Types, tokens, roots and functional structure
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Zero, number features, and the semantics of nouns

1 Introduction

Bylinina and Nouwen (2018): a special individual in the semantics of plural nouns, ⊥ (the bottom-most element in a full lattice)

(1) [[boys]] = { ⊥, a, b, c, ab, ac, bc, abc)

Arguments: correct semantics for *zero N*, correct semantics for *fewer than # N*, *at most # N*

Bylinina and Nouwen suggest that ⊥ has no role in the explanation of number morphology of (count) nouns (number morphology as a separate set of facts):

(2) **Zero**/two/fifty-five students/*student
One student/*students (Borer 2005, Krifka 1989)

My argument: ⊥ *can* be used to explain number morphology on count nouns, both in English and in other languages

(3) *Turkish*
Sıfır/bir/iki/üç/yirmi üç çocuk/*çocuk-lar
Zero/one/two/three/twenty-three boy.SG/boy-PL
'Zero/one/two/three/twenty-three boy(s)' (Bale *et al*. 2011, Scontras 2014)

[*Zero* does not combine with N at all in some languages:
(4) *Western Armenian*
a. ***Zero*** dəgha/dəgha-ner
zero boy.SG/boy-PL 'Zero boys'
b. Meg dəgha/*dəgha-ner 'One boy'
c. Yergu dəgha/dəgha-ner 'Two boys'
(Bale *et al*. 2011, Bale and Khanjian 2014, Donabédian 1993, Sigler 1997)]

zero N	***one N***	***two, etc. N***	**languages**
plural	singular	plural	English, Spanish, German
singular	singular	singular	Turkish, Hungarian, Finnish

Number marking on N with different numerals in some languages with plurals

Assumptions about (a) the functional structure of NPs and the syntactic position of numerals (from Scontras 2014 and others), and (b) the semantics of the number features responsible for number morphology (from Harbour 2014 and Martí to appear, under review)

2 ⊥

Bylinina and Nouwen (2018): *zero* denotes a number (just like any other numeral), semantics of plural nouns includes the bottom-most element ⊥, the **E**-operator

Zero not a negative quantifier:

(5) John owns four cars. Bill owns zero/thirteen (*ones)
(6) John owns four cars. Bill owns *no/none

(7) John doesn't love her, does/*doesn't he?
(8) John loves her, *does/doesn't he?
(9) No students love her, do/*don't they?
(10) Zero students love her, *do/don't they?

(11) No student has visited me in years
(12) *Zero students have visited me in years

Analysis:

(13) [[zero]] = 0

(14) $[[boys_{BN}]] = \{\perp, a, b, c, ab, ac, bc, abc)$

(15) Non-nominal predicates (*in the text*, *passed the test*) need an operator to deliver the correct semantics (cf. Link's 1983 *-operator): ⊥ also included in $in\_the\_text_{BN}$, $passed\_the\_test_{BN}$

(16) ⊥ needed independently of *zero*, e.g., *fewer than n N VP*, *at most n N VP* incorrectly fail to come out true if 0 n VP unless ⊥ is assumed

⊥ and DPs with *zero*

(17) Zero students passed the test
An *at least* semantics: $\exists x[\#x = 0 \ \& \ students_{BN}(x) \ \& \ pass\_the\_test_{BN}(x)]$ +
numeral-triggered exhaustification: $\neg\exists y\,[\#y > 0 \ \& \ student_{BN}(x) \ \& \ pass\_the\_test_{BN}(x)]$

⊥ and numeral-less DPs

(18) An additional existential operator: **E**
$\mathbf{E}x[\varphi] \Leftrightarrow \exists x[\#x > 0 \ \& \ \varphi]$

(19) There are typos in the text
~~$\exists x\,[typos_{BN}(x) \ \& \ in\_the\_text_{BN}(x)]$~~ ~~(a tautology)~~
$\mathbf{E}x\,[typos_{BN}(x) \ \& \ in\_the\_text_{BN}(x)]$ (not a tautology)

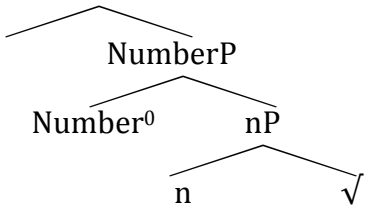
(20) A contingent statement is better than a trivial one (cf. Landman 2011)

3 Number features and the numeral+noun construction

Martí (under review): an account of the numeral+noun construction based on Harbour (2014) and Scontras (2014)

Harbour (2014)

(21)



(22) [[nP]] = {a, b, c, ab, ac, bc, abc} (set of atomic and plural individuals; cf. Link 1983)

(23) NumberP, the host of number features. Only three number features: [±atomic], [±minimal] and [±additive]

(24) [[+atomic]] = λPλx. P(x) & atom(x) (atoms)
[[−atomic]] = λPλx. P(x) & ¬atom(x) (non-atoms)

(25) There is a domain of entities, D_{at}, that contains only atoms: for all individuals x, x is an atom iff $x \in D_{at}$ (D_{at} = {a, b, c})
There is a domain of entities, $D_{\neg at}$, that contains only non-atoms: for all individuals x, x is a non-atom iff $x \in D_{\neg at}$ ($D_{\neg at}$ = {ab, bc, ac, abc})

(26) [[+atomic]]([[nP]]) = λx. [[nP]](x) & atom(x) (= {a, b, c})
[[−atomic]]([[nP]]) = λx. P(x) & ¬atom(x) (= {ab, ac, bc, abc})

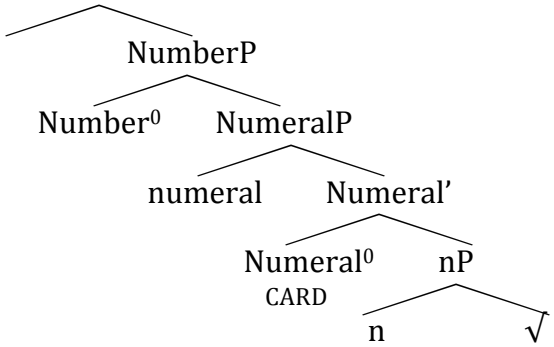
(27) [[+minimal]] = λPλx. P(x) & ¬∃y P(y) & y<x (without proper parts)
[[−minimal]] = λPλx. P(x) & ∃y P(y) & y<x (with proper parts)

(28) [[+minimal]]([[nP]]) = λx. [[nP]](x) & ¬∃y [[nP]](y) & y<x (= {a, b, c})
[[−minimal]]([[nP]]) = λx. [[nP]](x) & ∃y [[nP]](y) & y<x (= {ab, ac, bc, abc})

(29) [±atomic] and [±minimal] give same result in the basic case, but features come apart in a number of cases: exclusive vs. inclusive first person, duals and trials (Harbour 2011, 2014) and with numerals (Martí 2017a; cf. Scontras 2014)

Martí (under review), building on Harbour (2014) and Scontras (2014)

(30) for noun phrases with a numeral



(31) [[two]] = 2
[[CARD]] = λPλnλx. P(x) & #x = n (Hackl 2001, Scontras 2014 and others)

(32) [[two CARD nP]] = λx. [[nP]](x) & #x = 2 = {ab, bc, ac}

English

(33) [+atomic] spelled out as ∅, [−atomic] spelled out as *–s*

a. [[[+atomic] [$_{nP}$ boy]]] = λx. [[boy]](x) and atom(x) → ✔*boy*
b. [[[−atomic] [$_{nP}$ boy]]] = λx. [[boy]](x) and ¬atom(x) → ✔*boys*
c. #[[[+atomic] two CARD [$_{nP}$ boy]]] → ✖*two boy*
d. [[[−atomic] two CARD [$_{nP}$ boy]]] = λx. [[boy]](x) & card(x) = 2 → ✔*two boys*
e. [[[+atomic] one CARD [$_{nP}$ boy]]] = λx. [[boy]](x) & card(x) = 1 → ✔*one boy*
f. #[[[−atomic] one CARD [$_{nP}$ boy]]] → ✖*one boys*

English: *one* with singular noun because only [+atomic] combined with onesomes is well-formed; *two*, etc. with plural noun because only [−atomic] combined with twosomes, etc. is well-formed

[−Atomic] semantics for English plurals?

(34) Krifka (1989, 1995), Lasersohn (1998, 2011), Sauerland (2003), Sauerland, Anderssen and Yatsushiro (2005), Spector (2007), Zweig (2009), a. o.: only interpretations generated semantically for plurals are inclusive (i.e., they include atoms)

(35) I don't have children

(36) No students took the exam

(37) Martí (to appear) argues for the grammatical existence of both [−atomic] plurals and inclusive plurals (inclusive plurals: NumberP-less noun phrases) (cf. Farkas and de Swart 2010)

(38) The argument is based on the fact that [−atomic] is a crucial feature in the composition of duals (Noyer 1992, Nevins 2011, Harbour 2014)—without it, languages with inclusive plurals are predicted not to have duals, contrary to fact

Turkish

(39) [+minimal] spelled out as ∅, [−minimal] spelled out as *–lar*

a. [[[+minimal] [$_{nP}$ çocuk]]] = λx. [[çocuk]](x) & ¬∃y [[çocuk]](y) & y<x → ✔*çocuk*
b. [[[−minimal] [$_{nP}$ çocuk]]] = λx. [[çocuk]](x) & ∃y [[çocuk]](y) & y<x → ✔*çocuklar*
c. [[[+minimal] iki CARD [$_{nP}$ çocuk]]] = λx. [[iki CARD [$_{NP}$ çocuk]]](x) & ¬∃y [[iki CARD [$_{nP}$ çocuk]]](y) & y<x (two) → ✔*iki çocuk*
d. #[[[−minimal] iki CARD [$_{nP}$ çocuk]]] → ✖*iki çocuklar*
e. [[[+minimal] bir CARD [$_{nP}$ çocuk]]] = λx. [[bir CARD [$_{nP}$ çocuk]]](x) & ¬∃y [[bir CARD [$_{nP}$ çocuk]]](y) & y<x (one) → ✔*bir çocuk*
f. #[[[−minimal] bir CARD [$_{nP}$ çocuk]]] → ✖*bir çocuklar*

Turkish: *one*, *two*, etc. with singular noun because only [+minimal] combined with onesomes, twosomes, etc. is well-formed

Turkish *çocuk* 'boy' not number-neutral?

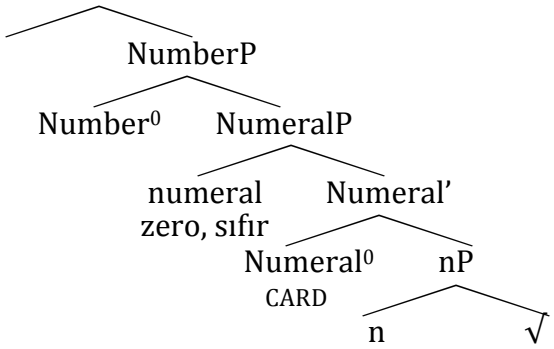
(40) Received view in the literature is that *çocuk* 'boy' is number-neutral (Acquaviva 2005, Bale, Gagnon and Khanjian 2011a, Bliss 2004, Corbett 2000, Göksel and Kerslake 2005, Görgülü 2012, Walter 2014; cf. Ionin and Matushansky 2006)

(41) Sağ (2016, 2017) and Martí (under review): but the cases where a number-neutral interpretation for *çocuk* obtains are always cases where incorporation has taken place. So, number-neutrality derives from incorporation. *Çocuk* 'boy' is singular

(42) Turkish *çocuklar* 'boys' as plural/non-minimal ((39)b) (Görgülü 2012), but raises question of whether Turkish plurals have inclusive readings, and, if they do (Renans *et al*. 2017, Sağ 2017), what this means for this proposal (cf. Martí to appear)

4 Back to *zero*

(43)



(44) [[nP]] = {⊥, a, b, c, ab, ac, bc, abc}

(45) Non-nominal predicates (*in the text*, *passed the test*) still need an operator to deliver the correct semantics; I follow Bylinina and Nouwen's proposal

(46) Atoms in full lattices: Let L have a bottom element ⊥. An element x of L is an atom iff ⊥ < x and there exists no element y of L such that ⊥ < y < x

(47) Atoms now have proper parts, but the only proper part of an atom is ⊥

(48) ⊥ is not an atom and has no proper parts

(49) There is a domain of entities, D_{at}, that contains only atoms: for all individuals x, x is an atom iff $x \in D_{at}$ (D_{at} = {a, b, c})
There is a domain of entities, $D_{\neg at}$, that contains only non-atoms: for all individuals x, x is a non-atom iff $x \in D_{\neg at}$ ($D_{\neg at}$ = {⊥, ab, bc, ac, abc})

English

(50) Since ⊥ is not an atom, what [+atomic] did before is what [+atomic] does now:
[[+atomic]]({⊥, a, b, c, ab, ac, bc, abc}) = [[+atomic]]({a, b, c, ab, ac, bc, abc}) = {a, b, c}

(51) Since ⊥ is a non-atom, the effect of [−atomic] is different:
[[−atomic]]({⊥, a, b, c, ab, ac, bc, abc}) = {⊥, ab, bc, ac, abc} ≠
[[−atomic]]({a, b, c, ab, ac, bc, abc}) = {ab, bc, ac, abc}

(52) [+atomic] spelled out as ∅, [−atomic] spelled out as *-s*
a. [[[+atomic] [$_{nP}$ boy]]] = λx. [[[$_{nP}$ boy]]](x) and atom(x) → ✔*boy*
b. [[[−atomic] [$_{nP}$ boy]]] = λx. [[[$_{nP}$ boy]]](x) and ¬atom(x) → ✔*boys*
c. #[[[+atomic] two CARD [$_{nP}$ boy]]] → ✖*two boy*
d. [[[−atomic] two CARD [$_{nP}$ boy]]] = λx. [[[$_{nP}$ boy]]](x) & card(x) = 2 → ✔*two boys*
e. [[[+atomic] one CARD [$_{nP}$ boy]]] = λx. [[[$_{nP}$ boy]]](x) & card(x) = 1 → ✔*one boy*
f. #[[[−atomic] one CARD [$_{nP}$ boy]]] → ✖*one boys*
g. [[zero CARD [$_{nP}$ boy]]] (= {⊥})
h. #[[[+atomic] zero CARD [$_{NP}$ boy]]] (= ∅) → ✖*zero boy*
i. [[[−atomic] zero CARD [$_{NP}$ boy]]] (= {⊥}) → ✔*zero boys*

English: same results as before, and *zero* with plural noun because only [−atomic] combined with ⊥ is well-formed

(53) Bare plurals: the **E**-operator (as in Bylinina and Nouwen)

(54) An *at least* semantics for all numerals, which is obligatorily exhaustified in the case of *zero* to avoid a tautology, as in Bylinina and Nouwen

Turkish
(55) [[+minimal]] = λPλx. P(x) & ¬∃y P(y) & y<x (without proper parts)
[[−minimal]] = λPλx. P(x) & ∃y P(y) & y<x (with proper parts)

(56) Since ⊥ has no proper parts but atoms now do, the effect of [+minimal] is different:
[[+minimal]]({⊥, a, b, c, ab, ac, bc, abc}) = {⊥} ≠
[[+minimal]]({a, b, c, ab, ac, bc, abc}) = {a, b, c}

(57) Since ⊥ has no proper parts but atoms now do, the effect of [−minimal] is different:
[[−minimal]]({⊥, a, b, c, ab, ac, bc, abc}) = {a, b, c, ab, ac, bc, abc } ≠
[[−minimal]]({a, b, c, ab, ac, bc, abc}) = {ab, ac, bc, abc}

(58) [±minimal] reformulated with the **E**-operator

(59) [[+minimal]] = λPλx. P(x) & ¬**E**y P(y) & y<x (without proper parts other than ⊥)
[[−minimal]] = λPλx. P(x) & **E**y P(y) & y<x (with proper parts other than ⊥)

(60) [[+minimal]]([[nP]]) = λx. [[nP]](x) & ¬**E**y [[nP]](y) & y<x (={⊥, a, b, c})
[[−minimal]]([[nP]]) = λx. [[nP]](x) & **E**y [[nP]](y) & y<x (={ab, ac, bc, abc})

(61) [+minimal] spelled out as ∅, [−minimal] spelled out as *-lar*

a. [[[+minimal] [$_{nP}$ çocuk]]] = λx. [[[$_{nP}$ çocuk]]](x) &
¬**E**y [[[$_{nP}$ çocuk]]](y) & y<x → ✔*çocuk*

b. [[[−minimal] [$_{nP}$ çocuk]]] = λx. [[[$_{nP}$ çocuk]]](x) &
Ey [[[$_{nP}$ çocuk]]](y) & y<x → ✔*çocuklar*

c. [[[+minimal] iki CARD [$_{nP}$ çocuk]]] = λx. [[iki CARD [$_{nP}$ çocuk]]](x) & (two)
¬**E**y [[iki CARD [$_{nP}$ çocuk]]](y) & y<x → ✔*iki çocuk*

d. #[[[−minimal] iki CARD [$_{nP}$ çocuk]]] → ✖*iki çocuklar*

e. [[[+minimal] bir CARD [$_{nP}$ çocuk]]] = λx. [[bir CARD [$_{nP}$ çocuk]]](x) & (one)
¬**E**y [[bir CARD [$_{nP}$ çocuk]]](y) & y<x → ✔*bir çocuk*

f. #[[[−minimal] bir CARD [$_{nP}$ çocuk]]] → ✖*bir çocuklar*

g. [[sıfır CARD [$_{nP}$ çocuk]]] (= {⊥}) (zero)

h. [[[+minimal] sıfır CARD [$_{nP}$ çocuk]]] → ✔*sıfır çocuk*

i. #[[[−minimal] sıfır CARD [$_{nP}$ çocuk]]] → ✖*sıfır çocuklar*

(62) Each of ⊥, the onesomes, the twosomes, etc. have no relevant proper parts by the time they combine with *zero*, *one*, or *two*, etc., so [+minimal] can combine with them. With [−minimal], the combination is empty

Turkish: same results as before, and *zero* with singular noun because only [+minimal] combined with ⊥ is well-formed

(63) Turkish bare plurals: **E**-operator of [−minimal] ensures only pluralities (no ⊥); ∃-operator further up the tree (**E** also works)

(64) An *at least* semantics for all numerals, which is obligatorily exhaustified in the case of *zero* to avoid a tautology, as in Bylinina and Nouwen

Western Armenian

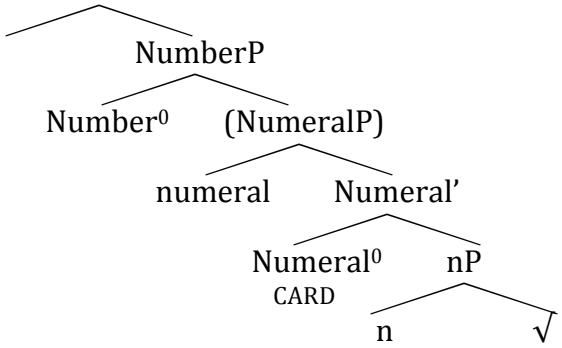
(65) Following Scontras (2014), Western Armenian = English + Turkish

(66) I.e., Western Armenian Number^0 can be occupied by either [±atomic] (→ (33)) or [±minimal] (→ (39))

(67) In addition, either Western Armenian *zero* cannot combine with nouns (syntactic restriction), or Western Armenian has no ⊥ (→ semantics of *fewer than # N VP* or *at most # N VP* different in English/Turkish and Western Armenian; they should be false if 0 n VP)

5 Semantics of roots

(68)



(69) Harbour, Martí non-committal as to the semantics of √ or the exact meaning of n, but n in Harbour converts roots into nouns

(70) Does n introduce ⊥? Is it introduced by √ instead?

(71) Non-nominal predicates also need to include ⊥ in Bylinina and Nouwen's system, so we miss a generalization if it is n, v, etc. that introduce it → √ introduces it

(72) One can assume that √ denotes kinds (e.g., √CAT denotes the set of all possible cats; cf. Chierchia 1998 and many others)—what does it mean for the kind to include ⊥? Does it help to explain kind-related phenomena? Does it hinder the understanding of kind-related phenomena?

6 Conclusions

(73) There is an independently-motivated compositional semantics account of the number morphology of nouns when modified by *zero* which derives some of the cross-linguistic patterns

(74) That account is the same as the account of the number morphology of nouns when modified by other numerals. This is the null hypothesis

(75) Harbour's NumberP, with the features that he postulates to explain the expression of grammatical number cross-linguistically

(76) Martí's account of the numeral+noun construction, couched in Harbour's system

(77) Bylinina and Nouwen's introduction of ⊥ into the semantics of count nouns, with additional associated assumptions

(78) Roots probably introduce ⊥—what does this mean for the semantics of roots? For the semantics of kinds?

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