ISSN: 2539-3804

Pragmatic and grammatical factors affecting the interpretation of number terms: evidence from an experimental study[1]

Gala Villaseñor García
Ittay Gil Carrillo
Universidad Nacional Autónoma de México
Ciudad de México, México

Abstract
There is a great deal of discussion in the specialized literature around the meaning and interpretation of the so-called number terms. It has been established that these terms can denote sets of exact cardinalities, as well as sets compatible with "at least" and "at most" cardinalities (intervalar readings). We present evidence from an experimental study showing that exact readings of number terms under certain grammatical constructions (with a quantifier or predicative function as well as when preceded by a definite article) are preferred by speakers even under certain pragmatic contexts in which intervalar readings could be derived. Our results align with the so-called *naïve* perspective of the exact semantics of number terms, but also with the fact that both the grammatical structure as well as the pragmatic context play an important role in the interpretations that they can acquire (*exactly*, *at least*, *at most*).
Key words: numerals; predicates and quantifiers; exact/intervalar interpretations; experimental study.

---

[1] This paper is a result of the research project "Influencia de variables semánticas y pragmáticas en la interpretación de los términos numéricos" (VIGG-190816. Departamento de Lingüística Aplicada. Escuela Nacional de Lenguas, Lingüística y Traducción, Universidad Nacional Autónoma de México. 2019 – 2021). The authors are the main researchers in the project.
We would like to thank Carmen Curcó, Teresa Peralta and Axel Barceló for sharing their insights and providing valuable feedback on the ideas presented here, as well as the other participants in the "Términos numéricos e implicatura escalar" seminar (IIFs, UNAM).

Recibido: 12-02-21. Aprobado: 26-08-21.

Resumen

Aspectos pragmáticos y gramaticales en la interpretación de términos numéricos: evidencia desde un estudio experimental

Hay una ardua discusión en la literatura especializada concerniente al significado y la interpretación de los términos numéricos. Se ha establecido que estos pueden denotar conjuntos exactos de cardinalidades, así como conjuntos compatibles con cardinalidades de "al menos" y "a lo más" (lecturas intervalares). Presentamos evidencia de un estudio experimental que muestra que las lecturas exactas de los términos numéricos bajo ciertas construcciones gramaticales (con función de cuantificador o de predicado, así como cuando están precedidos por un artículo definido) son las preferidas incluso bajo ciertos contextos pragmáticos en los que podría tener lugar una lectura intervalar. Nuestros resultados van en línea con la llamada perspectiva *ingenua* sobre la semántica exacta de los términos numéricos, pero también con el hecho de que tanto la estructura gramatical como el trasfondo pragmático juegan un importante papel en las interpretaciones que pueden adquirir *(exactamente, al menos, a lo mucho).*

Palabras clave: numerales; predicados y cuantificadores; interpretaciones exactas/intervalares; estudio experimental.

Résumé

Des aspects pragmatiques et grammaticaux concernant l'interprétation de termes numériques : évidence à partir d'une étude expérimentale

Il existe une énorme discussion dans la littérature spécialisée sur le sens et l'interprétation des soi-disant « termes numériques ». On a établi que les termes numériques sont capables de dénoter des ensembles qui possèdent une cardinalité exacte, mais aussi des ensembles qui sont compatibles avec des cardinalités « au moins *n* » et « au plus *n* » (connues comme des interprétations intervallaires). Dans ce sens, nous montrons une preuve d'une étude expérimentale qui démontre les interprétations exactes en relation avec des références numériques, dans certains contextes grammaticaux (en tant que quantificateur ou bien un prédicat, ainsi que celles précédées d'un article défini) qui sont les plus choisies même sous certains contextes pragmatiques dans lesquels une interprétation intervalle pourrait avoir lieu. Nos résultats sont en accord avec la perspective sémantique *naïve* des termes numériques dont la sémantique est exacte, mais aussi avec le fait que la structure grammaticale ainsi que le contexte pragmatique ont une influence dans leur interprétation.

Mots-clés : numérales ; prédicats et quantificateurs ; interprétations exactes/intervallaires ; étude expérimentale.

SOBRE LOS AUTORES

Gala Villaseñor García
Obtuvo el Doctorado en Lingüística por la UNAM. Actualmente labora como profesora de tiempo completo en el Departamento de Lingüística Aplicada de la Escuela Nacional de Lenguas, Lingüística y Traducción de la UNAM. Es docente de la Licenciatura en Lingüística Aplicada y en el Curso de Formación de Profesores. Sus intereses de investigación incluyen la semántica y la pragmática desde metodologías experimentales, y actualmente su trabajo se centra en el estudio de términos numéricos.
Correo electrónico: galavillasenor@enallt.unam.mx

Ittay Gil Carrillo
Doctor en Lingüística por la Universidad Nacional Autónoma de México (UNAM). En la actualidad es profesor de la Licenciatura en Lingüística Aplicada y en el Programa de Posgrado en Lingüística en la Escuela Nacional de Lenguas, Lingüística y Traducción (UNAM). Su trabajo académico se centra en estudiar cuestiones tanto semánticas como pragmáticas desde una perspectiva experimental. Actualmente su trabajo está centrado en la naturaleza escalar, los términos numéricos, así como la gestualidad.
Correo electrónico: ittaygil@enallt.unam.mx

CÓMO CITAR ESTE ARTÍCULO

Villaseñor, G., & Gil, I. (2022). Pragmatic and grammatical factors affecting the interpretation of number terms: evidence from an experimental study. *Lenguaje*, *50*(1), 93-114. https://doi.org/10.25100/lenguaje.v50i1.11010.

INTRODUCTION

Virtually every culture in the world uses numbers for a wide range of purposes, from very basic usages such as counting, to the most sophisticated enterprises of humankind as understanding the Universe. Not surprisingly, they have their own linguistic equivalent: number terms[2], which are elements distinct from and not to be confused with the mathematical terms known as numbers[3]. A number term is a linguistic element that denotes cardinal quantities and is used in various ways, such as when we learn to add or to subtract numbers as shown in (1a), or when referring to a label or proper name as in (1b), when we quantify things as in (1c), or when we delimitate nouns as in (1d). Number terms in language often have multiple functions: arithmetical, as labels, as quantifiers, as adjectives, among others (Geurts, 2006).

(1) a. Two plus two equals four.
b. Chanel number five.
c. Four students passed the exam.
d. The four children over there.

Not only can a number term exhibit different functions, but it may also have different interpretations within the same function. Take for example the utterances illustrated in (2).

(2) a. You need to make three mistakes to be allowed to take the test again. (Musolino, 2004, p. 3).
b. You can make three mistakes and still pass this test. (idem).
c. You must take three cards from the pile to start the game.

In (2a-c) we have the number term "three" functioning as a quantifier, but note that the readings one could derive could be very different in each case, at least, *prima facie*: (2a) is compatible with you having made three mistakes or more in order to repeat the test, so the interpretation that becomes available seems to be that you need to make "at least three" mistakes to repeat the test, while (2b-c) suggest a different reading. In fact, (2b) will receive the preferred reading of "at most three" whilst (2c) will receive an exact interpretation or an "exactly three" reading. In other words, (2a), (2b) and (2c) seem to be

[2] In the specialized literature these terms are sometimes referred to interchangeably either as *number terms* or as *numerals*. In this paper, we will be referring to them as *number terms (NT)*, since we distinguish number term as the linguistic token that denotes numerosity and numerals as the graphical representation of numbers (Curcó, 2015; Villaseñor, 2017).

[3] "Numbers" are mathematical objects that denote exact cardinalities. In simple terms: 3 = 3. An addition of 3 + 4 = 7 and not = 8, for example. "Number terms", to the contrary, can denote other cardinalities besides the exact one. "Three dogs barking" is compatible with a scenario of six barking dogs, where the number term "three" does not necessarily mean 3.

interpreted as having the same truth conditions as (2*a-c). These interpretations are cases of what are called *intervalar* or *bound readings*, namely the "at least" or *lower-bound reading* as in (2*a), the "at most" or *upper-bound reading* as in (2*b) in contrast to the exact *bilateral,* or *doubly-bounded reading* as in (2*c).

(2*) a. You need to make (at least) three mistakes to be allowed to take the test again. (Musolino, 2004, p. 3).
b. You can make (at most) three mistakes and still pass this test. (idem).
c. You must take (exactly) three cards from the pile to start the game.

Several discussions in the field of semantics and pragmatics have arisen from these observations, where "bare numerals present an interesting challenge to formal semantics and pragmatics: they seem to be ambiguous between various readings, and the choice of a particular reading seems to depend on complex interactions between contextual factors and linguistic structure" (Spector, 2013). The goal of a theory of interpretation would be to give a systematic account of whether, when and how each type of bound reading arises. Although no such theory is available as yet, we have made significant advances in this direction.

Theoretical discussions have long revolved around the semantic content of number terms, and three main accounts have been formulated (Carston, 1998; Geurts, 2006; Horn, 1972). The *neo-Gricean* account sustained that number terms have a lower-bound semantics, and depending on the context, their exact interpretation would be derived via a scalar implicature (Horn, 1972). Other scholars have defended the *naïve* view of number terms as having an exact semantic content. In this line of reasoning, Geurts (2006) explains the derivation of the lower-bound reading via semantic operations, while Breheny (2008) maintains that non-exact interpretations are derived due to background knowledge and pragmatic mechanisms. A third account, defended by Carston (1998), suggests that number terms have a neutral, underspecified lexical meaning and, depending on the context of emission, their interpretation would adopt one of the various construals discussed above.

The vast majority of studies have provided both theoretical and experimental evidence that contradicts the *neo-Gricean* account (Breheny, 2008; Papafragou & Musolino, 2003; Huang et al., 2013, Villaseñor, 2018; Villaseñor et al., 2021) in favor of an exact semantics of number terms. However, we still need to explain the reasons why and under which contexts number terms sometimes receive intervalar interpretations. These reasons could be categorized as either grammatical or pragmatic phenomena.

Grammatical factors that affect the interpretation of number terms

As previously noted, it has been observed that under certain linguistic contexts, number terms can receive bounded readings, while in others the only possible reading will be the exact.

Predicate and quantifier semantic function

It has been noted that depending on the grammatical environment in which it appears, a number term can have either a predicate or a quantifier function in a sentence (Geurts, 2006; Curcó, 2015; Villaseñor, 2018) and depending on this function, a lower-bound reading could be available. In certain languages such as Spanish, the predicate function will be given when the term appears after a linking verb such as "ser" (to be), in purely grammatical terms referring to the property or quality attributed to that entity. In this case, the only possible reading of the term will be the exact, as observed in the example in (3). The reason why the only possible reading is the exact is because under this function the number term will represent a unique set with cardinality |n| which the entity must be linked with. It is due to this characteristic of unicity in the set which leads to all intervalar readings being excluded.

(3) Los detenidos fueron tres. (exactly three)
'The detainees were three.'

In contrast, when the number term has a quantifying function, it will not predicate a property of the entity but will rather denote the cardinality of a set about which something else is predicated. This set will not necessarily be defined as a unique set, but the existence of several other sets could be possible. For example, in (4), it is predicated that there is a set of three girls who wear glasses, but it is compatible with the possibility of there being more than three girls wearing glasses.

(4) Tres niñas usan lentes. (exactly / at least three)
'Three girls wear glasses.'

As illustrated in Figure 1, if there actually were, for example, exactly four girls wearing glasses (set A), it would also be compatible with the existence of at least two different subsets of three girls wearing glasses (subsets B and C). In this way, uttering '*three girls wear glasses*' will be logically true even in the case where the total cardinality of the referred set were larger than 3. In other words, it is true about set A that there are 3 girls wearing glasses. In this case and for that reason, when a number term has a quantifying function, a lower-bound reading will be logically available.

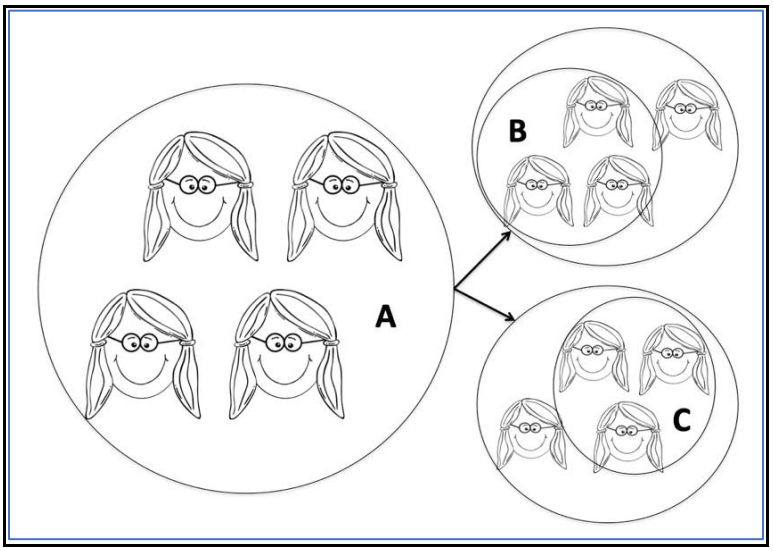

Figure 1. Quantifier function compatibility with larger cardinality sets

In sum, when a number term has a predicate function, the only possible reading will be the exact, whereas when it has a quantifier function, a lower-bound reading will be acceptable as well as the exact. This has been observed by Geurts (2006) but, to our knowledge, no empirical studies have been conducted other than Villaseñor et al. (2021) in order to explore this specific observation within an experimental method.

Number terms preceded by a definite article

Definite articles such as "the" in English or "el / la / los / las" in Spanish express a characteristic of maximality and uniqueness of the referent (Von Fintel et al., 2014). In this sense, when a number term is preceded by a definite article it presupposes that the referent is the only and maximum set. For example, the predicate in (5) states that there is a unique set with a maximum cardinality of 3 students who passed the test. The uniqueness feature is presupposed because of the definite determiner. Accordingly, the only possible interpretation in this linguistic context will be the exact.

(5) Los tres estudiantes pasaron el examen.
'The three students passed the test.'

When there is no definite article preceding the number term, the interpretation will be equal to the case in which the number term functions as a quantifier ('Three students passed the test'), giving rise to an acceptable reading of "at least three / three or more students". That is, it is compatible with either an exact or a lower-bound interpretation for the reasons previously discussed.

Previous experimental research

In order to experimentally examine the previous assumptions, an experimental study conducted by Villaseñor et al. (2021) explored the degree of acceptance of intervalar readings in various linguistic contexts in Spanish: when the number term is preceded by a definite article and when it has a semantic function of either a predicate or a quantifier. In this experiment, pragmatic factors and world knowledge references were minimized in order to isolate and control the grammatical factors and the possible interpretations arising from them.

For this purpose, a study using pseudowords was designed so as to avoid the biasing of background knowledge in the interpretation, explaining to the participants that the stimuli reflected situations that happen in a faraway planet named Kabea. For example, for a stimulus such as (6) (exploring the number term with a predicative function), participants judged the acceptance of the interpretations in (6*). For each stimulus, the three possible interpretations were counterbalanced across different versions of the task, and the exact reading served as a control. Participants were asked to indicate on a four-point Likert scale the acceptance of the possible readings derived from the number term used in the stimuli that corresponded to the different linguistic conditions explored.

100

(6) Stimulus:
En Kabea los *hurcalios* son cuatro[4]. (predicative condition)
There are four *-pseudo noun (plural)-* in Kabea.

(6*) Interpretation. Acceptance task:
a) En Kabea los *hurcalios* son exactamente cuatro. (Bilateral reading. Control)
There are exactly four *-pseudo noun (plural)-* in Kabea.
b) En Kabea los *hurcalios* son a lo mucho cuatro. (Upper-bound reading)
There are at most four *-pseudo noun (plural)-* in Kabea.
c) En Kabea los *hurcalios* son al menos cuatro. (Lower-bound reading)
There are at least four *-pseudo noun (plural)-* in Kabea.

Firstly, the findings of this study provided evidence in favor of the views that account for an exact semantics of number terms (Breheny, 2008; Geurts, 2006) as in all the linguistic conditions provided, the preferred interpretation was the exact. This is not surprising, but rather supports the theoretical arguments and existing empirical data (Villaseñor, 2017) which show that there is in fact a hierarchy among the possible readings that a number term can received and the exact reading is the default, contrary to the

[4] The quantifier counterpart would be, for example, "En Kabea cuatro hurcalios paramorian" "In Kabea, four *-pseudo noun (plural) pseudo verb-*".

predictions of the contextualist view in which all readings are equally possible depending on the context since the semantics of the term is underspecified.

Additionally, interesting results were found in the linguistic condition that supposedly accepts a lower-bound interpretation. When the number term had a quantifier function, participants strongly rejected the lower-bound readings against the theoretical predictions (as noted before, in the quantifier condition, the lower-bound reading is supposed to be logically available). This result replicates the findings of Villaseñor (2017) where participants in that study similarly found the lower-bound readings to be unacceptable, and contradicts the theoretical supposition that number terms have a secondary lower-bound semantic content as Geurts (2006) suggested. Accordingly, it adds to the empirical evidence against the neo-Gricean view (Horn, 1972) which advocates in favor of a lower-bound semantics of number terms.

Lastly, in the linguistic conditions under which the number term had a predicative function as well as when it was preceded by a definite article, participants clearly rejected both intervalar readings of the number term, which agrees with the theoretical predictions for these two types of linguistic conditions. That is, in these two cases neither of the two possible bound readings is possible.

In sum, the findings suggest that without a relevant pragmatic context and references to world-knowledge, the preferred interpretation of number terms is the exact, while the lower-bound reading is rejected even when there are theoretical reasons to sustain that it should be, if not preferred, at least partially accepted.

These results called for further exploration. A question arising from this study is to what extent a strong pragmatic context could bias not only the acceptance but even the preference of intervalar readings in all linguistic conditions. Addressing this question was the aim of the experiment to be discussed in this paper.

Experimental study on the acceptability of intervalar readings of number terms under strong pragmatic contexts

The principal aim of this study was to explore the acceptability and/or possible preference of both intervalar readings of number terms under a strong pragmatic context. That is, a contextual situation surrounding the utterances in question which could intuitively bias the interpretation of number terms to either a lower- or an upper-bound reading. In this sense, the intention was to explore the strength to which world knowledge could guide the acceptance or even the preference of non-exact readings of number terms under the linguistic conditions mentioned above.

To meet this aim, we explored the following grammatical contexts in Spanish: when a number term is preceded by a definite article and with either a predicate or quantifier function. Our assumption is that number terms have an exact semantic content,

but while in the predicative and definite determiner contexts all intervalar readings are blocked, in the quantifier condition the lower-bound interpretation should be available.

We also assume that contextual pragmatic factors and background knowledge are usually strong enough to permeate the semantic content of utterances and influence their interpretation. For example, even if we assume that number terms have an exact semantics, in utterances such as (7a) our intuition guides us towards a possible upper-bound reading, since we presume that if the speaker is stating that she gets drunk too fast and it is an undesirable situation, she would not want to drink more than two beers. On the contrary, in (7b) we presume that if the speaker really enjoys drinking beer, a scenario where she drinks more than two beers would also be likely.

(7) a. When I go out I usually drink two beers because I get drunk really fast and I definitely don't enjoy it. (exactly two / at most two)
b. When I go out I drink two beers because I really enjoy tasting new kinds of beer and hanging out with my friends. (exactly two / at least two)

In this sense, we wanted to explore in this study the extent to which a strong pragmatic context could influence the preference of intervalar readings even over the exact interpretation of number terms, given that in the previous experimental studies all non-exact readings were strongly rejected.

METHODOLOGY

Subjects

Seventy-three subjects participated in the study, divided into two groups of 36 and 27 participants. All were native speakers of Spanish between 18 and 50 years old, with a mean age of 34. They were recruited online and participated voluntarily in the study.

Procedure

The study consisted of two versions of a questionnaire created in Google Forms, versions A and B. Respondents were invited to participate voluntarily and they were assigned to one of the questionnaire, which they answered remotely.

Participants were asked to respond to the whole questionnaire in a single session and to try to avoid being exposed to any distractions during the task. They were also reassured that there were no correct or incorrect answers, so they were expected to select answers based on which they considered more natural, with the option of choosing more than one possible interpretation. An example of the task was provided on the instructions screen (Figures 2 and 3).

Verás un enunciado y después cuatro opciones distintas de enunciados, y deberás decir cuál o cuáles de esas opciones es compatible con lo que la persona quiso decir. Puedes elegir solamente una o, en caso de haber más de una posibilidad, puedes elegir varias. Por ejemplo:

María dice; Tengo 32 años.
¿Qué quiso decir María?

- Tengo alrededor de 32 años
- Tengo exactamente 32 años
- Tengo por lo menos 32 años
- No estoy segura cuántos años tengo

Figure 2. Instructions as seen by participants

You will first read an utterance and afterwards you will see four different options for its interpretation. You will need to choose the options which are compatible with what the person meant to say. You can choose only one, or in case of there being more than one possibility, you can choose several of them. For example:

María says: I am 32 years old.
What did María mean?

- I am around 32 years old.
- I am exactly 32 years old
- I am at least 32 years old
- I'm not sure how old I am

Figure 3. Instructions (English translation, not seen by participants)

Each item was shown individually, as illustrated in Figure 4. Once respondents chose the option(s) that they thought could naturally arise from the utterance, they moved on to the next item and could not go back to the previous items in the task.

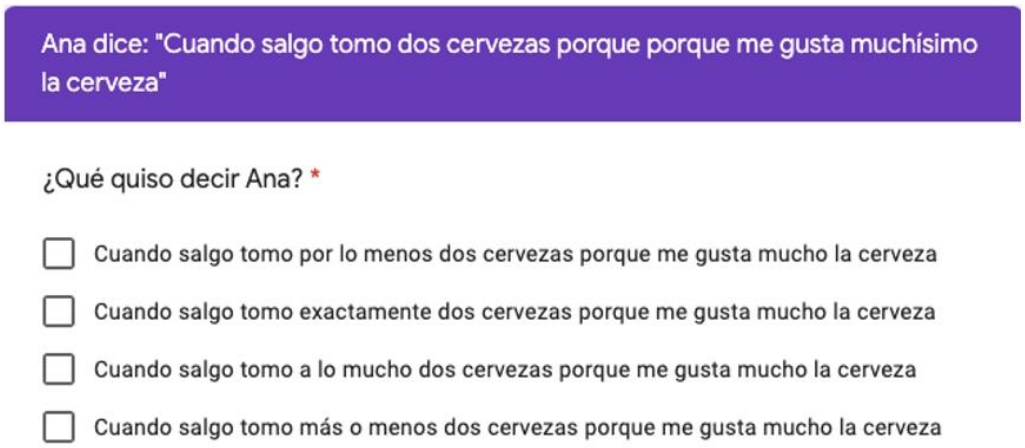

Figure 4. Example of stimuli used in the experiment

Within the options available, the possible interpretations of the number term in the stimuli (exact and intervalar bindings) were explicitly phrased, by using one of the expressions in 8.

(8). a. Exact expression in Spanish

(exactly n)

exactamente n

b. Upper-bound expressions in Spanish

a lo mucho n *(at most)*

a lo más n

máximo n

c. Lower-bound expressions in Spanish

al menos n *(at least n)*

mínimo n

Materials and design

The study had a 3x2 design, corresponding to three types of linguistic conditions (quantifier, predicate, definite determiner) and the two different pragmatic contexts presented in the items, one of which was biased towards an upper-bound interpretation (hereafter, UPC) and other biased towards the lower-bound interpretation of the number term (hereafter, LPC). This pragmatic bias was expressed by clauses of purpose related to everyday scenarios and common situations. For example:

(9) Ana said:

Main clause: *My brother packed the three magazines*... (Definite determiner condition)

- UPC (Upper-bound pragmatic condition): ...*because he didn't have enough space in his backpack.*

- LPC (Lower-bound pragmatic condition): *...because he has a long flight and doesn't want to get bored.*

The main clause was the same in all versions while the clauses related to the two pragmatic conditions (UPC-LPC) were distributed within subjects but counterbalanced per item across the two versions of the task. The grammatical condition was also distributed within subjects. The dependent variable was the interpretation of the number term selected by participants (exactly / at least / at most). For example:

(10) What did Ana mean?
- That her brother *packed exactly three magazines...*
- That her brother *packed at least three magazines...*
- That her brother *packed at most three magazines...*

There were four items for each of the pragmatic contexts within each linguistic variable. In other words, each linguistic variable consisted of a total of eight items divided between the two different pragmatic options, as shown in Table 1.

Table 1. Number of items per linguistic condition and pragmatic context

Linguistic variable	UPC	LPC	Total
Definite determiner	4	4	8
Predicative function	4	4	8
Quantifier	4	4	8
Total	12	12	12

Additionally, there were 24 filler items, making a total of 36 items per questionnaire version. Participants took approximately 15 minutes to complete the task.

Predictions

Our prediction was that in all three conditions we would find an overall acceptance of the exact interpretation of the number term since we assume that number terms have an exact semantic meaning regardless of the grammatical context in which they appear, as sustained by previous theoretical and experimental evidence (Geurts, 2006; Villaseñor, 2017, *inter alia*).

Additionally, we expected to find a significant difference in the type of accepted intervalar interpretations depending on the pragmatic context. That is, we expected a higher number of "at least" interpretations to be chosen in the LPC context, and a higher

number of "at most" interpretations to be chosen in the UPC context. However, we predicted that those options would be preferred even over the exact paraphrase, indicating that the strongest factor affecting the interpretation of number terms is the pragmatic context, in this case made explicit by the clauses of purpose. Especially in the case of the quantifier condition, we expected to find a very high acceptance of lower-bound readings in the LPC, since in that specific case the pragmatic context would match the logical compatibility of an "at least" interpretation.

RESULTS

Firstly, our findings showed, as predicted, that the exact interpretation was the most salient in all the explored variables when contrasting the pragmatic variables versus the possible readings of the number terms (with all linguistic variables grouped). Additionally, contrary to the findings of the previous experiment in which bound readings were not accepted, we found that the pragmatic background was strong enough to bias interpretation towards the corresponding intervalar readings. These two findings were in line with our initial predictions and we found statistical significance when contrasting the two pragmatic variables with the type of accepted interpretation of the number term (*chi sq. p<0.0001*), as shown in Table 2.

Table 2. Acceptance of interpretations of the NT per pragmatic context (all linguistic conditions grouped)

	EXACTLY	AT LEAST	AT MOST
LPC	**265**	**148**	50
UPC	**280**	37	**189**
Total	545	185	239

An interesting result was that, in general terms, even with strong pragmatic contexts, the exact reading still appears to be preferred over the corresponding intervalar interpretations, as seen in Table 2. That is, in both pragmatic contexts we expected to find higher frequencies in the corresponding intervalar option rather than in the exact one but instead found that even when the pragmatic variable does make the intervalar readings accessible, it does not overwrite the exact semantics. This can be taken as additional indirect evidence in favor of the exact semantics view of number terms (Geurts, 2006; Villaseñor, 2017; Villaseñor et al., 2021), contradicting the contextualist view of them having underspecified semantics (Carston, 1998).

Moreover, when looking into the results per condition, some interesting observations can be made. As we will show next, we found an acceptance of lower-bound readings in the LPC even under conditions that only accept exact interpretations from speakers for grammatical reasons (predicative and definite conditions). Likewise, we found a high acceptance of upper-bound readings in the UPC even when the three linguistic conditions under study do not grammatically accept them.

Table 3 and Figure 5 show the frequencies of interpretations per linguistic condition and per pragmatic variable. The two italicized columns in the table correspond to the expected choice of interpretation given the pragmatic context, and the numbers in bold are the highest frequencies obtained. When conducting a *chi-square* statistical test contrasting the linguistic conditions and the possible readings of the number terms per pragmatic condition, we found significance in both pragmatic variables. In Table 3, standardized residuals are included, where the values that most contributed to the level of significance are in bold[5].

[5] Standardized residuals indicate the strength of difference between the observed values per cell and the expected values if the null hypothesis were true. That is, they show which values or cells are contributing most to the significance value obtained, and which are contributing the least. In general, the most significant SR are the values greater than +2 or lower than -2.

Table 3. Frequencies of interpretations per linguistic condition and per pragmatic variable

		UPC			LPC	
Linguistic variable	Exactly	At least	***At most***	Exactly	***At least***	At most
Quantifier	**56**	23	89	**73**	63	12
Predicate	**111**	6	71	**89**	63	22
Definite determiner	**113**	8	29	**103**	22	16
Total	**280**	37	189	**265**	148	50
chi-sq		***p=<0.0001***			***p=<0.0001***	
Std. Residuals	**-3.83**	**+3.06**	**+3.31**	-1.27	**+2.28**	-1
	+0.68	**-2.09**	+0.09	-1.06	+0.99	+0.74
	+3.29	-0.9	**-3.61**	**+2.48**	**-3.44**	+0.2

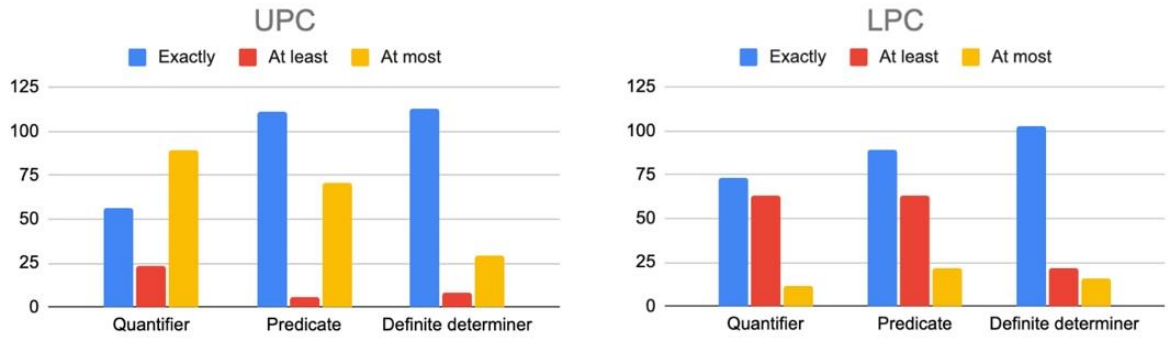

Figure 5. Frequencies of interpretations per linguistic condition and per pragmatic variable

From to the previous table and figures, it can be seen that the pragmatic context generally affects the acceptance of intervalar interpretations of number terms. This holds true even when the linguistic condition does not accept any non-exact readings, as noted in the predicate condition where we found a high acceptance of "at most" readings in the

 doi: 10.25100/lenguaje.v50i1.11010

UPC and "at least" readings in the LPC. Nevertheless, in this condition the exact interpretation was preferred over the intervalar reading in both pragmatic contexts.

Additionally, it stands out that in the definite determiner condition, respondents did not fully accept the intervalar readings in any of the pragmatic variables, and there was a marked preference for the exact interpretation. This suggests, is that in this particular linguistic condition the pragmatic context has almost no influence on the interpretation, and the grammatical context is the strongest factor in determining possible interpretations.

Lastly, it seems that in the quantifier condition, the pragmatic context does have an influence on the interpretation of the number term, especially in the case of the UPC where the most salient reading was the "at most" option. In this case, it seems that the pragmatic factor is even stronger than the semantic reading of the number term. On the other hand, in the LPC we expected to find a very high frequency of "at least" choices, since such reading would be in line with both the pragmatic and the compatible lower-bound semantic reading, assuming that in this condition the core meaning is the exact but is also logically compatible with the "at least" interpretation . This was not the case though, as we found that in this pragmatic context both the exact and the lower-bound readings were equally salient, and the frequency of exact choices was even a little higher than the intervalar one.

The following question was whether there is a significant correlation between the types of linguistic conditions and the preferred interpretation of the number term independent of the pragmatic context. When grouping both pragmatic variables and conducting a *chi-sq* statistical analysis contrasting the types of linguistic conditions against the type of interpretation, we found a significant statistical result ($p<0.0001$), as shown in Table 4 and Figure 6.

Table 4. Frequencies of number term interpretations per linguistic condition (pragmatic variables grouped)

(Pragmatic variables grouped)	Exact reading	Lower-bound reading	Upper-bound reading
Quantifier	**129**	**86**	**101**
Predicate	200	69	93
Def. det.	**216**	**30**	**35**
chi-sq = p<0.0001	***-3.77***	***+3.21***	***+2.94***
	-0.4	*-0.1*	*+0.71*
	+4.46	***-3.29***	***-3.92***

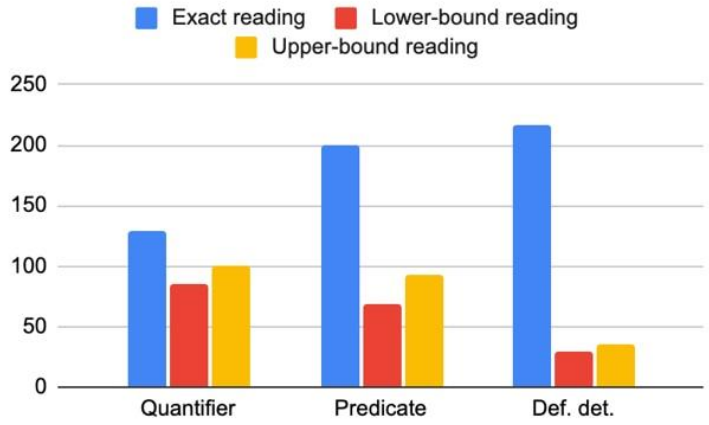

Figure 6. Frequencies of number term interpretations per linguistic condition (pragmatic variables grouped)

In both the predicative and the definite determiner conditions, the preferred reading was the exact, especially in the latter, where there does not seem to be a high acceptance of the intervalar readings. This preference for the exact interpretation does not seem to hold as strongly for the quantifier condition, where the frequencies are more or less equally distributed across the three types of interpretation, even when the number in the exact reading is slightly higher. This is worth noting as it aligns with the findings of the previous study, in which lower-bound linguistic conditions, such as the quantifier function, do not seem to favor the corresponding lower-bound interpretation of number terms.

DISCUSSION

In general, we found that a strong pragmatic context does seem to affect the interpretation of number terms and makes non-exact readings accessible. This does not come as a surprise but rather confirms that a given pragmatic context related to background knowledge can be strong enough to bias the interpretation of these terms to the corresponding intervalar reading, no matter the linguistic condition in which they appear.

In the condition that accepts lower-bound readings (a number term as a quantifier), we expected to find significantly higher frequencies of the "at least" paraphrase in the LPC, but we really did not find a strong bias towards the lower-bound reading compared to the exact interpretation. That is, even when the quantifier condition logically allows for a lower-bound reading of number terms, results showed that the frequency of acceptance of exact readings (n=73) was even higher than the lower-bound readings (n=63) in the LPC, contrary to the prediction. In this sense, we started out assuming that pragmatic background knowledge would be strong enough to bias the interpretation of any given linguistic structure, and so we expected to find in the LPC that the corresponding lower-bound reading would be overwhelmingly higher than the exact option in this grammatical condition, which was not the case. This result should be further explored but indirectly adds to the evidence that number terms have an exact lexical meaning, contradicting the assumption that number terms have a lower-bound semantics, as first suggested in the neo-Gricean view (Horn, 1972).

Additionally, in the UPC we found high frequencies of "at most" readings and very low frequencies in the "at least" in this same linguistic condition, suggesting that this pragmatic context was even stronger than the grammatical environment in which the number term appears.

Under the exact linguistic conditions (number terms as a predicate and preceded by a definite determiner), we found a higher rate of exact interpretations in both the UPC and the LPC, no matter the pragmatic condition. Overall, even when there was some acceptance of upper-bound readings in the UPC and vice versa, the exact interpretation seems to be the most salient, which aligns with the linguistic predictions assuming that those grammatical contexts do not accept intervalar readings.

However, only in the predicative condition did we obtain a moderate acceptance of the intervalar readings according to the pragmatic context. In the UPC, the frequency of accepted "at most" readings was moderately lower (n=71) than the exact readings (n=111), whereas in the LPC the lower-bound reading (n=63) was slightly lower than its exact (n=89) counterpart. What this suggests is that in this condition, the pragmatic factor does have an influence on the reading of the number terms, even when grammatical context is still the strongest factor that guiding the interpretation.

However, in the definite determiner condition we did not find a marked acceptance of any intervalar readings of the number terms. In the UPC, the acceptance of upper-bound interpretations was significantly lower (n=29) than the exact counterpart (n=113), while in the LPC the same pattern holds, where the the lower-bound (n=16) reading was significantly lower than the exact interpretation (n=103). What this suggests is that this grammatical condition effectively blocks any possible intervalar readings, even when the utterance is inserted in a strongly bias-raising, pragmatic context.

CONCLUSION

The findings of this study add to evidence in favour of number terms having an exact core meaning, as suggested in previous literature and studies (Geurts, 2006; Villaseñor, 2017; Villaseñor et al., 2021) and against the contextualist view of them having an underspecified semantic content which is fully dependent on pragmatic factors (Carston, 1998), as well as against the neo-Gricean account which suggests that they have a lower-bounded semantic content.

Additionally, contrary to the findings of previous studies (Villaseñor, 2017; Villaseñor et al., 2021) where intervalar readings were not accepted at all in any of the linguistic conditions explored here when minimizing pragmatic factors, we found that under a strong pragmatic context related to background and world knowledge, these terms can receive non-exact interpretations in both the quantifier and predicative conditions. In the definite determiner condition, however, it seems that the pragmatic context does not have an important influence on the interpretation of these terms, since in neither of the pragmatic conditions did we find an acceptance of non-exact readings. This suggests that in this linguistic condition, the grammatical context is not only the strongest but likely the only factor guiding interpretation.

We can conclude that even when the pragmatic context does play a significant role in the derivation of the possible interpretations that a number term can receive, this pragmatic factor is not as strong as to overwrite the semantic core meaning of number terms. This is especially true under certain grammatical environments, as in the case of definite constructions, where no matter the background assumption under consideration, an intervalar reading is not accessible.

Finally, our findings also call for further study to explain why the upper-bound readings seem to be more accepted than the lower-bound interpretations, as observed in the results of this experiment. Moreover, we need to further explore what other grammatical environments make intervalar interpretations available, as in the case of number terms being under the scope of modal operators, as shown in some of the examples in 2(c) at the beginning of this paper.

REFERENCES

Breheny, R. (2008). A New Look at the Semantics and Pragmatics of Numerically Quantified. Noun Phrases. *Journal of Semantics*, *25*(2), 93-139. https://doi.org/10.1093/jos/ffm016.

Carston, R. (1998). Informativeness, Relevance and Scalar Implicature. In R. Carston & S. Uchida (Eds.), *Relevance Theory: Applications and implications* (pp. 179-236). https://doi.org/10.1075/pbns.37.11car.

Curcó, C. (2015). Significado conceptual y significado procedimental en la interpretación de los términos numéricos. *Lenguas Modernas*, (45), 9-38. https://revistas.uchile.cl/index.php/LM/article/view/42716.

Geurts, B. (2006). Take 'five'. The meaning and use of a number word. In S. Vogeleer & L. Tasmowski (Eds.), *Non-definiteness and Plurality* (pp. 311-329). https://doi.org/10.1075/la.95.16geu.

Horn, L.R. (1972). *On the Semantic Properties of Logical Operators in English* (Doctoral dissertation). University of California, California, United States of America. https://linguistics.ucla.edu/images/stories/Horn.1972.pdf.

Huang, Y.T., Spelke, E., & Snedeker, J. (2013). What Exactly do Numbers Mean? *Language Learning Learning and Development*, *9*(2), 105-129. https://doi.org/10.1080/15475441.2012.658731.

Musolino, J. (2004). The semantics and acquisition of number words: Integrating linguistic and developmental perspectives. *Cognition, 93*(1), 1-41. https://doi.org/10.1016/j.cognition.2003.10.002.

Papafragou, A., & Musolino, J. (2003). Scalar implicatures: experiments at the semantics-pragmatics interface. *Cognition*, *86*(3), 253-282. https://doi.org/10.1016/s0010-0277(02)00179-8.

Spector, B. (2013). Bare Numerals and Scalar Implicatures. *Language and Linguistics Compass*, *7*(5), 273-294. https://doi.org/10.1111/lnc3.12018.

Villaseñor, G. (2017). Interpretación de términos numéricos: un estudio empírico. *Estudios de Lingüística Aplicada, 35*(66), 135-172. https://doi.org/10.22201/enallt.01852647p.2017.66.835.

Villaseñor, G. (2018). *Aspectos Lingüísticos y Pragmáticos de los Términos Numéricos: una Aproximación Experimental* (Doctoral dissertation). Universidad Nacional Autónoma de México, Ciudad de México, México. https://repositorio.unam.mx/contenidos/aspectos-linguisticos-y-pragmaticos-de-los-terminos-numericos-una-aproximacion-teorica-y-experimental-3537791?c=Azwzz8&d=true&q=*:*&i=1&v=1&t=search_0&as=0.

Villaseñor, G., Curcó, C., & Peralta, M. (2021). Lecturas intervalares de los términos numéricos en distintos contextos lingüísticos: un estudio experimental. *Forma y Función*, *34*(1). https://doi.org/10.15446/fyf.v34n1.83846.

Von Fintel, K., Fox, D., & Iatridou, S. (2014). Definiteness as Maximal Informativeness. In L. Crnič & U. Sauerland (Eds.), *The Art and Craft of Semantics: A Festschrift for Irene Heim* (pp. 165-174). https://semanticsarchive.net/Archive/jZiNmM4N/FintelFoxIatridou.pdf.