Cumulativity asymmetries and composition

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Problems with cumulation of syntactically derived predicates

(1) *The two women wanted to meet the two men.* (cf. Beck and Sauerland 2000)

Alternative system where cumulation is built into composition rules (Schmitt 2017)

This system allows us to analyse cumulativity asymmetries with items like *every* without using abstract LFs or event semantics

(2)  
  a. *Two girls fed every dog in this town.*
  b. *Every girl in this town fed two dogs.*

(3) *Two girls taught every dog two new tricks.* (Schein 1993)

Why this might be preferable to existing treatments of cumulative asymmetries
Today's talk

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2. Alternative system where cumulation is built into composition rules (Schmitt 2017)

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Why this might be preferable to existing treatments of cumulative asymmetries
1 A problem for standard accounts of cumulativity

2 Alternative: Cumulation as part of the composition

3 Cumulativity asymmetries: Data

4 Cumulativity asymmetries: Analysis
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Cumulativity asymmetries: Analysis
Sentences with two or more plural DPs can display cumulativity

(4)  a. *The two women* wanted to meet *the two men*.
    b. *Ada and Bea* wanted to meet *Carl and Dean*.

(5)  **true** scenarios
    a. Ada wants to meet Carl, Bea wants to meet Dean
    b. Ada wants to meet Dean, Bea wants to meet Carl
    c. Ada wants to meet Carl, Ada wants to meet Dean, Bea wants to meet Dean

(6)  **not true** scenarios
    a. Ada wants to meet Carl
    b. Ada wants to meet Carl, Ada wants to meet Dean

**Cumulative truth conditions**

Each of the two women wanted to meet at least one of the two men & for each of the two men, at least one of the two women wanted to meet him
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Each of the two women wanted to meet at least one of the two men & for each of the two men, at least one of the two women wanted to meet him
Cumulation operators

Operation \(\ast\) on binary relations: closure under pointwise sum

\[
\langle a, c \rangle, \langle b, d \rangle \mapsto \langle a + b, c + d \rangle
\]


(7) a. \( R = \{\langle Ada, Carl \rangle, \langle Bea, Dean \rangle, \langle Bea, Eric \rangle\} \)
    b. \( \ast R = \{\langle Ada, Carl \rangle, \langle Bea, Dean \rangle, \langle Ada + Bea, Carl + Dean \rangle, \langle Ada + Bea, Carl + Eric \rangle, \langle Bea, Dean + Eric \rangle, \langle Ada + Bea, Carl + Dean + Eric \rangle\} \)

Non-lexical cumulativity (Beck and Sauerland 2000)

(8) The two women wanted to meet the two men.

There is no lexical expression denoting \( R = [\lambda x.\lambda y. y \text{ wanted to meet } x] \).

(Expression denoting) \(\ast\) must be able to apply to predicates derived by LF-movement
Cumulation operators

Operation ** on binary relations: closure under pointwise sum
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(7) a. \( R = \{ (Ada, Carl), (Bea, Dean), (Bea, Eric) \} \)
    b. \( **R = \{ (Ada, Carl), (Bea, Dean), (Ada + Bea, Carl + Dean), \\
                    (Ada + Bea, Carl + Eric), (Bea, Dean + Eric), (Ada + Bea, Carl + Dean + Eric) \} \)

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Summary

- Sentences with two or more plurals have ‘weak’ – cumulative – truth-conditions
- These truth conditions are derived by an operation ** (***, etc.) that applies to a relation
- In cases of ‘non-lexical’ cumulation, the argument of ** must be derived by covert movement of plural-denoting expressions

Problem for this view: ‘Flattening effect’
Summary

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**Flattening effects: Background**

(9) The Georgian ambassador called this morning, the Russian one at noon. The ambassadors kept insisting that Trump must take a walk with Putin and build a golf club in Tbilisi, but neither addressed the Caucasian conflict!

(10) SCENARIO:
   a1 kept insisting that T must take a walk with Putin.
   a2 kept insisting that T must build a golf club in Tbilisi. (68) true

Predicate conjunctions behave like ‘pluralities’ of predicates

- They allow for cumulative readings. Link (1983), Krifka (1990)
- They allow for non-lexical cumulation. Schmitt (2013)

Informal notion of predicate pluralities and of ** as generalized cumulation. ** needs to apply to the relation:

(11) $R = \lambda Q_{(et)} \cdot \lambda x. x$ kept insisting that Trump must $Q$
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Flattening effects: The problem (1/2)

(12) **SCENARIO:** Ada made Gene feed her dog Carl, Bea made Gene feed her dog Dido and brush her cat Eric.

(13) Those rude girls gave a lot of chores to poor Gene. In fact . . .

*Ada and Bea made Gene [[feed the dogs]ₚ and [brush Eric]ₒ]* when all he wanted to do was take care of poor hamster Harry. true in (12) (Schmitt 2017)

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Flattening effect

Intuitively, we have cumulation between a+b and the following predicate plurality:

(14) feed Carl + feed Dido + brush Eric

So the cumulated relation appears to be binary even though we have three plural expressions.

For ** to apply, we would need an LF constituent denoting (14). But it’s unclear how to derive this!
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Flattening effect

Intuitively, we have cumulation between \( a + b \) and the following predicate plurality:

\[
(14) \quad \text{feed } Carl + \text{feed } Dido + \text{brush } Eric
\]

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Flattening effect

Intuitively, we have cumulation between \(a+b\) and the following predicate plurality:

(14) \text{feed Carl} + \text{feed Dido} + \text{brush Eric}

So the cumulated relation appears to be binary even though we have three plural expressions.

For ** to apply, we would need an LF constituent denoting (14). But it’s unclear how to derive this!
Flattening effects: The problem (2/2)

(15)  *Ada and Bea made Gene [[feed the dogs]₀ and [brush Eric]₀]*

(16)  **Scenario:** Ada made Gene feed her dog Carl, Bea made Gene feed her dog Dido and brush her cat Eric.

What could ** apply to? Two options (slightly simplified):

1. ** applies to R1, which takes the arguments a+b and c+d:

   (17)  \[ R₁ = \lambda x₀.\lambda y₀. y \text{ made Gene feed } x \text{ and brush Eric.} \]

   Wrong prediction: No cumulation with \( P+Q \) – (15) can only be true if each girl made Gene brush Eric.

   (15) predicted **false** in scenario (16)

2. ** applies to R2, which takes the arguments a+b and \( P+Q \):

   (18)  \[ R₂ = \lambda P_⟨et⟩.\lambda y₀. y \text{ made Gene } P. \]

   Wrong prediction: No cumulation with the dogs – (15) can only be true if some girl made Gene feed both Carl and Dido.

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Flattening effects: The problem (2/2)

(15)  Ada and Bea made Gene [[feed the dogs]_P and [brush Eric]_Q]

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What could ** apply to? Two options (slightly simplified):

1. ** applies to R1, which takes the arguments a+b and c+d:

   (17)  \[ R1 = \lambda x_e. \lambda y_e. y \text{ made Gene feed } x \text{ and brush Eric.} \]

   Wrong prediction: No cumulation with P+Q – (15) can only be true if each girl made Gene brush Eric.

   (15) predicted false in scenario (16)

2. ** applies to R2, which takes the arguments a+b and P+Q:

   (18)  \[ R2 = \lambda P_{(et)}. \lambda y_e. y \text{ made Gene } P. \]

   Wrong prediction: No cumulation with the dogs – (15) can only be true if some girl made Gene feed both Carl and Dido.

   (15) predicted false in scenario (16)
Flattening effects: The problem (2/2)

(15) \textit{Ada and Bea made Gene [\textit{feed the dogs}]_P and [\textit{brush Eric}]_Q.}

(16) \textsc{scenario}: Ada made Gene feed her dog Carl, Bea made Gene feed her dog Dido and brush her cat Eric.

What could \textbf{2} apply to? Two options (slightly simplified):

\textbf{1} ** applies to R1, which takes the arguments \(a+b\) and \(c+d\):

(17) \(R1 = \lambda x_e.\lambda y_e. y \text{ made Gene feed } x \text{ and brush Eric.}

Wrong prediction: No cumulation with \(P+Q\) – (15) can only be true if each girl made Gene brush Eric.

(15) predicted \textbf{false} in scenario (16)

\textbf{2} ** applies to R2, which takes the arguments \(a+b\) and \(P+Q\):

(18) \(R2 = \lambda P_{\langle et \rangle}. \lambda y_e. y \text{ made Gene } P.

Wrong prediction: No cumulation with \textit{the dogs} – (15) can only be true if some girl made Gene feed both Carl and Dido.

(15) predicted \textbf{false} in scenario (16)
Flattening effects: What went wrong?

(19) *Ada and Bea* made Gene [[feed the dogs]ₚ and [brush Eric]ₒ].

(20) **Scenario**: Ada made Gene feed her dog Carl, Bea made Gene feed her dog Dido and brush her cat Eric.

If cumulation requires LF-movement of the plural expressions, we can’t cumulate a+b with the predicate conjunction and the individual conjunction ‘simultaneously’, since the former syntactically contains the latter.

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Goal: Derive cumulative readings in a surface-compositional way.
Flattening effects: What went wrong?

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Goal: Derive cumulative readings in a surface-compositional way.
A problem for standard accounts of cumulativity

Alternative: Cumulation as part of the composition

Cumulativity asymmetries: Data

Cumulativity asymmetries: Analysis
The part structure of lower pluralities ‘projects’ up to higher pluralities (cf. focus projection / Hamblin sets)

(22)  

\[
\text{feed } \text{Carl and Dido} \\
\text{feed}(\text{carl}) + \text{feed}(\text{dido})
\]

\[
\text{feed}_{\langle e, \langle e, t \rangle \rangle} \quad \text{carl}_{e} + \text{dido}_{e}
\]

(23)  

\[
\text{feed and brush Dido} \\
\text{feed}(\text{dido}) + \text{brush}(\text{dido})
\]

\[
\text{feed}_{\langle e, \langle e, t \rangle \rangle} + \text{brush}_{\langle e, \langle e, t \rangle \rangle} \quad \text{dido}_{e}
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Crucial step: Cumulativity encoded in how lower pluralities project: Compositional rule
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\[(22) \quad \text{feed Carl and Dido} \]

\[
\begin{align*}
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\end{align*}
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\]

Crucial step: Cumulativity encoded in how lower pluralities project: Compositional rule
For this rule to be generalizable – one more level of complexity: Plural sets

(24) **feed and brush Carl and Dido**

\[
\{ \text{feed(carl)} + \text{brush(dido)}, \text{feed(dido)} + \text{brush(carl)}, \ldots \} \\
\{ \text{feed}_{e,(e,t)} + \text{brush}_{e,(e,t)} \} \quad \{ \text{carl}_e + \text{dido}_e \}
\]

Assumption: Carl, Dido and Eric are the only pets.

(25) **feed and brush two pets**

\[
\{ \text{feed(carl)} + \text{brush(dido)}, \text{feed(dido)} + \text{brush(carl)}, \text{feed(carl)} + \text{brush(eric)}, \text{feed(dido)} + \text{brush(eric)}, \ldots \} \\
\{ \text{feed}_{e,(e,t)} + \text{brush}_{e,(e,t)} \} \quad \{ \text{carl}_e + \text{dido}_e, \text{carl}_e + \text{eric}_e, \text{dido}_e + \text{eric}_e \}
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No syntactically derived predicates needed; in cases of non-lexical cumulation, the cumulation rule applies at every intervening node.
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(24)  \textit{feed and brush \textit{Carl} and \textit{Dido}}

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\{ \text{feed}_{e,\langle e,t \rangle} + \text{brush}_{e,\langle e,t \rangle} \} \quad \{ \text{carl}_e + \text{dido}_e \}
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Ontology, informally

Pluralities across semantic domains

- All domains $D_a$ contain both atoms and pluralities (i.e. we have pluralities of functions, truth-values etc.). Pluralities correspond to nonempty sets of atomic domain elements.
- For any type, an operation $+$ maps a set $S \subseteq D_a$ to its sum, a plurality in $D_a$.

\[ (26) \quad D_e = \{ \text{Ada, Bea, Ada+Bea} \} , \]
\[ D_{(e,t)} = \{ \lambda x.\text{smoke}(x), \lambda x.\text{dance}(x), \lambda x.\text{smoke}(x) + \lambda x.\text{dance}(x) \ldots \} \]

Plural sets across semantic domains

- For every type $a$, we also have a type $a^*$ of ‘plural sets’ with elements from $D_a$.
- The domain $D_a^*$ is disjoint from $\varphi(D_a)$, but has the same algebraic structure.

\[ (27) \quad \text{notation: } [a, b, \ldots] \text{ plural set corresponding to } \{a, b, \ldots\} \]
\[ (28) \quad D_e^* = \{ [ ], [\text{Ada}], [\text{Bea}], [\text{Ada+Bea}], [\text{Ada, Bea}], [\text{Ada, Ada+Bea}], [\text{Bea, Ada+Bea}], [\text{Ada, Bea, Ada+Bea}] \} \]
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Ontology, informally

Pluralities across semantic domains

- All domains $D_a$ contain both atoms and pluralities (i.e. we have pluralities of functions, truth-values etc.). Pluralities correspond to nonempty sets of atomic domain elements.
- For any type, an operation $+$ maps a set $S \subseteq D_a$ to its sum, a plurality in $D_a$.

(26) $D_e = \{ \text{Ada, Bea, Ada+Bea} \}$, $D_{(e,t)} = \{ \lambda x.\text{smoke}(x), \lambda x.\text{dance}(x), \lambda x.\text{smoke}(x) + \lambda x.\text{dance}(x) \ldots \}$

Plural sets across semantic domains

- For every type $a$, we also have a type $a^*$ of ‘plural sets’ with elements from $D_a$.
- The domain $D_a^*$ is disjoint from $\wp(D_a)$, but has the same algebraic structure.

(27) notation: $[a, b, \ldots]$ plural set corresponding to $\{a, b, \ldots\}$
(28) $D_e^* = \{ [\ ], [\text{Ada}], [\text{Bea}], [\text{Ada+Bea}], [\text{Ada, Bea}], [\text{Ada, Ada+Bea}], [\text{Bea, Ada+Bea}], [\text{Ada, Bea, Ada+Bea}] \}$
Informally, a cover of \((P, x)\) is a relation between atomic parts of \(P\) and atomic parts of \(x\) in which each atomic part of \(P\) and each atomic part of \(x\) occurs at least once.

\[(29)\quad P = \text{smoke} + \text{dance}, \quad x = \text{Abe} + \text{Bea}\]

a. \(\{\langle \text{smoke}, \text{Abe} \rangle, \langle \text{dance}, \text{Bea} \rangle\}\)
b. \(\{\langle \text{smoke}, \text{Bea} \rangle, \langle \text{dance}, \text{Abe} \rangle\}\)
c. \(\{\langle \text{smoke}, \text{Bea} \rangle, \langle \text{dance}, \text{Abe} \rangle, \langle \text{dance}, \text{Bea} \rangle\}\) . . .

Intuition: Cumulative truth conditions wrt. pluralities \(P, x\) and relation \(R \approx\) there is some cover such that for each pair \((P', x')\) in the cover, \(R(P', x')\) holds.
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- a. \(\{\langle \text{smoke, Abe} \rangle, \langle \text{dance, Bea} \rangle\}\)
- b. \(\{\langle \text{smoke, Bea} \rangle, \langle \text{dance, Abe} \rangle\}\)
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Deriving cumulation: The operation \( C \)

- It takes two plural sets \( P_{\langle a,b \rangle}^* \) and \( x_a^* \) and gives us another plural set.
- Essentially, we take all covers of some plurality from \( P_{\langle a,b \rangle}^* \) and some plurality from \( x_a^* \).
- For each cover \( R \), we take the sum of the set \( \{ P(x) \mid (P, x) \in R \} \).

(30) a. Two girls are smoking and dancing.
b. Assumption: The only girls are A, B and C.

(31) Covers: \{⟨\text{smoke}, B⟩, ⟨\text{dance}, A⟩\}, \{⟨\text{smoke}, A⟩, ⟨\text{dance}, B⟩\}, 
{⟨\text{smoke}, C⟩, ⟨\text{dance}, A⟩}, \{⟨\text{smoke}, A⟩, ⟨\text{dance}, C⟩\}, \{⟨\text{smoke}, B⟩, ⟨\text{dance}, C⟩\},
{⟨\text{smoke}, C⟩, ⟨\text{dance}, B⟩}, \ldots

(32) \( C([\text{smoke+dance}]) ([\text{A+B, A+C, B+C}]) = [\text{smoke(B)+dance(A)}, \text{smoke(A)+dance(B)}, \text{smoke(C)+dance(A)}, \text{smoke(A)+dance(C)}, \text{smoke(B)+dance(C)}, \text{smoke(C)+dance(B)}, \ldots] \)
Deriving cumulation: The operation $C$

- It takes two plural sets $P_{(a,b)}^*$ and $x_{a^*}$ and gives us another plural set.
- Essentially, we take all covers of some plurality from $P_{(a,b)}^*$ and some plurality from $x_{a^*}$.
- For each cover $R$, we take the sum of the set $\{P(x) \mid (P, x) \in R\}$.

(30)  
\begin{enumerate}
  \item Two girls are smoking and dancing.
  \item Assumption: The only girls are A, B and C.
\end{enumerate}

(31)  
Covers: \{\langle smoke, B \rangle, \langle dance, A \rangle\}, \{\langle smoke, A \rangle, \langle dance, B \rangle\},
\{\langle smoke, C \rangle, \langle dance, A \rangle\}, \{\langle smoke, A \rangle, \langle dance, C \rangle\}, \{\langle smoke, B \rangle, \langle dance, C \rangle\},
\{\langle smoke, C \rangle, \langle dance, B \rangle\}, \ldots

(32)  
$C([\text{smoke+dance}]) ([A+B, A+C, B+C]) = [\text{smoke}(B)+\text{dance}(A),
\text{smoke}(A)+\text{dance}(B), \text{smoke}(C)+\text{dance}(A), \text{smoke}(A)+\text{dance}(C),
\text{smoke}(B)+\text{dance}(C), \text{smoke}(C)+\text{dance}(B), \ldots]$
Cumulative composition (2/4)

Deriving cumulation: The operation \( C \)

- It takes two plural sets \( P^*_{\langle a, b \rangle} \) and \( x^*_a \) and gives us another plural set.
- Essentially, we take all covers of some plurality from \( P^*_{\langle a, b \rangle} \) and some plurality from \( x^*_a \).
- For each cover \( R \), we take the sum of the set \( \{P(x) \mid (P, x) \in R \} \).

(30)

a. Two girls are smoking and dancing.

b. Assumption: The only girls are \( A, B \) and \( C \).

(31) Covers: \{⟨smoke, B⟩, ⟨dance, A⟩⟩, {⟨smoke, A⟩, ⟨dance, B⟩⟩, 
{⟨smoke, C⟩, ⟨dance, A⟩⟩, {⟨smoke, A⟩, ⟨dance, C⟩⟩, {⟨smoke, B⟩, ⟨dance, C⟩⟩, 
{⟨smoke, C⟩, ⟨dance, B⟩⟩, . . .

(32) \( C([\text{smoke+dance}]) ([A+B, A+C, B+C]) = [\text{smoke}(B)+\text{dance}(A), \text{smoke}(A)+\text{dance}(B), \text{smoke}(C)+\text{dance}(A), \text{smoke}(A)+\text{dance}(C), \text{smoke}(B)+\text{dance}(C), \text{smoke}(C)+\text{dance}(B), . . .] \)
Deriving cumulation: The operation $C$

- It takes two plural sets $P_{\langle a,b \rangle}^*$ and $x_a^*$ and gives us another plural set.
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(30)  
  a. Two girls are smoking and dancing.  
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(31)  
  Covers: $\{\langle$smoke, $B\rangle, \langle$dance, $A\rangle\}$, $\{\langle$smoke, $A\rangle, \langle$dance, $B\rangle\}$,  
        $\{\langle$smoke, $C\rangle, \langle$dance, $A\rangle\}$, $\{\langle$smoke, $A\rangle, \langle$dance, $C\rangle\}$, $\{\langle$smoke, $B\rangle, \langle$dance, $C\rangle\}$,  
        $\{\langle$smoke, $C\rangle, \langle$dance, $B\rangle\}$, $\ldots$

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  $C([\text{smoke+dance}]) ([A+B, A+C, B+C]) = [\text{smoke}(B)+\text{dance}(A),  
                         \text{smoke}(A)+\text{dance}(B), \text{smoke}(C)+\text{dance}(A), \text{smoke}(A)+\text{dance}(C),  
                         \text{smoke}(B)+\text{dance}(C), \text{smoke}(C)+\text{dance}(B), \ldots]$
The ‘sum’ operation used by $C$ works differently for plural sets (this is needed later for distributive conjunction).

**Recursive sum**

Cross-categorial operation $\oplus$.

- Equivalent to normal sum $+$ except for plural sets
- Exception: Recursive sum of plural sets. The resulting plural set contains sums formed by choosing an element from each plural set and summing up all of the chosen elements.

\[(33) \quad \oplus (\{ [Ada, Bea], [Carl+Dido] \}) = [Ada+Carl+Dido, Bea+Carl+Dido]\]

- In the case of nested plural sets, this is done ‘recursively’.
The operation $C$ is available as a compositional rule in addition to functional application.

(34) 

\[ C(P, x) \]

\[ b^* \]

\[ P \]

\[ x \]

\[ \langle a, b \rangle^* \]

\[ a^* \]

A plural set $S$ of propositions is true iff $S$ contains at least one element $p$, s.th. all atomic parts $p'$ of $p$ are true.
The operation $C$ is available as a compositional rule in addition to functional application.

\[(34)\]

\[
\begin{array}{c}
C(P, x) \\
\quad b^* \\
\quad P \\
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\end{array}
\]

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DP semantics

We employ some ‘trivial’ type shifts between domains $D_a$ and $D_a^*$ that we don’t indicate here.

### Plural definites and indefinites

... denote plural sets of type $e^*$ (singleton in the case of definites)

\[
\text{(35)} \quad [\text{the girls}] = [\text{Ada} + \text{Bea}] \quad \text{(if Ada and Bea are the only girls)}
\]

\[
\text{(36)} \quad [\text{two pets}] = [\text{Carl} + \text{Dido}, \text{Carl} + \text{Eric}, \text{Dido} + \text{Eric}] \quad \text{(if Carl, Dido and Eric are the only pets)}
\]

### Conjunction expresses the ‘recursive sum’ $\oplus$

\[
\text{(37)} \quad \begin{align*}
\text{a.} \quad \text{For any type } a: [\text{AND}_{a(aa)}] &= \lambda x_a. \lambda y_a. x \oplus_a y \\
\text{b.} \quad [\text{Ada and two pets}] &= [\text{Ada}] \oplus [\text{Carl} + \text{Dido}, \text{Carl} + \text{Eric}, \text{Dido} + \text{Eric}] \\
&= [\text{Ada} + \text{Carl} + \text{Dido}, \text{Ada} + \text{Carl} + \text{Eric}, \text{Ada} + \text{Dido} + \text{Eric}]
\end{align*}
\]
We employ some ‘trivial’ type shifts between domains $D_a$ and $D_{a^*}$ that we don’t indicate here.

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\[(37) \quad \text{a. For any type } a: [\text{AND}_{a(aa)}] = x_a.\lambda y_a.x \oplus_a y\]

\[(\text{b. } [\text{Ada and two pets}] = [\text{Ada}] \oplus [\text{Carl}+\text{Dido}, \text{Carl}+\text{Eric}, \text{Dido}+\text{Eric}] = [\text{Ada}+\text{Carl}+\text{Dido}, \text{Ada}+\text{Carl}+\text{Eric}, \text{Ada}+\text{Dido}+\text{Eric}]\]
We employ some ‘trivial’ type shifts between domains $D_a$ and $D_a^*$ that we don’t indicate here.

### Plural definites and indefinites

...denote plural sets of type $e^*$ (singleton in the case of definites)

(35) $[\text{the girls}] = [\text{Ada}+\text{Bea}]$  
     (if Ada and Bea are the only girls)

(36) $[\text{two pets}] = [\text{Carl}+\text{Dido}, \text{Carl}+\text{Eric}, \text{Dido}+\text{Eric}]$  
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### Conjunction expresses the ‘recursive sum’ $\oplus$

(37) a. For any type $a$: $[\text{AND}_{a\langle aa\rangle}] = \lambda x.\lambda y.x \oplus a y$

b. $[\text{Ada and two pets}] = [\text{Ada}] \oplus [\text{Carl}+\text{Dido}, \text{Carl}+\text{Eric}, \text{Dido}+\text{Eric}]$
   = $[\text{Ada}+\text{Carl}+\text{Dido}, \text{Ada}+\text{Carl}+\text{Eric}, \text{Ada}+\text{Dido}+\text{Eric}]$
Deriving the flattening effect

(38) Ada and Bea made Gene [[feed the dogs]_P and [brush Eric]_Q]

(39) [A made G feed C+A made G feed D+B made G brush E, 
A made G feed C+B made G feed D+B made G brush E, ...]

(40) Scenario: Ada made Gene feed her dog Carl, Bea made Gene feed her dog Dido and brush her cat Eric.
Interim summary

- Semantic plurality ‘projects’ by means of a cross-categorial operation $C$ which also encodes cumulativity.
- Operators like $\star\star$ are not needed in the syntax: In the case of non-lexical cumulation $C$ applies at every intervening node.
- This is made possible by assuming pluralities and plural sets of any semantic type.
- Unlike earlier approaches to cumulativity, the present theory naturally accounts for the flattening effect.
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1. A problem for standard accounts of cumulativity

2. Alternative: Cumulation as part of the composition

3. Cumulativity asymmetries: Data

4. Cumulativity asymmetries: Analysis
Cumulativity asymmetries

Since the present system does not require additional LF movement of plural expressions, it can account for interactions between cumulativity and scope.

Indeed, we find such interactions in several languages!

Distributive items

1. always have a distributive reading wrt. semantically plural expressions in their scope
2. allow for cumulative readings if they occur in the scope of a semantically plural expression
3. give rise to flattening effects: the part structure of a plurality in their scope remains accessible for cumulation with a higher plurality

Examples: singular universal quantifiers – English every NP, German jed- NP, German sowohl A als auch B ‘A as well as B’
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Distributive items: English every

• distributive reading wrt. lower plural expressions

(41)  **Every copy-editor** found two mistakes in the manuscript.  
true in scenario (42-a), false in scenario (42-b)

(42)  copy-editors: c1, c2 mistakes: m1, m2
   a.  c1 found m1, m2. c2 found m1, m2.
   b.  c1 found m1. c2 found m2.  

• cumulative reading possible wrt. higher plural expressions

(43)  (The) two copy-editors found every mistake in the manuscript.  
true in scenario (44-a), true in scenario (44-b) Schein (1993), Kratzer (2000)

Note: Champollion (2010) argues that scope, rather than thematic roles, determines the availability of a cumulative reading in English (contra Kratzer 2000).
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  a. c1 found m1, m2. c2 found m1, m2. (**41** true)
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Distributive items: English *every*

- gives rise to flattening effects

(44) *Ada and Bea taught every dog two new tricks.* adapted from Schein (1993)

Cumulative reading ‘weaker’ than expected (Schein 1993)

(45) **SCENARIO**
There are two dogs, Carl and Dido.
Ada taught Carl trick 1 &
Ada taught Carl trick 2 &
Ada taught Dido trick 3 &
Bea taught Dido trick 2

(49) true

**Flattening effect for distributive items**

- Binary cumulation between *Ada and Bea* and *every dog* too strong: would require that for some dog $x$, Bea taught $x$ two tricks.
- Binary cumulation between *Ada and Bea* and *two tricks* too strong: would require that the tricks are the same for each dog.
- Cumulation of 3-ary predicate too weak: does not require two tricks per dog.
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Distributive items: German sowohl . . . als auch

For some speakers of German, the distributive conjunction sowohl A als auch B shows the same contrast.

(46) scenario: There were two skiing World Cup races this weekend. Hans competed in the downhill race and won it. Peter competed in the slalom and won it. Oddly enough, they are the only two Austrians participating this weekend.

(47) a. Zum Glück haben sowohl der Hans als auch der Peter die zwei Rennen gewonnen!
‘Fortunately, Hans as well as Peter won the two races.’ not true in scenario (46)

(48) a. Zum Glück haben die zwei Österreicher sowohl die Abfahrt als auch den Slalom gewonnen!
‘Fortunately, the two Austrians won the downhill race as well as the slalom.’ true in scenario (46)
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- Universal quantifiers: English every NP, German jed- NP
- German sowohl ... als auch
- Distributive conjunctions seem to show cumulativity asymmetries (subject vs. object) in other languages (more research needed!):
  - Hungarian A is és B is
  - Polish i A i B

- Cross-linguistic variation: With Italian ogni the asymmetry seems to be based on grammatical function and information structure, not scope (Flor 2017)

We have to account for a general pattern!
Distributive items

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- Distributive conjunctions seem to show cumulativity asymmetries (subject vs. object) in other languages (more research needed!):
  - Hungarian A is és B is
  - Polish i A i B
- Cross-linguistic variation: With Italian ogni the asymmetry seems to be based on grammatical function and information structure, not scope (Flor 2017)

We have to account for a general pattern!
Distributive items

1. always have a distributive reading wrt. semantically plural expressions in their scope
2. allow for cumulative readings if they occur in the scope of a semantically plural expression
3. give rise to a ‘flattening effect’ if they are cumulative wrt. higher and distributive wrt. lower expressions simultaneously

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We have to account for a general pattern!
1. A problem for standard accounts of cumulativity

2. Alternative: Cumulation as part of the composition

3. Cumulativity asymmetries: Data

4. Cumulativity asymmetries: Analysis
Flattening effect with distributive items

(49)  *Ada and Bea taught every dog two new tricks.*

(50)  **SCENARIO**

There are two dogs, Carl and Dido.

*Ada taught Carl trick 1 &
Ada taught Carl trick 2 &
Ada taught Dido trick 3 &
Bea taught Dido trick 2*

Informally, *Ada and Bea* must be in a cumulative relation with one of the elements of the following set:

(51)  \{ taught C trick 1 + taught C trick 2 + taught D trick 1 + taught D trick 2, \\
      taught C trick 1 + taught C trick 2 + taught D trick 2 + taught D trick 3, \\
      taught C trick 3 + taught C trick 2 + taught D trick 1 + taught D trick 2, \ldots \} \\

We want predicate pluralities that ‘cover’ every dog and assign two tricks to every dog. Which lexical entry for *every* will give us this set?
Flattening effect with distributive items

(49)  \textit{Ada and Bea taught every dog two new tricks.}

(50)  \textbf{SCENARIO}

There are two dogs, Carl and Dido.
Ada taught Carl trick 1 &
Ada taught Carl trick 2 &
Ada taught Dido trick 3 &
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Informally, \textit{Ada and Bea} must be in a cumulative relation with one of the elements of the following set:

(51)  \{ taught C trick 1 + taught C trick 2 + taught D trick 1 + taught D trick 2, taught C trick 1 + taught C trick 2 + taught D trick 2 + taught D trick 3, taught C trick 3 + taught C trick 2 + taught D trick 1 + taught D trick 2, \ldots \}

We want predicate pluralities that ‘cover’ every dog and assign two tricks to every dog. Which lexical entry for \textit{every} will give us this set?
Flattening effect with distributive items

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We want predicate pluralities that ‘cover’ every dog and assign two tricks to every dog. Which lexical entry for *every* will give us this set?
Semantics of *every/jeder*

**every NP, informally**

- Denotes a function of type $\langle\langle e, a\rangle^*, a^*\rangle$, i.e. it directly manipulates plural sets of predicates.
- For every atomic individual $x$ in the NP extension, we choose one predicate-plurality $P$ from the set, apply each $P' \leq_a P$ to $x$ and take the sum (i.e. $P$ applies ‘distributively’ to $x$)
- For each such assignment of predicate-pluralities, we take the sum over all individuals

**every NP, more formally**

- for any $P_{\langle e, a \rangle}$, $x_a : D(P, x) = +(|Q(x) : Q$ is an atomic part of $P|)$
- for any $P_{\langle e, t \rangle}^* : \mathcal{A}(P^*) = \{x_e | \exists P \in P^*. \exists Q \leq P.Q(x)\}$ (all individuals satisfying some part of some predicate in the plural set $P^*$)
- $[\text{every}] = \lambda P_{\langle e, t \rangle}^*. \lambda R_{\langle e, a \rangle}^*. [+\{D(f(x), x) | x \in \mathcal{A}(P^*)\}] \ |f$ is a function from $\mathcal{A}(P^*)$ to $R^*\]$
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- for any $P_{(a,b)}$, $x_a : D(P, x) = +\{Q(x) : Q$ is an atomic part of $P\}$
- for any $P^*_{(e,t)} : \mathcal{A}(P^*) = \{x_e | \exists P \in P^*. \exists Q \leq P.Q(x)\}$ (all individuals satisfying some part of some predicate in the plural set $P^*$)
- $[\text{every}] = \lambda P_{(e,t)}^*. \lambda R_{(e,a)}^*. [+(D(f(x), x) | x \in \mathcal{A}(P^*))] | f$ is a function from $\mathcal{A}(P^*)$ to $R^*]$
Assume that A and B are the only girls.

(52) \[[\text{every girl}]\left([\text{smoke}]\right) = [\text{smoke}(A) + \text{smoke}(B)]\]

(53) \[[\text{every girl}]\left([\text{smoke+drink}]\right) = [\text{smoke}(A) + \text{drink}(A) + \text{smoke}(B) + \text{drink}(B)]\]

(54) \[[\text{every girl}]\left([\text{smoke+drink, dance}]\right) = [\text{smoke}(A) + \text{drink}(A) + \text{smoke}(B) + \text{drink}(B), \text{dance}(A) + \text{smoke}(B) + \text{drink}(B), \text{dance}(B) + \text{smoke}(A) + \text{drink}(A), \text{dance}(A) + \text{dance}(B)]\]
Assume that \( A \) and \( B \) are the only girls.

(52) \[ [\text{every girl}] ([\text{smoke}]) = [\text{smoke}(A) + \text{smoke}(B)] \]

(53) \[ [\text{every girl}] ([\text{smoke} + \text{drink}]) = [\text{smoke}(A) + \text{drink}(A) + \text{smoke}(B) + \text{drink}(B)] \]

(54) \[ [\text{every girl}] ([\text{smoke} + \text{drink, dance}]) = [\text{smoke}(A) + \text{drink}(A) + \text{smoke}(B) + \text{drink}(B), \text{dance}(A) + \text{smoke}(B) + \text{drink}(B), \text{dance}(B) + \text{smoke}(A) + \text{drink}(A), \text{dance}(A) + \text{dance}(B)] \]
Semantics of *every/jeder*

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Deriving the scope-related asymmetry (1/2)

Every copy-editor found two mistakes.  

scenario: copy-editors: c1, c2, mistakes: m1, m2, m3

a. c1 found m1, m2. c2 found m1, m3. .

b. c1 found m1. c2 found m2.

Prediction: Singular universals always distributive wrt. material in their scope
Deriving the scope-related asymmetry (1/2)

(55)  *Every copy-editor found two mistakes.*

(56)  scenario: copy-editors: c₁, c₂, mistakes: m₁, m₂, m₃

a.  c₁ found m₁, m₂.  c₂ found m₁, m₃.  .

b.  c₁ found m₁.  c₂ found m₂.

[c₁ found m₁+ c₂ found m₂ + c₂ found m₂+ c₂ found m₃, c₁ found m₁+ c₂ found m₂ + c₂ found m₁+ c₂ found m₃, . . . ]

Prediction: Singular universals always distributive wrt. material in their scope
(55) Every copy-editor found two mistakes.

(56) Scenario: copy-editors: c1, c2, mistakes: m1, m2, m3

a. c1 found m1, m2. c2 found m1, m3.  
   (55) true

b. c1 found m1. c2 found m2.  
   (55) false

[c1 found m1+ c2 found m2 + c2 found m2+ c2 found m3,  
c1 found m1+ c2 found m2 + c2 found m1+ c2 found m3, ...]

every copy-editor  

[found m1+ found m2, found m2+ found m3,  
found m1+ found m3]  

found [m1+m2, m2+m3, m1+m3]  

two mistakes

Prediction: Singular universals always distributive wrt. material in their scope
Deriving the scope-related asymmetry (2/2)

(57) Two copy-editors found every mistake in the manuscript. cumulative possible

(58) copy-editors: c1, c2, c3 mistakes: m1, m2
a. c1 found m1, m2. c2 found m1, m2. (57) true
b. c1 found m1. c2 found m2. (57) true

\[
C([c1+c2, c2+c3, c1+c3])([\text{found } m1+\text{found } m2])
= [\text{c1 found } m1+c2 \text{ found } m2, c2 \text{ found } m1+c3 \text{ found } m2, c1 \text{ found } m1+c3 \text{ found } m2 \ldots]
\]

two copy editors

Prediction: Since every \( P Q \) returns a plurality of values, cumulativity wrt. material outscoping every possible
Deriving the scope-related asymmetry (2/2)

(57) Two copy-editors found every mistake in the manuscript. cumulative possible

(58) copy-editors: c1, c2, c3 mistakes: m1, m2
   a. c1 found m1, m2. c2 found m1, m2. (57) true
   b. c1 found m1. c2 found m2. (57) true

\[
C([c1+c2, c2+c3, c1+c3])([found m1+found m2])
= \{ c1 found m1+c2 found m2, c2 found m1+c3 found m2, c1 found m1+c3 found m2 \ldots \}
\]

two copy editors [every mistake]([found]) = [found m1+found m2]

Prediction: Since every \( P Q \) returns a plurality of values, cumulativity wrt. material outscoping every possible
Deriving the scope-related asymmetry (2/2)

(57) Two copy-editors found every mistake in the manuscript.

(58) copy-editors: c1, c2, c3 mistakes: m1, m2

a. c1 found m1, m2. c2 found m1, m2. (57) true
b. c1 found m1. c2 found m2. (57) true

Prediction: Since every P Q returns a plurality of values, cumulativity wrt. material outscoping every possible
Deriving the scope-related asymmetry (2/2)

(57) Two copy-editors found every mistake in the manuscript. cumulative possible

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b. c1 found m1. c2 found m2. (57) true

Prediction: Since every \( P \ Q \) returns a plurality of values, cumulativity wrt. material outscoping every possible
Deriving the flattening effect

(59) *Ada and Bea taught every dog two new tricks.*

(60) **SCENARIO:** A taught C t1 & A taught C t2 & A taught D t3 & B taught D t2

\[
\text{[ A taught C t1+A taught C t2 + B taught D t2+A taught D t3, A taught D t1+B taught D t2 + B taught C t2+B taught C t3, . . . ]}
\]

\[
\text{[every dog](taught t1+taught t2, taught t2+taught t3, taught t1+taught t3 ) = [ taught C t1+taught C t2 + taught D t2+taught D t3, taught D t1+taught D t2 + taught C t2+taught C t3, . . . ]}
\]

\[
\text{[taught t1+taught t2, taught t2+taught t3, taught t1+taught t3]}
\]

\[
\text{taught two new tricks}
\]
(59) Ada and Bea taught every dog two new tricks.

(60) **Scenario:** A taught C t1 & A taught C t2 & A taught D t3 & B taught D t2

\[
\begin{align*}
[A \text{ taught } C \ t1 &+ A \text{ taught } C \ t2 + B \text{ taught } D \ t2 &+ A \text{ taught } D \ t3, \\
A \text{ taught } D \ t1 &+ B \text{ taught } D \ t2 + B \text{ taught } C \ t2 &+ B \text{ taught } C \ t3, & \ldots] \\
\end{align*}
\]
(59) *Ada and Bea taught every dog two new tricks.*

(60) **Scenario:** A taught C t1 & A taught C t2 & A taught D t3 & B taught D t2

\[
\begin{align*}
& \text{[ A taught C t1+A taught C t2 + B taught D t2+A taught D t3,} \\
& \text{A taught D t1+B taught D t2 + B taught C t2+B taught C t3, \ldots ]}
\end{align*}
\]
We assume a ‘particle’ structure for distributive conjunction. 

(61)  

a.  \( A \text{ is } \text{és} \text{ } B \text{ is} \)  
    A too and B too  

b.  \( \text{sowohl } A \text{ als auch } B \)  
    as well A as also B  

c.  \( \text{LF: } \left[ [ \text{PRT } A] \text{ [and } [\text{PRT } B]] \right] \)  

Distributive conjunctions are like every NP, but ‘atoms’ are the individual conjuncts. Cumulativity built into the particle meaning.

(62)  \( \text{Sowohl die Mädchen als auch die Buben haben zwei Fehler gefunden} \)  
    \( \text{PRT the girls PRT also the boys have two mistakes found} \)  
    ‘Both the girls and the boys found two mistakes.’
Distributive conjunction (1/2)

We assume a ‘particle’ structure for distributive conjunction. Szabolcsi (2015)

(61)  
a.  \( A \text{ is} \text{ és} \text{ } B \text{ is} \)  
   A too and B too  

b.  \( \text{sowohl } A \text{ als auch } B \)  
as.well A as also B  

c.  \( \text{LF: } [ [\text{PRT } A] \text{ [and [PRT } B]]] \)  

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\( \text{PRT the girls PRT also the boys have two mistakes found} \)  
‘Both the girls and the boys found two mistakes.’
Distributive conjunction (2/2)

\[(63)\]

\[
[C([f + g], [A]) \oplus C([f + g][B])] = \\
[[f(A) + g(A) + f(B) + g(B)]] \\
\approx_{\text{shift}} [f(A) + g(A) + f(B) + g(B)]
\]

\[
\approx_{\text{shift}} [[\lambda P_{(e,a)^*} \cdot C(P^*, [Ada]) + \lambda P_{(e,a)^*} \cdot C(P^*, [Bea])]]
\]

\[
\approx_{\text{shift}} [[\lambda P_{(e,a)^*} \cdot C(P^*, [Ada]) + \lambda P_{(e,a)^*} \cdot C(P^*, [Bea])]]
\]

\[
\lambda P_{(e,a)^*} \cdot C(P^*, [Ada]) \quad \text{and} \quad \lambda P_{(e,a)^*} \cdot C(P^*, [Bea])
\]

PRT Ada

PRT Bea
Questions/open problems

- Some technical issues (see handout)
  - Expansion to collective predicates?
  - Expansion to non-upward-monotone DPs (less than five, exactly five . . .)
  - Cross-linguistic differences concerning conditions on cumulative reading – scope vs. grammatical function (Flor 2017)
  - Homogeneity – every vs. plural definites
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- Expansion to collective predicates?
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Conclusion

- We presented a system that derives cumulativity without syntactically derived predicates and operators like **
- This system derives cumulative truth-conditions step-by-step, along the lines of the hierarchical structure
- This system accounts for the ‘flattening’ effects with conjunction
- We looked at cumulative asymmetries and ‘flattening’ effects with singular universals and distributive conjunction
- We showed how we can employ our system to account for cumulative asymmetries and ‘flattening’ effects
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Thanks to . . .

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5 Comparison with previous proposals

6 Distributive items cross-linguistically
Previous accounts of cumulative asymmetries

Two types of existing theories

- **Event-based analyses** (Schein (1993), Kratzer (2000), Zweig (2008)): Flattening effects require us to appeal to events.

- **Event-less analysis** (Champollion (2010)): No events required. We work with our cumulation operators (e.g. **), syntactically derived predicates and impose particular restrictions on the syntactic occurrence of singular universal and the interpretation of its trace.
Previous accounts of cumulative asymmetries

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Event-based analyses

Event-based analyses (Schein (1993), Kratzer (2000), Zweig (2008)): Flattening effects require us to appeal to events.

Basic idea: Cumulation does not have to target relations between individuals, but rather relations between events and individuals. By this we ensure that we don’t require cumulative relations between individuals.

(64)  *The two girls taught every dog two new tricks.*

(65)  \[ \exists e(\text{teach}(e) \& \text{agent}(e)(A + B) \& \exists Y = +\{y \mid \text{dog}(y)\}(\text{ben}(e)(Y)) \& \forall y \in Y(\exists Z \in [\text{two tricks}] \& \exists e' \leq e(\text{theme}(e')(Z)))) \]

The compositional event-based analyses in the literature (e.g. Zweig 2008) are missing ‘exhaustivity’ of the subevents quantified over (Kratzer 2000). Wrong prediction: (64) true in scenario (66).

(66)  **Scenario:** Girl 1 taught every dog two tricks. Girl 2 taught one of the dogs a new command (that does not count as a trick).

This problem can probably be solved by building ‘exhaustivity’ into the determiner meanings.
Event-based analyses

Event-based analyses (Schein (1993), Kratzer (2000), Zweig (2008)): Flattening effects require us to appeal to events.

Basic idea: Cumulation does not have to target relations between individuals, but rather relations between events and individuals. By this we ensure that we don’t require cumulative relations between individuals.

(64) *The two girls taught every dog two new tricks.*

(65) \[ \exists e (teach(e) \& agent(e)(A + B) \& \exists Y = +\{y \mid \text{dog}(y)\}(\text{ben}(e)(Y)) \& \forall y \in Y(\exists Z \in \text{[two tricks]} \& \exists e' \leq e(\text{theme}(e')(Z)))) \]

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(66) **Scenario:** Girl 1 taught every dog two tricks. Girl 2 taught one of the dogs a new command (that does not count as a trick).

This problem can probably be solved by building ‘exhaustivity’ into the determiner meanings.
Event-based analyses

Event-based analyses (Schein (1993), Kratzer (2000), Zweig (2008)): Flattening effects require us to appeal to events.

Basic idea: Cumulation does not have to target relations between individuals, but rather relations between events and individuals. By this we ensure that we don’t require cumulative relations between individuals.

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Differences to our proposal

- Just like Champollion (2010), our analysis does not require events

- Accordingly, we don’t require that every predicate that allows for cumulativity must have an event/state argument.

(67) a. *Drei Oligarchen besitzen jedes Haus in diesem Ort.*
three oligarchs own every house in this town
‘Three oligarchs own every house in this town.’

b. *Erstaunlicherweise folgen aus den zwei Prämissen mit jeder dieser Regeln zwei Sätze*
Surprisingly follow from the two premises with every of these rules
two theorems
‘Surprisingly the two premises give rise to two theorems by means of every one of these rules.’

- In particular, it is unclear to us how attitude verbs could be analyzed as taking a single (singular or plural) event as an argument. Cumulation across attitude verbs is, however, possible and our approach extends naturally to such cases.

(68) *The Georgian ambassador called this morning, the Russian one at noon. The ambassadors think that Trump should take a walk with Putin and build a golf club in Tbilisi, but neither addressed the Caucasian conflict!*
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Event-less analysis

Champollion (2010) argues that we don’t need to appeal to events in order to derive cumulative asymmetries and flattening effects with singular universals.

- *every NP* denotes a plurality of individuals

  \( [\text{every dog}] = [\text{the dogs}] = (\text{in our model}) \ C + D \)

- *every NP* must directly c-command a distributivity operator \( * \) or cumulation operator \( **, ***, \ldots \)

- trace of *every NP* must range over atoms

- **a.** The two girls taught every dog two new tricks.

  \([\text{the two g}] [\text{every d}] ** [1 2 [\text{two new t} [3 [t_1 **\text{taught} \ t_2 \ t_3 ]]]]]]]]

  \([2 1 [\text{two new t} [3 [t_1 ***\text{taught} \ t_2 \ t_3 ]]]]]]] = \lambda x_e. \lambda y_e. \text{there is a plurality } Z \text{ of two new tricks, s.th. } y \text{ cumulatively taught } Z \text{ to } x_{AT} \)

- This gives us the correct truth-conditions and (if some additional syntactic assumptions are made) cumulative asymmetries.
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\text{c. } & [[2 \ 1 [[\text{two new t} \ [3 \ [t_1 ** \text{taught} \ t_2 \ t_3 ]]]]]] = \\
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Differences to our proposal

- Since Champollion (2010) must assume that traces of distributive elements range over atoms only, his account, as opposed to ours, cannot deal with examples where we distribute down to non-atomic subpluralities.

(71) Sowohl die Mädchen als auch die Buben haben zwei Fehler gefunden.
    ‘Both the girls and the boys found two mistakes.’

(72) Scenario: The girls found two mistakes between them and the boys found two mistakes between them.

- Our account, as opposed to accounts working with derived predicates and **, generalizes to flattening effects with conjunction.

(73) Those rude girls gave a lot of chores to poor Gene. In fact Ada and Bea made Gene feed the dogs and brush Eric when all he wanted to do was take care of poor hamster Harry.

- Our account of long distance cumulativity doesn’t require LF movement out of an embedded clause.

(74) The ambassadors think that Trump should take a walk with Putin and build a golf club in Tbilisi . . .
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Distributive conjunctions, Hungarian

A *is* és *B is* – according to Szabolcsi (2015) ‘distributive’

(75)  

a. Sára and Marcsi are organizing a party. Sára is supposed to organize food via ‘Express Catering’, Marcsi beer via ‘Star Catering’...

b. Szerencsére Sára is és Marcsi is időben felhívta a két kiszállítót fortunately Sára is and Marcsi is on-time called the two catering céget.

‘Fortunately, both Sára and Marcsi called the two catering companies ahead of time.’

c. Scenario: S called ‘Express Catering’. M called ‘Star Catering’. (75-b) false

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elements due to Dóra Kata Takács (pc)
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