above, we will need it to eventually encode cumulativity in the composition: The compositional rule will have to be able to express that whenever two pluralities combine with one another, there is more than one way of ”matching” the part of one plurality with the parts of the other plurality.[23] For reasons of simplicity, I here model $\underline{\mathbf{D}}_a$ as the power set of $\mathbf{D}_a$, so I will be careful to keep functional denotations and plural set denotations apart.[24]

(84) For any type a, there is a set $\underline{\mathbf{D}}_a = \wp(\mathbf{D}_a)$.

In (85), I introduce some notational conventions:

(85) a. I use $\underline{\mathbf{x}}, \underline{\mathbf{y}}, \underline{\mathbf{z}}$ for elements of $\underline{\mathbf{D}}_e$, $\underline{\mathbf{P}}, \underline{\mathbf{Q}}$ etc. for elements of $\underline{\mathbf{D}}_{\bar{e},t}$, and $\underline{\mathbf{p}}, \underline{\mathbf{q}}$ etc. for elements of $\underline{\mathbf{D}}_t$.
I use $\mathbf{x}$, $\mathbf{y}$, $\mathbf{z}$ for elements of $\mathbf{D}_e$, $\mathbf{P}$, $\mathbf{Q}$ etc. for elements of $\mathbf{D}_{\bar{e},t}$, and $\mathbf{p}$, $\mathbf{q}$ etc. for elements of $\mathbf{D}_t$.

b. **sums**: For any $\mathbf{X}, \mathbf{Y} \in \mathbf{D}_a, \mathbf{X} \oplus \mathbf{Y} = \bigoplus\{\mathbf{X}, \mathbf{Y}\}$.

23 Plural sets are also useful when dealing with indefinites: In Haslinger & Schmitt 2018 we combine the system outlined here with a Hamblin-style treatment of indefinites, as proposed by Kratzer & Shimoyama (2002).

24 Above, I try to avoid technical overload. (83) would have to include the condition that for any type $b \neq a$, $\mathbf{D}_a$ and $\mathbf{D}_b$ are disjoint. A proper definition of plural sets wouldn't make use of simple power sets but rather define a set disjoint from the power set via an isomorphism w.r.t. $\cap, \cup$ and $\setminus$. See Haslinger & Schmitt 2018.

c. **part-of**: For any $\mathbf{X}, \mathbf{Y} \in \mathbf{D}_a, \mathbf{X} \leq \mathbf{Y}$ iff $\mathbf{X} \oplus \mathbf{Y} = \mathbf{Y}$

d. **atomic-part-of**: For any $\mathbf{X}, \mathbf{Y} \in \mathbf{D}_a, \mathbf{X} \leq_{AT} \mathbf{Y}$ iff $\mathbf{X} \leq \mathbf{Y}$ and $\mathbf{X} \in \mathbf{A}_a$

For any domain, I will assume a trivial "shift" $\Uparrow_a$ that takes elements from $\mathbf{D}_a$ to $\underline{\mathbf{D}}_a$ by giving us the respective singleton. I omit it in the derivations below to keep them readable.[25]

Lexical meanings are assigned by the function $\mathscr{L}$, which maps any lexical element of primitive type a to an element in $\mathbf{D}_a$, and any lexical element of type $\langle a, b\rangle$ to elements in $\mathbf{D}_{\langle a,b\rangle} \cup \{f\colon \mathbf{D}_a \to \underline{\mathbf{D}}_b\} \cup \{f\colon \underline{\mathbf{D}}_a \to \underline{\mathbf{D}}_b\}$. I assume that all lexical elements that are assigned a denotation in $\mathbf{D}_a$ (for any type a) are immediately taken to a denotation in $\underline{\mathbf{D}}_a$ via $\Uparrow_a$, which means that they will always occur as (singleton) plural sets for the purposes of composition.

I introduce some simplifications for the sake of readability: Unless it could lead to confusion, I replace characteristic functions of individuals by upper-case words: " **CAT**" stands for an element of $\mathbf{D}_{\langle e,t\rangle}$, namely, "$\lambda x_e.x$ is a cat", " $\underline{\mathbf{CAT}}$" for an element of $\underline{\mathbf{D}}_{\langle e,t\rangle}$, namely "$\{\lambda x_e.x$ 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: If, for the object language sentence *Abe fed Carl* I write "**Abe fed Carl**" in the meta-language, this will stand for TRUE (1) iff Abe fed Carl and for FALSE (0) otherwise.

4.1.2 Denotations for conjunctions

We can now introduce plural denotations for conjunctions (see Section 5 for the treatment of definite plurals). 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 (86): 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 of the conjuncts' denotations to elements (i.e., pluralities) of the other. (87) gives some examples.

(86) $[\![and_{\langle a,\langle a,a\rangle\rangle}]\!] = \lambda \underline{\mathbf{X}}_a.\lambda \underline{\mathbf{Y}}_a.\{\mathbf{X}' \oplus \mathbf{Y}'\colon \mathbf{X}' \in \underline{\mathbf{X}}, \mathbf{Y}' \in \underline{\mathbf{Y}}\}$

(87) a. $[\![$*Abe and Bert*$]\!] = [\![and_{\langle e,\langle e,e\rangle\rangle}]\!]\,(\underline{\mathbf{Abe}})\,(\underline{\mathbf{Bert}}) = \{\mathbf{Abe} \oplus \mathbf{Bert}\}$

25 This means that for any type a, $\Uparrow_a = \lambda X \in \mathbf{D}_a.\{X\}$.

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

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

In order to show that we don't inadvertently collapse the meanings of conjunction and disjunction, (88) gives the meaning of *or*, for any type a. It takes the disjuncts' denotations (plural sets) and yields us their union. (89) gives some examples.

(88) $[\![or_{\langle a,\langle a,a\rangle\rangle}]\!] = \lambda\, \underline{\mathbf{X}}_a.\lambda \underline{\mathbf{Y}}_a.\underline{\mathbf{X}} \cup \underline{\mathbf{Y}}$

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

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 let plural sets combine with the other elements in the clause.

Let us first consider what happens with matrix-clause conjunction, namely cases like (87c). We end up with a plural set - but how do such plural sets map to 1 and 0, respectively? I assume that the singular morpheme SG, (90), attaches to any root node. In principle, we could encode homogeneity in this morpheme by including a version of the "all-or-nothing" presupposition proposed by Löbner (1987). This would derive the homogeneity effects discussed in Section 2.3. But as a proper treatment of homogeneity will have to be more complex, anyway (including its projection behavior, see e.g., Križ & Spector 2017), I here use a simpler version that does not encode homogeneity. It only states that a plural set of truth-values is true iff it contains at least one plurality that is reducible to 1 — i.e., that is such that all of its atomic parts are true.

(90) $[\![sg]\!] = \mathscr{T} = \lambda\, \mathbf{p}_t.\exists q \in\ \mathbf{p}\,(\forall q' \leq_{AT} q\,(q' = 1))$

The full derivation for a matrix-clause conjunction then looks like (91b): (91a) gives the LF with the singular morpheme attached to the highest node. We get TRUE if all of the conjuncts are true, and FALSE otherwise.

(91) a. [SG *Abe fed Carl and Bert fed Dido*]

b. $[\![(91a)]\!] = \mathscr{T}(\{\mathbf{Abe\ fed\ Carl} \oplus \mathbf{Bert\ fed\ Dido}\})$
$= 1$ iff $\mathbf{Abe\ fed\ Carl} = \mathbf{Bert\ fed\ Dido} = 1$

Just to make the contrast to disjunction clear, (92) gives a parallel structure with *or*. It will come out as true if at least one of the disjuncts is true, and as false otherwise.

(92) a. [SG *Abe fed Carl or Bert fed Dido*]
b. $[\![(92a)]\!] = \mathscr{T}(\{\textbf{Abe fed Carl}, \textbf{Bert fed Dido}\})$
$= 1$ iff **Abe fed Carl** $=1$ or **Bert fed Dido** $= 1$

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 all of the examples in (93) (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 (93c)—(93h). We must furthermore be able to deal with the lack of semantic locality (examples like (93e), (93g) and (93h)) the lack of syntactic locality, exemplified by (93h), and, crucially, the plural projection problem, illustrated by (93f) and (93g).

(93) a. *Abe and Bert smoked.*
b. *Abe smoke and drank.*
c. *Abe and Bert smoked and drank.*
d. *Abe and Bert fed Carl and Dido.*
e. *Abe and Bert made Gina smoke and drink.*
f. *Abe and Bert fed the two cats and brushed Eric.*
g. *Abe and Bert made Gina feed the two cats and brush Eric.*
h. *Abe and Bert claimed that Eric smoked and danced.*

I propose that there are two rules of composition: Functional application (FA), and a new rule of composition, cumulative combination (CC), (94).[26] What CC does, essentially, is that it will derive cumulative truth-conditions step-by-step. In particular, CC will apply whenever 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 $\mathscr{C}$, which is defined below and essentially encodes cumulation. $\underline{\mathbf{V}}$ will contain all those pluralities $\mathbf{v}$ s.th. there is an $\mathbf{f} \in \underline{\mathbf{F}}$ and an $\mathbf{x} \in \underline{\mathbf{x}}$ and

26 In the system outlined here, FA will essentially apply whenever a function takes a plural set as its argument, for instance in the case of conjunction. See Schmitt 2019 for more discussion of the distribution of FA and CC in the current system.

v is the sum of cumulatively applying atomic parts of **f** to atomic parts of **x**: For every atomic part of **f**, there must be an atomic part of **x** that it applies to, and for every atomic part of **x** there must be an atomic part of **f** that it is an argument of.

(94) **Cumulative combination (CC)**
If α is a branching node with daughters β, γ, where $[\![\beta]\!] \in \underline{\mathbf{D}}_{\langle a,b\rangle}$ and $[\![\gamma]\!] \in \underline{\mathbf{D}}_{a}$,
$[\![\alpha]\!] = [\![\beta]\!] \bullet [\![\gamma]\!] = \{\mathbf{C} \in \mathscr{C}([\![\beta]\!], [\![\gamma]\!])\}$
where, for any $\underline{\mathbf{X}} \in \underline{\mathbf{D}}_{\langle a,b\rangle}, \underline{\mathbf{Y}} \in \underline{\mathbf{D}}_{a}, \mathscr{C}(\underline{\mathbf{X}})(\underline{\mathbf{Y}}) : =$
$\{\mathbf{C} \in \mathbf{PL}_b : \exists \mathbf{X} \in \underline{\mathbf{X}}, \mathbf{Y} \in \underline{\mathbf{Y}} : \forall \mathbf{C}' \leq_{AT} \mathbf{C}\,(\exists \mathbf{X'} \leq_{AT} \mathbf{X}, \mathbf{Y}' \leq_{AT} \mathbf{Y} : \mathbf{C'} = \mathbf{X'(Y')} \wedge \forall \mathbf{X}' \leq_{AT} \mathbf{X}\,(\exists \mathbf{Y'} \leq_{AT} \mathbf{Y}, \mathbf{C'} \leq_{AT} \mathbf{C}\,(\mathbf{C}' = \mathbf{X'(Y')}))$
$\wedge\ \forall \mathbf{Y}' \leq_{AT} \mathbf{Y}\,(\exists \mathbf{X'} \leq_{AT} \mathbf{X}, \mathbf{C}' \leq_{AT} \mathbf{C}\,(\mathbf{C}' = \mathbf{X'(Y')})))\}$

The effect of this compositional rule will become clearer if we look at some of the simple examples from (93). Consider first (93a) and (93b), which each contain only one plural expression. Their derivations are given in (95a) and (95b). 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 (95a) if both of Abe and Bert smoked and false otherwise. (95b) is analogous: It is true if Abe both smoked and danced, and false otherwise.

(95) a. $[\![sg[A\ and\ B\ smoked]]\!] = [\![sg]\!]\,(\,[\![smoked]\!] \bullet [\![Abe\ and\ Bert]\!]\,) = \mathscr{T}(\{\mathbf{SMOKED}\} \bullet \{\mathbf{Abe} \oplus \mathbf{Bert}\}) = \mathscr{T}(\{\mathbf{Abe\ smoked} \oplus \mathbf{Bert\ smoked}\})$
b. $[\![sg[Abe\ smoked\ and\ danced]]\!] = [\![sg]\!]\,([\![smoked\ and\ danced]\!] \bullet [\![Abe]\!]) = \mathscr{T}(\{\mathbf{SMOKED} \oplus \mathbf{DANCED}\} \bullet \{\mathbf{Abe}\}) = \mathscr{T}(\{\mathbf{Abe\ smoked} \oplus \mathbf{Abe\ danced}\})$

For sentences with more than one plural expression, like (93c) — (93h), the sentence-level plural set will contain more than one plurality. The derivation for (93d) is given in (96a) and that for (93c) in (96b). Note that in (96b), the DP-plurality projects to what is, in fact, a plurality of intransitive predicates. Accordingly, both in (96a) and in (96b), 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 propositional pluralities reduces to TRUE. We therefore derive the correct, cumulative truth-conditions for (93c) and (93d). Crucially, we arrive at these truth-conditions without forming a relation syntactically that is then affixed by a cumulation operator (as the predicate analysis would have us do). Rather, these truth-conditions are the effect of the compositional rule CC, which applies directly, so to speak, at every node as soon as a plurality enters the derivation.[27]

(96) a. $[\![sg[\textit{A and B smoked and danced}]]\!] = [\![sg]\!]([\![\textit{smoked and danced}]\!] \bullet [\![\textit{A and B}]\!])$
$= \mathscr{T}(\{\textbf{SMOKED} \oplus \textbf{DANCED}\} \bullet \{\textbf{A} \oplus \textbf{B}\}) = \mathscr{T}(\{\textbf{A smoked} \oplus \textbf{B danced}, \textbf{B smoked} \oplus \textbf{A danced}, \textbf{B smoked} \oplus \textbf{B danced} \oplus \textbf{A danced}, \ldots\})$

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

What these examples already illustrate is our new uniform notion of plurality — predicate conjunctions are treated as (singleton sets of) predicate pluralities. We also apply the new composition rule, but so far, it doesn't have any interesting consequences. Those will only be visible once we consider examples with more than one plurality.

4.3 Application to more complex cases

The more complex examples in (93e) — (93h) each played a part in rejecting the various analyses discussed in Sections 2 and 3. I first discuss (93f), which is the simple case of the plural projection problem. (97) gives the relevant steps of the derivation (I 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

27 The system also extends to cases with more than two pluralities. For instance, we derive the correct cumulative truth-conditions for the sentence in (ia) that contains three plural expressions. The VP has the denotation in (ib) and the entire sentence that in (ic). Again, it will be true if one of elements of the plural set reduces to TRUE.

(i) a. *Abe and Bert introduced Carl and Dido to Eric and Ferdl.*

b. $[\![\textit{[Dido and Carl [introduced to Eric and Ferdl]]}]\!] = \{\textbf{INTRODUCE C TO E} \oplus \textbf{INTRODUCE D TO F}, \textbf{INTRODUCE D TO E} \oplus \textbf{INTRODUCE C TO F}, \ldots\}$

c. $[\![sg[\textit{Abe and Bert [Dido and Carl [introduced to Eric and Ferdl]]}]\!]$
$= \{\textbf{A introduced C to E} \oplus \textbf{B introduced D to F}, \textbf{B introduced C to E} \oplus \textbf{A introduced D to F}, \textbf{A introduced D to E} \oplus \textbf{B introduced C to F}, \textbf{B introduced D to E} \oplus \textbf{B introduced D to F}, \ldots\}$

containing a predicate plurality, (97b). Conjoining this set with the second conjunct gives us again a set containing a predicate plurality, (97c). Note that we capture the intuition from Section 3.2: The denotation of *fed the two cats and brushed Eric* reflects the part-structure of the embedded plurality (the VP-conjunction will end up being denotationally equivalent to *fed Carl and fed Dido and brushed Eric*). Combining this set with the subject yields (97d) and thus the correct truth-conditions.

(97) a. *Abe and Bert fed the two cats and brushed Eric.*
b. $[\![$*fed C and D*$]\!] = \{$ **FED C** $\oplus$ **FED D**$\}$
c. $[\![$*fed C and D and brushed Eric*$]\!] = \{$**FED C**$\oplus$**FED D**$\oplus$**BRUSHED E**$\}$
d. $\{$**A fed C**$\oplus$**B fed D**$\oplus$**B brushed E**, **A fed D**$\oplus$**B fed C**$\oplus$**B brushed E**, **B fed C**$\oplus$**B fed D**$\oplus$**A brushed E**, **B fed C**$\oplus$**A fed D**$\oplus$**A brushed E**, **B fed D**$\oplus$**A fed C**$\oplus$**A brushed E**, **A fed C**$\oplus$**A fed D**$\oplus$**B brushed E**, $\ldots\}$

For the other examples, our extensional system won't suffice. I here chose the most simple variant of world-parametrization: Type *s* is added to our set of types and the set *W* of all possible worlds to our semantic domains. All lexical elements are assigned functions from worlds to extensions in that respective world and I add the two rules in (98) on the combination of atomic elements of **D**, which essentially encode extensional and intensional functional application. This means that I don't have to worry with how world-parametrization affects our pluralities and plural sets — we will simply form pluralities of intensions and sets thereof, as sketched in (99). (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".[28]

28 This treatment is insufficient once we broaden our empirical scope, as examples like (ib) require us to rethink matters: (ib) is true in the scenario in (ia) and therefore displays a form of cumulativity — but crucially, both Berta's and Carl's belief is *de dicto* (see Pasternak 2018a,b, Schmitt 2019). These could be used as yet another argument against the predicate analysis (which would only yield a *de re* reading, unless we radically alter our view on expressions like *two monsters*, as proposed by Condoravdi, Crouch & van den Berg 2001 for a different data set). Nevertheless, the current system doesn't derive these facts either: Intuitively, *two monsters* seems to project up to a plurality of propositions cumulatively believed by Berta and Carl. This projection is not yet captured by the system (but see Schmitt 2019).

(i) a. SCENARIO Berta and Carl spent the 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 a griffin. A little later, Carl heard a sound in his

(98) a. For any $X \in \mathbf{A}_{\langle s\langle a,b\rangle\rangle}$, $Y \in \mathbf{A}_{\langle s,a\rangle}$, $X(Y) = \lambda w.X(w)(Y(w))$
b. For any $X \in \mathbf{A}_{\langle s\langle\langle sa\rangle b\rangle}$, $Y \in \mathbf{A}_{\langle s,a\rangle}$, $X(Y) = \lambda w.X(Y)(w)$

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

We can now turn to the more complex instance of the plural projection problem, (93g), which none of the previous analyses, nor any potential variation thereof, could derive. Again, I only give the relevant steps of the derivation in (100), and as it is of no consequence for my purposes, I make the simplifying assumption that *make* denotes a function which takes a propositional argument, for instance $\lambda w.\lambda p_{\langle s,t\rangle}.\lambda x_e.x$ does everything to make p true in w. (100b) shows the denotation of the VP-conjunction (it is identical to what we derived in (97)). (100c) gives the denotation of the embedded clause, a set containing a plurality of propositions. This projects to a set containing a plurality of predicates, (100d), and combining the latter with the denotation of the subject in (100e) yields us a set of propositions analogous to those in (97d). Hence, we derive the correct truth-conditions and solve the plural projection problem.

(100) 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**, … $\}$

Note that this example also shows why the syntactic locality problem won't surface in the current analysis: Once the projection mechanism starts, so

room, and took it to be caused by a zombie. In the morning, they each took Joe aside and told him what they believed was going on at his castle. Joe tells me: *I know that people find it a little spooky here, but guess what…*
b. *these idiots believed that two monsters (altogether) were roaming the castle!*

to speak, it will project up, step-by-step. This process is not impeded by syntactic boundaries as no movement is involved.

4.4 Interim summary

I just spelled out a new analysis for plural denotations and plural composition with three crucial features: (i) All semantic domains contain pluralities (actual pluralities and plural sets). There is thus no difference between a domain of primitives, like the domain of individuals, and a domain of complex objects, for instance that of functions from individuals to truth-values. (ii) Conjunctions with conjuncts of any semantic category are treated on a par with other plural expressions, denoting sets containing the sum of all the conjuncts' denotations. (iii) Cumulative truth-conditions are not due to the semantic enrichment of predicates by operators, but rather to a composition rule that lets pluralities project up to the nodes dominating them.

Let us re-consider what this system derives and where it is superior to previous proposals. First, it straightforwardly derives the parallels between DP-plurals and VP-predicate and propositional conjunctions that we observed in Section 2. Existing non-intersective analyses of conjunction also yield adequate results for simple cases like (101a), but fail in configurations lacking semantic locality, like (101b) and (101c) (see Section 2.2). The current theory, on the other hand, naturally extends to these examples, as it does not require semantic locality: The VP-conjunction in the embedded clause denotes a predicate plurality, which then projects up, step-by-step, until it reaches the matrix subject.

(101) a. *Abe and Bert smoked and danced.*
b. *Abe and Bert made Gina smoke and drink.*
c. *Abe and Bert claimed that Eric smoked and danced.*

While this shows that the current system does better than non-intersective theories of conjunction, it does not yet mean that the current system is the only option we have. In particular, we can also derive the correct truth-conditions by expanding the predicate analysis: This analysis assumes that cumulativity is the result of cumulating relations between pluralities. That is, we could introduce higher order pluralities and form the required relation by LF-movement: $\lambda P.\lambda x.x$ made Gina P for (101b), $\lambda P.\lambda x.x$ claimed that Eric P for (101c). These relations could then be affixed by the cumulation operator **. However, I argued that this cannot be a general strategy for dealing with cumulativity. On the one hand, we run into the syntactic locality problem, illustrated by (101c) (and discussed in Section 3.2): The formation of the required relation will sometimes have to violate constraints on covert movement (e.g., movement across a clause-boundary in (101c)). The current system does not run into this problem: As we don't form relations syntactically, we don't expect any locality effects in the first place. Still, this is not yet sufficient evidence that the current system is superior to the predicate analysis: We could assume an unconstrained version of the predicate analysis that simply assumes that movement (for purposes of cumulation) is unconstrained. This is where the plural projection problem comes in: I argued (again in Section 3.2) that no analysis based on forming relations syntactically can deal with sentences like (102), where one plurality-denoting expression is embedded in another one. None of the relations we could form by movement (even if this movement is unconstrained) will be an adequate input for cumulation. The current system, on the other hand, where the part-structure of embedded pluralities is preserved by the denotation of embedding nodes, and where cumulativity is derived in a step-by-step process, derives the right truth-conditions.

(102) *Abe and Bert made Gina feed the two cats and brushed Eric.*

5 Discussion and outlook

This paper made two main claims. First, the class of expressions denoting pluralities is much bigger than previously thought: Conjunctions with conjuncts of several semantic categories 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 point resulted from the observation that alternative theories — where predicate denotations are cumulated — face both syntactic and semantic problems.

Given the data presented in this paper, the new system fares better than any previous proposal. It should be clear, however, that it can only be the backbone of a theory of plurality and plural composition. Not only are there several potential applications that I have not investigated, the system in its present formulation also makes a number of wrong predictions.

Most crucially, pluralities don't always project in the sense described above. In the current version, any plural expression (plural DPs, conjunctions of any category, e.g., conjunctions of VP- AP- NP-, relative clause-predicates, CP-, IP-propositions, DP-individuals and DP-quantifiers) will start the projection process. In sentences with one plurality, this predicts a particular distributive reading: Each atom of our respective plurality should essentially combine with "the rest of the sentence" separately. This prediction is correct for sentences like *Abe smoked and danced*, but false for sentences with collective predicates, like (103), or also sentences like (104a), where an NP-conjunction occurs in the restrictor of a determiner. The sentence has the two readings in (104b) and (104c), but my account only derives the one in (104b).[29]

(103) *Abe compared "The Iliad" and "War and Peace".*

(104) a. *Ten [$_{PL}$ cats and dogs] attacked Abe.*
b. Ten cats and ten dogs attacked Abe. PREDICTED
c. A plurality of ten animals that consisted only of cats and dogs attacked Abe. NOT PREDICTED

What this shows is that the theory is still lacking a notion of elements that block plural projection, namely elements that "eat up" plural sets.[30] Collective predicates certainly fall into this class, but I submit that determiners — or, more generally, quantificational elements, also do. More precisely, I think we can come to terms with (at least one aspect of) the problem if we model such elements as directly taking plural sets as their arguments.

This could look roughly as follows. Consider first the definite determiner, which I haven't treated so far. (105a) states that it takes a plural set of predicates $\underline{\mathbf{P}}$ as its argument (which corresponds to its restrictor) and maps it to the singleton plural set containing the plural individual $\mathbf{x}$ of which the following holds: It is the maximal individual such that for each of its atomic parts $\mathbf{y}$ we find some atomic part of some predicate plurality in $\underline{\mathbf{P}}$ that is true

29 As noted in the literature, NP-conjunctions in the restrictor of determiners require additional assumptions in *all* existing accounts of conjunction (although the analyses differ w.r.t. which determiners cause the problems). See Bergmann 1982, Cooper 1983, Partee & Rooth 1983, Heycock & Zamparelli 2005, Champollion 2016 a.o.

30 This is another parallel to alternative semantics as in the treatment of focus.

of $\mathbf{y}$. (C' is essentially a weaker version of the cumulativity relation $\mathscr{C}$, except that it is a relation in $\mathbf{D} \times \underline{\mathbf{D}}$ and not in $\underline{\mathbf{D}} \times \underline{\mathbf{D}}$.) For illustration, consider the sentence in (105b). This sentence should come out as true in the following scenario: There are two cats, Carl and Dido, and two dogs, Harry and Ida. Carl and Harry attacked Abe. Dido and Ida attacked Bert. By means of (105a), we obtain the denotation in (105c) for the subject DP: A plural set containing the plurality consisting of all the individuals that are either a cat or a dog. Combining this result via our Cumulative Combination rule from Section 4 with the plural set of predicates denoted by *attacked Abe and Bert* gives us the plural set of propositions indicated in (105d). Accordingly, we derive the correct truth-conditions.

(105) a. $[\![the]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle}:\ \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\ \mathbf{x}_e:\ C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge \neg\exists \mathbf{y} > \mathbf{x}(C'(\mathbf{y})(\underline{\mathbf{P}}))\}$
where $C'(\mathbf{a})(\underline{\mathbf{P}})$ holds for any $\mathbf{a}, \underline{\mathbf{P}}$ iff for every atomic part **a'** of $\mathbf{a}$, there is a $\mathbf{Q} \in \underline{\mathbf{P}}$, such that there is a part of $\mathbf{Q}$ that holds of **a'**.

b. *The cats and dogs attacked Abe and Bert.*

c. $[\![$*the cats and dogs*$]\!] = \{$**Carl** $\oplus$ **Dido** $\oplus$ **Harry** $\oplus$ **Ida**$\}$

d. $[\![$*The cats and dogs attacked Abe and Bert*$]\!] =$
$\{$**C attacked A** $\oplus$ **D attacked A** $\oplus$ **H attacked A** $\oplus$ **I attacked B**,
C attacked A $\oplus$ **D attacked A** $\oplus$ **H attacked B** $\oplus$ **I attacked B**,
C attacked A $\oplus$ **D attacked B** $\oplus$ **H attacked A** $\oplus$ **I attacked B**, … $\}$

Upward-monotone determiners like *ten* could be treated analogously, for instance as in (106), in order to derive the reading in (104c): *ten cats and dogs* yields the set of all pluralities consisting of ten individuals that each are either a cat or a dog.

(106) $[\![ten]\!] = \lambda \underline{\mathbf{P}}_{\langle e,t\rangle}:\ \exists \mathbf{x}_e(C'(\mathbf{x})(\underline{\mathbf{P}})).\{\mathbf{x}_e:\ C'(\mathbf{x})(\underline{\mathbf{P}}) \wedge |x| = 10\}$

Accordingly, an adequate treatment of quantification will have to block plural projection from some positions under a quantifier and what I just sketched could be a first step in this direction. However, blocking projection is not the only feat an account of quantification must accomplish. It must also explain why conjunctions of quantifiers don't behave as predicted. More precisely, the current system predicts that as soon as we have two or more plurality-denoting expressions in a sentence (plural DPs or any kind of conjunction), we obtain cumulative truth-conditions. This prediction was correct for the data discussed in this paper, and I think it might even be correct as a general claim, but in the case of quantifier conjunction, the particular cumulative truth-conditions I predict aren't the (only) ones we observe. Consider for instance (107): In its current version, the theory views the conjunction as denoting a quantifier plurality. Accordingly, the cumulative reading it predicts is such that there is one hunter that shot every dog and one hunter that shot every cat and each hunter did at least one of the following: shoot every dog, shoot every cat. It does not capture the more prominent construal where the two hunters, between them, shot the smallest plurality of individuals containing all the dogs and all the cats.

(107) *The two hunters shot every dog and every cat in this village.*

This shows that we must rethink quantificational elements not only in terms of their first arguments (taking plural sets as their arguments and thus blocking plural projection from their restrictor), but also in terms of their values: Examples like (107) show that quantifiers partake in cumulative readings, but that the projecting plurality cannot simply be a quantifier plurality. We address some aspects of this problem in Haslinger & Schmitt 2018, but it is an open question which elements exactly block plural projection and whether this particular behavior is correlated with the unexpected construals of conjunction just witnessed.

A second major issue, briefly addressed in Haslinger & Schmitt 2017, concerns the compatibility of the proposal formulated here with systems that require *and* and *or* to act as alternatives at some level — such as most theories of scalar implicatures. As in any non-intersective analysis of conjunction, the meaning for *and* provided in this paper is too weak to derive the effects usually assumed to result from the lexical contrast between *and* and *or*, like the exclusive construal of *or* in non-downward entailing contexts. At this point, I cannot offer any solution and thus I must leave this matter to future research.

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