

Zero N: number features and \perp ¹

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Comments welcome!

1 Introduction

Why does *zero* combine with morphologically plural nouns in languages like English (*zero apples* vs. **zero apple*) or Spanish? Why does it combine with morphologically singular nouns in other languages, such as Turkish and Hungarian? Why is *zero N* impossible in yet other languages, such as Western Armenian? Is this related to how the other numerals in the language combine with nouns? In this squib I show that there is an independently-justified, compositional semantics answer to these questions that combines Martí's (2017a) account of the morphology and semantics of the numeral+noun construction, based on Harbour's (2014) number features and on Scontras (2014), and Bylinina and Nouwen's (2017) semantics for *zero*. I show that once these assumptions are in place, the number marking on the noun that accompanies *zero* falls out without further stipulation. Given that Martí (2017a) shows that a Sauerland-style approach to plurality (Sauerland 2003) is not necessary in the account of the morphology and semantics of the numeral+noun construction (Martí 2017b, building on Farkas and de Swart 2010, shows it is not necessary in the account of plurality more generally), this squib also shows that a Sauerland-style approach to plurality is not necessary in the account of the properties of *zero N*, contra Bylinina and Nouwen (2017).

2 Number marking on nouns: data

One well-known and cross-linguistically common pattern, illustrated for English below, requires the use of a morphologically plural noun in the numeral²+noun construction with all numbers distinct from 1 (cf. Borer 2005, Krifka 1989):

(1) One *apple*/apples***

Zero/two/fifty-five **apples**/***apple**

A second attested pattern, illustrated for Turkish below, requires the use of a morphologically singular noun for all numbers in this construction (see Bale, Gagnon and Khanjian 2011, Martí 2017a, Scontras 2014):

(2) Turkish

Sıfır/bir/üç/yirmi üç **çocuk**/***çocuk-lar**
Zero/one/three/twenty-three boy.SG/boy-PL
'Zero/one/three/twenty-three boy(s)'

¹ Thanks to Klaus Abels and Nilüfer Şener.

² I focus on cardinals in this discussion and put aside decimals, ordinals, and fractions.

A third pattern is illustrated by Western Armenian. In Western Armenian, *zero N* is ungrammatical, (3)a, whether the accompanying noun is morphologically singular or plural (Bale and Khanjian 2014: 5, ft. 4), even though numerals greater than 1 usually allow both options, (3)c (Bale, Gagnon and Khanjian 2011, Donabédian 1993, Sigler 1997):

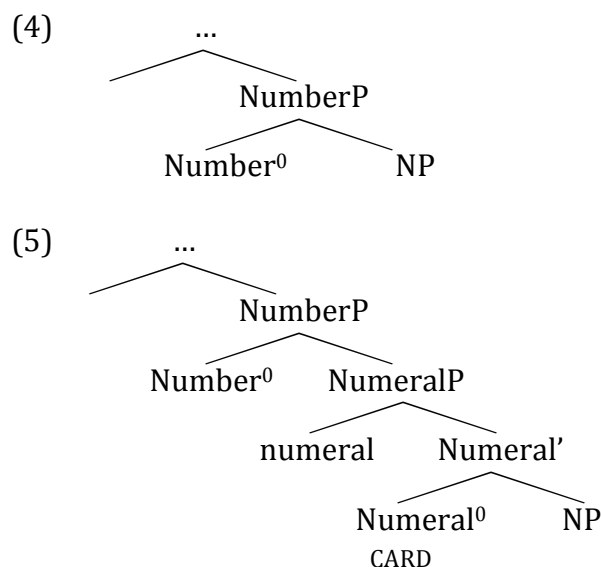
- (3) *Western Armenian*
- a. *Zero **dəgha/dəgha-ner** ‘Zero boys’
 - b. Meg **dəgha/*dəgha-ner**
 one boy.SG/boy-PL ‘One boy’
 - c. Yergu **dəgha/dəgha-ner**
 two boy.SG/boy-PL ‘Two boys’

Any account of these facts should explain why *one* is special in English and Western Armenian, but not in Turkish, why *zero* is special in Western Armenian but not in English or Turkish, and why different languages make different number marking choices for numerals other than *one* (cf. (3)c with its counterparts in the other languages). Additionally, such an account needs to get the semantics of the numeral+noun construction right in all of these cases. It is to these challenges that we now turn.

3 Martí’s (2017a) account of the numeral+noun construction

The first ingredient of the explanation proposed below is Martí’s (2017a) account of the pattern in (1)-(3) minus the *zero* facts. Once this account is combined with the semantics of *zero* in Bylinina and Nouwen (2017), introduced in section 4, the full pattern illustrated in (1)-(3) follows without further assumption.

Martí’s (2017a) account of the numeral+noun construction is as follows. First, she assumes the following syntax; (4) is for noun phrases without numerals, (5) is for phrases with numerals (‘...’ indicates that other material is possible higher in the tree)(cf. Borer 2005, Harbour 2014, Scontras 2014, and many others):



NP in both (4) and (5) denotes a join semilattice ([[*N]] in Link's 1983 terms) in all cases. For just three individuals, a, b, and c, we have:

$$(6) \text{[[NP]]} = \{a, b, c, ab, ac, bc, abc\}$$

NumeralP is realized only in (5), with the numeral (*one, two, etc.*) generated as its specifier. Numeral⁰ hosts Scontras' (2014) cardinality predicate (cf. Hackl 2001, and others), in (7), a function which takes a predicate P, furnished by NP, and a number n, furnished by the numeral, and returns a new predicate such that each of its members is in P and is constituted of exactly n atoms:

$$(7) \text{[[CARD]]} = \lambda P \lambda n \lambda x. P(x) \ \& \ \#x = n$$

For example:

$$(8) \text{[[two CARD NP]]} = \lambda x. \text{[[NP]]}(x) \ \& \ \#x = 2$$

NumberP is the projection of number features, which, following Harbour (2014), are both semantically contentful and relevant morpho-syntactically. This projection is realized in both trees, given that it is necessary in the account of number marking found in noun phrases both with and without a numeral. The semantics for the number features we need, [\pm atomic] and [\pm minimal], from Harbour (2011, 2014), is as follows³:

$$(9) \text{[[+atomic]]} = \lambda P \lambda x. P(x) \ \& \ \text{atom}(x) \\ \text{[[-atomic]]} = \lambda P \lambda x. P(x) \ \& \ \neg \text{atom}(x)$$

$$(10) \text{[[+minimal]]} = \lambda P \lambda x. P(x) \ \& \ \neg \exists y P(y) \ \& \ y < x \\ \text{[[-minimal]]} = \lambda P \lambda x. P(x) \ \& \ \exists y P(y) \ \& \ y < x$$

The feature [\pm atomic] is sensitive to the atomic nature of the members of [[NP]], in (6), as follows:

$$(11) \text{[[+atomic]]}(\text{[[NP]])} = \lambda x. \text{[[NP]]}(x) \ \& \ \text{atom}(x) = \{a, b, c\} \\ \text{[[-atomic]]}(\text{[[NP]])} = \lambda x. P(x) \ \& \ \neg \text{atom}(x) = \{ab, ac, bc, abc\}$$

[\pm Minimal] is sensitive to whether the members of the denotation of NP have ([-minimal]) or do not have ([+minimal]) proper parts:

$$(12) \text{[[+minimal]]}(\text{[[NP]])} = \lambda x. \text{[[NP]]}(x) \ \& \ \neg \exists y \text{[[NP]]}(y) \ \& \ y < x = \{a, b, c\} \\ \text{[[-minimal]]}(\text{[[NP]])} = \lambda x. \text{[[NP]]}(x) \ \& \ \exists y \text{[[NP]]}(y) \ \& \ y < x = \{ab, ac, bc, abc\}$$

Perhaps surprisingly, [\pm atomic] and [\pm minimal] give rise to the same result in the basic case. However, Harbour (2011) shows that [\pm atomic] and [\pm minimal] come apart in a number of interesting cases, including pronominal systems with

³ These denotations are simplified here in ways that don't affect matters in an important way. See Martí (2017a) for more on this.

an exclusive and inclusive first person distinction (where $[[+atomic]](P) \neq [[+minimal]](P)$), number systems with a dual (which combine the two features, so that dual is $[[+minimal]]([[−atomic]](P))$), and number systems with a trial (where $[\pm minimal]$ repeats, so that trial is $[[+minimal]]([[−minimal]]([[−atomic]](P)))$). Martí (2017a) argues that one further case where $[\pm atomic]$ and $[\pm minimal]$ come apart is precisely in their combination with numerals, as shown below.

Her account for English is as follows (cf. Scontras 2014), a language in which $[+atomic]$ is realized as \emptyset and $[-atomic]$ is realized as $-s$:

(13)

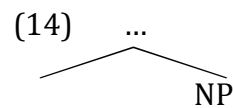
- a. $[[[+atomic] *boy]] = \lambda x. [[*boy]](x) \text{ and } atom(x) \rightarrow boy$
- b. $[[[-atomic] *boy]] = \lambda x. [[*boy]](x) \text{ and } \neg atom(x) \rightarrow boys$
- c. $\#[[+atomic] two \text{ CARD } *boy]] \rightarrow *two \text{ boy}$
- d. $[[[-atomic] two \text{ CARD } *boy]] = \lambda x. [[*boy]](x) \ \& \ card(x) = 2 \rightarrow two \text{ boys}$
- e. $[[[+atomic] one \text{ CARD } *boy]] = \lambda x. [[*boy]](x) \ \& \ card(x) = 1 \rightarrow one \text{ boy}$
- f. $\#[[-atomic] one \text{ CARD } *boy]] \rightarrow *one \text{ boys}$

(13)a is the only source for *boy*, and it gives rise, correctly, to a singular semantics for this noun phrase. (13)b gives rise to the form *boys* and assigns it an exclusive semantics, more on which below. (13)c is ill-formed, as there are no atoms in a set of plural individuals each of which is constituted of exactly two atoms (or ‘twosomes’, for short). It is also the only source of *two boy*, so *two boy* is ungrammatical. (13)d is the only source for *two boys* and gives rise, correctly, to a set of boy twosomes as its semantics. (13)e is the only well-formed source for *one boy*, and it also gives rise to the correct semantics. (13)f is ill-formed, since $[[one \text{ CARD } NP]]$ is a set of atoms, and $[-atomic]$ cannot combine with it. It is the only source for *one boys*, which is thus predicted to be ungrammatical. Notice that the denotation of NP is assumed to be as in (6) in all cases, contra Scontras (2014)—whether the noun surfaces in its singular or plural form is determined by the interaction of that denotation with the semantics of the Number⁰ and Numeral⁰ heads in (13). Notice that the English use of morphologically singular and plural forms in this paradigm follows here from an interaction between morphological and semantic assumptions. More precisely, that numerals greater than 1 combine with morphologically plural nouns in English follows from the fact that only in the case of such numerals does $[[numeral \text{ CARD } *boy]]$ satisfy the requirements of $[-atomic]$. *One*, on the other hand, is the only numeral where $[[numeral \text{ CARD } *boy]]$ satisfies $[+atomic]$ —this is how its special status in English is derived.

$[-Atomic]$ generates only an exclusive semantics for plural forms in English, as we saw in (13)b, where exclusive plurals are concerned with non-atoms only, and inclusive plurals are concerned with both atoms and non-atoms. As is well-known, English has both inclusive and exclusive plurals, so a legitimate question is how inclusive plurals are to be accounted for in an analysis like (13). One popular analysis, proposed by Sauerland (2003)⁴ and which Scontras (2014)

⁴ Many others have made similar proposals. See Krifka (1989, 1995), Lasersohn (1998, 2011), Sauerland, Anderssen and Yatsushiro (2005), Spector (2007), Yatsushiro, Sauerland and

uses in his analysis, takes it that singular features presuppose singularity and plural features are semantically vacuous. In this analysis, there isn't a feature like [-atomic] alongside [+atomic] that generates an exclusive reading for plural forms. Instead, plural forms are always semantically weak, with exclusive, stronger readings arising pragmatically. I call this and related analyses the Sauerland-style view of plurality in what follows. Martí (2017b) has shown, however, that this view of plurality is incompatible with Harbour (2011, 2014). However, as suggested by Martí (2017a) and shown above, it is precisely Harbour's features that we are using in the account of the numeral+noun construction—one important reason for doing so is that it makes the account more principled (for details of this argument, see Martí 2017a). Thus abandoning the Sauerland-style view of plurality, Martí (2017a) shows that it is possible to account for the number marking and semantics of the numeral+noun construction in English *and* for its exclusive and inclusive plurals by assuming that plural forms are ambiguous in English between an exclusive, [-atomic]-based semantics, and an inclusive semantics. In this approach, inclusive plurals in English arise from the possibility in this language not to generate NumberP in numeral-less noun phrases. (14) is the syntax of inclusive plurals:



English has both inclusive and exclusive plurals because plural forms in this language can spell out either (14) (which gives rise to $[[*boy]] = \lambda x. [[*boy]](x)$) or (4) (with [-atomic], as in (13)b). The choice between the two is regulated, as in Farkas and de Swart (2010), by the Strongest Meaning Hypothesis. Readers not convinced that the ambiguity approach of Martí (2017a) and others is the right approach to exclusive and inclusive plurality can take the analysis presented here as a demonstration that the Sauerland-style view of plurality is not necessary in the account of the full pattern in (1)-(3). The account proposed here works with either approach to plurality.

Martí's (2017a) analysis of the Turkish pattern (minus the *zero* facts) in (2) is as follows. Turkish is a [\pm minimal] system in this account: [+minimal] spells out as \emptyset and [-minimal] spells out as *-lar*. We thus have:

- (15)
- a. $[[[+minimal] *çocuk]] = \lambda x. [[*boy]](x) \ \& \ \neg \exists y [[*boy]](y) \ \& \ y < x \ \rightarrow \ \textit{çocuk}$
 - b. $[[[-minimal] *çocuk]] = \lambda x. [[*boy]](x) \ \& \ \exists y [[*boy]](y) \ \& \ y < x \ \rightarrow \ \textit{çocuklar}$
 - c. $[[[+minimal] \textit{iki CARD *çocuk}]] = \lambda x. [[\textit{iki CARD *çocuk}]](x) \ \& \ \neg \exists y [[\textit{iki CARD *çocuk}]](y) \ \& \ y < x \ \rightarrow \ \textit{iki çocuk}$
 - d. $\#[[-minimal] \textit{iki CARD *çocuk}]] \ \rightarrow \ \textit{* iki çocuklar}$
 - e. $[[[+minimal] \textit{bir CARD *çocuk}]] = \lambda x. [[\textit{bir CARD *çocuk}]](x) \ \& \ \neg \exists y [[\textit{bir CARD *çocuk}]](y) \ \& \ y < x \ \rightarrow \ \textit{bir çocuk}$
 - f. $\#[[-minimal] \textit{bir CARD * çocuk}]] \ \rightarrow \ \textit{* bir çocuklar}$

Alexiadou (2017) and Zweig (2009); cf. Farkas and de Swart (2010) and Grimm (2012). Kiparsky and Tonhauser (2012) provide a useful overview of the main issues.

(15)a and (15)b result in a singular semantics for *çocuk* ‘boy’, and an exclusive plural semantics for *çocuklar* ‘boys’, as desired. As Harbour (2011) notes, and as noted above, [\pm atomic] would have given the same result (see (13)a and (13)b). However, we obtain a different result in combination with numerals. For *iki çocuk* ‘two boys’ in (15)c, we obtain a set of boy twosomes (they have no proper subparts in [[*iki* CARD **çocuk*]], which contains only boy twosomes). This is the only possible source for *iki çocuk*, so its correct morphology and semantics are derived. (15)e denotes a set of boy individuals composed of exactly one atom, these atomic boy individuals having no proper subparts in [[*bir* CARD **çocuk*]] (which contains only boy atoms). This is the only possible source for *bir çocuk* ‘one boy’. [-Minimal] never gives rise to a well-formed result when combined with a numeral, as shown in (15)d and (15)f, since [-minimal] selects from its input P those individuals that have proper subparts in P, and there are no such subparts in [[*iki* CARD **çocuk*]], [[*bir* CARD **çocuk*]], etc. Thus, that all numerals combine with morphologically singular nouns in Turkish follows from the fact that, for any numeral, [[numeral CARD *boy]] satisfies the requirements of only [+minimal], not [-minimal].

For Western Armenian, Martí (2017a), following Scontras, assumes that either [\pm atomic], giving rise to the English pattern, or [\pm minimal], giving rise to the Turkish pattern, may be generated in Number⁰. In either case, morphologically plural nouns for the numeral *one* are ruled out.

To summarize. The *zero-less* pattern in (1)-(3) follows in Martí’s (2017a) system from the semantics of Harbour’s (2011, 2014) [\pm atomic] and [\pm minimal] and their spell out as \emptyset vs. *-s/-lar/-ner* and Martí’s (2017b) Harbour-based analysis of exclusive and inclusive plurality. I now explain Bylinina and Nouwen’s (2017) semantics for *zero* which, when added to this set of assumptions, will derive the full pattern in (1)-(3).

4 Bylinina and Nouwen’s (2017) semantics for *zero*

Bylinina and Nouwen (2017) argue that *zero* is not a more emphatic version of the negative quantifier *no*. *Zero* and *no* differ in distribution ((16)-(18)), polarity ((19)-(23)) and ability to license NPIs ((24)-(28)), and in split scope ((29)-(30)):

- (16) John owns four cars. Bill owns zero (*ones)
 John owns four cars. Bill owns thirteen (*ones)
 John owns four cars. Bill owns *no/none
- (17) There are zero/thirteen/??no litres of milk in the fridge
- (18) John visited his grandmother zero/thirteen/??no times
- (19) John doesn’t love her, does/*doesn’t he?
- (20) John loves her, *does/doesn’t he?
- (21) No students love her, do/*don’t they?
- (22) Most students love her, *do/don’t they?
- (23) Zero people love her, *do/don’t they? (De Clercq 2011)
- (24) No student has visited me in years

- (25) *Zero students have visited me in years
 (26) No student said anything
 (27) ?Zero students said anything (Gajweski 2011)
 (28) *Zero students bought any car (Zeiljstra 2007)
- (29) The company has fire no employees (Potts 2000)
 #‘It is not the case that the company is obligated to fire an employee’
- (30) The company has fire zero employees
 ‘It is not the case that the company is obligated to fire an employee’

Instead, they argue for a treatment of *zero* in which, just like other numerals, it denotes a number, 0, what we want from the perspective of the proposal in section 3. Bylinina and Nouwen propose that the denotation of count nouns is not a (join) semilattice, as is standardly assumed, but a full lattice, which includes the bottommost element, \perp , as well. \perp is of cardinality 0 and has no proper parts. Their proposal is to reconsider our view of pluralization as full lattice formation. (6), repeated here, is replaced with (32):

- (31) $[[NP]] = \{a, b, c, ab, ac, bc, abc\} (= [[*N]])$
 (32) $[[NP]] = \{\perp, a, b, c, ab, ac, bc, abc\} (= [[*N]])$

The truth-conditions for a sentence like (33), instead of being those in (34), are now those in (35), where the new version of pluralization is assumed to apply to predicates other than count nouns (e.g., *in the text*) as well:

- (33) There are typos in the text
 (34) $\exists x [*typo(x) \ \& \ *in_the_text(x)]$
 (35) $\exists x [*typo(x) \ \& \ *in_the_text(x)]$

One important issue that Bylinina and Nouwen address is that, while (34) states that there is at least one typo in the text, correctly, (35) is a tautology, since we now have that, for any predicate P, $P(\perp) = 1$. The same holds for the numeral+noun construction:

- (36) Zero students passed the test
 (37) $\exists x [\#x = 0 \ \& \ *student(x) \ \& \ *pass_the_test(x)]$

(37) is always true, independently of the number of students who passed the test, since one can always decide that $x = \perp$. In informal terms, the problem is that the truth-conditions for (37) are predicted to be those of *zero or more students passed the test*, which can never be falsified.

The solution proposed for (36) is to note that the semantics that this view provides for numerals is an *at least* semantics, and that exhaustification can generate the required stronger, *exactly* readings. The idea is as follows. Given the truth-conditions in (37), statements with other numerals (“one or more”, “two or

more”) are stronger. Uttering (36) signals that those stronger statements are false. We thus have, for (36):

$$(38) \neg\exists y [\#y > 0 \text{ } ^* \text{student}(x) \ \& \ ^* \text{pass_the_test}(x)]$$

Taken together, (37) and (38) result in an *exactly* reading: there are zero or more students who passed the test, and there are no more than zero students who passed the test—so exactly zero did. Unlike other numerals, exhaustification is obligatory for *zero*, since no exhaustification leads to a defective, tautological interpretation. And, since the semantics of *zero* is not stronger in downward-entailing environments (the negation of a tautology is a contradiction), the *exactly* implicature still obtains in such contexts (cf. *Nobody read zero books*). In fact, an *at least* semantics is what the accounts in Martí (2017a) and Scontras (2014) generate for numerals—so it is no problem for these accounts to adopt Bylinina and Nouwen’s solution.

The solution the more general problem that arises in (33) is to assume that the existential quantifier that operates on statements without numerals is not classical \exists but \mathbf{E} , as in (39). This takes into account the fact that the denotations of nouns now include \perp and results in the contingent (40) for (33):

$$(39) \mathbf{E}x[\varphi] \Leftrightarrow \exists x[\#x > 0 \ \& \ \varphi]$$

$$(40) \mathbf{E}x [^* \text{typo}(x) \ \& \ ^* \text{in_the_text}(x)]$$

While Bylinina and Nouwen (2017), following Hackl (2001), assume that a *MANY* predicate, as in (41), introduces \exists -quantification and combines numerals and predicates, Scontras and Martí, as discussed in section 3, assume that \exists -quantification is introduced elsewhere in the structure (cf. *CARD* in (7)):

$$(41) [[\text{MANY}]] = \lambda n \lambda P \lambda Q. \exists x \text{ } ^* P(x) \ \& \ ^* Q(x) \ \& \ \#x = n$$

This difference does not have consequences for us. It is still the case in both views that the distribution of the \exists and \mathbf{E} operators (\exists for numerals, \mathbf{E} in other cases) needs to be properly understood. Embedding the \exists -operator as part of the semantics of *MANY*, as in (41), does not change that. Below, I assume (7) and the \exists -operator for numerals, and the \mathbf{E} -operator for noun phrases without numerals.

It will be important in the analysis in section 5 to bear in mind the following. In full lattices, atoms are defined as follows (see Davey and Priestley 2002: 113):

$$(42) \text{ Let } L \text{ have a bottom element } \perp. \text{ An element } x \text{ of } L \text{ is an atom iff } \perp < x \text{ and there exists no element } y \text{ of } L \text{ such that } \perp < y < x$$

That is, in a full lattice, \perp is not an atom. That’s because \perp does not have \perp as a proper part, since $\perp = \perp$. If it is not an atom, then it is a non-atom. \perp has no proper parts, since the only part \perp has is \perp itself, and $\perp = \perp$.

5 The morphology and semantics of *zero N*

Given these assumptions, the account for the full pattern in (1)-(3) is as follows. For English, to the derivations in (13), repeated as (43)a-(43)f, we add (43)h and (43)i:

- (43)
- a. $[[[+atomic] \textit{*boy}]] = \lambda x. [[\textit{*boy}]](x)$ and $\textit{atom}(x) \rightarrow \textit{boy}$
 - b. $[[[-atomic] \textit{*boy}]] = \lambda x. [[\textit{*boy}]](x)$ and $\neg \textit{atom}(x) \rightarrow \textit{boys}$
 - c. $\#[[+atomic] \textit{two CARD *boy}]] \rightarrow \textit{*two boy}$
 - d. $[[[-atomic] \textit{two CARD *boy}]] = \lambda x. [[\textit{*boy}]](x) \ \& \ \textit{card}(x) = 2 \rightarrow \textit{two boys}$
 - e. $[[[+atomic] \textit{one CARD *boy}]] = \lambda x. [[\textit{*boy}]](x) \ \& \ \textit{card}(x) = 1 \rightarrow \textit{one boy}$
 - f. $\#[[-atomic] \textit{one CARD *boy}]] \rightarrow \textit{*one boys}$
 - g. $[[\textit{zero CARD *boy}]] (= \{ \perp \})$
 - h. $\#[[+atomic] \textit{zero CARD *boy}]] (= \emptyset) \rightarrow \textit{*zero boy}$
 - i. $[[[-atomic] \textit{zero CARD *boy}]] (= \{ \perp \}) \rightarrow \textit{zero boys}$

Notice, first, that using $[[\textit{*boy}]]$ instead of $[[\textit{*boy}]]$ does not change our earlier results. To see this for a case with just three individuals *a*, *b* and *c*, together with \perp , we have:

$$(44) \quad [[[+atomic]]] (\{ \perp, a, b, c, ab, ac, bc, abc \}) = [[[+atomic]]] (\{ a, b, c, ab, ac, bc, abc \}) \\ = \{ a, b, c \}$$

That is, \perp is not an atom. We do obtain a different result with $[-atomic]$, of course:

$$(45) \quad [[[-atomic]]] (\{ \perp, a, b, c, ab, ac, bc, abc \}) = \{ \perp, ab, bc, ac, abc \} \neq \\ [[[-atomic]]] (\{ a, b, c, ab, ac, bc, abc \}) = \{ ab, bc, ac, abc \}$$

This is unproblematic, however. Exclusive plurals as in (43)b (and inclusive ones) now include \perp , but the solution Bylinina and Nouwen invoke in (40) applies here. In (43)c/(43)d and (43)e/(43)f, since $|\perp| = 0$, \perp is neither in $[[\textit{two CARD *boy}]]$ nor in $[[\textit{one CARD *boy}]]$, so the results when the number features get added is as before.

For English *zero*, we have the following. Just as it was the case for sets of non-atoms, the only member of the set containing $\{ \perp \}$, which arises from (43)g, does not satisfy the requirements of $[+atomic]$ ((43)h): \perp is not an atom. If \perp is not an atom, then it is a non-atom, so (43)g satisfies the requirements of $[-atomic]$ ((43)i). Thus, the reason why with both *zero* and any numeral greater than 1 English uses the plural morphological marker on the noun is the same: both non-atoms and \perp are non-atoms. For Turkish, to the derivations we had in (15), we add (46)h and (46)i:

(46)

- a. $[[[+minimal] \text{ }^* \text{çocuk}]] = \lambda x. [[\text{ }^* \text{çocuk}]](x) \ \& \ \neg \exists y [[\text{ }^* \text{çocuk}]](y) \ \& \ y < x$
 $\rightarrow \text{çocuk}$
- b. $[[[-minimal] \text{ }^* \text{çocuk}]] = \lambda x. [[\text{ }^* \text{çocuk}]](x) \ \& \ \exists y [[\text{ }^* \text{çocuk}]](y) \ \& \ y < x$
 $\rightarrow \text{çocuklar}$
- c. $[[[+minimal] \text{ iki CARD } \text{ }^* \text{çocuk}]] = \lambda x. [[\text{ iki CARD } \text{ }^* \text{çocuk}]](x) \ \&$
 $\neg \exists y [[\text{ iki CARD } \text{ }^* \text{çocuk}]](y) \ \& \ y < x \rightarrow \text{iki çocuk}$
- d. $\#[[-minimal] \text{ iki CARD } \text{ }^* \text{çocuk}]] \rightarrow \text{* iki çocuklar}$
- e. $[[[+minimal] \text{ bir CARD } \text{ }^* \text{çocuk}]] = \lambda x. [[\text{ bir CARD } \text{ }^* \text{çocuk}]](x) \ \&$
 $\neg \exists y [[\text{ bir CARD } \text{ }^* \text{çocuk}]](y) \ \& \ y < x \rightarrow \text{bir çocuk}$
- f. $\#[[-minimal] \text{ bir CARD } \text{ }^* \text{çocuk}]] \rightarrow \text{* bir çocuklar}$
- g. $[[\text{ sıfır CARD } \text{ }^* \text{çocuk}]] (= \{ \perp \})$
- h. $[[[+minimal] \text{ sıfır CARD } \text{ }^* \text{çocuk}]] (= \{ \perp \}) \rightarrow \text{sıfır çocuk}$
- i. $\#[[-minimal] \text{ sıfır CARD } \text{ }^* \text{çocuk}]] (= \emptyset) \rightarrow \text{* sıfır çocuklar}$

Again, notice that using $[[\text{ }^* \text{çocuk}]]$ instead of $[[\text{ }^* \text{çocuk}]]$ does not change our earlier results. To see this for a case with just three individuals a, b and c, together with \perp , we have:

$$(47) \quad [[[-minimal]]](\{ \perp, a, b, c, ab, ac, bc, abc \}) = [[[-minimal]]](\{ a, b, c, ab, ac, bc, abc \}) = \{ ab, ac, bc, abc \}$$

That is, since \perp has no proper parts, it is minimal. We do obtain a different result with $[+minimal]$, of course:

$$(48) \quad [[[+minimal]]](\{ \perp, a, b, c, ab, ac, bc, abc \}) = \{ \perp, a, b, c \} \neq \\ [[[+minimal]]](\{ a, b, c, ab, ac, bc, abc \}) = \{ a, b, c \}$$

As before, this is harmless. The denotation of morphologically singular nouns in (46)a now includes \perp , but, again, the same solution Bylinina and Nouwen invoke for bare plurals in English works here. In (46)c/(46)d and (46)e/(46)f, since $|\perp| = 0$, \perp is neither in $[[\text{ iki CARD } \text{ }^* \text{çocuk}]]$ nor in $[[\text{ bir CARD } \text{ }^* \text{çocuk}]]$, so the results when the number features get added are as before.

Turning now to the account of *zero N* in Turkish, the only member of the set containing $\{ \perp \}$ ((46)g) satisfies the requirements of $[+minimal]$, since \perp has no proper minimal parts. Thus (46)h gives rise to the correct morphology and semantics for *sıfır çocuk* ‘zero boys’. On the other hand, \perp is not non-minimal, so a set containing it cannot satisfy the requirements of $[-minimal]$, and we obtain the result in (46)i, namely, **sıfır çocuklar*. Thus, the reason why with any numeral including *zero* Turkish uses the singular morphological marker on the noun is the same: atoms, non-atoms and \perp are all subpart-less once the numeral has combined with $[\text{CARD } \text{ }^* \text{çocuk}]$.

Finally, for Western Armenian, we can assume that, while the language does have the numeral *zero* (which, as before, denotes 0 and can be used to talk about mathematical calculations, for example), its nouns never contain \perp . That is, $[[\text{NP}]]$ in Western Armenian would be $[[\text{*N}]]$, not $[[\text{*N}]]$, and the only possible

derivations for Western Armenian would be as before. If a language was just like Western Armenian but its nouns did contain \perp , then we would predict that both morphologically singular ((46)h) and plural ((43)i) nouns would be able to appear with *zero*. Another possibility, suggested by Bylinina and Nouwen (2017: ft. 1), is that the syntax of Western Armenian does not license the use of *zero* in prenominal position. Finding out which analysis is better for Western Armenian and languages like it⁵ is a matter for another time.⁶

6 Conclusion

In this squib I have proposed a semantic explanation for the pattern of number marking on nouns in the numeral+noun construction in three different languages. The reason why the N of *zero N* shows the same number marking (plural) as the noun that combines with numerals greater than 1 in English is that \perp , the bottommost element in the full lattice of N, is not an atom (like the non-atoms of English plural forms, absent with singular forms). In turn, the reason why the N of *zero N* shows the same number marking (singular) as the noun that combines with all numerals in Turkish is that \perp does not have proper parts (like the members of the denotation of Turkish singular forms, absent with plural forms). This explanation makes sense in a theory where English number is sensitive to atomicity, and Turkish number is sensitive to minimality, as argued in Martí (2017a) and Scontras (2014). The reason why in Western Armenian *zero* doesn't combine with nouns might be that nouns in this language do not include \perp in their denotation, whereas, following Bylinina and Nouwen's (2017) proposal for English, both English and Turkish nouns do.

⁵ Western Armenian is not the only language lacking a *zero* for the numeral+noun construction—e.g., Hungarian (Csirmaz and Szabolcsi 2012) or Slovenian also lack it (Lanko Marušič, p.c.).

⁶ The account of the full pattern with *zero* in (1)-(3) works in Scontras' (2014) original account as well, where, recall, Scontras' account is based on a Sauerland-style view of plurality. Scontras' original account does not make use of Harbour's features, but it is compatible with Bylinina and Nouwen's treatment of *zero*.

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