One Is the Loneliest Number: The Acquisition of Spanish Indefinite *Un*

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1. Introduction

Various studies have shown that English-speaking children as young as 2 years old assign an exact interpretation to numerals like *one*, while they have a weak, 'at-least' meaning for quantifiers and words like *a*. It has been posited that children learn this difference based on an explicitly learned count list (1,2,3…), which makes the numeral scale more salient and allows them to compute a scalar implicature more easily (e.g. *one* must mean *one but not two*). However, this account poses a learnability problem for languages in which the phonological forms for *one* and *a* are identical, and where this element is part of the count list but also behaves morphosyntactically like a quantifier/indefinite, e.g. Spanish/Italian *un/a*, French *un/une,* etc.

In this paper we address the following questions:

(i) If this learning algorithm is universal, how do Spanish-speaking children learn the exact meaning of *un* 'a/one' and other higher numerals?
(ii) What do children weigh more heavily: pragmatic/semantic cues (i.e. the saliency of the scale and scalar implicature) or morphosyntactic cues (e.g. availability of feminine and plural forms for *un*, but not other numerals)?
(iii) Do Spanish-speaking children experience a delay in the acquisition of *two* and higher numerals in comparison to English-speaking children because of conflicting cues?

1.1. The meaning of numerals

Following Horn (1972), it is typically assumed that numerals, like quantifiers and indefinites, are 'scalar items' (see also Schulz & van Rooij, 2006; Spector, 2003, 2013, inter alia). Scales are used to generate sets of alternatives which are ordered according to their informational strength, e.g. *all ⇒ some, a, three ⇒ two, one.*

Scalar items can receive a 'weak' lower-bounded/'at-least' interpretation, the lexically or semantically specified meaning (e.g. *John had a drink, in fact he had many*) or a 'strong', 'exact' interpretation, pragmatically derived by appeal to a scale-mate (e.g. *two but not three, some but not all*).

1.2. Acquisition of numerals

Various studies have shown that children have difficulties computing implicatures for contrasts such as: *a* versus *some* (Barner, Chow, & Yang, 2009), *some* versus *all* (Hurewitz, Papafragou, Gleitman, & Gelman, 2006; Musolino, 2004; Noveck, 2001; Papafragou & Musolino, 2003); *might* versus *must* (Noveck, 2001); *start* versus *finish* (Papafragou & Musolino, 2003). In all these cases, children's consistent error is that they accept a weaker term where a stronger one would be appropriate, that is, they accept "some of the [fruits] are in the bowl" when all of them are.

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Of particular interest is the contrast in judgment found between *one* and *a* in a study conducted by Barner, Chow and Yang (2009). When presented in a context in which two objects are in a circle 2-5-year olds reply 'yes' when asked "Is there *a* [fruit] in the circle?" but 'no' when asked "Is there *one* [fruit] in the circle?". Similarly, when asked to place *one* [fruit] in the circle almost all the 2-year olds put in exactly one [fruit], but when asked to place *a* [fruit] in the circle the majority put in more than one. So although children typically have problems interpreting scalar items, including the indefinite *a*, where they fail to derive the implicature '*a* but not *some'*, they do derive the strong, exact meaning of *one*. How do they learn this?

1.2.1. The learning algorithm

Barner and Bachrach (2010) hypothesize that children first assign a lexically weak 'at least' meaning to both *a* and *one* (i.e. *one* = *a*) and then acquire the strong 'exact' meaning of *one* through a learning algorithm that incorporates scalar implicature. Specifically, they suggest that the precocity observed with numerals stems from the fact that children acquire numerals in the context of a learned and recited count list, which therefore makes explicit the alternatives on the scale. Given that *one* (but not *a*) appears as part of a learned count list, the acquisition of 'at least two' will place an upper bound for *one*, thereby deriving its exact interpretation. In other words, if *two* means 'two or more' and each numeral has a distinct meaning (Principle of Contrast; Clark, 1998), *one* must mean *exactly one* (not more).

The simplest and most desirable assumption is that the learning algorithm for numerals is uniform across children acquiring different languages. However, it is not obvious how the procedure proposed by Barner and Bachrach and Wynn would work in the Romance languages given that the first step in the sequence of numeral acquisition is the strengthening of numeral *one*, and this form behaves morphosyntactically like a quantifier, as opposed to a numeral.

1.3. On the status of Spanish 'un'

Traditionally, Spanish *un* has been analyzed as both an indefinite and a numeral (e.g. Alcina & Blecua, 1975; Bello, 1988; Fernández Ramírez, 1987; Real Academia Española, 1771, 1854, 1931; Seco, 1968). However, more recently it has been argued that the indefinite and numeral values of *un* are not two different linguistic elements (Kayne, 2009; Lapesa, 2000; Martínez, 1989).

Notice first that the indefinite/numeral distinction is not contrastive in terms of stress. In (1a) and (1b) both *un* and the noun bear stress; in (1c), stress is only on the second syllable of the verb:

(1) a. un día 'a day' → UN DÍA (non-specific day)
b. un día 'one day' → UN DÍA (exactly one day)
c. hundía 'it sank' → hunDÍA

Barbiers (2007) and Kayne (2009) in fact argue that Romance *un* is only an indefinite and does not correspond to numeral *one.* Kayne notes that the exceptional status of *un* is reflected in the Romance agreement system: *un* agrees in gender and number with the corresponding noun (2a), like quantifiers (2b), but unlike numerals (2c):

(2) a. Vi una madre y unas niñas.
see-PST.1SG a/one-F mother and a/one-F.PL girl-F.PL
'I saw a/one mother and some girls'

b. Algunas madres son amas de casa, pero muchas trabajan.
Some-F.PL mother-PL be-PRS.3PL housewives, but many-F.PL work-PRS.3PL
'Some mothers are housewives, but many work'

c. Vi dos madres y tres niñas.
see-PST.1SG two mother-PL and three girl-F.PL
'I saw two mothers and three girls'

Kayne also points out that in Romance, in contrast to other numerals, *un* may not co-occur with a definite article (3a-b), and it cannot modify *cien* 'hundred' (3c-d):

(3) a. *(*el) un libro* '(the) a/one book'
b. *los dos libros* 'the two books'
c. *(*un) cien libros* 'one-hundred books'
d. *doscientos libros* 'two-hundred books'

1.4. The acquisition problem

Barner and Bachrach (2010) propose that children can compute implicatures with numerals because they are explicitly memorized as a list and routinely recited, increasing the salience of the alternatives in the scale. By age 3 English-speaking children are considered to be "two-knowers", that is, they consistently give one or two objects when asked for one or two objects respectively, but not when asked for three. A few months later, children begin responding consistently to *three*. By 3;6-4;0 children know the meaning of *four* and can interpret all the other numerals in the list they can recite, i.e. they become "cardinal knowers". Recall that at that same age range, children still assign a lower-bounded interpretation to *a*.

In Spanish, *un* heads the counting list that all children learn to recite, and so, Spanish-speaking children should strengthen the meaning of *un* when they learn the weak meaning of *dos* 'two'. However, if Kayne (2009) is correct and Romance *un* is only an indefinite, children would need to ignore that item and start the sequence of numeral acquisition from *two*. In other words, if Spanish-speaking children are in fact more sensitive to the morphosyntactic cues associated with *un* and place *un* on the quantifier scale, as opposed to the numerical scale, will this lead to delays in their numeral acquisition or otherwise affect their numeral acquisition (as compared to English-speaking children)? Our study was designed to address these questions.

2. The present study

As is standard in numeral acquisition studies, the initial phase of our study consisted of two tasks: the Give-a-number task (Wynn, 1990), and the What's-on-this-card task (Gelman, 1993; LeCorre & Carey, 2007). These tasks allowed us to classify children into 'N-knower' levels. In the second phase we investigated children's comprehension of *un* 'a/one', *dos* 'two', *tres* 'three', *todos* 'all', and *algunos* 'some' using a Felicity Judgment task and a Sentence-Picture Matching task.

2.1. Participants

We recruited 40 Spanish-speaking children (17 girls) ages 2;9-5;6 (M = 4;2) from bilingual child care centers in Los Angeles, CA. The children were tested at the daycare centers. Spanish was the language spoken at home, and they all had at least 75% exposure to Spanish.[1] The comprehension tasks also included 13 native Spanish-speaking adult controls, ages 20-60 (M=36.2), nine of whom were teachers at the daycares and four were linguistically-naïve university students.

2.2. Classification tasks

The first classification task was the What's-on-this-card task (LeCorre & Carey, 2007). In this task the child was presented with flashcards illustrating four types of inanimate objects: shoes (*zapatos*), hats (*sombreros*), cookies (*galletas*), and apples (*manzanas*). For each type of item six cards were created, each showing 1, 2, 3, 4, 5, or 6 items. The experimenter showed the child the cards one at a time, asking in Spanish "What's on this card?" (*¿Qué hay en esta carta?)*. The first card was always a single item. On subsequent trials the cardinality depicted was pseudo-randomized, so that the same cardinality was never presented on two consecutive trials. To be classified as knowing the exact meaning of a number word,

[1] Even though the children who were tested were strongly Spanish-dominant, there is evidence that shows that bilingual children exhibit independent number-learning trajectories in each of their two languages, particularly before acquiring the exact meaning of *four* (Kimura, Wagner, & Barner, 2013; Wagner, Kimur, Cheung, & Barner, 2015).

children had to: (i) say "N" at least 50% of the time when presented with N objects; (ii) say "N" no more than 50% when presented with different numbers; and (iii) satisfy conditions 1 and 2 for all numbers lower than than N.

The second classificatory task, Give-a-number (Wynn, 1990), included 36 flashcards with drawings of six different inanimate objects: shoes (*zapatos*), hats (*sombreros*), cookies (*galletas*), apples (*manzanas*), balls (*pelotas*), and dolls (*muñecos*). Six cards were created for each object, each card depicting one item. The 36 cards were placed in front of the child who was then asked to hand the experimenter one to six items. Children who failed on a trial were asked for a numerosity which they had previously succeeded with. On the second fail, children were asked (in Spanish) "Is that N?" (*¿Es eso N?*) and then "Can you count and make sure?" (*¿Puedes contar para asegurarte?*). Three failures with a same numeral N disqualified the child at that N-knower level.

2.3. Results of classification tasks

Children did not always perform identically on the two tasks. For example, a child might be a one-knower on the What's-on-this-card task and a two-knower on the Give-a-number. In order to be conservative, we classified children according to their lower performance (N-level) on the two classification tasks.[2] The results are shown in Table 1.

Table 1. Overall classification of N-knowers.

	N	Mean	Range
Non-knowers	3	3;8	2;9-4;6
One-knowers	15	4;2	3;2-5;4
Two-knowers	11	4;4	3;7-5;4
Three-knowers	3	4;8	4;6-4;10
Four-knowers or more	8	5;1	4;6-5;6

In Table 2 we show the classification (N-knower levels) of our Spanish-speaking children together with the classification of English-speaking children (based on Give-a-number and What's-on-this-card task results from LeCorre & Carey, 2007; LeCorre, van de Walle, Brannon, & Carey, 2006; Sarnecka & Carey, 2008; Sarnecka & Gelman, 2004; and Wynn, 1990).

Table 2. Classification of N-knowers in Spanish and in English

	Spanish		English	
	Mean	**Range**	**Mean**	**Range**
Non-knowers	3;8	2;9-4;6	2;9	2;1-3;4
One-knowers	4;2	3;2-5;5	2;11	2;0-4;4
Two-knowers	4;4	3;7-5;4	3;3	2;0-4;4
Three-knowers	4;8	4;6-4;10	3;4	2;7-4;0
Four-knowers or more	5;1	4;6-5;6	3;6	2;5-4;1

[2] As in LeCorre et al. (2006), and LeCorre and Carey (2007), we found there was no significant difference between knower-levels as assessed with the Give-a-number task or the What's-on-this-card task ($p > .1$), and so, classifying the children according to one task or the other should be inconsequential. In fact, even if children had been classified according to their better performance, the mean age for each of the N-knower levels would have been roughly two months younger (non-knowers, M=3;8, one-knowers, M=3;9, two-knowers, M=4;2, three-knowers, M=4;4, four-knowers or more, M=4;10), which would still leave a significant gap between the Spanish-and English-speaking children.

We see that the Spanish-speaking children are significantly delayed in their numeral acquisition relative to their English-speaking counterparts. For example, the mean age at which the Spanish-speaking children become two-knowers is 4;4 compared to 3;3 for the English-speaking children.[3]

2.4. Comprehension tasks

After the children were classified into N-knower levels, they were given two comprehension tasks: a felicity judgment task and a sentence-picture matching task. These tasks allowed us to determine whether Spanish-speaking children treat *un* like other, higher numerals (as is the case for English-speaking children, for example) or whether they treat *un* as an indefinite, in line with quantifiers like *algunos* 'some'.

2.4.1. Felicity judgment task

The first test of comprehension was a felicity judgment task. The children were asked to judge sentences containing either the numerals *tres, dos* 'three, two', the quantifiers *todos, algunos* 'all, some', or *un*. Prior to testing the children trained to give pragmatic judgments with 'silly' sentences such as *This is an animal with four legs* to refer to a horse (Papafragou & Musolino, 2003). During the experiment, a puppet watched an image and described it. The child was then asked if the puppet had 'answered well' (*¿Lo dijo bien?*) or if he had said something 'silly' (*¿Dijo algo tonto?*). The sentences either matched the picture, e.g. *Hay un tomate en el plato* 'There's a tomato on the plate' when in fact there was one tomato on a plate and several off to the side of the plate, or the sentence was pragmatically infelicitous. The latter sentences always consisted of a lower-bounded reading of the numeral, quantifier, or indefinite (e.g. there would be three objects and the puppet would claim there were two). Finally, subjects were randomly asked to justify their answers by explaining why they thought that the puppet answered well or not.

2.4.2. Results

The results of the judgment task are given in Figure 1, which reports the percentage of correct rejections of the pragmatically infelicitous sentences.

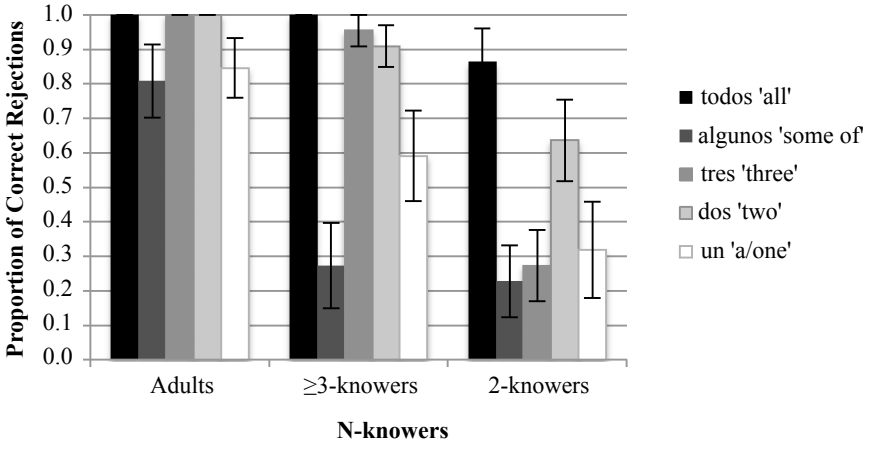

Figure 1. Results of felicity judgment task.

[3] The children who participated in this study were from medium-low socioeconomic Hispanic families. It is unlikely that this influenced our results insofar as Wagner et al. (2015) found that socioeconomic status was not a significant predictor of N-knower level in Spanish-speaking children. Our thanks to Jeff Lidz for bringing this issue to our attention.

Considering first the adults, although their performance with *algunos* 'some' and *un* 'a/one' trended in the direction of a lower-bounded reading, Wilcoxon signed-rank tests indicate they were not significantly different from their performance with *todos* 'all' (*algunos*, $p = .1$; *un*, $p = .1$), *tres* 'three' (*algunos*, $p = .1$; *un*, $p = .1$), and *dos* 'two' (*algunos*, $p = .1$; *un*, $p = .1$). Among the children, ≥3-knowers incorrectly accepted the lower bounded reading for *algunos* 'some' and *un* 'a/one' significantly more often than they did with *todos* 'all' (*algunos*, $p < .01$; *un*, $p = .02$), *tres* 'three' (*algunos*, $p < .01$; *un*, $p = .045$), and *dos* 'two' (*algunos*, $p < .01$; *un*, $p = .02$). This group also performed significantly better with *un* than with *algunos* ($p = .02$). We hypothesize, as Barner and Bachrach (2010) do, that this is due to the fact that *un* belongs to an explicit number list, while *algunos* does not. The 2-knowers incorrectly accepted the lower bounded reading for *algunos* 'some', *un* 'a/one', and *tres* 'three' significantly more often than they did with *todos* 'all' (*algunos*, $p < .01$; *un*, $p < 0.01$; *tres,* $p < .01$), and *dos* 'two' (*algunos*, $p < .01$; *un*, $p = .04$; *tres,* $p = .02$). Interestingly, this group did not perform significantly differently in *un* vs. *algunos* ($p = .32$). We hypothesize that at this age they are still weighing morphosyntactic cues more heavily than the numerical scale.

As in previous studies with English-speaking children, Spanish-speaking children treat the numerals they know (i.e. not *three* in the case of 2-knowers) as 'exactly N', but allow lower-bounded meanings for quantifiers like *algunos* 'some'. However, in contrast to English-speaking children, Spanish-speaking children don't treat *un* 'a/one' like other numerals (they know), but rather like the quantifier *algunos* 'some', assigning it a lower-bounded 'at least' meaning. That is, children say 'true' when given the statement *Hay un ratón en la caja* 'There's a/one mouse in the box' and shown an image of two mice in a box. But they say 'false' when given the statement *Hay dos ratones en la caja* 'There's two mice in the box' and shown an image of three mice in a box.

2.4.3. Sentence-picture matching task

In this experiment, we asked children to point to the image corresponding to a sentence containing either the numerals *tres, dos* 'three, two', the quantifiers *todos, algunos* 'all, some', or *un*. For example, they would hear the sentence *La señora metió un conejo en la jaula* 'the lady put a/one rabbit in the cage' accompanied by four pictures: a woman putting one, two, three, or no rabbits in a cage. They were trained on sentences containing the word *sólo* 'only' before the DP e.g. *Sólo el perro y el gato están durmiendo* 'only the dog and the cat are sleeping'. The order of the sentences and the position of the images were randomized on each trial.

2.4.4. Results

The results of the Sentence Picture-Matching task are given in Figure 2.

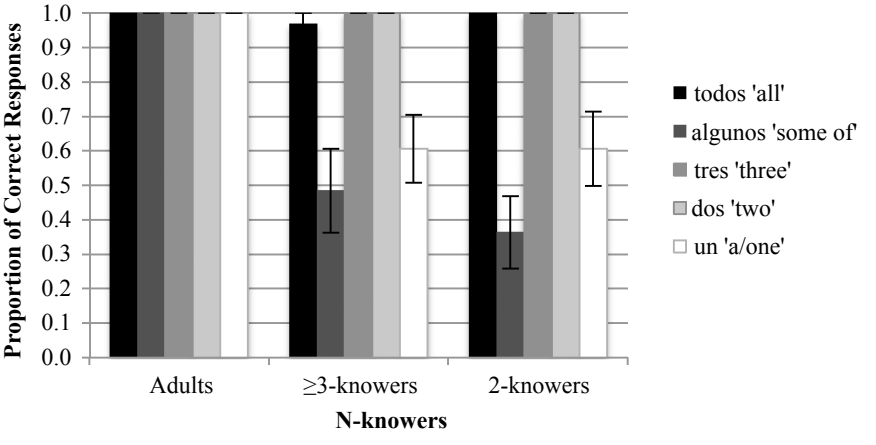

Figure 2. Results of the Sentence-Picture Matching task.

Turning first to the adult responses, when the alternatives on the scale were made explicit (in the other images) adults performed at 100% in all five conditions. As for the children, although their overall performance was better on this task than on the felicity judgment task, they still treated numerals as 'exactly N', while allowing lower-bounded meanings for quantifiers like *algunos* 'some'. Wilcoxon signed-rank tests indicate that ≥3-knowers correctly pointed to the image depicting the exact interpretation significantly more often for *todos* 'all' ($p = .01$), *tres* 'three' ($p = .01$), and *dos* 'two' ($p = .01$) than for *algunos* 'some'. Similarly, 2-knowers pointed to the correct image significantly more often for *todos* 'all' ($p < .01$), *tres* 'three' ($p < .01$), and *dos* 'two' ($p < .01$) than for *algunos* 'some'.

Importantly, they didn't treat *un* 'a/one' like other numerals, but like the quantifier *algunos* 'some' ($p > .1$), assigning it a weak 'at least' meaning. That is, when asked to point to the image corresponding to *La señora metió un conejo en la jaula* 'The lady put a/one rabbit in the cage' children would sometimes point to an image where two or three rabbits are in the cage. Wilcoxon signed-rank tests indicate that ≥3-knowers correctly pointed to the image depicting the exact interpretation significantly more often for *todos* 'all' ($p = .02$), *tres* 'three' ($p = .01$), and *dos* 'two' ($p = .01$) than for *un* 'a/one'. Similarly, 2-knowers pointed to the correct image significantly more often for *todos* 'all' ($p = .02$), *tres* 'three' ($p = .02$), and *dos* 'two' ($p = .02$) than for *un* 'a/one'.

3. Discussion and conclusion

In this study we provided new data on the acquisition of numerals and quantifiers in Spanish. Our main finding was that Spanish-speaking children treat *un* as a quantifier, and *not* like other numerals. This means that morphosyntactic cues, i.e. the availability of gender and number agreement with *un*, can override not only the saliency of the numerical scale, but also the saliency of other alternatives explicitly depicted in our sentence-picture matching task. In fact, even our adult controls did not always perform at ceiling with *un* either, consistent with Kayne's (2009) hypothesis that Romance *un* is only an indefinite (and not a numeral).

Additionally, we found that Spanish-speaking children are relatively delayed in the acquisition of the exact meaning of *two* and higher numerals as compared to English-speaking children (4;4 vs. 3;3 for *two/dos*). This is possibly due to the conflicting cues associated with *un.* Interestingly, while the children in our study did not assign an exact interpretation to *un,* they do so with *dos* 'two' and above.

Our results are consistent with the ones obtained in Japanese and Chinese, which lack obligatory singular-plural marking. Barner et al., (2009); Li, Le Corre, Shui, Jia, and Carey (2003), and Sarnecka, Kamenskaya, Yamana, Ogura, and Yudovina (2007) found that Japanese- and Chinese-speaking children are significantly delayed in the acquisition of *two* and higher numerals, despite receiving equal or greater exposure to count sequences in early childhood. Conversely, in Slovenian and Saudi Arabic, which have dual marking morphology, children derive the exact meaning of *two* significantly earlier than English-speaking children, even though these children appear to receive less training with number words than children from other countries (Almoammer et al. 2013).

Our results provide further evidence for the hypothesis that the transitions between knower level stages can be accelerated or delayed by the morphosyntactic use of number and number words, and that the (lack of) exact meaning for numerical concepts is at least partially bootstrapped from the language system.

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