

Countability distinctions without linguistic cues

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This paper investigates experimentally the role played by morphosyntactic cues to atomicity in quantity judgment tasks (*Who has more NOUN?*, Barner & Snedeker 2005). Two experiments, conducted on English and on French, show that while the absence of linguistic cues to atomicity does not affect quantity judgments in these languages, the absence of the relevant nouns in the quantity judgment prompts has an important impact. In the latter case, quantity judgments can be influenced by the availability of salient portions and alternative dimensions of measurement (Scontras et al. 2017).

1. Introduction

Quantity judgments (Barner & Snedeker 2005) have been widely used across languages to assess how speakers represent the semantics of nouns (Barner & Bale 2018 and references therein): count nouns (e.g. *panda*) and aggregate nouns (e.g. *furniture*) which are counted are atomic, whereas mass nouns (e.g. *wine*) which are measured, are not. Interestingly, recent studies (Deal 2017 and Scontras et al. 2017) have shown that the language form, and more specifically, the presence or absence of morphosyntactic cues to atomicity in quantity judgment prompts, could influence quantity judgments. The goal of this paper is to investigate the role played by morphosyntactic cues to atomicity in quantity judgment tasks in English and in French. French is particularly interesting for the following reason: unlike in English, the morphosyntactic cues to atomicity are not always perceptible in the auditory signal allowing us to provide participants nouns without explicit cues to atomicity in the quantity judgment prompts.

1.1. Quantity judgments

A quantity judgment task goes as follows: participants are shown pictures depicting two characters with different quantities of the same object. One character has one large object whereas the

other character has three small objects of the same kind. Crucially, the three small objects have a smaller combined volume than the larger object. That way, the experimenter knows that a participant choosing the character who has the three small objects based his judgment on number, whereas a participant choosing the character who has one large object based his judgment on volume. Participants are then asked to choose which character has more.

Quantity judgment tasks have been used to investigate experimentally the interpretation of different types of nouns. In particular, Barner & Snedeker (2005) used this task to investigate the interpretation of aggregate nouns such as *silverware* as compared to the interpretation of count nouns such as *shoes* and mass nouns such as *toothpaste*. Examples of their stimuli are depicted in Figure 1.

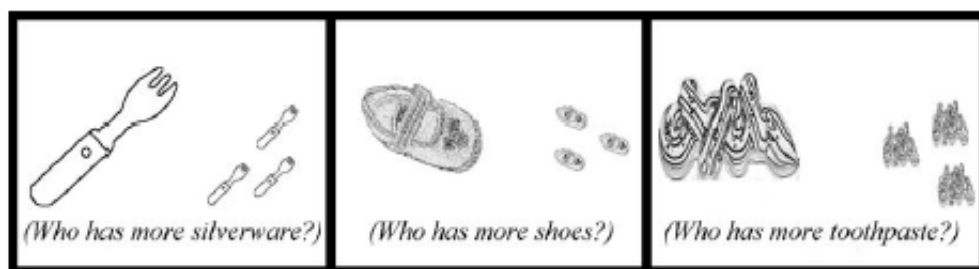


Figure 1: Example of Stimuli (Barner & Snedeker 2005:50)

Count nouns were judged on number (100% of cardinality judgments): the character who was judged to have more shoes was the character who had a greater number of shoes (regardless of the volume). By contrast, mass nouns were judged on volume (0% of cardinality judgments): that is, the character who was judged to have more toothpaste was the one who had a greater volume of toothpaste (regardless of the number of salient portions of toothpaste). Crucially, aggregate nouns such as *silverware* were judged on number (97% of cardinality judgments), as count nouns: that is, even if the volume of the big fork was greater than the combined volume of the three small forks, participants judged that three forks were more than one fork. These results support semantic theories arguing that nouns differ in the nature of their minimal parts (Bunt 1985, Chierchia 2010, Grimm 2012, Landman 2011).

Interestingly, recent crosslinguistic studies have shown that not all languages show this pattern. In particular, Lima (2014) found that in Yudja, a Tupi language spoken in Brazil, participants provide cardinality judgments for every type of nouns. In her study, she tested notional count nouns (e.g. *karaxu* ‘spoon’), notional mass nouns (e.g. *y’a* ‘water’) and aggregate nouns (e.g. *abeata* ‘clothes’). While participants provided judgments based on number for notional count nouns and aggregate nouns, as expected, they also provided judgments based on number for notional mass nouns. These results suggest that Yudja does not make any distinction between count nouns, aggregate nouns and mass nouns. Now, if providing a cardinality judgment in a quantity judgment task signals an atomic denotation, then mass nouns, as count nouns and aggregate nouns, are atomic in Yudja, as argued by Lima (2014).

Note however that as languages differ in the ways they express morphosyntactic cues to atomicity, the target question used in the Yudja study (*Ma de bitu NOUN dju au?* ‘Who has more NOUN?’) differs from the one used in the English study (*Who has more NOUN-s?*). Specifically, while the latter includes morphosyntactic cues to atomicity (in that case, singular

or plural morphology), the former does not. This raises the following questions: Could it be the case that the question used in the Yudja study favored cardinality judgments? Or is it really the case that all nouns are count in this language? And more generally, what is the role of linguistic cues to atomicity in quantity judgments? I will address the latter question in this paper.

1.2. *Is it all about the cues to atomicity?*

The interpretation of some nouns – so-called *flexible nouns* (e.g. *string*) – depends on the morphosyntactic cues they co-occur with. In particular, Barner & Snedeker (2005) have shown that when flexible nouns are pluralized, they are judged on number (97% of cardinality judgments), as count nouns, whereas when they occur in the singular form, they are judged on volume (3% of cardinality judgments), as mass nouns. Importantly, this study shows that in a quantity judgment task, participants can use morphosyntactic cues to atomicity to guide their quantity judgments. Other recent studies (Deal 2017 and Scontras et al. 2017) have shown that the language form, and more specifically, the presence or absence of morphosyntactic cues to atomicity in the target question, could influence quantity judgments.

To begin with, in Nez Perce, a Sahaptian language spoken in Idaho, Washington and Oregon, nouns typically lack morphosyntactic cues to atomicity. Noun modifiers such as adjectives are the ones that can be pluralized, when they combine with count nouns and when they combine with mass nouns. Deal (2017) investigated the interpretation of notional count nouns such as *soo* ‘spoon’ and notional mass nouns such as *qahas* ‘milk’ in Nez Perce using a quantity judgment task. She tested these nouns in two different conditions: (i) in the first condition, the target question included a bare adjective (i.e., an adjective that did not include any plural morphology) and (ii) in the second condition, the adjective was pluralized. As expected, in the latter condition, participants provided number based judgments for both notional count nouns and notional mass nouns (100% of cardinality judgments for notional mass nouns). Crucially however, when the adjective combining with notional mass nouns did not carry any plural morphology, Nez Perce speakers provided judgments based on volume (0% of cardinality judgments for notional mass nouns). These results interestingly show the impact that the linguistic form of the target question can have in quantity judgment tasks.

Furthermore, Scontras et al. (2017) investigated experimentally the influence of the linguistic form on quantity judgments by looking at the interpretation of English count nouns and mass nouns in the absence of clear linguistic cues to atomicity. They tested count nouns like *spoon* and mass nouns like *water* in two different conditions: (i) the NOUN condition and (ii) the NO NOUN condition. In the NOUN condition, the target question was of the following form: *Who has more NOUN?*. That is, the target question included a noun as well as morphosyntactic cues to atomicity (count nouns occurred in the plural form and mass nouns occurred in the singular form). By contrast, in the NO NOUN condition, the target question was *Who has more?*. That is, the latter did not include the relevant noun nor did it include any cue to atomicity. An example of stimuli is depicted in Figure 2.

In both conditions, they found a significant effect of ontological category: namely, count nouns were judged more often on the basis of cardinality than mass nouns, corroborating Barner & Snedeker’s (2005) results. Furthermore, a significant interaction between ontological category and cues was found: that is, while participants provided categorical judgments in the NOUN condition, these categorical judgments began to disappear in the NO NOUN condition.



who has more milk? vs. who has more?
 two-noun no-noun

Figure 2: Example of Stimuli (Scontras et al. 2017:6)

In particular, count nouns were judged less often on number in the NO NOUN condition than in the NOUN condition, and mass nouns were judged less often on volume in the NO NOUN condition than in the NOUN condition, as illustrated in Figure 3. Note that the cues being different for count nouns and mass nouns, the interaction between cues and ontological category was predicted. The comments provided by the participants who did not give the expected answers in the NO NOUN condition (that is, participants who based their judgments on volume for count nouns and on number for mass nouns) suggest that these participants used another dimension of measurement for count nouns (e.g. *Big knives are more expensive.*) and that they counted the salient portions of the substance named by mass nouns (e.g. *Left has three piles, right has one.* for the noun *Sugar*).

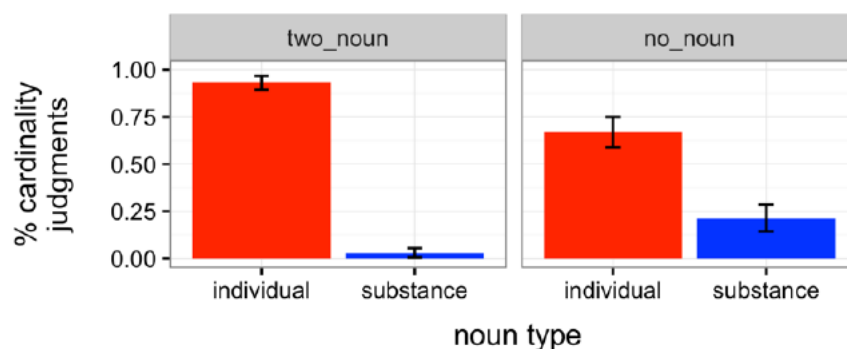


Figure 3: Results (Scontras et al. 2017:7)

At first sight, these results seem to suggest that the presence or absence of linguistic cues to atomicity influence quantity judgments in English as it was the case in Nez Perce. More generally, in the absence of linguistic cues to atomicity, quantity judgments are subject to a variety of factors such as alternative dimensions of measurement, contextually salient portions, etc. Since languages mark linguistic cues to atomicity differently, the results of crosslinguistic quantity judgments could well be influenced by these factors, and therefore could be not completely

telling. This study raises however two main questions: (i) What about other types of nouns (namely, aggregate and flexible nouns)? Are their quantity judgments also influenced by the presence or absence of linguistic cues to atomicity? (ii) In the NO NOUN condition, both the noun and the plural morpheme were omitted. Therefore, either the absence of the noun or the absence of the morphosyntactic cues to atomicity could have influenced the quantity judgments. What is the source of the effects observed in the results?

Note that the presence of the noun alone gives us presumably more information than the presence of a morphosyntactic cue to atomicity alone. In particular, the presence of the former tells us what the object or substance depicted in the stimulus is and how we may classify it. Since in English, it is not possible to omit the linguistic cues to atomicity while keeping the noun, it is hard to understand what exactly plays a role in quantity judgments. However, recall that in French, while the singular-plural distinction is made in the written forms, it is not pronounced in most contexts. As illustrated below, both the singular and the plural form of the noun *chat* ‘cat’ are pronounced the same way. In French, it is thus possible to remove experimentally the cues to atomicity while providing the noun at the same time.

(1) <i>Singular form</i>	(2) <i>Plural form</i>
a. chat	a. chats
cat	cat+PL
b. [ʃa]	b. [ʃa]

2. Experiment 1

Experiment 1 extends Scontras et al.’s (2017) study to every type of English nouns and sets a baseline for Experiment 2 on French. In particular, I investigate how participants perform quantity judgments of the four types of English nouns (count nouns, mass nouns, aggregate nouns and flexible nouns) in the presence (NOUN condition) or absence (NO NOUN condition) of morphosyntactic cues to atomicity.

2.1. Methods

2.1.1. Task and instructions

This experiment used a variant of Barner & Snedeker’s (2005) quantity judgment task. Participants were shown pictures depicting two characters with different quantities of the same object. One character had two large objects whereas the other character had six small objects. As illustrated in Figure 4, the boy was always on the left and the girl was always on the right. In half of the target items, the boy had the two large objects while the girl had the six small objects, and in the other half, the girl had the two large objects while the boy had the six small objects. Crucially, the combined volume of the two large objects was greater than the combined volume of the six small objects. Participants simultaneously listened to a question about which character had more and they were asked to answer that question by either pressing the “The boy” button or the “The girl” button. Finally, participants could optionally comment their answer as illustrated in Figure 4.



Figure 4: Example of Stimuli

2.1.2. Design and stimuli

Four types of nouns were tested: namely, count nouns, mass nouns, aggregate nouns and flexible nouns. The full list of nouns is provided in Table 1.¹

Noun Type	Nouns tested
Count Nouns	<i>Book, Hat, Candle, Mug, Bottle</i>
Mass Nouns	<i>Ketchup, Milk, Flour, Sugar, Ice Cream</i>
Aggregate Nouns	<i>Mail, Clothing, Furniture, Silverware, Jewelry</i>
Flexible Nouns	<i>Chocolate, Stone, String, Dessert, Cake</i>

Table 1: List of nouns tested in Experiment 1

These four types of nouns were tested in Scontras et al.'s (2017) NOUN and NO NOUN conditions. In the NOUN condition, the target question included the relevant noun as well as

¹To determine the category of the nouns tested in this experiment, we applied the following tests. Count nouns can be pluralized (e.g. *books*) and can combine with numeral modifiers (e.g. *two books*). Unlike count nouns, mass nouns cannot be pluralized (e.g. **ketchups*) nor can they combine with numeral modifiers (e.g. **two ketchups*). However, mass nouns can combine with *much* and *little* (e.g. *how much ketchup, little ketchup*), and they denote substances. As mass nouns, aggregate nouns cannot be pluralized (e.g. **furnitures*) nor can they combine with numeral modifiers (e.g. **two furnitures*). Aggregate nouns can also combine with *much* and *little* (e.g. *how much furniture, little furniture*). However, unlike mass nouns, aggregate nouns denote a collection of countable objects. Finally, flexible nouns behave as count nouns when they are pluralized (e.g. *chocolates, two chocolates*) and as mass nouns when they occur in the singular form (e.g. **two chocolate, how much chocolate, little chocolate*).

the relevant cues to atomicity (e.g. *Who has more books?*) whereas in the NO NOUN condition, neither the noun nor the cues to atomicity were provided (*Who has more?*). Furthermore, in the NOUN condition, mass nouns, aggregate nouns and flexible nouns were all given in the singular form, whereas count nouns were given in the plural form.

While the Noun Type factor was manipulated within participants, the target question was manipulated between participants. That is, half of the participants saw the target items of the NOUN condition and therefore listened to target questions that included cues to atomicity, whereas the other half saw the target items of the NO NOUN condition and therefore listened to the target question *Who has more?*. The schematic structures of the target questions used in the NOUN and NO NOUN conditions are given in Table 2.

Noun Type	Target question NOUN Condition	Target question NO NOUN condition
Count Noun	<i>Who has more N-s?</i>	<i>Who has more?</i>
Mass Noun	<i>Who has more N?</i>	<i>Who has more?</i>
Aggregate Noun	<i>Who has more N?</i>	<i>Who has more?</i>
Flexible Noun	<i>Who has more N?</i>	<i>Who has more?</i>

Table 2: Schematic structures of the target questions associated with each type of nouns

Each combination illustrated in Table 2 was repeated 5 times, for a total of 40 stimuli. Examples of stimuli for each type of nouns are depicted in Figure 9.

To ensure that participants listened to the auditory target questions and were paying attention to the task, 10 filler items of the form *Click on the boy!* and *Click on the girl!* were added. The results of the participants who did not press the correct button more than once were excluded from the analysis.

All items were counterbalanced so that the order in which count nouns, mass nouns, aggregate nouns, flexible nouns and fillers occurred systematically varied. Each participant received 20 target items including five for each type of nouns and 10 filler items.

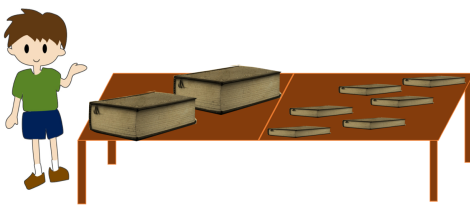
2.1.3. Participants

Participants were 90 native speakers of English (living in the US), recruited via Amazon Mechanical Turk and paid \$2 for their participation. 45 participants only saw the stimuli of the NOUN condition and the other 45 participants only saw the stimuli of the NO NOUN condition. Since each participant gave the correct answers to the filler items, none of them were excluded from the analysis.

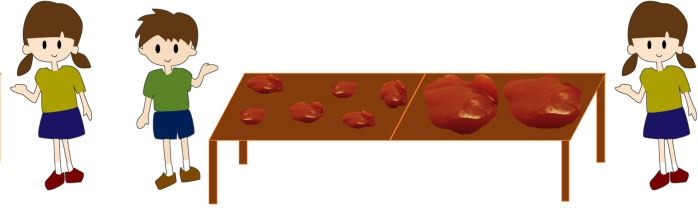
2.2. Results

Figure 10 summarizes the results of Experiment 1: namely, the rate of cardinality judgments depending on noun type and cues. Error bars refer to standard errors. Figure 11 summarizes the results of Experiment 1 per noun.

I analyzed participants' responses using a generalized logistic mixed model with Nouns and Subjects as random effects. As expected, participants based their quantity judgments on number



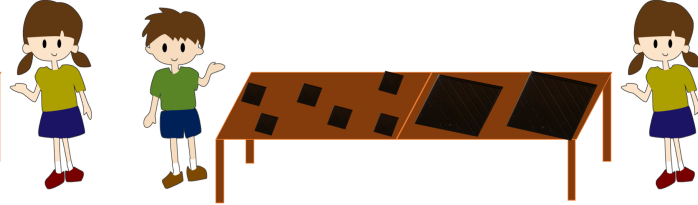
*Figure 5: Stimuli for the count noun *book**
 NOUN: Who has more books?
 NO NOUN: Who has more?



*Figure 6: Stimuli for the mass noun *ketchup**
 NOUN: Who has more ketchup?
 NO NOUN: Who has more?



*Figure 7: Stimuli for the aggregate noun *mail**
 NOUN: Who has more mail?
 NO NOUN: Who has more?



*Figure 8: Stimuli for the flexible noun *chocolate**
 NOUN: Who has more chocolate?
 NO NOUN: Who has more?

Figure 9: Example of stimuli for each type of nouns

significantly more for count nouns and aggregate nouns than for mass nouns and flexible nouns in both conditions: a significant effect of the ontological category was found both in the NOUN condition ($X^2(1) = 52.17$, $p < 5.073e-13$) and in the NO NOUN condition ($X^2(1) = 33.67$, $p < 6.544e-09$).

Moreover, the results of this experiment corroborate Scontras et al.'s (2017) results: count nouns and mass nouns were judged differently in the NOUN and the NO NOUN conditions. More precisely, participants based their quantity judgments on number significantly less for count nouns in the NO NOUN condition than in the NOUN condition ($\beta = 4.10$, $z = 4.37$, $p = 0.0003$) and significantly more for mass nouns in the NO NOUN condition than in the NOUN condition ($\beta = -2.06$, $z = -3.20$, $p = 0.0298$).

Regarding the results of other types of nouns, I interestingly found that while count nouns and aggregate nouns were not judged differently in the NOUN condition ($\beta = 1.39$, $z = 1.55$, $p = 0.4072$), in the NO NOUN condition, aggregate nouns were judged on number significantly more than count nouns ($\beta = -1.56$, $z = -2.98$, $p = 0.0155$). By contrast, mass nouns were not judged differently from flexible nouns in both conditions (NOUN condition: $\beta = -0.73$, $z = -1.46$, $p = 0.4615$; NO NOUN condition: $\beta = -0.18$, $z = -0.37$, $p = 0.9829$). Surprisingly however, flexible nouns in the NOUN condition were not judged differently from flexible nouns in the NO NOUN condition ($\beta = -1.45$, $z = -2.33$, $p = 0.2774$).

Finally, I found a significant interaction between target question and ontological category

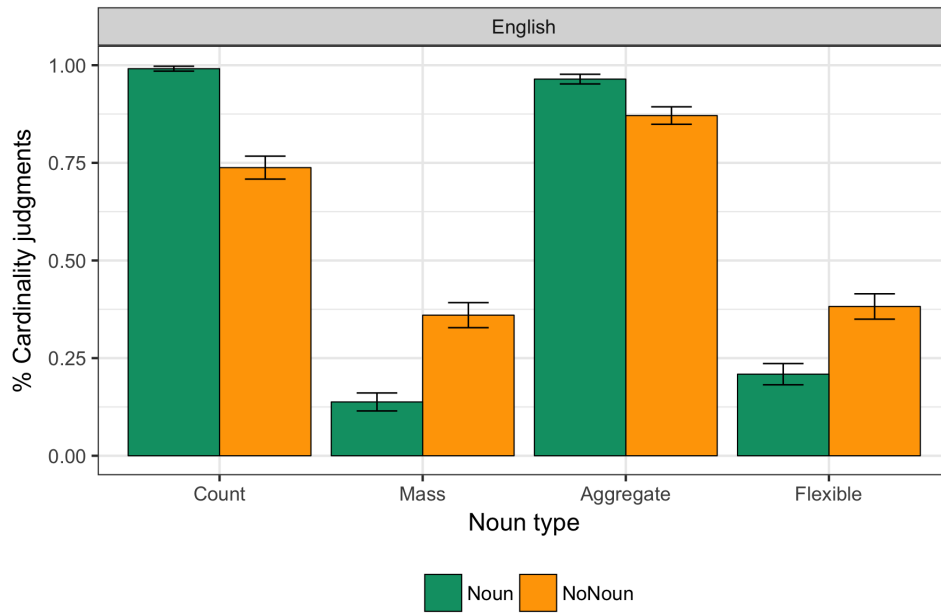


Figure 10: Rate of cardinality judgments depending on noun type and cues

($X^2 = 73.57$, $p < 2.2e-16$), corroborating once again Scontras et al.'s (2017) results.

2.3. Discussion

Recall that the goal of Experiment 1 was to investigate the role played by linguistic cues in quantity judgments by extending Scontras et al.'s (2017) study to every type of English nouns. Interestingly, while Scontras et al.'s (2017) results for count and mass nouns were confirmed, no contrast between the NOUN condition and the NO NOUN condition has been found for aggregate nouns and flexible nouns. In other words, while the absence of the noun and the morphosyntactic cues to atomicity did affect quantity judgments of count and mass nouns, it did not affect quantity judgments of aggregate nouns and flexible nouns. Another correlated surprising result is that while the absence of linguistic cues did affect count nouns and aggregate nouns differently, it did not affect mass nouns and flexible nouns differently.

In order to understand these results, let us look more closely at the results per noun summarized in Figure 11. To begin with, that count nouns in the NO NOUN condition were judged less often on number than count nouns in the NOUN condition may be due to the noun *bottle* and to the noun *candle*. *Bottle* being a container, it could be judged on volume if one takes into consideration the substances that can be contained into the bottles. Regarding the noun *candle*, participants may have taken into consideration the substance that makes up the candle. If that is the case, we would expect them to provide a judgment based on volume as they did for other substances. A post-hoc analysis confirms these claims. That is, when the results of the nouns *bottle* and *candle* are excluded from the analysis, count nouns are no longer judged differently in the NOUN and the NO NOUN conditions ($\beta = 3.60$, $z = 2.99$, $p = 0.0567$) and they are no longer judged differently from aggregate nouns in the NO NOUN condition either ($\beta = -0.83$, $z = -1.58$, $p = 0.76$).

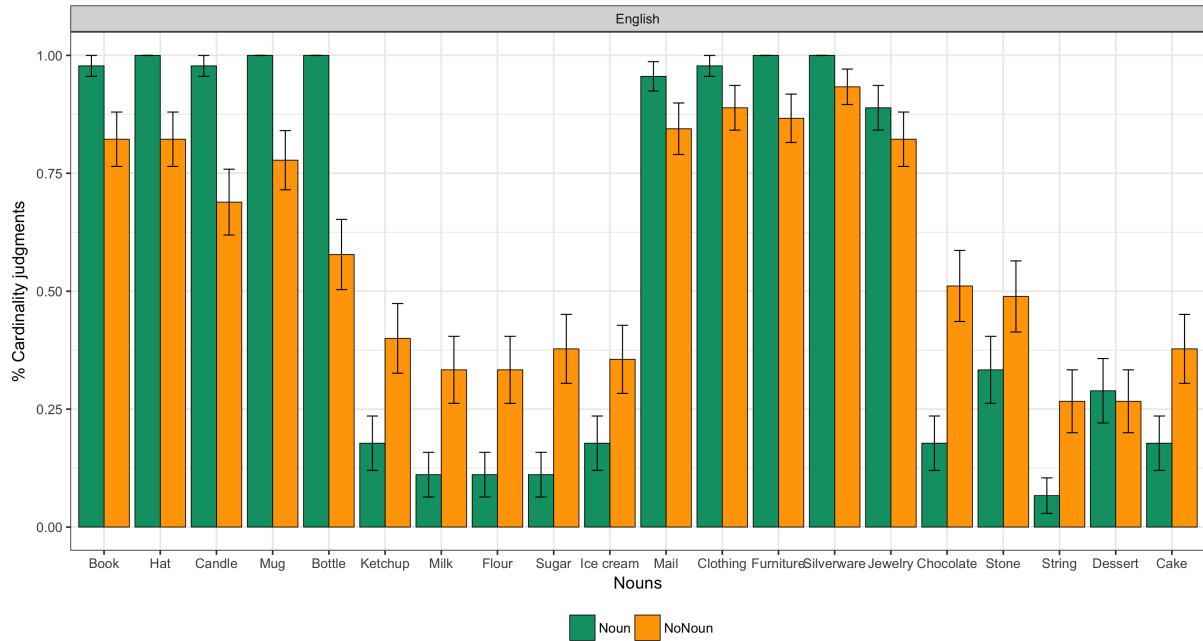


Figure 11: Rate of cardinality judgments per noun

If we now focus on flexible nouns, we observe a wide variation in the results.² This suggests that these nouns are not all flexible in the same way. For instance, unlike what was expected, the noun *dessert* does not seem to be flexible. One possible explanation is that although the noun occurred in the singular form in the NOUN condition, some participants provided a cardinality judgment because they took into consideration the different kinds of cakes. However, that flexible nouns were not judged differently in the NOUN condition and in the NO NOUN condition is surprising and still not understood given the results per noun.

Finally, the results of mass nouns corroborate Scontras et al.'s (2017) results suggesting that in the absence of linguistic cues, participants can count salient portions of the relevant substances. As noted by Scontras et al. (2017), these results contrast with the Yudja results from Lima (2014), who found that Yudja speakers provide cardinality judgments for every type of nouns. Our results show that counting salient portions of substances is not the default strategy in the absence of cues, suggesting that it is not the lack of cues that led to this default counting strategy in Yudja.

Now, recall that in the NO NOUN condition both the noun and the cues to atomicity were omitted. Therefore, that mass nouns were judged differently in the NOUN and in the NO NOUN conditions could either be due to the fact that the nouns were underspecified or to the fact that morphosyntactic cues to atomicity were missing. Since in English it is not possible to omit the linguistic cues to atomicity without eliding the noun, it is hard to understand what is the source of this effect. The goal of the second experiment is to address this issue.

²Note that since the singular form of flexible nouns was provided, I expected them to behave as mass nouns in the NOUN condition: that is, I expected participants to provide volume judgments for flexible nouns in the NOUN condition.

3. Experiment 2

In Experiment 2, I investigate the role of morphosyntactic cues to atomicity in quantity judgments by conducting the previous experiment in French. Recall that in French, while the singular-plural distinction is made in the written forms, it is not pronounced in most contexts. As illustrated below, both the singular and the plural form of the noun *chat* ‘cat’ have the same pronunciation. Using auditory stimuli, it is thus possible to remove experimentally the morphosyntactic cues to atomicity while providing the nouns to the participants at the same time.

(3) Singular form

- a. chat
cat
- b. [ʃa]

(4) Plural form

- a. chats
cat+PL
- b. [ʃa]

Now, if the contrasts observed in Experiment 1 as well as in Scontras et al. (2017) are due to the presence or absence of the relevant nouns in the quantity judgment prompts, count nouns and mass nouns should not be judged differently in the CUES condition (where both the nouns and the morphosyntactic cues to atomicity are provided to the participants) and in the NO CUES condition (where only the relevant nouns are provided to the participants) in this experiment. By contrast, if the previous results are due to the presence or absence of morphosyntactic cues to atomicity, the French results should be similar to the English results.

3.1. Methods

3.1.1. Task and instructions

I used the exact same task as in Experiment 1, namely a variant of Barner & Snedeker’s (2005) quantity judgments task. Note that in order to be able to remove experimentally the morphosyntactic cues to atomicity, it was crucial to have auditory stimuli.

3.1.2. Design and stimuli

As in Experiment 1, four types of nouns were tested: namely, count nouns, mass nouns, aggregate nouns and flexible nouns. The full list of nouns is provided in Table 3.³

This factor was crossed with the Cues factor. In the CUES condition, the target questions included morphosyntactic cues to atomicity. Count nouns occurred in the plural form (as indicated by the plural determiner *des*) whereas mass nouns, aggregate nouns and flexible nouns occurred in the singular form (as indicated by the singular determiners *du*, used with masculine nouns, and *de la*, used with feminine nouns). By contrast, in the NO CUES condition, the target questions did not include any cue to atomicity, the crucial determiners being absent of the quantity

³While the count nouns tested in this experiment are the same as the one tested in Experiment 1, the mass noun *ice cream* has been replaced by the mass noun *moutarde* ‘mustard’ for the following reason: the word for *ice cream* in French spoken in Québec is not the same as the word for *ice cream* in French spoken in France. Moreover, the list of aggregate and flexible nouns is quite different in both experiments since nouns that are aggregate and flexible in English do not necessarily fall into the same categories in French.

Noun Type	Nouns tested
Count Nouns	<i>Livre</i> ‘book’, <i>Chapeau</i> ‘hat’, <i>Bougie</i> ‘candle’, <i>Tasse</i> ‘mug’, <i>Bouteille</i> ‘bottle’
Mass Nouns	<i>Ketchup</i> ‘ketchup’, <i>Lait</i> ‘milk’, <i>Farine</i> ‘flour’, <i>Sucre</i> ‘sugar’, <i>Moutarde</i> ‘mustard’
Aggregate Nouns	<i>Courrier</i> ‘mail’, <i>Carrelage</i> ‘tiles’, <i>Vaisselle</i> ‘dishes’, <i>Matériel</i> ‘equipment’, <i>Monnaie</i> ‘change’
Flexible Nouns	<i>Chocolat</i> ‘chocolate’, <i>Corde</i> ‘rope’, <i>Fil</i> ‘thread’, <i>Pizza</i> ‘pizza’, <i>Gâteau</i> ‘cake’

Table 3: List of nouns tested in Experiment 2

judgment prompts. The schematic structures of the target questions used in the CUES and NO CUES conditions are given in Table 4. Crucially, in contrast to Experiment 1, each target question included the relevant noun.

Noun Type	Target question CUES Condition	Target question NO CUES Condition
Count Noun	<i>Regarde, il y a des X sur la table. Qui en a le plus?</i> ‘Look, there are some X on the table. Who has more?’	<i>Regarde ce qu’il y a sur la table. Qui a le plus de X?</i> ‘Look what is on the table. Who has more X?’
Mass Noun	<i>Regarde, il y a du/de la X sur la table. Qui en a le plus?</i>	<i>Regarde ce qu’il y a sur la table. Qui a le plus de X?</i>
Aggregate Noun	<i>Regarde, il y a du/de la X sur la table. Qui en a le plus?</i>	<i>Regarde ce qu’il y a sur la table. Qui a le plus de X?</i>
Flexible Noun	<i>Regarde, il y a du/de la X sur la table. Qui en a le plus?</i>	<i>Regarde ce qu’il y a sur la table. Qui a le plus de X?</i>

Table 4: Schematic structures of the target questions associated with each type of nouns

The Noun Type factor was manipulated within participants whereas the Cues factor was manipulated between participants. That is, half of the participants saw the target items of the CUES condition and therefore listened to target questions that included cues to atomicity, whereas the other half saw the target items of the NO CUES condition and therefore listened to target questions that did not include any cue to atomicity.

Each combination illustrated in Table 4 was repeated 5 times, for a total of 40 stimuli. Examples of stimuli for each type of nouns are depicted in Figure 16.

To ensure that participants listened to the auditory target questions and were paying attention to the task, 10 filler items of the form *Clique sur le garçon!* ‘Click on the boy!’ and *Clique sur la fille!* ‘Click on the girl!’ were added. The results of the participants who did not press the correct button more than once were excluded from the analysis.

All items were counterbalanced so that the order in which count nouns, mass nouns, aggregate nouns, flexible nouns and fillers occurred systematically varied. Each participant received 20 target items including five for each type of nouns and 10 filler items.

3.1.3. Participants

Participants were 69 native speakers of French (living in Canada and in France), recruited via Amazon Mechanical Turk and paid \$2 for their participation. 45 participants only saw the stimuli of the CUES condition and the other 24 participants only saw the stimuli of the NO CUES condition.⁴ Since eight participants (four in the CUES condition and four in the NO CUES condition) did not answer correctly some filler items, their results were excluded from the analysis.

⁴That less participants saw the stimuli of the NO CUES condition is due to the small number of native speakers of French on Amazon Mechanical Turk. Once the questionnaire of the CUES condition was completed, no more than 24 native speakers of French were available to complete the questionnaire of the NO CUES condition.

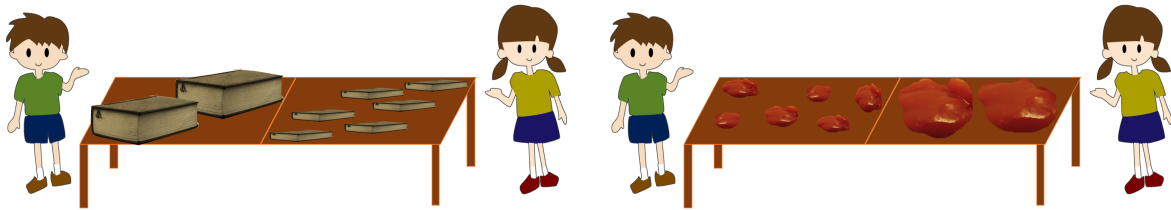


Figure 12: Stimuli for the count noun *livre*
CUES: Regarde, il y a des livres sur la table. Qui en a le plus?

NO CUES: Regarde ce qu'il y a sur la table. Qui a le plus de livres?

Figure 13: Stimuli for the mass nouns *ketchup*
CUES: Regarde, il y a du ketchup sur la table. Qui en a le plus?

NO CUES: Regarde ce qu'il y a sur la table. Qui a le plus de ketchup

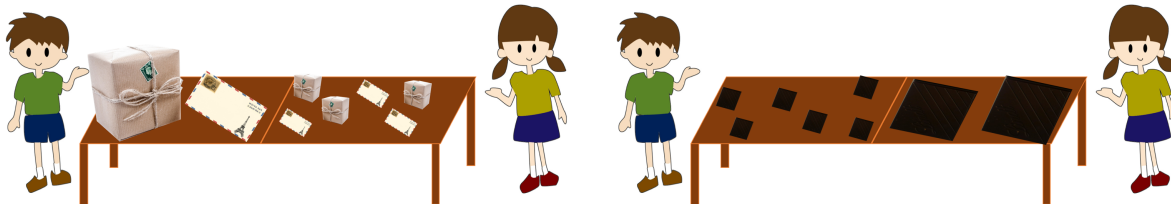


Figure 14: Stimuli for the aggregate noun *courrier*

CUES: Regarde, il y a du courrier sur la table. Qui en a le plus?

NO CUES: Regarde ce qu'il y a sur la table. Qui a le plus de courrier?

Figure 15: Stimuli for the flexible noun *chocolat*

CUES: Regarde, il y a du chocolat sur la table. Qui en a le plus?

NO CUES: Regarde ce qu'il y a sur la table. Qui a le plus de chocolat?

Figure 16: Example of stimuli for each type of nouns

3.2. Results

Figure 17 summarizes the results of Experiment 2: namely, the rate of cardinality judgments depending on noun type and cues. Error bars refer to standard errors. Figure 18 summarizes the results of Experiment 2 per noun.

I analyzed participants' responses using a generalized logistic mixed model with Nouns and Subjects as random effects. As expected, participants based their quantity judgments on number significantly more for count nouns and aggregate nouns than for mass nouns and flexible nouns in both conditions. In other words, I found a significant effect of the ontological category in both the *CUES* condition ($X^2(1) = 43.29$, $p < 4.728e-11$) and the *NO CUES* condition ($X^2(1) = 31.70$, $p < 1.801e-08$).

Interestingly, neither count nouns ($\beta = -0.24$, $z = -0.31$, $p = 1.00$) nor mass nouns ($\beta = -2.32$, $z = -2.83$, $p = 0.09$) were judged differently in the *CUES* and the *NO CUES* conditions. This contrasts with the results of Experiment 1.

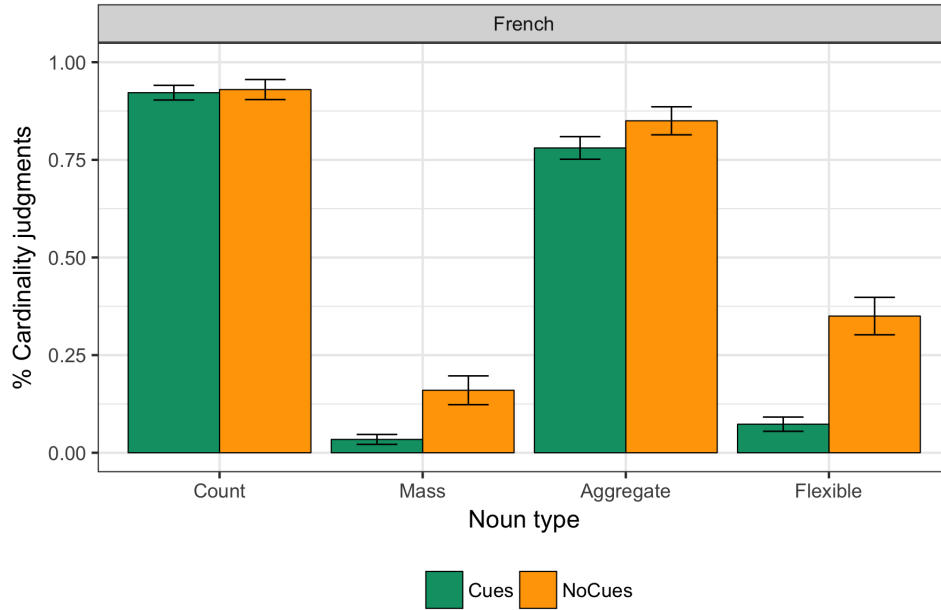


Figure 17: Rate of cardinality judgments depending on noun type and cues

Moreover, unlike in English, count nouns were not judged differently from aggregate nouns in both the CUES condition ($\beta = 1.42$, $z = 1.89$, $p = 0.23$) and the NO CUES condition ($\beta = 1.05$, $z = 1.39$, $p = 0.51$). And mass nouns were not judged differently from flexible nouns in both conditions either (CUES condition: $\beta = -1.28$, $z = -1.44$, $p = 0.4761$; NO CUES condition: $\beta = -1.67$, $z = -2.50$, $p = 0.06$). However, as expected, the presence or absence of cues did affect the quantity judgments of flexible nouns differently: participants based their quantity judgments on number significantly more in the NO CUES condition than in the CUES condition ($\beta = -2.77$, $z = -4.04$, $p = 0.001$).

Finally, combining the results of experiments 1 and 2 together, I found a significant interaction of language and linguistic cues ($X^2(7) = 22.45$, $p = 0.002$).

3.3. Discussion

Recall that the main goal of Experiment 2 was to investigate the role of morphosyntactic cues to atomicity in quantity judgments. The expectations were the following. If the results obtained in Experiment 1 as well as in Scontras et al. (2017) were due to the presence or absence of morphosyntactic cues to atomicity, we expected the results of Experiment 2 to be similar to the one of Experiment 1. By contrast, if the previous results were due to the presence or absence of the nouns in the target questions, we expected the results of this second experiment to be different from the English results. In particular, we expected count nouns and mass nouns to not be judged differently in the CUES and in the NO CUES conditions in French.

These results first suggest that morphosyntactic cues to atomicity do not influence quantity judgments in French. Indeed, the presence or absence of morphosyntactic cues did not affect the judgments of count nouns, mass nouns and aggregate nouns.⁵ The presence or absence of

⁵If we look at the results of aggregate nouns, we notice that two of them did not behave as expected: *carrelage*

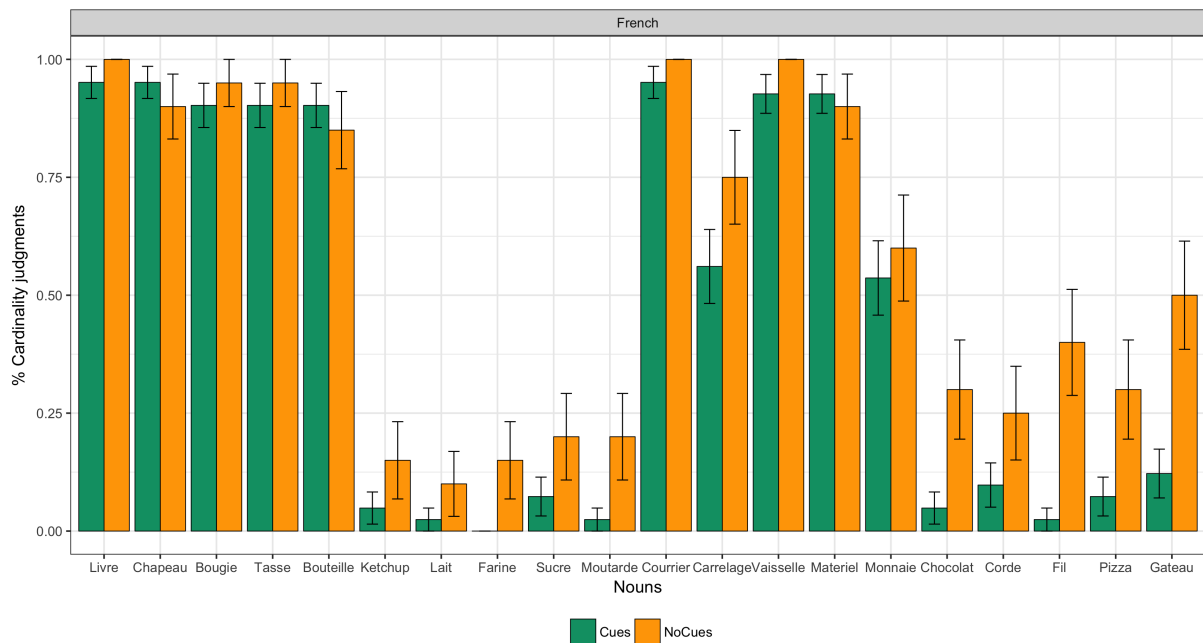


Figure 18: Rate of cardinality judgments per noun

morphosyntactic cues only affected the judgments of flexible nouns. In that case, the presence of linguistic cues helped participants to disambiguate the meaning of the nouns, corroborating Barner & Snedeker's (2005) results.

Furthermore, that we found a significant interaction between language and linguistic cues shows that the lack of cues is doing something different in English and in French. Now, recall that in English, the cues were twice underspecified in the NO NOUN condition: namely, both the nouns and the morphosyntactic cues to atomicity were missing. Knowing now that morphosyntactic cues to atomicity do not influence quantity judgments in French, this interaction between language and cues tells us that quantity judgments in English were affected by the absence of the relevant nouns in the quantity judgment prompts.

In a follow-up experiment, I show that quantity judgments in French are also affected by the absence of the relevant nouns in the target questions. This experiment uses the exact same task and stimuli as Experiment 2, but crucially in that case, the target question does not include the relevant nouns. That is, the target question is of the form *Qui en a le plus?* 'Who has more?'. Participants were 45 native speakers of French (living in Canada and in France), recruited via Amazon Mechanical Turk and paid \$2 for their participation. The results of four participants who did not provide the correct answers to some filler items were excluded from the analysis. Figure 19 summarizes the results: namely, the rate of cardinality judgments depending on noun type. These results show that as was the case in English, the absence of the relevant nouns in the quantity judgment prompts affects quantity judgments in French. In that case, quantity judgments can be influenced by the availability of salient portions and alternative dimensions

'tiles' and *monnaie* 'change'. While we understand that *monnaie* has a strong utility reading (in particular, participants could have assumed that two large coins are more valuable than six small coins), we do not understand the results obtained for the noun *carrelage*. Nevertheless, the important point is that these two nouns were not judged differently in the CUES and the NO CUES condition.

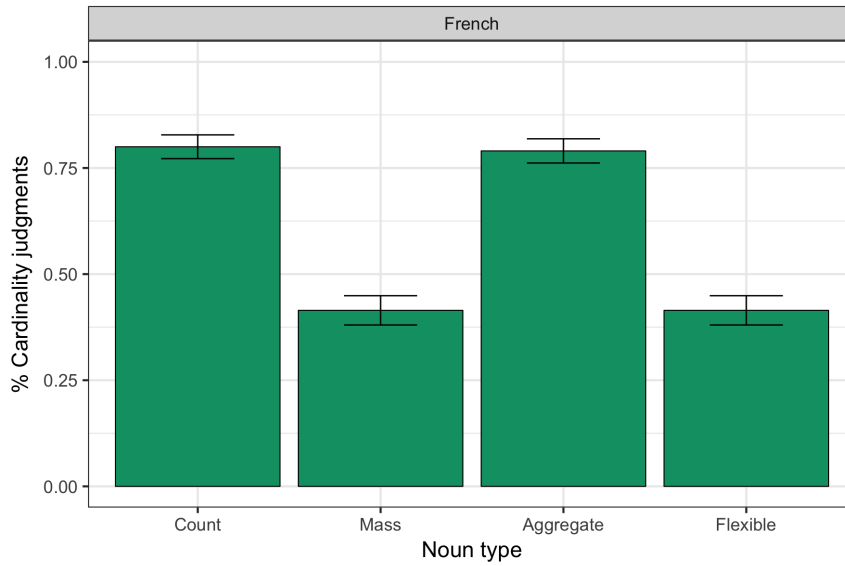


Figure 19: Rate of cardinality judgments depending on noun type

of measurement (consistent with Scontras et al. 2017).

When we have to perform a quantity judgment, the presence of the noun alone gives us a lot of information: what the object or substance depicted in the stimulus is and how we may classify it. But what do participants do when the nouns are not provided in the quantity judgment prompts? Presumably, they first have to fill in the nouns and the cues to atomicity to then give their quantity judgment. Scontras et al. (2017) tested the hypothesis that speakers mentally fill in the cues when the latter are absent from the quantity judgment prompts. They investigated the quantity judgments of count nouns and mass nouns in the following condition (named the FILL IN condition): participants were asked *Who has more ...?* and they had to fill in missing material in the target question before performing the quantity judgments. Interestingly, responses to the NO NOUN condition differed significantly from responses to the FILL IN condition, suggesting that the strategy participants adopted in the NO NOUN condition differs from the strategy they adopted in the FILL IN condition. However, as noted by Scontras et al. (2017), it is still possible that participants filled in missing material in the NO NOUN condition before performing their quantity judgment, but the material they filled in may differ from the material they provided in the FILL IN condition.

4. Conclusion

In this paper, I discussed the role of morphosyntactic cues to atomicity in quantity judgment tasks. The two experiments on English and on French show that while the absence of explicit cues to atomicity does not affect quantity judgments, the absence of nouns in the quantity judgment prompts has a great impact. What participants do when the nouns and the cues to atomicity are not provided in the quantity judgment prompts is still a mystery. While participants may fill in missing material before performing their quantity judgment, knowing what material they fill in could be a very hard task.

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Abbreviations

PL plural

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