Measuring and Counting in the Nominal and in the Verbal Domain

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What is measuring?

We are interested in measuring extensive quantities:

- Restriction for nominal measurement (cf. Krifka 1989, Schwarzschild 2002; cf. also Champollion 2010).
  - *three liters of milk*
  - **thirty degrees of milk*
- Intensive vs. extensive degrees with verbal measurement:
  - *Wir haben viel gelacht.* 'We laughed a lot'
  - *Wir haben sehr gelacht.* 'We had a good laugh', 'We laughed intensely'

Properties of extensive measure functions:

- Posits a homomorphism between concatenation, here join ⊔, and addition +
- Versions of this additive property:
  - If ¬xox′, i.e. x, x′ are disjoint, then m(x⊔x′) = m(x) + m(x′)
  - m(x⊔x′) = m(x) + m(x′) (– m(x⊓x′), if the meet x⊓x′ is defined)
- Archimedian property:
  - If x⊑x′ and m(x′) > 0, then m(x) > 0

Extensive measure functions and quantization:

- If m is extensive, then P = {x | m(x)=n} is quantized, i.e. if P(x) and x′ ⊏ x, then ¬P(x′).
- If x falls under *three liters of milk*, and x′ is a proper part of x, then x′ does not fall under *three liters of milk*

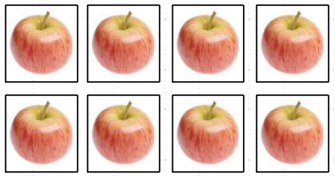
What is counting?

Extensive measure functions also satisfy what we expect from counting:

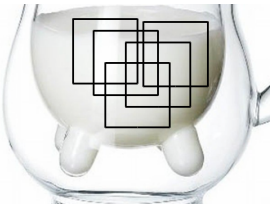
- They are additive: If x, x′ do not overlap: #(x⊔x′) = #(x) + #(x′), e.g. x is two apples, x′ is three apples, x and x′ do not overlap: #(x⊔x′) = #(x) + #(x′) = 2 + 3 = 5
- They should also have the Archimedian property: If x⊑x′ and #(x′) > 0, then #(x) > 0

To ensure the Archimedian property, counting is related to atomicity:

- Atom(x) ↔ ∃x′[x′ ⊏ x], i.e. x is an atom if x does not have proper parts.
- For all x in the domain of #: Atom(x) ↔ #(x) = 1
- Notice: The atoms in the domain of a counting function # do not overlap.
- 1-1-mapping to natural numbers becomes possible.



#(x) = 1



liter(x) = 1

- Counting does not fit to substance mass (or "mess") nouns: Atoms overlap (Landman 2011)

Measuring / Counting in nominal and verbal domain:

Superficial similarities:

- Measuring:
  - *three liters of milk*
  - *sleep for three hours, sleep the whole day*
- Counting:
  - *three apples*
  - *knock three times, knock thrice*

But there are important differences:

- Measuring:
  - *liter* is a head, *for three hours, the whole day* is an adjunct
- Counting:
  - *three* is a specifier (argument), *three times* is an adjunct

Krifka (1989), p. 182:

- Ein Gegenstück zu Numeralkonstruktionen scheint es hingegen im Verbalbereich in keiner Sprache zu geben, d.h. Verben haben nirgendwo eine syntaktische Valenzstelle für Numeralia entwickelt.

Doetjes (2008), p. 154:

- I would like to hypothesize that [an operation] that parallels the number marking known from the nominal system, is not available.

Why?

M / C in the nominal domain: Facts

Cf. Doetjes (2012) for a recent overview.
Measuring and Counting in English:

- Count nouns – count construction:
  one apple, three apple-s
- Mass nouns – measure construction:
  one liter of milk, three liter-s of milk
- Collective nouns – Classifier construction, for counting:
  one piece of furniture, three piece-s of furniture
  (?) *one head of cattle, fifty head of cattle*
- Plural count nouns, collective nouns – measure construction:
  three kilo-s of apples, thirty ton-s of cattle

In German:

- No linker in classifier construction:
  drei Liter Milch
- tendency for singular/number-neutrality of classifier:
  drei Liter Milch, drei Kopf Salat, but: *drei Flasche-n Milch*

In Turkish:

- No plural in count noun constructions:
  üç çocuk ‘three child’ – **üç çocuk-lar* ‘three child-PL’

M/C in the nominal domain: Facts

Measuring and counting in Chinese:

- No count nouns:
  **sān xióng* ‘three bear’
  **yi xióng* ‘one bear’
  **sān rén-men* ‘three person-PL’
- Construction with classifiers (hence, collective nouns):
  sān zhī xióng ‘three CL bear’
  sān ge rén ‘three CL person’
- Mass nouns – measure constructions:
  sān bàng (de) chā ‘three pound (LNK) tea’
- Collective nouns – measure constructions:
  sān qūn (de) xíong ‘three herd (LNK) bear’
- No *de* in true classifier constructions:
  *sān zhī *de xióng*

M/C in the nominal domain: Theory

Measuring by additive measure function, proposal with measure phrase

- Cf. Krifka (1995), Landman (2004), Borer (2005), Rothstein (2011), ...
- One proposal:
  $[_{DP}$ *the* $[_{NumP}$ *three* $[_{NumP'}[_{Num0}$ *liter-s* $]$ $[_{PP}$ *of* $[_{NP}$ *milk*$]]]]]$; number agreement
- Semantic analysis of NumP:
  $[\![$*liter(s)*$]\!]$ = λP:cumulative.λn:number.λx[P(x) ∧ liter(x) = n]
  $[\![$*liter(s) of milk*$]\!]$ = λn:number.λx[milk(x) ∧ liter(x)=n]
  $[\![$*three liters of milk*$]\!]$ = λx[milk(x) ∧ liter(x)=3]
- For German:
  - $[_{NumP}$ *drei* $[_{Num'}$ $[_{Num0}$ *Liter* $]$ $[_{NP}$ *Milch*$]]]$
  - $[_{NumP}$ *drei* $[_{Num'}$ $[_{Num0}$ *Liter* $]$ $[_{NP[Gen]}$ *guten Weines*$]]]$
- Num^0 is the head:
  - Gender: *die Milch*, *der Liter*, *der / *die eine Liter Milch*
  - Number: *the three liters of milk were / ??was still in the refrigerator*
- Chinese: *de* as postposed linker allows for an analysis as modifier:
  - $[_{NumP}$ *sān* $[_{Num'}$ *bàng* $[_{NP}$ *chā*$]]]$
  - $[_{NumP}$ $[_{PP}$ [*sān bàng*] *de*] $[_{NP}$ *chā*$]]$

M/C in the nominal domain: Theory

Chinese: Classifier construction.

- Syntactic analysis:
  - $[_{NumP}$ *sān* $[_{Num'}$ $[_{Num0}$ *zhī* $]$ $[_{NP}$ *xióng*$]]]$
- Interpretation of classifier:
  - Reference to general count function: λPλnλx[P(x) ∧ #(x) = n]
  - Reference to specific count function, e.g. *zhī*: animals,
    imposing non-overlapping atoms: λPλnλx[P(x) ∧ animal(x) = n],
    where animal(x) = 1, animal(x′) = 1, x ≠ x′ → ¬xox′ (non-overlap)
- Division of semantic labor (cf. Krifka 1989, 1995; Borer 2005)
  - head NP *xióng* ‘bear’ provides qualitiative criterion, no reference to units,
  - classifier provides for quantitative criterion, denoting a unit

M/C in the nominal domain: Theory

English: Count noun constructions.

- English count nouns have a “built-in” classifier,
  express both a qualitative and a quantitative criterion of application
- Possible syntactic analysis: *apple* as head of Num0:
  - $[_{NumP}$ *three* $[_{Num'}$ $[_{Num0}$ *apple-s*$]]]$,
    where *apple* = λnλx[apple(x) ∧ #(apple)(x) = 1],
    with #(apple): count function
  - Plural is strictly by agreement: *one point zero apples / *apple*
- Another possible syntactic analysis by head movement of bare noun stem into Num^0:
  - $[_{NumP}$ *three* $[_{Num'}$ $[_{Num0}$ *apple* – $[_{Num0}$ *s*$]]$ $[_{N}$ ~~*apple*~~$]]]$,
    where $[_{Num0}$ *-s*$]$ = λPλnλx[P(x) ∧ #(P)(x) = n],
    in singular agreement: ∅, in Breton, Arabic: singulative
  - Perhaps plausible for English, where measure words, classifiers agree,
    not so plausible for German, where they don’t tend to agree:
  - *fifty *head / heads of cattle*
    fünfzig Kopf / Köpfe Salat

M/C in the nominal domain: Theory

- Bare plurals by existential quantification (“semantic pluralization”)
  - $[_{NumP}$ ∅ $[_{Num'}$ *apple-s*]] = λx∃n[apple(x) ∧ #(apple)(x) = n]
  - Allows for application to single apples,
  - cf. A: *Do you have children?* – B: *Yes, one. / *No, one.*
- Bare plurals by derivational means:
  - Turkish: *çocuk-lar* : λx[child(x) ∧ #(child)(x) ≥ 2]
  - *Çocuğunuz var mı?*, lit: ‘Your child exists?’
  - Predicts that plural is not used with number words: **üç çocuk-lar*,
    as the atoms of *çocuk-lar* are overlapping.

Greenberg’s generalization:

- Classifier languages don’t express number on nouns
- Explanation:
  - No agreement plural, as noun in argument position, not head position:
    $[_{NumP}$ *sān* $[_{Num'}$ *zhī* $[_{NP}$ *xióng*$]]]$
  - No need for semantic pluralization either
  - If plural refers to two or more entities (Turkish style),
    then atoms are overlapping,
    violating a requirement for the classifier

M/C in the nominal domain: Theory

Measuring with count nouns:

- Measure phrases applied to plurals:
  - $[_{NumP}$ *three* $[_{Num'}$ *kilos* $[_{PP}$ *of* $[_{NumP}$ *apples*$]]]]$
    $[_{NumP}$ *drei* $[_{Num'}$ *Kilo* $[_{NumP}$ *Äpfel*$]]]$
    λx[∃n[apples(x) ∧ #(apples)(x) = n] ∧ kg(x) = 3]
  - **three kilos of five apples* excluded, violation of cumulativity
- Mass quantifiers with count nouns:
  a lot of milk / a lot of apples
  - Two options in German (colloquial):

viel-e / wenig-e Äpfel	*viel / wenig Äpfel*	*viel / wenig Milch*
many / few apples	much / little apples	*much / little milk*

  - DP level difference:

die vielen/wenigen Äpfel	**die viel / wenig Äpfel*	*die viel-e / wenig-e Milch*

  - Suggested analysis:
    $[_{NumP}$ *viele* $[_{Num'}$ $[_{Num0}$ *Äpfel*$]]]$, agreement plural
    $[_{DP}$ *viel / wenig* $[_{NumP}$ *Äpfel*$]]$, semantic plural
    $[_{DP}$ *viel / wenig* $[_{NumP}$ *Milch*$]]$, predicative mass noun
    viel/wenig employ additive measure function.

M/C in the verbal domain: Facts

Counting events with verbal classifier construction:

- English, with *time*
  Mary called three times.
  Mary called John three times.
- German: *Mal*, no plural, just as with other classifiers (cf. *Stück*):
  Maria rief drei Mal (John) an.
- Verbal classifier construction in Mandarin Chinese
  (Fassi-Fehri & Vinet 2008): *cì, biàn, huí, xià*
  tā dàodá guò shāndǐng liǎng cì
  3SG arrive-reach ASP mountaintop two times
  ‘I have reached the top of the mountain twice’

Verbal quantifiers:

- English *once, twice, (thrice)*; *never, rarely, seldom, sometimes, often, always*
  Mary often called John.
  Mary always called John.

M/C in the verbal domain: Facts

Pluractional (iterative) marking in language – cf. Lasersohn 1995, Ojeda 1998

- A widespread phenomenon, occuring in many language families
- Example Chechen (Nak-Daghestan, Yu 2003)

as q'iigashna twop-qwessira	*as q'iigashna twop-qissira*
1.SG crow.PL.DAT gun.throw.PAST	1.SG crow.PL.DAT gun.throw.PL.PAST
'I shot crows'	'I shot crows many times'

- Example Lithuanian (Indo-European, Armoskaite 2012)

Jonas važ-iav-o i Toront-a	*Jonas važ-ine-o i Toront-o*
Jonas travel-PROG-3SG to Totonto-ACC	Jonas travel-PL-3SG to Toronto-ACC
'Jonas was traveling to Toronto'	'Jonas made frequent travels to Toronto'

But never used with explicit counting events; Example: Chechen.

adama takhan yttaza chai melira	**adama takhan yttaza chai miillira*
Adam.ERG today ten.times tea drink.PAST	Adam.ERG today ten.times tea drink.PL.PAST
'Adam drank tea ten times today'	

Cf. also Semelfactive marking, e.g. Russian *nu-, s-* (Dickey & Janda 2009)

Interpretation of pluractional marking:

- Frequentative reading, see above
  typically used for several events, but sometimes just two (Faller 2012, Quechua)
- Habitual reading (cf. van Geenhoven 2001 on Greenlandic Eskimo)
- Participant distributive reading, e.g. 'The children embraced me'
- Durative reading, e.g. 'The wound hurt (for a long time)'

M/C in the verbal domain: Facts

Participant multiplicity:

- Example one event / many event ambiguity (Lasersohn 1995)
  Before he made the decision, he talked to a few friends.

Cognate objects

- Event unit nouns in Arabic (Fassi-Fehri & Vinet 2008):

raqasa raqs-an	*raqasa raqs-at-an*	*raqasa raqs-at-ayni*
he.danced dance-ACC	he.danced dance-UNIT-ACC	he.danced dance-UNIT-DUAL
'He danced a dancing'	'He danced one dance'	'he danced two dances'

Object-derived measure functions for events (Krifka 1990)

Four thousand ships passed through this lock last year.
Forty thousand tons of radioactive waste passed through this lock last year.

M/C in the verbal domain: Facts

Measuring constructions (see above):

- With durational adverbials, selecting non-telic verbal predicates:
  Mary wrote letters for an hour.
  Mary wrote a letter for an hour. (accommodated: repeatedly, partly)
  The light flashed for an hour. (accommodated: repeatedly)
- With time frame adverbials, selecting telic verbal predicates:
  Mary wrote two letters in an hour.
  Mary ran in an hour. (accommodated: a defined run)
- With extent nominals:
  Mary wrote letters the whole day.
  Maria schrieb den ganzen Tag [Accusative] *Briefe.*
  Maria schrieb eine Stunde (lang) Briefe.

M/C in the verbal domain: Theory

Measure construction:

- Example *for*-Adverbials in a Neo-Davidsonian event semantics:
  $[_{VP}\ [_{VP}$ *write letters*$]\ [_{PP}$ *for an hour*$]]$
  $[_{VP}$ *write letters*$]$: $\lambda e[\text{write}(e) \wedge \exists x[\text{letters}(x) \wedge \text{TH}(e,x)]]$,
  a cumulative event predicate
  $[_{PP}$ *for an hour*$]$: $\lambda P{:}\text{cumulative}\ \lambda e[P(e) \wedge \text{hour}(e) = 1]$
  $[_{VP}\ [_{VP}$ *write letters*$]\ [_{PP}$ *for an hour*$]]$:
  $\lambda e[\text{write}(e) \wedge \exists x[\text{letter}(x) \wedge \text{TH}(e,x)] \wedge \text{hour}(e) = 1]$,
  cumulativity of P satisfied due to incrementality of TH, cumulativity of *letters*

Count construction via counting participants:

- Assume cumulativity of basic predicates (Krifka 1989, Kratzer 2004):
  - Davidsonian: $\text{write}(e, x, y), \text{write}(e', x', y') \rightarrow \text{write}(e \sqcup e', x \sqcup x', y \sqcup y')$
  - Neo-Davidsonian, for thematic roles: $\theta(e) = x, \theta(e') = x' \rightarrow \theta(e \sqcup e') = x \sqcup x'$
- $[_{VP}$ *write* $[_{DP}$ *two letters*$]]$, here focus on the object argument only
  $\lambda R \lambda e \exists x[\text{letter}(x) \wedge \#(x)=2 \wedge R(e)(x)](\lambda e \lambda x[\text{write}(e) \wedge \text{TH}(e)=x])$
  $= \lambda e \exists x[\text{letter}(x) \wedge \#(x)=2 \wedge \text{write}(e) \wedge \text{TH}(e)=x]$
- holds of if $e = e' \sqcup e''$, $x = x' \sqcup x''$,
  and $\text{TH}(e')=x'$, $\text{TH}(e'')=x''$, $\text{write}(e')$, $\text{write}(e'')$, $\text{letter}(x')$, $\text{letter}(x'')$, $\#(x')=1$, $\#(x'')=x$

M/C in the verbal domain: Theory

Opens explanation of cognate object counting:

- *dance two dances,*
  event measurement is inherited from measurement of nominalization
  λe∃e′[dance(e) ∧ RES(e) = e′ ∧ dance(e′) ∧ #(dance)(e′) = 2]

Derived measure functions:

- *four thousand ships passed*
  construction of measure function for events:
  #(*ship pass*)(e) = 1 iff ∃x[ship(x) ∧ pass(e) ∧ TH(e)=x];
  generalize this to an additive measure function.

M/C in the verbal domain: Theory

Verbal classifiers, counting events:

- Example: [$_{VP}$ [$_{VP}$ *write a letter*] [$_{AdvP}$ *two times*]]
- [$_{AdvP}$ *two times*] = λP:non-overlapping atoms λe[#(P)(e) = 2]
  where #(P)(e) is an additive measure function standardized by:
  #(P)(e) = 1 iff Atom(P) = 1
- Example: Non-overlap requirement satisfied or enforced,
  λe[#(λe′∃x[letter(x) ∧ #(x)=1 ∧ TH(e′)=x ∧ write(e′)])(e) = 2]
  = λe∃e′∃e″[¬e′oe″ ∧
  ∃x[letter(x) ∧ #(x)=1 ∧ TH(e′)=x ∧ write(e′)] ∧
  ∃x[letter(x) ∧ #(x)=1 ∧ TH(e″)=x ∧ write(e″)]],
  notice that if TH is a verb of creation, two letters are written due to ¬e′oe″
- Notice: No enforcement of cumulativity, rather to atomicity;
  this corresponds to the “multiplicative” interpretation of *times* phrases:
  *three times two apples, three times two liters of milk, *three times milk*

Incompatability with pluractional marking:

- Pluractional marking, scope over object:
  PL(λxλe[write(e) ∧ TH(e)=x]) = λQλe[#(Q(λeλx[write(e) ∧ TH(e)=x]) ≥ 2]
- Applied to [$_{DP}$ *a letter*]: λRλe∃x[letter(x) ∧ #(x)=1 ∧ R(e)(x)]:
  = λe[#(λe′∃x[letter(x) ∧ #(x)=1 ∧ write(e′) ∧ TH(e′)=x])(e) ≥ 2]
- Attempt to apply meaning of *three times* fails because this predicate has overlapping atoms.

M/C in nominal and verbal domain: Explanation of differences

Verbal measure constructions: modifiers, nominal ones typically are heads:

- Comparison:
  - [$_{NumP}$ *three* [$_{Num'}$ [$_{Num0}$ *liters*] [$_{PP}$ *of milk*]]]
  - [$_{VP}$ [$_{VP}$ *sleep*] [$_{PP}$ *for an hour*]]
- Consequence: Verbal measure constructions can take variable scope.

Count constructions in the nominal domain, not in the verbal domain:

- Putative example, intended meaning: ‘John arrived three times’
  * *John* [$_{VNumP}$ *tree* [$_{VNum'}$ [$_{VNum0}$ *arrived* CL] [$_{VP}$ ~~*arrived*~~]]]
- Possible exception: Karitiana, cf. Doetjes this conference)
- A distractor: external modification of incorporated elements,
  something like German, Kalaallisut (Grenlandic Eskimo)
  - *Schüsse abgefeuert habe ich zwei*
    shoots fired AUX 1sg two
    ‘I fired two shots’, ‘I shot twice’
  - Marlun-nik ammassat-tor-punga
    two-INSTR sardine-eat-INDIC.ITR.1SG
    ‘I ate two sardines’, ~ ‘I ate a sardine twice’

M/C in nominal and verbal domain: Explanation of differences

- Possible non-linguistic reason:
  - In order to count we should be able to manipulate objects,
  - e.g. arrange them, this is not possible with temporal entities.
  - But: Temporal entities come aligned in time, it should be able to count them
  - Counterargument:
    We would have to count distinct cotemporaneous events
- Possible linguistic reason:
  - If the verb stem has to raise into the head of a verbal NumP,
    it could not rise to other heads, e.g. tense, aspect, finiteness,
    but kind of information is more important for verbal meanings.