Zero degrees: numerosity, intensification, and negative polarity [*]

Sherry Yong Chen
MIT

1 Introduction

Research on numerals has always stood at the heart of degree semantics. In this paper, I focus on the analysis of one particular numeral, *zero*, which eventually brings us to several big-picture questions: Are all numerals alike? What are the challenges for a unified semantics? Furthermore, what's the analytical connection between plural and degree semantics?

These questions are motivated by some novel observations which sets *zero* apart from other numerals in three ways: (1) *zero* can directly modify certain uncountable nouns, a fact that is surprising for a numeral; (2) *zero* gives rise to intensifying effects in a way that no other numerals do; (3) *zero* licenses NPIs in certain environments (contra. Bylinina & Nouwen 2017). Based on empirical data, I offer an analysis of *zero* as a degree quantifier which explains its NPI licensing possibilities based on additional syntactic considerations, and sketches a pragmatic account of the intensifying effects. Although my data and analysis focuses on cases when *zero* modifies a nominal degree predicate, I will show that it can also be extended to cases discussed in Bylinina & Nouwen (2017), as long as we adopt Rett's (2008) semantics for plural count nouns and assume that they also have a degree argument.

2 *Zero*: some observations

Let me begin by postulating a null hypothesis that may not be immediately obvious: *zero* patterns with the negative quantifier *no* but behaves as a rather unusual numerals, at least in the environment we are about to look at. Bearing this in mind, I will first discuss some observations that seem to point us to the direction of this hypothesis.

2.1 Modifying nominal degree predicates

Zero can directly modify what I will call *nominal degree predicates*, which denote abstract concepts and typically have a degree adjective counterpart. For example:

(1)   a.   Mary has *zero/no* tolerance for betrayal.
      b.   Mary has *one tolerance for betrayal.

(2)   a.   Jack showed *zero/no* interest in physics.
      b.   Jack showed *one interest in physics.

(3)   a.   John has *zero/no* confidence in winning the game.
      b.   John has *two confidence(s) in winning the game.

(4)   a.   Anne demonstrated *zero/no* sense of fashion.
      b.   Anne demonstrated *three sense(s) of fashion.

The nominal degree predicates in (1)-(4), such as *tolerance* and *confidence*, are typically uncountable and cannot be directly modified by regular numerals, as shown in the (b) sentences. However, *zero* can combine directly with these nouns, which is somewhat surprising if *zero* is simply a numeral. In these cases, *zero* is interchangeable with the negative quantifier *no*. Intuitively, *zero* seems to be expressing the (precise) degree of a nominal predicate. The rest of the paper pursues this intuition in the framework of degree semantics.

More interesting things are going on with the modification possibilities of *zero*. Specifically, when modifying nominal degree predicates, *zero* is subject to different modification possibilities than other numerals:it is infelicitous with certain comparative expressions, such as *more than* and *over*, whereas other numerals do not show this restriction.

(5)   a. ??Mary has more than *zero* confidence in this contest.
      b.   Susan certainly has more than ten publications!

(6)   a. #Vera has over *zero* tolerance for betrayal.
      b.   Over ten students came to the lecture today.

Moreover, *zero* can be modified by *absolutely* while other numerals cannot:

(7)   a.   Naomi has absolutely *zero* interest in physics.
      b. #John purchased absolutely five jackets!

Finally, while the present paper focuses on English *zero*, cross-linguistic data also suggests that it is rather unusual as a numeral. In Brazilian Portuguese,[1] *zero* is the only numeral that can directly modify nominal degree predicate, as shown in (8a) with the noun *confiança* 'confidence':

---

[1] I thank Filipe Hisao Kobayashi for providing the data.

(8) a. Oliver tá   com (*zero*) confiança   (*zero*).
         Oliver be.3SG with zero   confidence zero
         'Oliver has zero confidence.'
     b. Maria tem   *zero* publicações (**zero*)
         Maria have.3SG zero publications zero
         'Maria has zero publications.'

Note that in (8a), *zero* can appear either pre-nominally or post-nominally, whereas in (8b), the post-nominal position is no longer possible, as is the case for all other numerals. This shows that *zero* behaves as a rather unusual numeral when modifying nominal degree predicates; instead, it patterns with *no* and adjectives.

2.2   Intensifying effects

The oddity of *zero* does not end here. In this section, I offer data which shows that *zero* can give rise to intensifying effects in a way that no other numerals do.

Let's begin with a well-known observation for intensifying effects: with typical intensifiers, the intensified form must follow the unintensified form. For example, in (9) *very good* must follow *good*, and in (10) *real close* must follow *close*:

(9) a. "He is good, *very* good," Bercow says.   (The Guardian, 2014)
     b. #"He is *very* good, good."

(10) a. (The) Iraq vote is close, *real* close.   (Politico, 2007)
     b. #The Iraq vote is *real* close, close.

Note that this ordering restriction exists more generally in various types of intensification strategies, such as reduplication, so it is not just a specific restriction on certain adverbial modifiers. In (11a), similar to the examples we have seen, the reduplicated/intensified form of the adjective must be ordered after the unintensified one; the reversed order in (11b) leads to infelicity:

(11) a. But he was crazy about her. Like *crazy crazy*. (Discretion: A Novel)
     b. #But he was *crazy crazy* about her. Like crazy.

We will not say much about the whys and hows of this ordering restriction here. Instead, I would like to point out that there is a parallel observation of our interest, namely, the ordering between *no*-NP and *zero*-NP also appears to be fixed, with *zero*-NP following *no*-NP. Plenty of naturally-occurring examples that conforms to this pattern can be found:

(12)   There is no chance, *zero* chance, that the US would be sued on something
         like our financial regulations.   (Barack Obama, 2015)

(13)   The justice department revealing it has found no evidence, *zero* evidence
         that Donald Trump tower was ever wire-tapped ...   (CNN, 2017)

(14)   We have no information – *zero* information – about the base rate prevalence
         of lying in the general public.   (Journal of Law and Health)

These data show that *zero*-NP is somehow more intensified than *no*-NP. But where
do these intensifying effects of *zero* come from?[2]

2.3 *Zero*: NPI Licensing?

Numerals normally don't license NPIs.[3] Based on the following examples in which
zero modifies a plural count noun, Bylinina & Nouwen (2017, p. 21) claim that *zero*
does not license even weak NPIs:

(17)   *No/*Zero* students ever said anything.

(18)   *No/*Zero* students bought any car.

I do not take issues with the judgement in the above example, but I want to point
out that the claim about *zero* not being able to license NPIs at all is not in fact
empirically adequate. Notice that there is a confound in all their examples: *zero*-
NP is always in the subject position and the NPI is in the nuclear scope of *zero*.
I would like to point out that even when modifying plural count nouns, *zero* can
actually license NPIs but only in its restrictor:[4]

(19)   Julia has *no/zero* publications in anything related to linguistics.

(20)   Adding "write a book" to your to-do list will result in *no/zero* books ever
         being written.

(21)   *No/Zero* students from any European country came to the conference.

   How about the *zero* that modifies nominal degree predicates? Well, as it turns

---

[2]There's a related observation regarding the intensifying effects of *zero*: typically, the unintensi-
fied form of a degree adjective is compatible with the negation of the intensified form (Beltrama &
Bochnak, 2015):

(15)   'The tower is tall but not extremely tall.'

Interestingly, *zero* also has such an intensifier use, but only with downward monotonic degree ad-
jectives (i.e. "antonymous adjectives" that are on a "reversed" scale, see Rett, 2017 and Morzycki,
2009), as if it is *itself* the intensified form of these adjectives:

(16)   a *small but not zero* chance of success; *low but not zero* risk; *weak but not zero*.

This set of data raises further questions: numerals don't conjoin with most adjectives, but why is
zero singled out in the above cases? I will not go into a detailed analysis of these facts to space limit.

[3]For discussions about *exactly n* with low numerals licensing NPIs in restricted environments,
see Linebarger (1987), Gajewski (2008), and Crnič (2014), a.o.

[4]I thank Roger Schwarzschild and Irene Heim for pointing out some of the initial observations
and discussing them with me.

out, this *zero* seems to be able to license (weak) NPIs in both its restrictor (22a-c) and nuclear scope (23a-c). The paradigm in provided below:

(22)   a.   There is *no/zero* tolerance for any lying, stealing, or cheating.
         b.   Kara showed *no/zero* interest in anything to do with boys.
         c.   John has *no/zero* chance of ever becoming the President of the United States.

(23)   a.   *No/Zero* information was ever released to anyone outside the company.
         b.   *No/Zero* evidence ever existed proving I was wrong.
         c.   There was *no/zero* privacy anywhere in this house.

The data above present further curiosities: Why does this *zero* show more NPI licensing possibilities? What do we make of the contrast between the two *zero*s in terms of NPI licensing? In the next section, I will offer an analysis of *zero* as a degree quantifier which answers these questions.

3   The Analysis

The analytical challenge we are facing centers around the following dilemma. On the one hand, treating *zero* as a regular numeral will leave many of our observations unexplained. Specifically, why is *zero* not sensitive to the countability of the nominal degree predicate? Why can it be conjoined with adjectives, but only antonymous ones? On the other hand, if we analyze *zero* as its close cousin, the negative generalized quantifier *no*, then what do we do with the ordering restriction between *no*-NP and *zero*-NP?

Table 1 summarizes the data presented so far, highlighting the similarities and differences between the *zero* that modifies nominal degree predicates, regular numerals, and the negative quantifier *no*.

	Zero	Other numerals	No
Modifies gradable nouns	✓	✗	✓
Combines with *more than*/*over*	✗	✓	✗
Combines with *absolutely*	✓	✗	✓
Has an intensifier use	✓	✗	✗
Licenses NPIs in the restrictor	✓	✗	✓
Licenses NPIs in the nuclear scope	✓	✗	✓

Table 1: Comparison between degree-modifying *zero/numerals/no*

3.1   *Zero*: a degree quantifier

In this section, I propose a degree quantifier analysis of *zero*. The key ingredients of my proposal go as follows: I adopt the view that nominal degree predicates have a

degree argument as well as some relevant dimension of measurement baked in their semantics (Heim, 2006); Following Morzycki (2009), I analyze gradable nouns as denoting a measure function from individuals to some degree, as shown in (28). The denotation of a typical nominal degree predicate such as *information* is in (29):

(24) $[\![N_{\langle d,et \rangle}]\!] = \lambda d.\ \lambda x.\ P(x) \wedge \mu_S(x) \geqslant d$

(25) $[\![\text{information}]\!] = \lambda d.\ \lambda x.$ x is information and the amount of x is no less than d

Zero is a degree quantifier of type $\langle dt, t \rangle$. The lexical entry of *zero* is provided in (30)[5], which essentially states that the predicate *I* is false of all degrees that are greater than **0**:

(26) $[\![zero_{\langle dt,t \rangle}]\!] = \lambda P_{\langle d,t \rangle}.\ \forall d > \mathbf{0}[\neg\ I(d)]$

Having introduced the key ingredients, I now take "*zero* information was released" as a simple example to illustrate the proposed syntactic structure of a *zero*-sentence. Crucially, since N takes a degree as its argument and *zero* is a degree quantifier, *zero* will have to QR, leaving behind a trace of type *d*.
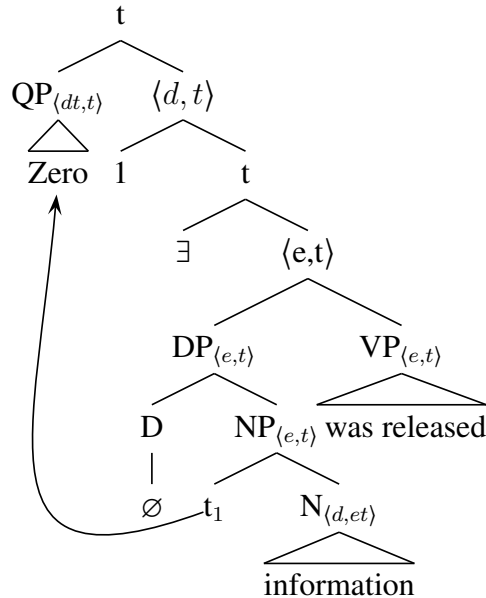
Below I adopt the overall architecture from Solt (2015) to implement the compositional analysis. Compositional rules involved here include: functional application **(FA)**, predicate modification **(PM)**, predicate abstraction **(PA)**, and **Existential Closure (∃C)** (Heim & Kratzer, 1998).

---

[5]This degree quantifier analysis of *zero* relates closely to Alrenga & Kennedy's (2014) analysis of NO, a negative element assumed in their analysis of comparative clauses: $[\![\text{NO}_{max}]\!] = \lambda P_{\langle d,t \rangle}.\ max(P) = \mathbf{0}$. Thank you to Reviewer #3 for pointing this out.

$[\![[_{DP} \varnothing\ t_1\ \text{information}]]\!] = [\![N]\!]\ (d_1)$

$= \lambda x.\ \text{information}(x) \wedge \mu_S(x) \geqslant d_1$ **by FA**

$[\![[_{IP} \varnothing\ t_1\ \text{information was released}]]\!] = ([\![t_1\ \text{information}]\!]\ )([\![\text{was released}]\!]\ )$

$= \lambda x.\ \text{information}(x) \wedge \mu_S(x) \geqslant d_1 \wedge \text{released}(x)$ **by PM**

$\Rightarrow \exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d_1 \wedge \text{released}(x)]$ **by ∃C**

$\Rightarrow \lambda d_1.\ \exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d_1 \wedge \text{released}(x)]$ **by PA**

$[\![_{QP}\ \text{zero}]\!] = [\![\text{zero}]\!] = \lambda I_{\langle d,t\rangle}.\ \forall d > \mathbf{0}[\neg\ I(d)]$

$[\![[_{IP}[\text{zero}][\varnothing\ t_1\ \text{information was released}]]]\!]$

$= \lambda P_{\langle d,t\rangle}.\ \forall d > \mathbf{0}[\neg\ I(d)](\lambda d_1\ \exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d_1 \wedge \text{released}(x)])$

$= \forall d > \mathbf{0}[\neg\exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d \wedge \text{released}(x)]]$ **by FA**

Given the truth condition, the sentence *zero information was released* is true *iff* the amount of information that was released is **0**. In this semantics, *zero* has and only has the *exactly* meaning, which is exactly what we find with *Zero N* but not other numerals. There is no need to postulate an additional exhaustification operation process that derives the *exactly* meaning based on the *at least* meaning, because in a sense exhaustification is already built-in.

3.2   NPI licensing revisited

Recall that we observe that the degree quantifier *zero* seems to license an NPI in both its restrictor and nulear scope[6]. I repeat two of the examples below:

(27) a. Kara showed *zero* interest in anything to do with boys.
  b. *Zero* information was ever released to anyone outside the company.

I now turn to an explanation for the NPI facts presented so far. Due to space limit, I will not be able to discuss the very sophisticated literature on NPI licensing, but will just assume the following as my starting points: (i) the condition on NPI licensing is environment based (Heim, 1984; Gajewski, 2005); (ii) (Strawson) Downward entailment (DE) is the central notion of a theory of licensing (von Fintel, 1999); (iii) DE-ness can be defined across syntactic categories. For now, these will suffice for our purpose.

Our semantics for *zero* predicts that it does create a (non-trivial) DE environment in both its restrictor and nuclear scope, as shown in the proof below:

(28) $[\![\text{important information}]\!] \subseteq [\![\text{information}]\!]$

  a. *Zero* information was released.
   $\Rightarrow$ *Zero* important information was released.

---

[6]Unlike *no*, the degree quantifier *zero* never really licenses strong NPIs, e.g. *in years*. This may suggest that *zero* is never a sentential negation like *no*.

b. $\forall d > \mathbf{0}[\neg\exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d \wedge \text{released}(x)]]$
$\Rightarrow \forall d > \mathbf{0}[\neg\exists x[\text{information}(x) \wedge \text{important}(x) \wedge \mu_S(x) \geqslant d \wedge \text{released}(x)]]$

(29) $[\![\text{student linguists}]\!] \subseteq [\![\text{linguists}]\!]$

a. *Zero* information was released to the linguists.
$\Rightarrow$ *Zero* information was released to the student linguists.

b. $\forall d > \mathbf{0}[\neg\exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d \wedge \exists y[\text{released}(y)(x) \wedge \text{lin-guist}(y)]]]$
$\Rightarrow \forall d > \mathbf{0}[\neg\exists x[\text{information}(x) \wedge \mu_S(x) \geqslant d \wedge \exists y[\text{released}(y)(x) \wedge \text{lin-guist}(y) \wedge \text{student}(y)]]]$

Note, however, if the NPI licensing ability of *zero* is entirely environment-based, this should predict that *zero* can license an NPI regardless what kind of noun it modifies, be it an uncountable gradable noun or a plural countable noun. This is not enough, and I'll return to this key contrast shortly.

Second, note that the licensing of NPIs by *zero* is – perhaps not surprisingly – subject to locality conditions and intervention effects:

(30)   a. Kara showed *zero* interest in anything to do with boys.
b. ??Kara showed *zero* interest in the lecture which has anything to do with quantum chromodynamics.   (Complex NP)
c. ??Kara showed *zero* interest in anything to do with boys and the lecture on quantum chromodynamics.   (Coordinate Structure Constraint)
d. ??Kara showed *zero* interest in every lecture that has anything to do with quantum chromodynamics.   (Intervener: *every*)

Taking these intervention effects into consideration, and in order to contrast the different NPI licensing facts between the the degree quantifier *zero* and the numeral *zero*, I argue that a structural analysis may turn out fruitful here.
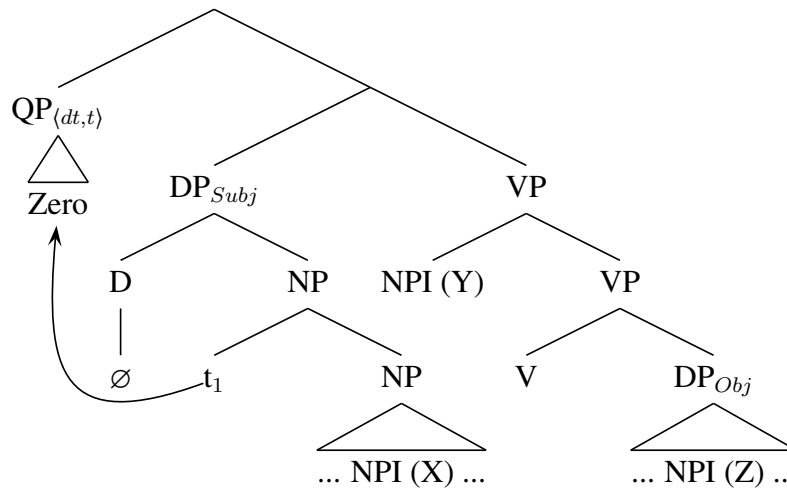
The key proposal goes as follows: the degree quantifier *zero* itself – rather than *zero*-NP – is the licensor. That is to say, *zero* licenses an NPI in the restrictor as well as the nuclear scope at LF, after QR applies[7]. As shown in (36), when *zero* is in the subject position, there are three positions in which an NPI will be licensed: X, Y, Z.

---

[7]Note that this structural analysis partly relies on the idea that QR interacts with NPI licensing. Antecedent-Contained Deletion (ACD), amongst other things, provides independent evidence for such an interaction (Merchant, 2000):

(31)   a. John didn't admit to being interested in any of the movies that Mary did.
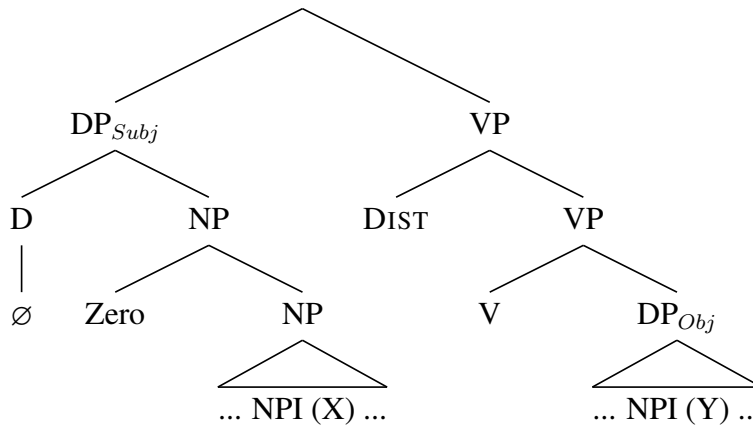b. *John denied being interested in any of the movies that Mary did.

Both sentences in (37) have an ACD site hosted by a DP projected from *any*, an NPI item. Crucially, *any*-NP has to QR for ACD resolution: in (a), it can target a VP-level landing site right below *not*; in (b), it will have to fall outside the scope of *deny* after QR applies, rendering the NPI unlicensed.

(32) $[_{TP} [_{DP} [Zero [_{NP} ... X ...]]] [_{VP} ... Y ... [_{DP} ... Z ...]]]$

```
                            QP⟨dt,t⟩
                          /        \
                    △              \
                  Zero   DP_Subj         VP
                        /      \        /    \
                      D        NP   NPI (Y)   VP
                      |       /  \           /   \
                      ∅  t₁   NP            V    DP_Obj
                            /    \              /     \
                          NP                  △        △
                     /△\          ... NPI (X) ...   ... NPI (Z) ...
```

Now, there remains one challenge in extending this analysis to the *zero* that modifies plural count noun for me: the numeral *zero* fails to license an NPI in its nuclear scope. I suggest that we can model it as a case of intervention effects. Specifically, a possible candidate we have in mind as the intervener is the distributor operator DIST, which I assume to obligatorily apply to distributive plural count nouns in the subject position.

(33)   *Zero* in the subject position: $[_{TP} [_{DP} [Zero [_{NP} ... X ...]]]$ DIST $[_{VP} ... [_{DP} ... Y ...]]]$
        NPI licensing position: X, *Y

```
                            TP
                          /      \
                    DP_Subj          VP
                    /      \        /    \
                  D        NP    DIST     VP
                  |       /  \           /    \
                  ∅    Zero   NP        V    DP_Obj
                             /  \              /    \
                           △                 △
                     ... NPI (X) ...       ... NPI (Y) ...
```

If this analysis is on the right track, we would predict that the numeral *zero* which modifies a plural count noun can license an NPI when there is a collective predicate, since the distributive operator is no longer a problem. I think this prediction is indeed born out:

9

(34)   *Zero* soldiers surrounded any castle.

This wraps up both semantic and syntactic conditions for *zero* to license an NPI in different environments.

3.3   Toward a pragmatic account of the intensifying effects

As mentioned in Section 2.2, one of the things that set *zero* apart from regular numerals is the intensifying effects it exhibits in various environments. Specifically, we observe that there is an ordering restriction between *no*-NP and *zero*-NP, with the latter always following the former. Building on our semantic analysis in the previous section, I now sketch a pragmatic account for these intensifying effects.

To begin with, the hypothesis that I am entertaining is that *zero* is a stronger alternative to antonymous adjectives on a lexical scale. Many aspects of the intensifying effects we observed for *zero* are reminiscent of observations made for scalar implicatures. First of all, there is the ordering restriction:

(35)   a.   His chances to survive are *small*. In fact, I think there's *zero* chance.
        b.   #His chances to survive are *zero*. In fact, I think there's *small* chance.

The above contrast minds us of a similar ordering restrictions on lexical alternatives (in the sense of a lexical theory of scalar implicature, e.g. Levinson, 2000): the following (b) example is infelicitous because the stronger alternative entails the weaker alternative, illustrating the same phenomenon in a familiar domain:

(36)   a.   The water is cold. In fact, it is freezing.
        b.   #The water is freezing. In fact, it is cold.

Can we generalize the above idea to explain the ordering between *no*-NP and *zero*-NP? Well, not quite, unfortunately. This is because *no* and *zero* can't be scalar alternatives. Crucially, the difference between *no* and *zero* is not truth conditional;[8] notice that the following example involves a contradiction:

(37)   #The justice department revealing it has found *no evidence, but not zero evidence,* that Donald Trump tower was ever wire-tapped ...

However, note that there is no contradiction here:

(38)   The justice department revealing it has found *no good evidence, but not zero* evidence, that Donald Trump tower was ever wire-tapped.

One idea inspired by this example is goes along the lines of domain restriction. To put simply, while *no* is subject to domain restriction, *zero* does not have domain selection because it is not a generalized quantifier. Let me elaborate a bit more

---

[8]Thank you to Reviewer #1 for pointing this out!

10

on this. When a speaker says "*no* evidence", it can be pragmatically ambiguous in terms of precision. From the speaker's perspective, "*no* evidence" and "*zero* evidence" are truth conditionally equivalent. However, the hearer doesn't have in mind such a non-restrictive context: domain restriction allows *no* to be weakened, such that when a speaker says "*no* evidence", this could be interpreted by the hearer as "*no* good evidence". In order to be be more precise, the speaker adds "*zero* evidence" – good or bad. At this point, there is no longer any room for pragmatic ambiguity that needs clearing up, and that is how *zero*-NP can be more intensified than *no*-NP – "intensification" in terms of the precision of degree modification.

While this story will corroborate our current theory of *zero* as a degree quantifier, there are a few concerns. Rick Nouwen (p.c.) points out to me that it seems unlikely that only generalised quantifiers allow domain selection, given how few proper generalized quantifiers there probably are. In addition, whether numerals are subject to domain restriction and whether they are also generalized quantifiers are two questions that are still subject to much debate. To this end, I think we may also consider an alternative explanation of the ordering between *no* and *zero* by comparing them to *every* and *every single*, which also seem to be truth-conditionally equivalent but are ordered in terms of intensity. I leave the details of this alternative account for future work.

4 Toward a unified analysis

4.1 Two lives of *zero*?

So far, we have looked at the degree quantifier *zero*, which modifies nominal degree predicates and behaves like an unusual numeral. There's also another *zero*, which modifies plural count nouns and behaves rather like a regular numeral. In Table 2, I summarize the key empirical data discussed so far.

	Degree quantifier *zero*	Numeral *zero*
Modifies singular-form nouns	✓	×
Combines with *more than*/*over*	×	✓
Combines with *absolutely*	✓	??
Licenses NPIs in the restrictor	✓	✓
Licenses NPIs in the nuclear scope	✓	×
Subject to domain restriction	×	×

Table 2: Comparison between the degree quantifier *zero* and the numeral *zero*

I would like to draw a comparison between the two different analyses of *zero*. To do so, let me first introduce Bylinina & Nouwen's (2017) analysis of *zero* as a regular numeral.

4.2 The numeral *zero*: Bylinina & Nouwen (2017)

Focusing on plural count nouns, Bylinina & Nouwen in their paper point out several semantic differences between *zero* and *no*, which they use to argue against the possibility of treating them on a par. For instance, *no* but not *zero* can appear in exceptive licensing and negative inversion (Déprez, 1999; Moltmann, 1995):

(39)   *No*/**Zero* students but Bill came.

(40)   On *no*/**zero* occasions did he mention my help.

Furthermore, as we have seen, this *zero* can't license NPIs in its nuclear scope:

(41)   *No*/**Zero* students ever said anything.

(42)   *No*/**Zero* students bought any cars.

Based on these data, Bylinina & Nouwen reason that *zero* shows weaker negative force and more flexible scope compared to *no*, and thus it should be treated as a regular numeral rather than a generalized quantifier. They offer a numeral semantics for *zero* by adopting a modificational approach and an *at least* meaning for numerals:

(43) $[\![\,zero\,]\!] = \lambda x\,[\,\#x \geq 0\,]$

A consequence of such an analysis is their theory for plural count predicates, which now denote a full lattice structure derived by the operator $^{\times}$ (distinct from the more familiar semi-lattice operator *) which includes the bottommost element, $\perp$. However, as the authors point out, this will generate trivial truth conditions, such that a *zero*-sentence is always trivially true.

(44)   Any predicate $^{\times}P$ is true of $\perp$.
         If x in *zero students* is $\perp$, then it must be true.

To address this issue, Bylinina & Nouwen suggest that EXH applies obligatorily to the numeral *zero*. Exhaustification is required even in DE environments where it is unexpected, because the semantics of *zero* is just as uninformative in DE environments as it is in UE environments.

(45) $[\![\,\text{EXH } Zero \text{ students passed the test.}\,]\!] =$
         $\exists x[\,\#x \geq 0\,\&\,^{\times}\text{student}(x)\,\&\,^{\times}\text{pass-the-test}(x)]$
         $\&\,\neg\exists y[\#y > 0\,\&\,^{\times}\text{student}(y)\,\&\,^{\times}\text{pass-the-test}(y)]$

4.3 Problems and extensions

As an attempt to explain *their* NPI data, Bylinina & Nouwen further stipulate the following two licensing conditions for NPIs:

(46)   Given the structure $[_\alpha$ EXH $[_\beta$ ...$[_\gamma$ NPI]...]]
        Condition 1: the environment γ is non-trivially DE in β
        Condition 2: the environment γ is non-trivially DE in α

The conditions say that, given an *at least* semantics of *zero*, γ is not non-trivially DE in β, before EXH applies, hence its failure to licence an NPI.

There are several problems with such an analysis. First of all, it incorrectly rules out the cases where *zero* does actually license NPIs in its *restrictor*, as we noted earlier. It does not account for the range of data we have demonstrated for *zero*. Second, these conditions as far as I can see are stipulated particularly for *zero*; should they be applied to other NPI licensors, these conditions are too strong. Another question that immediately arises is, when EXH is irrelevant, in an NPI licensing environment, how do we define the environments α and β?

I believe that these remaining challenges are substantial for a purely numeral analysis of *zero*. By contrast, in a degree quantifier account, we are able to explain the various behaviors of *zero* in different environment, with our starting point being its modification of nominal degree predicates. Furthermore, if we assume a degree argument for plural predicates, as has been done in work such as Cresswell (1976 and Rett (2008), the degree quantifier analysis of *zero* can also be successfully extended to plural count nouns. A countable noun denotes the following:

(47) $[\![$ pizza $]\!]$ = λx. λd. pizza(x) & |x| = d   (Rett, 2008, p.36)

Note that because plural count nouns in this frame work is of type $\langle e, dt \rangle$ (unlike gradable nouns, which is of type $\langle d, et \rangle$), it first combines with a measure phrase via Solt's (2015) rule of Degree Argument Introduction (DAI), before combining with a degree quantifier:

$[\![[_{Meas}$ *Meas* pizzas$]]\!]$ = ($[\![$ Meas $]\!]$)($[\![$ pizzas $]\!]$)
= (λx. λd. μ_S(x) $\geqslant$ d)(λx. pizza(x))
= λd. λx. pizza(x) $\wedge$ μ_S(x) $\geqslant$ d   **by DAI**

Every following step of the compositional analysis goes exactly as it does in our demonstration earlier. Considering this, the degree quantifier account of *zero* seems to fare better in terms of both empirical evidence and theoretical elegance.

5   Implications

I have presented an analysis of *zero* as a degree quantifier, and have argued that this analysis fares better compared to a numeral analysis, especially in light of the new NPI licensing data. The current analysis crucially involves including **0** to the endpoint of a degree scale, analogous to Bylinina & Nouwen's move of adding a **0** element in a full lattice for the theory of plurality. I would like to emphasize that it

is a move that has nontrivial consequences on our semantic theory. As Bylinina & Nouwen (2017, p.2) themselves put it, "... the fact that languages allow ascription of zero quantity to an entity provides evidence that linguistic semantics has access to what at first sight may seem like an ontological oddity: an entity with *zero* quantity." In my analysis, I make the same ontological commitment: an entity with *zero* degrees/amounts. This is not a commitment that everyone will be comfortable with, and perhaps for good reasons; Morzycki (2017), for example, identifies *zero* as one of the "semantic viruses" that brings us much headache while lying just "at the corner of our language". To the extent that we have a principled way to decide what is at the core of language, I believe the study of *zero* deserves theoretical attention as it highlights a closer analytical connection between plural and degree semantics, and provides many interesting data points that will allow future work to move toward a more general theory of intensification.

References

Alrenga, P. & Kennedy, C. (2014). *No more* shall we part: quantifiers in English comparatives. *NLS*, *22*(1), 1–53.

Beltrama, A. & Bochnak, M. R. (2015). Intensification without degrees cross-linguistically. *NLLT*, *33*(3), 843–879.

Bylinina, L. & Nouwen, R. (2017, May). On "zero" and semantic plurality. In *Proc.of the 27th SALT Conference*. University of Maryland, College Park.

Cresswell, M. J. (1976). The semantics of degree. In B. H. Partee (Ed.), *Montague grammar* (pp. 261–292). New York: Academic Press.

Crnič, L. (2014). Non-monotonicity in npi licensing. *NLS*, *22*(2), 169–217.

Déprez, V. (1999). The roots of negative concord in French and French based creoles. In M. DeGraff (Ed.), *Language creation and language change: creole, diachrony and development* (pp. 329–375). Cambridge, MA: MIT Press.

von Fintel, K. (1999). NPI licensing, Strawson entailment, and context dependencies. *Journal of Semantics*, *16*(2), 97–148.

Gajewski, J. (2005). *Neg-raising: presupposition and polarity*. (Doctoral dissertation, MIT).

Gajewski, J. (2008). NPI *any* and connected exceptive phrases. *NLS*, *16*(1), 69–110.

Heim, I. (1984). A note on negative polarity and downward entailingness. In C. Jones & P. Sells (Eds.), *Proc. of the 14th NELS Conference* (pp. 98–107). Amherst, MA: GLSA.

Heim, I. (2006). Little. In M. Gibson & J. Howell (Eds.), *Proceedings of the 16th SALT Conference* (pp. 35–58). Ithaca, NY: CLC Publications.

Heim, I. & Kratzer, A. (1998). *Semantics in generative grammar*. Malden, MA: Blackwell.

Levinson, S. C. (2000). *Presumptive meanings: the theory of generalized conversational implicature*. Cambridge, MA: MIT Press.

Linebarger, M. C. (1987). Negative polarity and grammatical representation. *Linguistics and Philosophy*, *10*(3), 325–387.

Merchant, J. (2000). Antecedents-contained deletion in negative polarity items. *Syntax*, *3*(2), 144–150.

Moltmann, F. (1995). Exception sentences and polyadic quantification. *Linguistics and Philosophy*, *18*(3), 223–280.

Morzycki, M. (2009). Degree modification of gradable nouns: size adjectives and adnominal degree morphemes. *NLS*, *17*(2), 175–203.

Morzycki, M. (2017). Some viruses in the semantics. In N. LaCara, K. Moulton, & A.-M. Tessier (Eds.), *A Schrift to Fest Kyle Johnson* (pp. 281–292). University of Massachusetts, Amherst.

Rett, J. (2008). *Degree modification in natural language.* (Doctoral dissertation, Rutgers The State University of New Jersey - New Brunswick).

Rett, J. (2017, September). *The semantics of many, much, few, and little*. Unpublished manuscript, UCLA.

Solt, S. (2015). Q-adjectives and the semantics of quantity. *Journal of Semantics*, *32*(2), 221–273.