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Quantity judgment and the mass-count distinction across languages: Advances, problems, and future directions for research

Alan Bale[1] and David Barner[2]

[1] Concordia University, 1455 de Maisonneuve Ouest, Montreal, QC, H3G 1M8, CA

[2] University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0109, US

Corresponding author: Alan Bale (alan.bale@concordia.ca)

We review advances in the experimental study of the mass-count distinction and highlight problems that have emerged. First, we lay out what we see to be the scientific enterprise of studying the syntax and semantics of the mass-count distinction, and the assumptions we believe must be made if additional progress is to occur, especially as the empirical facts continue to grow in number and complexity. Second, we discuss the new landscape of cross-linguistic results that has been created by widespread use of the quantity judgment task, and what these results tell us about the nature of the mass-count distinction. Finally, we discuss the relationship between the mass-count distinction and non-linguistic cognition, and in particular the object-substance distinction.
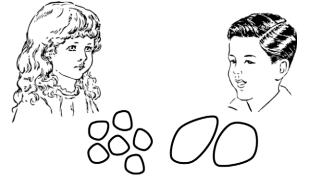
1 Introduction

In 2009, we published a paper (Bale & Barner 2009) on the mass-count distinction that argued for a methodology, deployed also in experiments (Barner & Snedeker 2005; 2006; Barner, Wagner & Snedeker 2008; Barner, Inagaki & Li 2009), which set out to test the semantic interpretation of mass and count nouns. This method relied on quantity judgments, as shown in (1), which established that speakers of English decide "who has more" based on number when a noun like *stone* is presented in count syntax, as in (1a), but they decide based on weight or volume when the noun is presented in mass syntax, as in (1b).

(1)   a.   Suzie has some stones and so does Billy. Who has more stones?
       b.   Billy has some stone and so does Suzie. Who has more stone?

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In our paper, we argued that alternative methods fail to capture basic intuitions regarding uncontroversial mass and count nouns, and therefore cannot not be trusted to assess more controversial cases, which in turn might be used to adjudicate between theories. In particular, multiple theories hinge upon the interpretation of what we called "object-mass nouns" like *furniture* and *luggage*. On some accounts, which deny that mass nouns could have countable denotations, it is argued that the mere presence of objects in the extension of a noun cannot alone be taken as evidence that these nouns *individuate* – or encode these denotations *qua* countable objects (Link 1983; 1998; Gordon 1985; Macnamara 1986; Bloom 1994; 1999; Wisniewski, Imai & Casey 1996). According to Bloom (1994: 45), "mappings relevant to the study of linguistic competence must be between grammatical classes and cognitive classes – not classes of entities in the world." Others have argued that we should simply trust our eyes: If a noun has countable objects in its extension, it must individuate (Gillon 1999; Chierchia 2001). For example, according to Gillon (1999: 9), "World knowledge tells one that ammunition has minimal parts, or atoms, known as rounds." The quantity judgment task overcame this impasse, because it showed that for cases like the ones in (1), the mere presence of countable objects in the extension of a noun is not sufficient to support quantification by number, and that judgments are nevertheless highly sensitive to alternation between mass and count syntax. Subsequent evidence that judgments for words like *furniture* were based on number was therefore compelling, because it suggested that judgments are not based purely on the presence of discrete physical objects in the world, but are in some important sense linguistically mediated. This collection of results, we noted, could not be explained by any of the previously articulated theories of the mass-count distinction (Bale & Barner 2009).

Many empirical studies have subsequently been conducted using the quantity judgment method, and these studies have taken the field in a variety of interesting directions. One important outcome is that the quantity judgment task has provided a simple, reliable, measure of semantic interpretation that is easily administered in diverse experimental contexts, allowing researchers to more easily acquire and compare data across different languages. The papers in this volume attest to this: Studies using the quantity judgment task have been conducted in English, Japanese, Mandarin, Hebrew, Yudja, French, Brazilian Portuguese, inter alia (e.g., Barner, Inagaki & Li 2009; Cheung, Barner & Li 2009; Inagaki & Barner 2009; de Oliveira & Rothstein 2011; Lin & Schaeffer 2018; Lima 2018; MacDonald & Carroll 2018; Van Witteloostuijn & Schaeffer 2018; Yin & O'Brien 2018). Also, the task has been used to study not only nouns that denote objects and substances – which are very likely misleading case studies for theory building, as we describe below – but also for more abstract nouns, like those that denote events (e.g., some dances/some dancing). These studies have sometimes been conducted in special populations, including young children and individuals with language impairment, to gain further purchase on the interplay between lexical semantics and the compositional semantics of morphosyntactic forms like the plural. Finally, recent work has explored how both children and adults use different cognitive systems, like the approximate number system, as verification procedures during sentence processes.

The present paper is intended to take stock of these advances, but also to highlight problems that have emerged in the application of the quantity judgment task. Below, we proceed in three parts. First, we lay out what we see to be the scientific enterprise of studying the mass-count distinction, focusing both on why this case study is important, but also what assumptions we believe must be made if any additional progress is to occur, especially as the empirical facts continue to grow in complexity. Second, we describe the new landscape of cross-linguistic results that have been created by the quantity judgment

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task, and what these results tell us about the nature of the mass-count distinction, and whether it is useful to continue work under the assumption that such a distinction indeed exists. Third, we discuss the relationship between the quantity judgment task and cognition, and in particular the object-substance distinction.

2 A scientific investigation of the mass-count distinction

As studies of the mass-count distinction have expanded to include a growing number of diverse languages, it has become increasingly difficult to be sure that these studies are in fact investigating the same underlying phenomenon, given the surface differences found across languages. For this reason, we believe that it is critical to continuing progress that researchers agree on our mutual object of study and how to identify it. What is the mass-count distinction, and what, as a field, do we seek to learn about it?

Unfortunately, although a collection of morpho-syntactic features have often been used to identify mass and count nouns in languages like English, things quickly become hairy when other languages are considered. Whereas in some languages the presence of singular-plural morphology is highly correlated with count syntax (as in English), in others it is not. Some languages make a clear distinction between quantifiers that can occur with either mass or count nouns, and others do not. Perhaps in response to this, rather than rely on syntactic properties, some studies have instead sought to define the mass-count distinction in terms of semantic, or even purely referential terms, leading to problems that are not only descriptively perilous, but also that make coherent theory building almost impossible. In the context of this special issue, which focuses on studying diverse groups of languages and speakers, we believe this issue is especially important, since often it will be difficult to determine whether the same phenomena are indeed at issue.

The root of confusion regarding the nature of the mass-count distinction dates as far back Quine (1960), who identified mass and count nouns in terms of a conjunction of syntactic and conceptual properties. In his discussion, Quine proposed a quick and dirty analysis that defined the mass-count distinction neither as purely syntactic nor purely semantic, but instead as a join of syntactic and semantic properties. While we obviously agree that the mass-count distinction has a semantics, Quine defined the mass-count distinction in terms of a particular semantics (defined in terms of conceptual categories), baking this analysis into the name of the distinction itself, and placing the scientific study of its semantics into the ruts of the object-substance distinction for the remainder of the 20th century, a trend which continues even today.

Our view is that, if we hope to understand the semantics of a syntactic distinction like mass vs. count, it is important to first distinguish between syntax, semantics, and non-linguistic conceptual representations, and to generate a first-pass description of the syntactic facts before attempting to characterize how it is interpreted by semantic or conceptual systems. The primary reason for this is methodological. If we begin with the assumption that the mass-count distinction is rooted in a conceptual object-substance distinction and that mass nouns are therefore those which have non-atomic semantic denotations, then no legitimate empirical debate can ensue regarding the semantics of the distinction *since this semantics is presupposed by the definition of the distinction*. Instead, the debate becomes one of asking how, e.g., the object-substance distinction is expressed syntactically across languages. Given that all of the papers in this special issue set out to test the semantics of linguistic expressions, we assume that this cannot be the approach that most in the field would like to take. Instead, most appear to share an interest in how a particular syntactic distinction is interpreted semantically (and in turn how this might relate to conceptual systems). On this approach, wherein we begin with a syntactic distinction and seek to

discover its semantics, we may find that the syntactic distinction is not universal even if object and substance representations are, and further, that it is not transparently related to the object-substance distinction. These two worlds of inquiry could not be more different.

What might constitute the syntax of the mass-count distinction? As a starting point, let's consider the criteria first laid out by Bloomfield (1933: 205–206).

(2)   Summary of Bloomfield's Observations
      a.   **Singular-Plural Contrast**: Count nouns have alternate forms corresponding to singular and plural. Most mass nouns only have a singular form (though there are some with only a plural form).
      b.   **Antecedents**: Only noun phrases headed by count nouns in the singular serve as antecedents for the pronouns *another* and *one*.
      c.   **Quantifier Distribution**: The indefinite article *a*, the determiners *each*, *every*, *either*, *neither* and the cardinal numeral *one* modify only count nouns in the singular. The determiners *few*, *a few*, *fewer*, *many*, *several* and the cardinal numerals greater than or less than one modify only count nouns in the plural. The determiners *all*, *enough* and *more* may modify mass nouns or plural count nouns, but not singular count nouns; and mass nouns and plural count nouns, but not singular count nouns, may occur without a determiner. The quantifiers *little*, *a little*, *less* and *much* modify only mass nouns.

Note that on Bloomfield's analysis, similar to that of Jesperson, the initial description of the mass-count distinction was completely morpho-syntactic and not defined in terms of semantic or conceptual notions, like object vs. substance.

Given this syntactic characterization, one obvious problem is that it is stated in reference to structures found in English, which may or may not be necessary components of a mass-count distinction. How might we decide this when examining other languages? One approach is to adopt a strict set of criteria, and thereby assume that English is a meaningful benchmark for identifying mass-count languages. For example, a researcher might decide to only classify a language as having a syntactic mass-count distinction if it exhibits nominal sub-categories that perfectly mirror the distributional characteristics identified in (2). In other words, if it has (i) a singular-plural alternation, (ii) different pronouns that are sensitive to different types of nominal antecedents, and (iii) a distribution of quantifiers that reflect two subcategories of nouns. For better or for worse, relatively few languages would have such a distinction. Still, within this relatively small set of languages, a fairly coherent research program might be conducted, in which we ask whether this collection of syntactic facts corresponds to a coherent semantic analysis.

Alternatively, a somewhat broader approach might be taken. Note that all of the distributional characteristics in (1) relate to quantificational elements (number marking, numeral modification, and the presence or absence of certain types of determiners). Given this fact, one might reason that a given language has a mass-count distinction if and only if it has nominal subcategories that are sensitive to (or determined by) quantification determiners, number affixes, *or* numeral modification (note the use of *or* instead of *and*). Such a characterization would allow for variation in terms of the details of the distribution (e.g., whether plural marking is necessarily involved, or whether the numeral system needs to operate as it does in English, etc.). Also, as above, such a characterization would allow a purely syntactic starting point for inquiry, such that the independent variable in the object of study (the syntax) is defined independently of the dependent variable (i.e., the semantics), thereby assuring that the empirical enterprise is non-circular in nature.

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Shifting our focus to semantic research questions, things are somewhat more complicated. Semantics, by definition, is a theoretical enterprise that seeks to explain the (compositional) interpretation of lexical items, phrases, and sentences. Hence, semantic investigations depend on some form of assumed syntactic structure – one cannot ask how something is interpreted without specifying what it is that is being interpreted. With this in mind, one might wonder what types of semantic research questions are possible in the case of the mass-count distinction. For example, one obvious question, given that a language has a mass-count distinction, is whether there exists an isomorphism between syntax and semantics, such that the number of categories in one domain is equal to the number in the other, and mappings from syntax to semantics are one-to-one.

With respect to this question, Jespersen (1924), who coined the term *mass words*, proposed an isomorphism between syntax and semantics wherein count nouns denote countable objects and mass nouns denote substances or more abstract entities that similarly cannot be counted,[1] an idea that was endorsed by Quine (1960). Later, this kernel of an idea was expanded to include a variety of abstract nouns, by capitalizing on the notions of *cumulativity* and *divisity* (see Cheng 1973; Bunt 1979; 1985; Link 1983; among others). For example, Cheng argued that the meaning of words like *mud* are importantly different from words like *cat* in two respects: first, if *x is mud* and *y is mud* and *z* is the combination of *x* and *y*, then *z is also mud* (cumulativity; see also Quine 1960); second, if *z is mud* and *x* and *y* are two parts that make up *z*, then *x is mud* and *y is mud* (divisity). Critically, these observations do not hold of singular nouns like *cat*. For example, if *x is a cat* and *y is a cat*, and *z* is the group containing both cats (i.e., *z* is the material combination of both cats), it does not follow that *z is a cat*. Similarly, if *z is a cat*, and *x* and *y* are parts that make up *z* (such as the legs of a cat and the body of the cat), it does not follow that *x is a cat* and *y is a cat*.

Link (1983) recast these entailments more abstractly using Boolean algebras. In his theory, nouns like *cat* denote a set of atoms (objects that have no subparts) whereas nouns like *mud* denote a set that is closed, both upwardly and downwardly, under the "part-of" relation (i.e., if the elements *x* and *y* are members of the denotation, then any element *z* that is part of *x* or *y* is a member of the denotation; and any element *z* that is the combination of *x* and *y* is also a member of the denotation). These general properties hold whether the singular count nouns or mass nouns are abstract or concrete (e.g., count nouns like *idea* and *worry* versus mass nouns like *hope* and *happiness*). Singular count nouns always denote a set of atoms whereas mass nouns have denotations that are divisive and cumulative (and hence do not contain atoms).

Many linguists and psychologists have adopted some version of Link's formal theory and have embraced a tight correspondence between syntax and semantics, such that count nouns always have atoms in their denotations and mass nouns, including words like *equipment* and *furniture*, never do (see Gordon 1985; Macnamara 1986; Bloom 1994; 1999; Wisniewski et al. 1996; among others). In other words, all mass nouns were argued to have the same formal properties as substances, even those that can be used to refer to objects such as *equipment* and *furniture*. Others have argued that whereas count nouns uniformly have atomic denotations, mass nouns vary, such that some, like *mud* and *happiness,* do not have atoms in their denotation while others, like *furniture* and *equipment* do (see, for example, the discussions in Bloomfield 1933; Bunt 1985; Gillon 1992; 1999;

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[1] Jespersen (1924) characterizes the distinction in terms of quantification: One class of nouns can be quantified by number whereas the other cannot. It is clear from the text that the semantic notion of quantification (i.e., how the denotation can be conceptually measured) is isomorphic to the syntactic notion of quantification (i.e., what quantifiers the noun can combine with), although these two notions of quantification are never identified or teased apart.

2012; Chierchia 1998; Bale & Barner 2009; Rothstein 2010; Pelletier 2012). Also, as discussed by Gillon (1992), criteria like cumulativity and divisity apply without difficulty to plural count nouns, suggesting that they relate less to the mass-count distinction than to semantic non-singularity.

This debate sets up one possible semantic research question that would not be possible were the mass-count distinction initially defined in terms of both syntactic *and* semantic criteria: In languages that have a syntactic mass-count distinction, do some mass nouns have countable atomic denotations or are atomic denotations only possible for count nouns? It is with respect to this question that the quantity judgment data are critical (Bale & Barner 2009; see also McCawley 1979; Gathercole 1985; Barner & Snedeker 2005; 2006; Barner et al. 2008). Mass nouns such as *furniture* and *equipment* permit quantity judgments based on number in comparative sentences whereas nouns like *water* and *mud* do not. For example, speakers of English evaluate the sentences in (3a) and (3b) based on the number of items possessed by each person. Even if John only has three small chairs, four small side tables, and a small couch whereas Mary has two giant chairs and a huge couch that weighs more than all of John's items taken together, John still has more furniture than Mary.

(3)   a.   John has more furniture than Mary.
        b.   John has more chairs than Mary.
        c.   John has more mud than Mary.

In contrast, nouns with non-atomic denotations, such as mud in (3c), never permit comparison by number, even when suitable portions for counting are available. For example, if John has five small buckets of mud whereas Mary has one huge bucket Mary has more mud so long as her bucket contains a greater mass or volume of mud-stuff, despite the fact that John has a greater number of portions.

Critically, the contrasts observed with comparative constructions in English hinge somewhat on syntax (over and above contextual ones, though context can be made to play a role).[2] For example, the same noun in the same context yields different methods of comparison when used as a mass noun versus a count noun. Consider the examples in (4) and (5) taken from Bale and Barner (2009).

(4)   a.   Esme has more ropes than Seymour.
        b.   Esme has more strings than Seymour.
        c.   Esme has more stones than Seymour.

(5)   a.   Esme has more rope than Seymour.
        b.   Esme has more string than Seymour.
        c.   Esme has more stone than Seymour.

In (4), evaluating the truth or falsity of the sentences require counting the number of ropes, strings and stones. In contrast, evaluating the comparisons in (5) requires assessing the length, mass, volume or area associated with the rope, string or stone. In one and the same context, the sentences in (4) could be true while the ones in (5) could be false. In fact, statements like the ones in (6) are completely consistent.

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[2] Subjects may, for example, fall back on dimensions like mass or volume to compare large sets of objects (e.g., *loaded into a moving van*), whether described as chairs or as furniture, using the available continuous dimension as a proxy for number. However, what's critical is whether this dimension is preferred over number when both sources of information are readily retrievable from context (see Barner, Wagner & Snedeker 2008 for a method for testing subjects' preferred measuring dimensions).

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(6)   a.   I don't have more rope than Seymour but I have more ropes.
          b.   I don't have more string than Seymour but I have more strings.
          c.   I don't have more stones than Seymour but I have more stone.

It is clear that although not all mass nouns support quantification by number, others do. The best explanation of these facts is that nouns like *furniture* do indeed have atomic denotations and that comparative constructions are able to measure these denotations in terms of the number of atomic parts. Nouns without atoms require a different type of measurement.

As alluded to earlier, the type of inquiry just described – where the semantics of a morpho-syntactic distinction is investigated – is critically different from the question of whether certain lexical items in a given language have atomic denotations or not. For this reason, we interpret the findings of Lin and Schaeffer (2018) with caution (for similar evidence from Japanese and Mandarin, but a slightly different interpretation, see Barner, Inagaki & Li 2009; Inagaki & Barner 2009). Discovering that a language permits lexical items that are either atomic or non-atomic cannot alone support the conclusion that the language makes a mass-count distinction, particularly if it turns out that mass nouns can be either atomic or non-atomic in a language like English. While it is valuable to understand whether all languages permit lexical items with atomic and non-atomic denotations, we believe that it is critical to separate this issue from the investigation of mass-count semantics, unless we are satisfied with simply stipulating the semantics of the distinction from the outset – i.e., that the mass-count distinction is whatever syntactic distinction we find in a language that corresponds to a distinction between atomic and non-atomic reference. While this might be an entirely respectable scientific approach, it would not (and by definition **cannot**) be the same question that researchers ask when they wonder whether all mass nouns in English have non-atomic denotations. On an approach that begins with semantics as the core of the mass-count distinction, words like *furniture,* having atomic denotations, would by definition be considered count nouns, with the result that mass and count nouns in English would have overlapping distributional profiles (with some count nouns, like *cat,* allowing singular and plural forms, and others, like *furniture*, not).

In short, a scientific enterprise that seeks to find the syntactic correlates of an object-substance (or atomic vs. non-atomic) distinction is a different enterprise from one which seeks to discover the semantic correlates of a syntactic mass-count distinction. These projects differ not only in their methods, but also their conclusions, and surely deserve different names. In the remainder of this paper, we confine our attention to the question that we believe is the focus of most formal semanticists – i.e., what constitutes the syntactic distinction between mass vs. count cross-linguistically, and what are the semantic correlates of this distinction?

3 The mass-count distinction and cross-linguistic variation

Given the focus of this special issue on the use of quantity judgment in diverse populations, the present section will explore ways in which researchers might navigate cross-linguistic variation, to ensure that comparable phenomena are being studied and compared. Investigating the mass-count distinction across languages can take many forms. For example, one might explore the various ways in which languages encode measurement and counting that are similar to or different from the ways they are encoded in English using the mass-count distinction (see Krifka 1995; Chierchia 1998; Borer 2005; Doetjes 2011; Bale & Gillon forthcoming). In such an investigation, the goal is not necessarily to test whether a given language has a mass-count distinction, but instead to probe variation with respect to the syntactic expression of number, measurement, and quantification. Such a research

program is broad and open ended. Another possible research direction asks (1) whether a language has a morpho-syntactic mass-count distinction and (2) if it does, whether the interpretation of these subcategories is similar to English or other canonical mass-count languages. In this section, we discuss aspects of both approaches, leaving aside for now the third possibility, mentioned earlier, of exploring how different languages represent objects and substances. We return to this question later in the paper.

3.1 Problems with diagnosing a mass-count distinction in other languages

One of the potential pitfalls of investigating the mass-count distinction in understudied languages is that agreed-upon signatures of such a distinction, like those described in (2), may not readily translate to other languages. For example, in some languages the singular-plural distinction is implemented as a sub-distinction among count nouns, whereas in others it is not; the plural morpheme is used with almost any noun, object-denoting and substance-denoting alike (see Davis & Mathewson 1999; Gillon 2010; Mathieu 2012; among others). Similarly, many languages that have a rich classifier system, like Japanese, Mandarin, and Korean, also lack a syntactic mass-count distinction (Allan 1980; Wiltschko 2012; Lin & Schaeffer 2018; MacDonald & Carroll 2018; Yin & O'Brien 2018), though in some cases languages appear to have both (see Pelletier 2012 for examples), or they resist a definitive analysis (see the discussion of Western Armenian in Khanjian 2012 and the discussion of plural marking and classifiers in Doetjes 2012). In this section, we discuss the general strategy of using the presence of a classifier system (i.e., the lack of direct numeral modification) to diagnose whether a language lacks a mass-count distinction. We review evidence presented in Bale & Coon (2014) that shows that at least some classifier systems depend on the semantic and syntactic characteristics of numerals and thus are completely divorced from the syntactic and semantic properties of nouns.

As noted in Bale & Coon (2014), whether a numeral can directly modify a noun sometimes depends on the numeral itself rather than the subcategory of the noun, such that direct numeral modification (and thus classifier distribution) may be orthogonal to the mass-count distinction. For example, in Ch'ol (Mayan), numerals that are historically related to the traditional Mayan counting system require a classifier to mediate between the numeral and noun, whereas numerals that are historically borrowed from Spanish prohibit such a classifier. This is shown with *cha'* ('two', historically from Mayan) and *nuebe* ('nine', historically from Spanish) in (7) and (8).[3]

(7)   *Ch'ol (Mayan)*
        a.   cha'-p'ej   tyumuty
              two-CLF   egg
        b.   *cha'   tyumuty
              'two   egg'

(8)   *Ch'ol (Mayan)*
        a.   *nuebe-p'ej   tyumuty
              nine-CLF   egg
        b.   nuebe   tyumuty
              'nine   egg'

Thus, in this language, the possibility of direct numeral modification is independent of nominal properties.

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[3] A similar pattern exists in other unrelated languages such as Mi'gmaq (Eastern Algonquian; see Bale & Coon 2014).

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Such facts raise the possibility that in other languages numeral modification may also not reflect the presence of a mass-count distinction, even though direct versus indirect numeral modification can be used to distinguish mass nouns from count nouns in languages like English. Similar issues arise for singular and plural marking and the distribution of quantifiers (for a more thorough discussion of these issues see Bale & Gillon forthcoming). In sum, irrespective of the particular morpho-syntactic forms in question, few if any are likely to be perfectly predictive of mass-count status cross-linguistically, even if they are well correlated with mass-count status within a particular language.

3.2 The relationship between classifiers and mass-count syntax

Problems with diagnosing a mass-count distinction (such as those discussed in Section 3.1) are relevant to the research program that investigates how mass-count syntax is interpreted cross-linguistically. However, seeking out specific indicators of mass-count status, like singular-plural marking, is not the only possible research approach one might adopt. One might also ask whether there are alternative morpho-syntactic systems that represent the same underlying syntactic distinction between mass and count. In this vein, researchers have investigated classifier languages like Mandarin, Japanese, Western Armenian, and Ch'ol, inter alia (see Krifka 1995; Chierchia 1998; 2010; Cheng & Sybesma 1998; 1999; Borer 2005; Doetjes 2011; Li 2011; Rothstein 2011; Li & Rothstein 2012; Bale & Coon 2014; among others). As discussed briefly with Ch'ol above, classifier languages often require an extra word or morpheme to mediate the relationship between a numeral and a noun. For example, although I can say *one child* in English by inserting the numeral *one* adjacent to the noun *child*, the equivalent expression is ungrammatical in Mandarin Chinese: **yī háizi* ('one child'). Instead, the classifier *ge* is required: e.g., *yī ge háizi* ('one child'). Such classifiers break down into two basic categories: (1) those that license a noun's inherent unit of counting (e.g., counting individuals) – often called *sortal classifiers*; and (2) those that provide information about the measuring unit – often called *mensural* or *non-sortal classifiers*.

There are two main claims within the literature on the relationship between classifier languages and the mass-count distinction. One is that the distinction between sortal and non-sortal classifiers is analogous to the mass-count distinction (Cheng & Sybesma 1998; 1999). The other is that all bare nouns in classifier languages are semantically equivalent to mass nouns in English. In other words, classifier languages do not have count expressions (at least not at NP level). We believe that both of these claims can be problematic, however, especially if they are based on premature assumptions about how the mass-count distinction is encoded in languages like English.

Let's first address the claim regarding classifiers before returning to the status of bare nouns. There are two potential problems with the claim that sortal classifiers create count-like expressions whereas non-sortal classifiers create mass-like expressions. First, scholars who argue that such a claim is true (e.g., Cheng & Sybesma 1998; 1999) base their arguments, in part, on how classifier phrases relate to atomic and non-atomic denotations: Sortal classifiers license atomic denotations whereas mensural classifiers do not. However, there are two problems with this. First, as already noted, the syntactic mass-count distinction does not correlate with this semantic distinction; mass nouns can have both atomic and non-atomic denotations. Thus, even if it is true that the sortal versus non-sortal distinction correlates with an atomic versus non-atomic distinction, this does not necessarily demonstrate anything about their status as mass or count.

Second, and perhaps more critically, the sortal vs. mensural distinction found in Mandarin classifiers has an analog in English, which appears to be orthogonal to the mass-count distinction. Much like Mandarin sortal classifiers, English features a closed class of measure terms that rely on a subordinate noun's inherent "natural units" for counting – terms such

as *item* and *piece* (e.g., *one piece/item of furniture* and *several pieces/items of clothing*). As shown in (9), such terms behave much like the default classifier *ge* in Mandarin, which is used in a variety of different counting expressions but contains no information regarding the properties of the individual things to be counted (other than to adopt the natural counting units associated with the adjacent noun; for psychological data, see Li, Barner & Huang 2008).

(9)   *Mandarin Chinese*
        a.   liǎng ge   **jī-dàn**
             two   CLF.SORTAL   egg
             'two eggs'

        b.   liǎng ge   **rén**
             two   CLF.SORTAL   people
             'two people'

Also, English has an open class of measure terms that determine their own unit of measurement – terms such as *bottle* and *litre* (e.g., *two bottles of wine; five litres of milk*). These measure terms are similar to non-sortal (mensural) classifiers in classifier languages, such as the Mandarin classifier *píng* in (10), which provides information about how to count (e.g., *bottles-worth of wine/water*).

(10)   *Mandarin Chinese*
        a.   liǎng píng   jiǔ
             two   CLF.bottle   wine
             'two bottles of wine'

        b.   liǎng píng   shuǐ
             two   CLF.bottle   water
             'two bottles of water'

The syntax and semantics of these different types of measure terms in English are not substantially different from those found in Mandarin (see the discussion in Li 2011; Rothstein 2011; Bale & Barner 2012; Li & Rothstein 2012; Bale & Gillon forthcoming). And critically, in English, this distinction is entirely orthogonal to the mass-count distinction. For example, both sortal and non-sortal measure terms can be used in noun phrases that function syntactically as count. Also, both count and mass nouns can appear as the complement of non-sortal measure terms (e.g., *two crates of furniture*, *two crates of apples*, *four kilos of apple*, *four kilos of apples*), suggesting the existence of two dissociable syntactic distinctions, not one.[4] At least in languages like English, the sortal versus non-sortal distinction can coexist with the mass-count distinction and furthermore, the distributional properties of the two distinctions do not correlate. Thus, whether a language has a sortal/non-sortal distinction is a not a likely a reliable indicator of whether or not a language makes a syntactic syntactic mass-count distinction.[5]

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[4] Interestingly, the measure term *item* can be used with object-mass nouns (e.g., *one item of furniture/clothing/luggage/jewelry/mail*), much like a sortal classifier, but critically cannot be used with count nouns (e.g., *one item of chair*) or substance-mass nouns (e.g., *one item of wine*), suggesting again that the sortal vs. mensural distinction does not map onto count vs. mass syntax.

[5] Rothstein (2011) notes that measure nouns have both a partitioned and a measure reading. In general, the sortal terms are only consistent with the partitioned reading whereas other measure terms are ambiguous between the two readings. Rothstein (2011) claims that partitioned readings are more count-like whereas measured readings are more mass-like. Although this might be true in terms of the semantic distinction between atomic and non-atomic denotations, it is not clear whether this claim is true of all the distributional characteristics noted in (2).

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Let's now turn our attention to the other claim often made in the literature on classifier languages, namely that all bare nouns in such languages are semantically like mass terms in English (see Krifka 1995; Chierchia 1998; Borer 2005; Bale & Barner 2009; 2012; Rothstein 2010; Bale & Gillon forthcoming; among others). Some of the authors who make this claim hypothesize that all bare nouns in classifier languages are substance-like (see, e.g., Lucy 1992). However, most who make this claim argue that mass nouns are underspecified with respect to whether they have atomic or non-atomic denotations. Hence, the claim is not that all nouns in classifier languages have non-atomic, substance-like denotations, but rather that nouns vary in this respect and resemble mass nouns with respect to other criteria such as divisity or cumulativity.

Many researchers have sought to evaluate the behavior of bare nouns in classifier languages – and for that matter, in other types of languages with understudied quantificational systems – with the aim to establish whether such nouns have both atomic and non-atomic denotations just like mass nouns (Barner et al. 2009; Inagaki & Barner 2009; Li, Dunham & Carey 2009; Lin & Schaeffer 2018). There are at least two ways that classifier languages might differ: (1) they might uniformly have non-atomic denotations, or (2) they might exhibit a degree of contextual flexibility that is atypical of mass nouns (sometimes having atomic denotations and other times having non-atomic denotations, depending on context).

As argued by Bale & Barner (2009), comparative constructions are an ideal way to test whether a given noun has an atomic versus a non-atomic denotation, and indeed, many researchers have used this tool (see Barner et al. 2009; Inagaki & Barner 2009; Li, Dunham & Carey 2009; Lima 2014; 2015; Lin & Schaeffer 2018; Lima 2018; MacDonald & Carroll 2018; Yin & O'Brien 2018). However, as with numeral modification discussed above, it is important to ensure that comparative constructions interact with nominal denotations in other languages in the same way they do in English. As mentioned in Section 2, one reason that quantity judgment offers a strong diagnostic in English is that it is exquisitely sensitive to the nature of nominal denotations. For example, even in contexts where person A has three long ropes and person B has four short ropes (and where the collective length of A's ropes is longer than the collective length of B's ropes), A is judged to have more rope even when B is judged to have more ropes. In other words, the comparative is not completely determined by how the referents are divided, but rather how the denotations are semantically encoded (e.g., the denotation of *ropes* has atomic minimal parts whereas the denotation of *rope* does not).

Still, as already noted, context can sometimes be made to swamp the semantics of a noun in certain cases, making it important that researchers use methods that favor sensitivity to grammar over sensitivity to these contextual factors. For example, subjects may base judgments on mass for all nouns, regardless of syntax, if numerical information is not readily retrievable from context, or if weight is the information required by the context – e.g., when paying a moving company to haul large numbers of chairs, billed by weight.[6] Also, in our previous work, we have found that when subjects are presented with photographs of stimuli rather than real objects and substances, inexperienced test takers often resort to basing all judgments on number. However, these same subjects – whether English-speaking 3-year-olds or adult speakers of Mayan languages – base judgments on mass or volume when presented with real three dimensional versions of the identical

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[6] To the extent that such contextual factors affect quantity judgments across the board – for mass and count nouns alike – then they raise little in the way of concern for the method. If, however, it can be shown that context effects only mass nouns, like *furniture* (and that such effects occur only in English, but not to equivalent count nouns in other languages, like *meubles* in French), then one might worry that data from the task are overly influenced by context. We currently know of no such evidence.

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stimuli. Such effects suggest caution when interpreting cross-linguistic quantity judgment data, and may be germane to assessing cases in which speakers uniformly make judgments on number (e.g., see Lima 2018 for one case in which it is possible this is an issue).

Putting these methodological concerns aside, preliminary experimental results suggest that bare nouns in classifier languages pattern, for the most part, like mass nouns in English: some comparisons with bare nouns are decided by number and others by other types of measurements (mass, volume, length, etc.). For example, in the study by Inagaki and Barner (2009), Japanese speakers were given a comparative sentence with a bare noun and asked to judge which of two characters had more (see also Barner, Inagaki & Li 2009). As we describe below, the results of this study resemble those reported by Lin and Schaeffer (2018), suggesting that the phenomena are not specific to Japanese (for further evidence from Mandarin, see Cheung, Barner & Li 2010). When nouns like *kutu* ('shoe'), *roosoku* ('candle'), *kagu* ('furniture') and *irui* ('clothing') were used, speakers decided who had more based on the number of objects each character had. In contrast, when nouns like *karasi* ('mustard'), *hamigakiko* ('toothpaste') and *piinattubataa* ('peanut butter') were used, speakers decided who had more based on volume. Thus, it appears that, like mass nouns in English, bare nouns in Japanese have both atomic (i.e., number-licensing) and non-atomic (i.e., non-number-licensing) denotations.

However, there are notable differences between Japanese and Mandarin bare nouns and English mass nouns, especially when it comes to so-called flexible nouns that name strings, stones, chocolates and papers. In English, these nouns trigger a comparison exclusively by number when used in count syntax but exclusively by volume/length when used in mass syntax. In contrast, as is found for Mandarin in Lin and Schaeffer (2018), Barner, Inagaki & Li (2009) report that Japanese nouns *isi* ('stone'), *himo* ('string'), *tyokoreeto* ('chocolate'), and *kami* ('paper') sometimes triggers a comparison by number and sometimes by length/volume (about a 50–50 split). Thus, Japanese speakers behave as if these bare nouns are ambiguous between an atomic and non-atomic interpretation. While such evidence that single lexical items can quantify either by number or mass/volume might be taken as evidence for lexical mass-count features (as in Pelletier 2012), for the reasons already described above, we instead conclude that nouns across languages provide conceptual criteria that allow different modes of quantification without involving a syntactic specification of mass or count features at the lexical level. For example, Barner et al. concluded that Japanese and English have similar lexico-conceptual representations for words like *string* and *stone,* and that these words that are systematically polysemous in each language (allowing either reference to objects or substances), but that English differs from Japanese only because it provides a mechanism for syntactically selecting between these different lexical meanings (for related data, see Barner, Inagaki & Li 2009; Li, Dunham & Carey 2009). For this reason, speakers of Japanese must use context to decide whether the speaker intends to refer to units of string or string-stuff, and thus perform at 50% when context is neutral.

However, these results should be taken with a grain of salt. This type of exploration into bare nouns is still in its infancy and more cross-linguistic work needs to be done before coming to any firm conclusions about how nouns are interpreted in languages with and without a mass-count distinction. Hence the importance of investigating languages like Mandarin and Yudja using comparative constructions (see Lima 2014; 2015; 2018; Lin & Schaeffer 2018), and the importance of investigating the problems that second-language learners have in making quantity judgments when their first language lacks a mass-count distinction (see MacDonald & Carroll 2018; Yin & O'Brien 2018). Hopefully as more evidence emerges, we will get a better picture of the interactions between the lexicon, our conceptual system and the various ways that syntax encodes quantification, measurement and counting.

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4 Cognitive correlates of the mass-count distinction

In this third and final section, we examine an issue that, in our view, presents a significant barrier to progress on the project of understanding the mass-count distinction, and other similar syntactic distinctions. As noted above in our discussion of cross-linguistic facts, many languages, despite not having a syntactic mass-count distinction, nevertheless have nouns that express related content. The quantity judgment task can be administered to speakers of classifier languages, for example, to differentiate nouns that quantify by number from those that do not, despite the fact that these languages do not exhibit signature morpho-syntactic features of the mass-count distinction. Similarly, before children begin to produce quasi-cardinal quantifiers or plural nouns, they are able to learn labels for discrete countable objects, as well as for entities that are not countable. Finally, when we are asked to rapidly generate examples of mass and count nouns, we spontaneously list words like *cat, dog, water,* and *mud* – prototypical object and substance nouns.

These kinds of observations have led to the conclusion that the mass-count distinction must arise from a type of conceptual ontology, with substance-kind and object-kind concepts at the core of the categories mass and count, respectively. As already noted, this link is made early in the literature, by Quine (1960), and again by psychologists, especially in the developmental literature (Macnamara 1982; Soja, Carey & Spelke 1991; Imai & Gentner 1997; Bloom 1999), but also elsewhere. On many of these accounts, which we have previously called Quinian correspondence theories, a bidirectional mapping between syntax and semantics is proposed, such that mass and count nouns correspond to substances and objects, respectively. Naturally, every theorist recognizes that other nouns also exist, and that these should ultimately be explained by a final theory, but there appears to be an implicit belief that beginning with an explanation of object and substance nouns will inevitably lead to a theory that can also explain words like *hockey*, *hope*, and *deliciousness*.

A central claim in our 2009 paper on the quantity judgment task was that this type of Quinian account cannot explain even object and substance nouns, let alone nouns that denote events, properties, or other abstract phenomena. At the core of this argument was that the mass-count distinction is fundamentally not rooted in these kinds of ontological classes at all, but instead is defined by modes of quantification (an idea that dates back to Jespersen 1924) – not a coincidence, given that the syntactic phenomena for which we seek a semantics are themselves quantificational in nature. On this view, evidence suggesting that speakers of classifier languages like Mandarin (Barner, Inagaki & Li 2009; Li, Dunham & Carey 2009; Lin & Schaeffer 2018) and Japanese (Barner et al. 2009; Inagaki & Barner 2009) readily encode countable individuals with nouns is germane to ruling out stronger Whorfian accounts of language (Imai & Gentner 1990; Gentner & Boroditsky 2001) as well as views that propose that count syntax or analogous structures are necessary for individuation (Quine 1960; Borer 2005). However, as already noted in the previous section, these studies should not be taken as evidence that these languages make a mass-count distinction. What they **do** clearly show is that, when a language lacks a syntactic mass-count distinction, subjects base quantity judgments purely on the lexical semantics of nouns.

As an alternative to the view that the syntactic mass-count distinction corresponds to two classes of lexical items with objects and substances at their cores, in Bale & Barner (2009) we proposed that instead different nouns provide idiosyncratically different conceptual representations, resulting in many modes of quantification – not just two. Stated otherwise, the central claim of our 2009 paper was that mass-count syntax is asymmetrical: The addition of count syntax forces quantification by number, whereas mass syntax is interpreted as an identity function of lexical meanings which are entirely idiosyncratic

and heterogeneous in nature, such that they can quantify by any dimension whatsoever, whether mass, volume, distance, time, intensity, or number. On this view, there is no conceptual core to mass nouns (or mass syntax), and, to the extent that count nouns have a conceptual core, it is related to **number**, not objects.

Evidence that the mass-count distinction is asymmetrically rooted in quantification comes in several forms. To begin, we will focus on evidence from the quantity judgment task. First, several studies now show that subjects base quantity judgments on number for object-mass nouns like *furniture, mail, clothing,* and *jewelry* (Barner & Snedeker 2005; MacDonald & Carroll 2018; Van Witteloostuijn & Schaeffer 2018; Yin & O'Brien 2018). This is despite the fact that native speakers of English base judgments on mass or volume for mass usages of words like *string, stone, chocolate,* etc. Second, when children and adults are first learning the mass-count distinction, they struggle with flexible nouns like *string* and *stone.* Rather than defaulting to quantifying by mass or volume in absence of count syntax, when these words are presented in mass syntax, young children learning English, L2 learners of English, and individuals with SLI prefer to quantify by number (Barner & Snedeker 2006; Snape 2008; Inagaki 2014; MacDonald & Carroll 2018; Van Witteloostuijn & Schaeffer 2018; Yin & O'Brien 2018). Third, and critically, many different types of mass noun quantify by number, not just superordinate nouns like *furniture*, though superordinate nouns are typically the focus of those who are skeptical of object-mass nouns (McCawley 1979; Prasada 1999; Gordon & Rodman 2006).[7] Because words like *furniture* are relatively infrequent, in subsequent work we provided evidence of linguistic mechanisms that allow for the unbounded syntactic generation of new cases – i.e., for creating an open class of object-mass nouns. Such a mechanism is provided by garden-variety nominalization in English, whereby almost any action-denoting word can be projected as a noun to either a count or mass context. The word *run,* for example, can be used as a verb (11a), but also as a count noun (11b) or a mass noun (11c).

(11)   a.   John likes to run.
        b.   John did several short runs yesterday.
        c.   John has done lots of running in his life.

As can be readily seen using standard diagnostics, these nominalized cases of *run* are clearly count (11b) and mass (11c) respectively. The count noun *run* in (11b) can be singular or plural, and can be preceded by a numeral or quasi-cardinal quantifier. The mass noun *running* in (11c) cannot be modified in these ways, but is nevertheless subject to modification by quantifiers like *lots* and *much,* and can be combined with measure phrases – e.g., *John did two hours of running.* Critically, when English-speaking subjects are asked to interpret these expressions in the quantity judgment task, these different uses of *run* show the characteristic signatures that are also found for mass-count flexible words like *stone* and *string.* Consider the example in (12).

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[7] McCawley argues that expressions like *more furniture* denote degrees to which the function of furniture is fulfilled, such that having more furniture does not mean having more objects, but having a greater degree of furnishing achieved by whatever furniture one has. In Barner, Wagner & Snedeker (2008), we note several reasons why this cannot possibly be the meaning of such an expression. One is that such an account cannot explain expressions like *big furniture* which seems quite clearly to describe the size of objects, not the size of fulfilled functions. Relatedly, we can paint *more furniture* than a friend, which presumably amounts to painting a greater number of items (or painting for a longer time), but does not relate to functions. Finally, for this idea to be right, it would need to predict that speakers of French interpret the count noun *meubles* differently from the mass noun *furniture.* We currently know of no such evidence. We suggest that *furniture* is related to *furnish* much like *the hammer* relates to *hammering*: The former is an object or set of objects which has a function that is denoted by the latter.

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(12) a. Jake ran in the morning for 3 minutes, at lunch for 2 minutes, and in the evening for ten minutes.
  b. Jerry ran for 60 minutes in the morning.
  c. Who did more running today?
  d. Who went for more runs today?

Presented with a series of examples like this, including flexible words like *swim, run, dance, sleep,* etc., English-speaking participants robustly base quantity judgments on number for action words used in count syntax, but base their judgments on other, non-numerical dimensions, for the same words used in mass syntax (Barner, Wagner & Snedeker 2008). Thus, for action words, the quantity judgment task provides a robust differentiation of mass and count syntax.

Critically, prior to conducting the quantity judgment task, we distinguished action words like *dance* and *run* from a second class of action words, including *jump, kick,* and *bite*. To create these categories, we presented subjects with a list of the 45 most frequent action words in child speech and asked them to imagine using the words in the sentence frame, "John *X*-ed", and whether such a sentence would **require** reiterating the same action over and over, or whether it is possible to perform the action continuously. This resulted in what we will call here "iterativity" ratings for these 45 words. We then examined the 15 most iterative and 15 least iterative words, and how they are interpreted when used in mass or count syntax. Here, what we found is that, whereas non-iterative words like *dance* resulted in a crisp quantity judgment effect, where only count uses resulted in judgments based on number, iterative words like *jump* resulted in almost no effect of mass-count syntax at all. Consider the example in (13):

(13) Jerry and Jake like to jump high in the air. Yesterday, Jerry jumped four times:

  i.   Before breakfast, he jumped 2 in. off the ground.
  ii.   At lunch, he jumped 4 in. off the ground.
  iii. At work, he jumped 3 in. off the ground.
  iv.   Before bed, he jumped 2 in. off the ground.

  Jake jumped two times:

  i.   Before lunch, he jumped 14 in. off the ground.
  ii.   At work, he jumped 18 in. off the ground.

  Question: Overall, who did more jumps/jumping?

For items such as this, subjects based quantity judgments on number to exactly the same degree, regardless of whether the nouns were presented in mass syntax or count syntax – i.e., they behaved like object-mass nouns. What's more, in an additional task in which we asked subjects how they would decide how to measure actions like dancing, running, etc. we found that when these words were presented as count nouns, they almost uniformly judged that the best way to compare, e.g., who did more runs, was number. This was true of all words tested in the study, regardless of whether they were identified as iterative or not. However, when words were presented in mass syntax, participants did not prefer any single measuring dimension, except if they were iterative. For non-iterative words, subjects mentioned dimensions like distance, time, height, intensity, and depth as relevant to measuring differences in walking, running, dancing, etc. though they almost never mentioned mass or volume for these words. Critically, regardless of whether they were

presented in mass or count syntax, if a noun was judged to be iterative, then subjects also judged that it should be measured according to number, syntax be damned.

The upshot of these studies is that there is no simple way to reduce the mass-count distinction to a two-fold distinction akin to object vs. substance. Some action words quantify by number independent of mass-count syntax, while other action words quantify by number in count syntax, but by many different dimensions when used in mass syntax, whether time, distance, intensity, or otherwise. These data make clear that the mass-count distinction is asymmetrical, such that count syntax imposes a uniform measuring dimension upon nouns, whether they denote objects, actions, or other abstract phenomena, whereas mass syntax does not impose any particular measuring dimension upon words, but leaves this entirely to the word's lexical semantics. They also make clear that the mass-count distinction is not reducible to an object-substance distinction, and that the most informative data regarding its semantics can be gleaned from outside the realm of concrete physical phenomena.

Further evidence that investigations of the mass-count distinction should not begin with a two-way ontological distinction like that between objects and substances comes from two additional sources. First, object and substance nouns are not representative of count and mass, respectively. Consider just the case of mass nouns: Using the online MRC Psycholinguistics Database, we generated a list of the most frequent nouns in written English that do not have a plural form and then ordered them in terms of frequency. While this list is not a perfect representation of mass noun usage in English, it nevertheless provides an unbiased sampling of the relative distribution of substance nouns. Among the 100 most frequent nouns in the list, 15 denoted kinds of substances, and included: *felt, earth, clay, dust, china, flesh, gold, milk, concrete, steel, dirt, oxygen, hydrogen, bread, cotton.*[8] The remaining 85 denoted abstract phenomena that could not be conceived of as substances, including: *good, might, information, money, music, education, military, evidence, peace, English, pay, equipment, training, knowledge, thinking, French, literature, running, importance, health, news, standing, jazz, status, worth, leadership, poetry, assistance, produce, presence, quiet,* etc. These facts suggest that, when linguists query their imaginations for examples of mass and count nouns, the prototypes that come to mind – words like *water* and *cat* – may be prototypical without being representative of the category at large.

Echoing this analysis, a study by Samuelson & Smith (1999) analyzed adult ratings of words from the MacArthur Communicative Development Inventory (Fenson et al. 1994) – i.e., words that are highly likely to appear in child speech during the first 3 years of life and thus are especially likely to be concrete in nature – and found that although subjects classified 70% of count nouns in the list as names for solid things, only 35% of mass nouns were classified as names for non-solid substances, a result which they concluded indicates "asymmetric relations between mass syntax and non-solidity" (Samuelson & Smith 1999: 30).

Early studies of how children learn nouns also suggest that the object-substance distinction does not form the core of the mass-count distinction. Across almost every study that has explored the relation between mass-count syntax and the object-substance distinction, an asymmetry has been reported, such that subjects restrict the application of novel count nouns to countable entities, but allow mass nouns to denote objects or substances. These studies have typically used triad tasks, in which a novel stimulus is shown to the subject and labeled with an unfamiliar word – e.g., "This is a blicket," and then the subject

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[8] Many of these words are polysemous, such that some uses may have referred to other types of phenomena (e.g., some uses of china may have referred to the country rather than to tableware made of porcelain). If anything, this would reduce the number of substance-denoting mass nouns in the corpus, consistent with our claim that such nouns are relatively unusual among mass nouns.

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is shown two additional stimuli, one that matches the original in material but differs in shape, and another which matches in terms of shape but not materials. At this point they are asked to decide which of the two new stimuli matches the original label, "Can you find the blicket?" In these studies, the novel word is either presented in mass or count syntax (or sometimes in ostensibly ambiguous syntax). What these studies have found is that when a word is presented in count syntax, subjects subsequently choose a shape match at test, whereas when it is presented in mass syntax, this shape preference is diminished. However, while this difference is generally the main focus of these studies, what is perhaps more striking is how small this difference is.

In one study, by Soja (1992), 2-year-old children matched words according to shape 90% of the time when presented in count syntax, and 76% of the time when presented in mass syntax. Likewise, Subrahmanyam, Landau & Gelman (1999) reported a difference of 90% vs. 86%, now in 3-year-olds. Perhaps more compelling are results from older participants. In the same study by Subrahmanyam et al., older children matched mass nouns according to shape 44% of the time, and adults did so 30% of the time. In a later study, we explored the nature of these effects (Barner & Snedeker 2006). Much like Subrahmanyam et al., we showed that adults matched count nouns by shape 75% of the time and mass nouns 24% of the time overall. However, in our study we tested subjects with three types of stimulus: non-solid substances, simply shaped solid objects, and solid objects with complex shapes that suggested the existence of a function. Focusing just on mass nouns, we found that adults extended labels by shape less than 10% of the time for both non-solid substances and simple solid objects, but did so more than 50% of the time for complex solid objects. Children in the study showed a similar pattern, but with a stronger shape bias. In short, the tasks that most strongly establish the relation between objects, substances and the mass-count distinction actually provide very weak evidence for such a link, and instead more strongly support an asymmetry, whereby count syntax specifies a preference for countable individuals, and mass syntax is neutral, allowing meanings to be determined chiefly by the nature of the elements in the denotation.

These various findings relating to action-denoting mass nouns, the frequency of abstract mass nouns, and the asymmetry of shape preferences in word learning tasks suggest to us that theory-making in linguistics – as well as psycholinguistic tests of these theories – should not begin and end with studies of the object-substance distinction. Also, cross-linguistic studies seeking to find evidence of universal mass-count lexical categories should not be premised upon the assumption that object and substance nouns must be count and mass, respectively. The overwhelming evidence of past studies is that mass nouns readily encode countable individuals, whether this is indicated by quantification of objects, discrete and countable events, or by the extension of novel nouns by shape. Unlike count syntax, which uniformly specifies quantification over individuals, mass syntax leaves the determination of quantification and reference to the lexical semantics of nouns.

The considerations just enumerated raise a very general point of concern, which is that studies moving forward should either diversify the scope of words used in experimental studies, or should consider the implications of work done on object and substance nouns for the wider set of nouns that exist in natural languages. For example, while we are intrigued by work implicating the approximate number system in quantity judgment by Odic et al. (2018), we also wonder to what degree such studies hinge on the syntactic difference between mass and count rather than the psychophysics of the object-substance distinction. In Odic et al., mass-count syntax was not crossed with stimulus type, making it impossible to know whether effects were driven by syntax or by differences in how the visual system evaluates area vs. number. In fact, in their study the "mass" sentences

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were actually syntactically ambiguous and compatible with either mass or count syntax. Also, the word *blob*, like *circle* or *triangle* is uniquely resistant to substance readings, and by standard metrics is a canonical count noun, readily used with numerals, quasi-cardinal quantifiers, and plural morphology, but not compatible with mass modifiers (e.g., ??*lots of blob*).[9] Because the referents of count nouns, like mass nouns, can have area (the measurement of which surely depends on the same psychological processes involved in the measurement of area when evaluating the denotations of mass nouns), we suspect that identical results would be obtained if the count noun *blob* were replaced by object-denoting count nouns like *ball*. Our point here, much like above, is that equating the mass-count distinction with an object-substance distinction can be perilous and may lead to conclusions that do not describe the mass-count distinction itself. Observations about how substances are quantified, while of central importance to psychology, are very unlikely to generalize to how *dancing, peace,* or *hope* are quantified, each of which surely draw on entirely different perceptual systems (to the extent that perception is relevant), and thus, presumably, different verification procedures, too. Consequently, it remains unclear how signatures of verification procedures for objects and substances might speak to theories of the mass-count distinction.

5 Conclusion

The quantity judgment task has been used by a growing number of studies to address long-standing empirical impasses regarding the interpretation of mass and count nouns, and the nature of the mass-count distinction. Our goal in this paper was to explore this progress, and also to investigate ways in which further progress might be most easily achieved, with special attention to barriers regarding the nature of the empirical enterprise, how to study cross-linguistic variation, and how linguistic representations of the mass-count distinction interface with conceptual representations of objects and substances, inter alia.

In Section 2, we discussed alternative ways of framing the investigations of the mass-count distinction. At various points in the history of work on the mass-count distinction, linguists, philosophers, and psychologists have sometimes confounded two distinct research projects. One project seeks to discover the semantic correlates of the morpho-syntactic subcategories of mass and count. The second seeks to determine the syntactic correlates (if any) of the semantic or conceptual representations, like the distinction between objects and substances. We argued that the first project has led to a fruitful investigation of the relationship between syntax and semantics: Count syntax appears to be closely tied to quantification by number whereas mass syntax is underspecified in this respect and allows quantification by an unbounded number of measuring dimensions, including number. The second project may also bear fruit, but it is our contention that, if it does, this fruit will not relate to the nature of the mass-count distinction, per se, but instead to a different enterprise entirely, one whose theoretical and empirical boundaries have yet to be fully articulated. In our view, it is difficult to begin a research program by selecting conceptual distinctions like object vs. substance in an *ad hoc* way, without a priori considerations to restrict which conceptual distinctions are fundamental (e.g., object vs. action; object vs. non-object; object vs. liquid, etc.).

Given an agreed upon object of study – e.g., what is the semantic interpretation of the morpho-syntactic mass-count distinction – there remain important theoretical barriers to executing the empirical project. For example, it is not clear, *a priori*, how to go about identifying when a language has a mass-count distinction, whether this language is one

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[9] Although the authors note that *goo* patterned like *blob*, they did not show that *blob* patterns differently from canonical count nouns like *ball*. Instead, the lack of difference between *goo* and *blob* suggests that syntax plays no role in judgments (since the former is a mass noun, and the latter a count noun).

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that has been understudied in the past, like Yudja, or whether it is a well-studied language like English or French. In Section 3, we suggested ways in which researchers might begin to test whether a language has two nominal subcategories that might be classified as mass and count, drawing on an investigation into the syntax and semantics of the language's entire quantificational system. In keeping with the discussion in Section 2, we suggested that the identification of mass and count categories cannot begin with conceptual criteria, since such an approach necessarily leads to circularity (since there is no sensible enterprise of investigating the semantics of a syntactic distinction if the syntactic distinction is first individuated along semantic criteria).

Finally, in Section 4, we argued that, to make further progress, researchers should move beyond the small set of nouns that have driven research over the pass 60 + years, moving away from object and substance nouns, which are not representative of nouns in general, and beginning with larger, more representative samples of nouns drawn uniformly from naturalistic corpora. Mass and count nouns describe all aspects of human experience, including thoughts, actions, groups, emotions, political entities, sports, or hobbies. Although an initial focus on objects and substances drove the creation of useful theoretical tools, such as the mereological logics that so readily explain an object-substance distinction, we believe that work which focuses on a broader dataset promises a correspondingly broader theoretical horizon, which focuses on the quantificational properties that define the mass-count distinction, rather than the somewhat simpler ontological distinction that has thus far driven intuitions. The mass-count distinction is fundamentally quantificational in nature, not a distinction between ontological types, or between properties that can be characterized by perceptual systems.

Abbreviations
CLF = classifier

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Competing Interests
The authors have no competing interests to declare.

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