Countability and measured parts in mixed drink nouns

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Abstract Liquids (*oil*, *wine*) are considered to be canonical non-countable nouns. Yet nouns referring to cocktails and coffee drinks (*margarita*, *cappuccino*) display strongly countable behavior, which raises questions about the semantics of countability and the relationship between nouns and the things to which they refer. This paper investigates these mixed drink nouns and proposes the source of their countability lies in their possessing one or more MEASURED PARTS which provide a unit for individuation. These parts, in connection with the ratio relationship between the drink's ingredient parts, is the source of countability for these nouns.

Keywords: semantics; lexical semantics; nominal countability; mereology

1 Introduction

The central question in the literature on nominal countability is why some nouns combine directly with plural syntax while others do not. A speaker can make reference to one *dog* or multiple *dogs*, but not to one *rice* or multiple *rices*. In answering these questions, the literature on countability has usually focused on paradigmatic cases of individuals, like *dog* or *apple*, and substances, like *water* and *wine*, along with aggregates and granulars, like *furniture* or *rice* which behave as non-countable predicates despite existing as discrete objects in the physical world. But another puzzling group of nouns exists—which, as of yet, the literature has not addressed—that make reference to substances but are countable. These are mixed drink nouns which denote cocktails, such as *martini* and *margarita*, along with coffee drink terms like *americano* or *cappuccino*. Unlike other nouns referring to liquids, this group of mixed drink nouns are, surprisingly, countable. These are a puzzling class of nouns: a priori, there is no reason why a mixture of two or more liquids which are referred to with non-count nouns should result in something described by a countable noun.

Mixed drink nominals are of interest for two reasons. The first is that they provide a puzzle for formal semantic theories of countability. Count nouns are standardly taken to have denotations which are atomic—that is, lacking any proper parts. Mixed drink nouns are an exception to this rule and while they are a small exception, the way in which they do not conform to the usual formal structure warrants further exploration. They provide evidence for countability where the noun's denotation is not atomic, but instead one of its proper parts provides the unit for counting. In this sense, mixed drink nouns provide an example of subatomic quantification (Wągiel 2021) as their countable status is due to the structure of their parts and these being accessible for counting. In addition to being of interest for formal semantic theories of countability, mixed drink nouns also raise interesting questions about the relationship between the structure of language and the structure of the world more broadly. In general, in languages with a countability distinction like English, count nouns refer to discrete objects, while non-count nouns refer to unindividuated substances, material, properties, or abstract entities. Mixed drink nouns are countable, yet they refer to substances. In what ways might they

differ from other drink nouns, all of which are non-countable? How is their semantic behavior, relative to countability, influenced by features of the drinks to which they refer and speakers' world knowledge about these features?

This paper investigates this class of mixed drink nouns, their grammatical behavior, and provides the first semantic analysis of these nouns. Their behavior reveals a rich structure of ingredient parts, relationships between parts, and standardized measures. I will argue that the source of countability for cocktails and other mixed drink nouns is a combination of the unique ratio relationship between their parts and the existence of a MEASURED PART as a component of the ingredients of the drink which provides a unit for individuation. While this measured part—often referred to colloquially as *a shot* of liquor or espresso—is only one of the ingredients making up a mixed drink, it is central to the countability of the noun. Thus, countability of the noun is rooted in the noun's parts and their structure. This paper also shows that this small group of nouns are a rich ground for further semantic investigation, especially in their unique behavior in quantity judgment tests and with quantifiers that target specific parts of a noun's denotation. Section 2 provides an overview of nominal countability behavior, while section 3 outlines the grammatical behavior of mixed drink nouns and gives examples of these nouns in a number of syntactic and semantic countability tests. In section 4, I provide an analysis of the countability of these mixed drink nouns and propose the concept of a MEASURED PART. Section 5 concludes.

2 Nominal countability in English

Two facets of countability have been identified in the literature—the syntactic and semantic (Gillon 2012; Deal 2017; Bale 2021). Separating the syntactic countability behavior of a noun from its semantic countability with distinct criteria and tests distinguishes different groups of nouns and, in many cases, helps clarify the source of countability. I will follow this approach, first examining the syntactic and morphological features of countability behavior, before moving to the semantics.

2.1 Syntactic countability

The syntactic facet of countability regards whether nouns occur with plural marking or combine directly with numerals and determiners, like *many*, in (1).

(1) There are *six dogs* and *many cats* at the shelter.

Non-countable, or mass, nouns do not combine directly with numerals, but instead require a measure or container phrase to be grammatical, as in (2a). These nouns also occur with mass-specific determiners, like *much*, as in (2b).

(2) a. I'll get *one gallon of milk* and *two bottles of wine* from the store.

b. There is *so much dirt* on the floor!

While non-countable nouns do not combine directly with cardinal numbers in most uses, there is still some degree of flexibility provided by coercion phenomena. In these uses, non-countable nouns can be counted when either a standard portion or distinction between multiple types is established in context. In the literature, these functions has often been referred to as the UNIVERSAL PACKAGER or UNIVERSAL SORTER (Bunt 1985).

While a noun like *water* directly combining with numerals is normally ungrammatical, it can occur in a context such as ordering at a restaurant in (3a), where there's an established standard portion of *three glasses of water*. The inverse is true for count nouns in UNIVERSAL GRINDER (Pelletier 1975) constructions like (3b).

(3) a. Can we get *three waters* for the table?
b. There is *too much apple* in this salad.

This type of mass-to-count coercion behavior is restricted to contexts where a standard portion or unit for individuation has already been established (Rothstein 2010; Zamparelli 2020; Grimm et al. 2021) though frequent and familiar uses—such as a drink being portioned in a cup or other standard drinking vessel—can be easily extended to novel coercion uses. In cases where a noun refers to a drinkable, liquid, substance it can be felicitously used in a sentence like (3a). However, coerced readings usually account for only a small percentage of uses for a given noun, and thus most of the literature treats these uses as a unique sub-case of nominal countability; even though *water* can occur in a count reading as in (3a), this countability does not account for most uses of *water* and thus *water* is considered to be a non-countable noun. I will return to the issue of nominal coercion, specifically portioning, for mixed drink nouns in section 3.5.

2.2 Semantic countability

While syntactic determiners of countability focus on the distribution of nouns with certain morphosyntax, examining the semantic facet of countability often involves placing a noun into different acceptability judgment constructions or other experimental conditions. These often help tease apart the reference of a noun from other facets of the syntax, such as the portioning or grinding coercions seen above. The underlying question is whether a noun refers to an individual or otherwise has some sort of accessible unit for counting. For example, acceptability with stubbornly distributive predicates like *large* or *big* is one test for accessibility of individuals (Schwarzschild 2011), as can be seen in the pairs in (4) and (5).

(4) a. The *apple* is large.
b. The *apples* are large.

(5) a. ?The *milk* is large.
b. ?The *milks* are large.

The predicate *large* distributes over the apples in (4b)—each apple is itself large, not the apples collectively—which is possible since count nouns like *apple* pick out individuals. Non-countable nouns like *milk* have no clear individual for *large* to distribute over.[1]

In a similar vein, quantity judgments (Gathercole 1985; Barner & Snedeker 2005) are another way to determine if a noun references individuals. Quantity judgment tests accomplish this by creating contexts where two portions of some noun are compared, a participant is asked "who has more?" and the judgment given—either more in volume or more in number—reflects whether the participant is quantifying over individual entities or the total volume. Nouns which have no semantically accessible units for individuation are unable to be compared on the basis of number, but only on total volume. For example, in experiments by Barner & Snedeker (2005) participants were asked to judge who had

[1] Setting aside cases of coercion where a container reading like *bottle of milk* would be understood.

more between two larger units or portions and six smaller units or portions. Count and object-mass nouns like *shoes* and *silverware* are examples of nouns that are judged to be more on the basis of number and non-countable nouns like *toothpaste* are examples of nouns judged to be more based on volume.

Looking at the behavior of English nouns relative to these facets of countability, two main groups emerge: countable nouns like *dog* or *book* and non-countable nouns like *water* and *rice*.[2] Given the diagnostics provided in this two-part summary of countability, one might expect mixed drink nouns like *martini* and *cappuccino* to behave similarly to other drink nouns, like *wine* or *coffee*. Mixed drink nouns refer to liquid substances, which appear to lack semantically accessible units for individuation. Mixed drinks are composed of other liquid substances, which themselves are referred to with non-countable nouns, such as *tequila*, *whiskey*, or *simple syrup*. These mixed drink nouns should be expected to occur as countable only when coerced into UNIVERSAL PACKAGER constructions, especially given that many of them have a standardized portion in restaurant contexts. But the predominantly count behavior of mixed drinks would be unexpected. However, despite these predictions, mixed drinks are countable, as the next section will lay out.

3 Mixed drink nouns

First, which nouns qualify as 'mixed drink' nouns? This paper will look at two main groups—nouns which refer to cocktails and coffee drinks—though other nouns might also fall into this category. I will take cocktails to be the paradigmatic case. In its most common sense, *cocktail* refers to a drink made from some combination of liquors, liqueurs, juices, syrups, or other ingredients. While many combinations of these ingredients can be a cocktail, this paper will limit the set of cocktail nouns to the 89 drinks recognized by the International Bartenders Association as of 2021. A number of coffee drinks, such as *cappuccino, latte, americano* and *mocha*, will also be included. These are all drinks where the base component consists of a shot or shots of espresso, with additional ingredients like milk or flavorings. While there does not exist an industry-standard list of coffee drinks like for cocktails, the menus of major coffee shop chains provide a good reference for this group of nouns.

3.1 Mixed drinks and proper names

Before getting into the mixed drink noun data, I would like to briefly discuss the common noun status of mixed drinks. The terms used to refer to different mixed drinks, especially cocktails, come from a wide range of sources. Some cocktail nouns reference the base alcohol and method of preparation, such as *gin fizz* or *whiskey sour* but most are either unique coinages using common nouns, like *old fashioned* or *tuxedo*, named after places or people, like *manhattan* or *mary pickford*, or some combination of the two, like with *cuba libre* or *hemingway special*. Most coffee drink nouns, and many cocktail nouns, are loanwords, such as Italian *cappuccino* or Cuban Spanish *mojito*. And in modern usage, there are semi-productive affixes like *-tini* for anything served in a martini glass or *-ccino* for any drink with espresso and milk. Etymology is not the focus of this paper, but the data raises some questions as to whether mixed drink nouns are proper names or

[2] However, note that not all nouns fit neatly into this binary. A third group, object-mass nouns like *furniture*, are syntactically non-countable but make reference to individual objects. Other nouns like *stone* or *fence* seem to be flexible between countability classes. I will not discuss these nouns here.

common nouns.[3] I take the view that despite the origins of some mixed drink terms, they are common nouns and not names.

Unlike familiar examples of proper names such as *France* or *Taylor Swift*, mixed drink nouns do not make unique reference to a single object or individual. Instead, mixed drink nouns have particular conditions under which some substance is or is not a particular drink. I can't mix whiskey and blackberry liqueur together, garnish it with an orange wedge, and call it a *margarita*. This points towards a common noun interpretation of mixed drink names, despite the fact that some originate from proper names. Thus, mixed drink terms like *macchiato* or *long island iced tea* should be treated like any other predicates which pick out certain portions of matter in the world falling under their extension.

3.2 A corpus of mixed drink nouns

If mixed drink nouns are common nouns, not proper names, the next question is how they behave syntactically and semantically when it comes to countability—are they similar to or different from other common nouns for drinks like *water*, *beer*, or *lemonade*? To gather data relevant to these questions, I created a small corpus of mixed drink nouns. I chose nouns for drinks which had the most well-known and distinctive names to avoid confusion with other word senses, for example excluding nouns like *cosmopolitan* or *aviation*. The corpus contained 10 cocktail and 7 coffee drink nouns (*bellini, bloody mary, daiquiri, margarita, martini, mimosa, mojito, negroni, pina colada, whiskey sour, americano, cappuccino, cortado, frappe, latte, macchiato, mocha*) along with 9 other drinks that are non-countable nouns (*beer, cider, coffee, juice, lemonade, milk, tea, water, wine*).

For each of these 26 nouns, I performed web searches of noun phrases containing a given mixed drink noun with the indefinite article (*a margarita*), a numeral quantifier (*two cappuccinos*), a count quantifier (*many lattes*), and with a mass quantifier (*much mimosa*). I gathered example sentences from the first page of search results, excluding incomplete sentences, cases where the noun was not the head noun (*there's so much mimosa magic to be had*), and cases of marginal grammatically. I used context, credibility of the website, and the apparent level of bartending or barista knowledge of the writer, if discernible, to judge whether a sentence should be included. Given that discussions of food and drink are viewed as largely informal topics, the examples collected ranged from more formal sources (news articles, legal proceedings, recipe books) to less formal (internet forums, blogs, social media). While further work remains to create a full-scale corpus of mixed drink nouns, this initial work provides enough data to categorize the general behavior of these nouns. The examples in the remainder of the paper are taken from the corpus or from additional natural-language examples from supplemental web searches of these mixed drink nouns in specific noun phrase constructions.[4]

3.3 Syntactic countability of mixed drinks

The data in the mixed drink corpus demonstrates that all of these nouns occur with strongly countable morphosyntax, including occurrence with count determiners and numerals. The examples in (6) provide a summary of these contexts.

[3] This is also an issue for editors and style guides, who have to make the call whether to capitalize all words within a mixed drink name, lowercase all, or capitalize only the proper nouns within the names, e.g. *Singapore sling* or *rum and Coke*. For consistency throughout this paper, I will write all mixed drink terms in lowercase.

[4] For access to a copy of the corpus and sources for the supplemental examples, please email the author.

(6) a. I haven't had *a mojito* this good in a while.

b. In college, I would get inspired and work at the most oddball hours fueled by too *many Americanos*.

c. I had *two piña coladas* back to back and could not feel anything.

d. It's hard to speculate exactly how *many martinis* I'd knock back in one evening, but three sounds about right.

This syntactic countability of mixed drink nouns even appears in unique situations, such as with phrase cocktail names like *sex on the beach* or for drinks that end in *y* like *bloody mary* in (7).

(7) a. Also, when the bachelorette party bus unloads in front of your bar, whipping up *a dozen Sex on the Beaches* is an easy task.

b. We serve *a hundred to a hundred and fifty Bloody Marys* a day.

This syntactic behavior differs sharply from other drink terms like *beer* or *coffee*, which are paradigmatic cases of non-countable nouns—only occurring in count noun phrase constructions when coerced into portion or type readings. In the results of web searches I performed, both mixed drink and other non-countable drink nouns occur in volume measure phrases, but in slightly different ways. Non-countable nouns most frequently use measure pseudopartatives, where a measure noun like *pints* combines with *of*, as in (8a). With mixed drink nouns, measure phrases more frequently use direct modification, as in (8b).

(8) a. What effect would *12 pints of beer* in one night have on the body?

b. *A 16 ounce cappuccino* at McDonald's contains 142 mg of caffeine per serving.

In the cases where mixed drink nouns do occur in non-countable uses, the focus is often on the total volume consumed and subsequent impact of the alcohol or caffeine in the drink, such as in the examples in (9).

(9) a. I feel hungover just thinking of having that *much negroni*.

b. Drinking too *much latte* can cause the same side effects as drinking too much coffee, such as jitters, insomnia, and headaches.

The other context where mixed drink nouns occur with non-countable syntax is in spilled readings. This behavior parallels other count nouns in UNIVERSAL GRINDER readings.

(10) a. Remember when I spilled *mimosa* all over myself at brunch?

b. No one should cry over investors' spilled *macchiato* in the Luckin saga.

Syntactically, mixed drink nouns behave as count nouns. This distributional difference is odd unless mixed drink nouns are assumed to have an underlying unit for individuation, unlike non-countable drink nouns.

3.4 Semantic countability of mixed drinks

When it comes to semantic countability tests, mixed drinks, for the most part, behave like count nouns. First, mixed drink nouns are felicitous with stubbornly distributive predicates, unlike their non-count drink counterparts.

(11) a. The *margaritas are large* and not watered down.
b. Well, our *pineapple martini is big* and filling, we might as well call it soup!
c. The *lattes are big*, beautiful and of course delicious.

The mixed drinks in (11) are perfectly acceptable with these distributive predicates—the drink behaves as an individual for the predicate to distribute over. However, the comparable constructions with non-countable drinks in (12), sound odd, and the only interpretations possible have to do with portion size or a very esoteric comparison of types of a substance, such as a sense of *big* in (12c) as a descriptor of bold flavor. And these readings seem only possible in restricted contexts where relative portion sizes or type comparisons have been established via coercion to type readings or with the UNIVERSAL PACKAGER.

(12) a. ?The *lemonades are large* and not watered down.
b. ?Our *beer is big* and filling.
c. ?The *wines are big*, beautiful and of course delicious.

In comparison with these non-countable drink examples, the mixed drink nouns in (11) have a straightforward reading with distributive predicates just like count nouns do. And just like with the syntactic countability behavior discussed in the section above, this status is surprising.

The questions raised by the apparent count noun behavior of mixed drinks with the distributivity tests also carries over to other semantic countability tests like quantity judgment tests. Given the data so far, it might seem straightforward to assume that mixed drink nouns must be both syntactically countable and semantically make reference to individual units of some sort—that they behave as count nouns all the way through, with just the exception of UNIVERSAL GRINDER readings where the noun has a substance reading when spilled or scattered. The assumption with these tests is that for count nouns it is natural to compare on the basis of number, where the entire unit is quantified. Consider the following:

(13) a. Who has *more margaritas*?
b. Who ordered *more margaritas*?
c. Who drank *more margaritas*?

To get a better sense of how a mixed drink noun like *margarita* would behave, I not only took into account my own readings of the sentences in (13), but also informally canvassed a number of colleagues. The responses, surprisingly, varied widely, and most people said that multiple readings were possible for them.

In a sentence like (13a), most people said *margarita* seems to be compared based on volume, which is a result more consistent with a non-countable reading of *margarita*. Others said the sentence was just odd, or mentioned that their first reading of it was

in a type sense, e.g. which restaurant or bar could offer more types of margaritas. I can get both a comparison-by-volume and a comparison-by-number-of-glasses reading for (13a), as well as the type reading, though it seems like a somewhat odd or vague sentence. Changing the verb in the comparative constructions has a major effect on the judgment as well. In contexts like (13b) it seems more intuitive, to me at least, to compare drinks by number—for example, judge three smaller margaritas to be more than two larger ones, even if the latter is more total volume of beverage—since the context of ordering individuates drink by drink. In a context like (13c), the number of glasses that the margaritas were drunk from seems less relevant, so the focus returns to the total volume of margaritas. Despite my own intuitions for these sentences, when talking with colleagues judgments seem to vary widely, and many seemed to feel that both comparison by number and comparison by volume readings are possible.

Complicating matters further, I would argue that another dimension of judgment exists for cocktail nouns specifically—the total volume of alcohol, not total volume of liquid, consumed. If one person is drinking big frozen margaritas that are watered down with ice and mixer while another person is drinking smaller margaritas on the rocks with a higher percentage of alcohol by volume, a reading is possible where the second person is drinking more in terms of volume of alcohol, regardless of the total volume of liquid for each drinker. Should this dimension of quantity be considered quantity based on volume (total volume of alcohol, regardless of the amount of mixers), quantity based on number (total number of shots of alcohol, regardless of the number of drinks those shots were in), or something else entirely? In the case of mixed drink nouns, more than just straightforward volume and number are at play, and I feel that the results of quantity judgment tests are thus only helpful in that they raise questions about countability, portioning, and the role of the alcohol part for cocktail drinks. I will set aside the complicated results of the quantity judgment tests for now, but I will return to some of these questions in section 4.4 below.

3.5 Standard portions and coercion

In the data presented so far, these mixed drink nouns behave more like count nouns than non-countable nouns despite referring to fluid substances. Given this, one might suggest that the ideal way to account for the behavior of these nouns is by treating them as non-countable nouns which nearly always invoke the UNIVERSAL PACKAGER, arguing that in all uses of these nouns a standard portion *glass of* interpretation is applied, generating a count reading. This seems plausible at first glance. Mixed drinks are liquids, and made from liquids that are referenced by non-countable terms but are so commonly ordered, mixed up, and served as individual, single-portion drinks that one could argue speakers only think of a portioned, and thus countable, version. However, upon further investigation, this approach runs into a few difficulties.

First, given what is known about nominal coercion by portioning or type readings and the distributional behavior or nouns relative to it (Zamparelli 2020; Grimm et al. 2021), positing that the countability behavior of an entire group of nouns is the result of near-universal coercion seems tenuous. If the main motivation for this approach is the physical fluidity of the objects the nouns refer to, rather than the grammatical behavior of those nouns, positing that all mixed drink countability is the result of portioning interpretations is a hard sell. Examples of mixed drink nouns behaving in a clearly non-countable way are incredibly few and far between, with these examples being cases of the UNIVERSAL

GRINDER construction, as in (10), which is a phenomena well-established in the literature to apply to count nouns with only a handful of exceptions.

Second, if mixed drink nouns are non-countable but always occur in a coerced portioning reading, they should behave like other portioned non-countable nouns do when placed into a different container than their standard serving glass. Instead, mixed drink nouns behave generally like count nouns when placed in a container larger than their standard serving glass. Recipes for pitchers of a drink, such as in (14a), occur with mixed drink nouns in count plural form,[5] as do phrases like *bottomless* applied to cocktails in (14b) in contrast with *bottomless* applied to non-countable drink terms like in (14c), where the noun does not take on count plural syntax.

(14) a. Here's how to make an extra-cold *pitcher of Martinis* like Ernest Hemingway.

b. *Bottomless mimosas and bloody marys* are considered a "loss leader," an item sold at a loss with the goal of getting diners to spend more on other items.

c. The theater offers treats for your dog, as well as *bottomless wine and whiskey* for you.

The fact that mixed drink nouns retain their countability even when poured into pitchers or when they are in a *bottomless*, constantly-refilled context demonstrates that they are conceptualized and spoken about as whole entities, unlike non-countable drink nouns such as *wine* or *whiskey*. This is strong evidence against a UNIVERSAL PACKAGER coercion being the source of mixed drink countability. Instead, mixed drink nouns should be straightforwardly treated as count nouns.

4 Mixed drink countability: parts, ratios, and subatomic structure

A satisfactory account of the mixed drink noun countability behavior needs to explain the source of mixed drink countability—and how this differs from other non-countable drink nouns. Ideally, the puzzling behavior of mixed drink nouns in quantity judgment tests can also be accounted for. I will accomplish both of these by proposing that mixed drinks have a unique parthood structure, including a central MEASURED PART, in specific ratio relationships, which differs somewhat from previous theories of part-whole relationships in the semantics literature. Since Quine (1960), many approaches to the semantics of countability involve some notion of mereological structure, especially following the formal lattice-theoretic framework of Link (1983). The analysis presented in this section anchors mixed drink countability in the existence of one or more MEASURED PARTS, not at the level of the drink as a whole but at the level of the drink's ingredient parts. This proposal relies on a structure of parts that is semantically accessible and relevant to quantification and the count-mass distinction. This is modeled using a mereotopological framework (Casati & Varzi 1999; Grimm 2012), which involves both parthood relationships and spatial configurations, such as overlap and connectedness.

Given that the ingredient parts making up a mixed drink both stand in a ratio relationship to one another and are strongly self-connected due to their physical arrangement—

[5] Note that while count plural constructions like (14a) were the most frequent in the searches I conducted for examples, non-countable constructions like *pitcher of margarita* also occur. In discussion with colleagues, many felt that both constructions were grammatical, with a few only accepting *pitcher of* with the count use and one only accepting it with the non-count use. This difference might also be impacted by factors including age and dialect of English.

being shaken or stirred together—the accessibility of one or more units for counting at the part level provides a basis for the countability for the whole. In a sense, mixed drinks are a specific sum of ingredient parts that form a whole entity. Unlike substances, mixed drink nouns crucially contain one or more countable units as parts. Since one or more elements making up a mixed drink noun is individuatable there is criterion for counting the whole, whereas a standard treatment of them as non-countable nouns modeled as semi-lattices with no bottom elements fails.

Section 4.1 introduces the part-whole structure of mixed drinks, along with the appropriate formal mereotopological definitions. Section 4.2 gives a detailed overview of the measured parts proposal, and the relationship between countable unit parts and the countability of the mixed drink noun as a whole. Sections 4.3 and 4.4 explore the implications of this proposal for subatomic modification and for comparative quantity judgments, respectively.

4.1 Parts and ratios

What differences are there between mixed drinks and other drinks? Consider *wine* and *mimosa*. One is a non-count noun, one is a count noun. Both are found in similar contexts, spoken about in similar ways, and both are materially similar—they are alcoholic drinks composed of fruit juices, some of which have been fermented. What difference is there between the two that would lead to a speaker talking about *wine* or *a glass of wine* on the one hand and *a mimosa* on the other? I believe this difference is due to a speaker's knowledge of the world and knowledge of the inherent structure in a mimosa which is lacking in wine. Wine, while made up of different ingredients, is bottled, uncorked, poured, and drank as a singular substance whereas a mimosa is a mixture of two things—sparkling wine and orange juice—in a particular ratio. Considering the entire class of mixed drinks it is apparent that they all share the feature of being some mixture of ingredient parts. What it means to be a margarita—the thing picked out by the noun *margarita*—is not so much to be some singular margarita-substance but instead to be a mixture of other substances—tequila, triple sec, and lime juice.

Since Quine (1960) and Link (1983), much of the discussion on the representation of count and mass nouns has focused on atomicity, using mereological approaches to model semantics: count nouns are atomic, and have no proper parts, whereas mass nouns are non-atomic. While this approach works well for many nouns, there are a number of cases it does not capture, including mixed drink nouns, which are count but seem to crucially involve semantically accessible parts. Thus, I will build my semantics for mixed drink nouns, starting with the same basic mereological building blocks. Classical Extensional Mereology proposes a framework with a domain, U, the parthood relation, $\subseteq$, and the sum operator $\oplus$. I will follow the formal definitions given by Simons (1987), though my notation differs slightly (see also Casati & Varzi (1999)).

For a mixed drink noun like *margarita*, the denotation should be the sum of the drink's ingredient parts, and specify what those parts are, such as in (15).

(15) $[\![\text{margarita}]\!] = \lambda x\ [x = y_0 \oplus y_1 \oplus y_2 \wedge \textsc{tequila}(y_0) \wedge \textsc{triple sec}(y_1) \wedge \textsc{lime juice}(y_2)]$

Per this formula, an entity is a *margarita* if it is composed of three parts—tequila, triple sec, and lime juice. But the existence of ingredient parts is not the only factor in play. Given the current proposal in (15), if a drink contains twenty milliliters of tequila, ten milliliters of triple sec, and one liter of lime juice, it satisfies the reference of *margarita*.

But that would be a mildly alcoholic limeade, not a margarita. So the denotation needs to make reference to the amounts of each part, otherwise it will over-generate. The International Bartender's Association specifies that a margarita is 50 milliliters of tequila, 20 milliliters of triple sec, and 15 milliliters of lime juice, so this could be included in the formula in something along the lines of (16).

(16) $[\![\text{margarita}]\!] = \lambda x\ [x = y_0 \oplus y_1 \oplus y_2 \wedge \textsc{tequila}(y_0) \wedge \textsc{triple sec}(y_1) \wedge \textsc{lime juice}(y_2) \wedge \mu(y_0) = 50 \text{ milliliters} \wedge \mu(y_1) = 20 \text{ milliliters} \wedge \mu(y_2) = 15 \text{ milliliters}]$

Now, formally, an entity is a *margarita* if it is composed of three parts—tequila, triple sec, and lime juice—and the measure of tequila is 50 milliliters, the measure of triple sec is 20 milliliters, and the measure of lime juice is 15 milliliters. Note that nothing in my proposal hinges on the specifics of the measure function μ, though I treat it as an extensive function on an entity following Champollion (2017). Any measure semantics could work here, the main issue is that there is some specification of volume.

But (16) isn't quite right. What matters for mixed drinks is not only the measurements of the parts, but the ratio between those measurements. Otherwise, only margaritas made with exact milliliter measurements would be described by this formula, so it now under-generates. The formula should account for jumbo margaritas, mini margaritas, and margaritas made with any system of volume measurement like ounces or teaspoons. What is needed is not a specific measurement but something that can fix the ratio relationship between the parts that make up the drink. This can be achieved by instead setting the measurements, divided by a ratio constant of sorts, equal to one another, as in (17).

(17) $\frac{\mu(y_0)}{5} = \frac{\mu(y_1)}{2} = \frac{\mu(y_2)}{1.5}$

This captures the ratio relationship for a margarita as 5:2:1.5 without specifying any particular volume measurements; the measure of each part can be increased or decreased, but since it must stay in the same ratio relationship the measure of the other parts must increase or decrease accordingly, or the mixture is not a margarita. Now the formula for the denotation of *margarita* can be modified to include this relationship between parts, rather than a specific measurement for each part.

(18) $[\![\text{margarita}]\!] = \lambda x\ [x = y_0 \oplus y_1 \oplus y_2 \wedge \textsc{tequila}(y_0) \wedge \textsc{triple sec}(y_1) \wedge \textsc{lime juice}(y_2) \wedge \frac{\mu(y_0)}{5} = \frac{\mu(y_1)}{2} = \frac{\mu(y_2)}{1.5}]$

However, this still has a major flaw as it says nothing about the physical arrangement of the ingredient parts. Classical Extensional Mereology is incredibly flexible in its definition of a M(ereological)-INDIVIDUAL—any group of objects can be an M-INDIVIDUAL, and sum formation is unrestricted. A semantics textbook on my shelf and a particular cluster of grapes growing in a French vineyard can compose a M-INDIVIDUAL, despite the distance between them. In the case of mixed drinks, consider a scenario where a person walks into a bar, orders two shots of tequila, a shot of triple sec, and a shot of lime juice, drinks each of them, and then says they enjoyed drinking *a margarita*. The correct ingredients in roughly the correct ratio were present, but calling those shots a *margarita* would be incorrect. The referents of mixed drink nouns consist of ingredient parts in ratios that also are mixed together in particular ways.

This presents a problem formally, since the proposal needs a way to handle spatial arrangement as well as parthood to rule out these separate-shots cases. While unrestricted sum formation allows mereology to model many types of part-whole relations, it has a

downside, since there's no way for mereology to distinguish M-INDIVIDUALS that correspond to everyday intuitions and experiences—such as a delicious margarita in my hand—from M-INDIVIDUALS that do not—such as the scattered group of margarita ingredients behind the counter at a bar. A formal approach is needed that accounts not only for parts of a drink but also the arrangement of and relationships that hold between them. Frameworks such as mereotopology (Casati & Varzi 1999) extend classical mereological frameworks with topological notions of spatial arrangement. The inclusion of topology has allowed for formal semantic proposals to model the different metaphysical and grammatical behavior of whole objects, granulars and aggregates, and mass substances (Grimm 2012; Lima 2014; Scontras 2014; Krifka 2021; Wągiel 2021). Key topological axioms added to mereology include overlap, connectedness, and touch. From these, formal representations of entities as consisting of parts that are self-connected can be defined.

It may at first seem odd to put a liquid substance in the category of individuals, but as seen in section 3 cocktail nouns behave as strongly count predicates, and thus my proposal will be that they are individuals which are maximally strongly self-connected. To do this, a few key mereotopological notions are needed. The following definitions are adapted from Grimm (2012). The connection relation, C, is taken as primitive; this relation is both reflexive and symmetrical. Any two entities are connected if they share a boundary, which includes cases where two things are only touching, such as the wine and the bottle it is in. Two things overlap (19a) if and only if they share a part. An entity is self-connected (19b) if and only if any two parts that form the whole of that entity overlap. Strong self-connection (19c) is possible if an entity is self-connected and its interior is also self-connected, which prevents cases of tangential overlap.

(19) a. $\text{O}(x,y) := \exists z[z \subseteq x \wedge z \subseteq y]$

b. $\text{SC}(x) := \forall y\ \forall z[\forall w\ (\text{O}(w, x) \longleftrightarrow (\text{O}(w, y) \vee \text{O}(w, z))) \rightarrow \text{C}(y, z)]$

c. $\text{SSC}(x) := \text{SC}(x) \wedge \text{SC}(\text{INT}(x))$

These can be used to then define a MAXIMALLY STRONGLY SELF-CONNECTED (MSSC) entity relative to a given property, P.

(20) $\text{MSSC}(P)(x) := P(x) \wedge \text{SSC}(x) \wedge \forall y\ [P(y) \wedge \text{SSC}(y) \wedge \text{O}(y, x) \rightarrow y \subseteq x]$

An entity is a maximally strongly self-connected whole if every part is strongly self-connected, overlaps the whole, and anything else which has the same property is also maximally strongly self-connected. These mereotopological definitions distinguish arbitrary or unstructured mereological sums from entities which are physically self-connected. Adding this to the proposed denotation for *margarita* creates the following.

(21) $[\![\text{margarita}]\!] = \lambda x\ [x = y_0 \oplus y_1 \oplus y_2 \wedge \text{TEQUILA}(y_0) \wedge \text{TRIPLE SEC}(y_1) \wedge \text{LIME JUICE}(y_2) \wedge \frac{\mu(y_0)}{5} = \frac{\mu(y_1)}{2} = \frac{\mu(y_2)}{1.5} \wedge \text{MSSC}(\text{MARGARITA})(x)]$

Since this now specifies both what parts make up a margarita and that they are maximally strongly self-connected, the formula captures the cases intuitively understood to be margaritas while excluding cases such as separate shots of margarita ingredients.

Now that this has been worked out for *margarita*, it can also be generalized for the semantics of any mixed drink noun by giving a sequence of variables for the parts and the predicates, as in (22). The parts of the drink are represented as a series of indexed

variables, $\vec{y}_0^n$, given that some mixed drinks only have two parts while others have three or more. For each part, y, there exists a corresponding ratio constant, r, and the parts are set in a ratio relationship with each other. The specifics of this depend on the particular drink, but the formula allows for a flexible number of ingredients in any ratio relationship, which can account for everything from *americanos* to *zombies*.

(22) $[\![\text{mixed drink}]\!] = \lambda x\ \exists \vec{y}_0^n\ \exists \vec{P}_0^n\ [x = \oplus \vec{y} \wedge \forall y_i\ \forall P_i\ [P_i(y_i)] \wedge \exists \vec{r}_0^n\ \forall \vec{y}_0^n\ [\frac{\mu(y_i)}{r_i} = \frac{\mu(y_j)}{r_j}] \wedge \text{MSSC(P)(x)}]$

Thus, an entity is a mixed drink if it is composed of two or more parts which are all an ingredient of the drink and where the measure of each part divided by its ratio value is equal to the measure of every other part divided by its ratio value and the whole is maximally strongly self-connected.

4.2 Measured parts

The formal parthood structure worked out in the above section provides a framework to introduce the concept of a MEASURED PART. This, I argue, is the source of the countability of these mixed drink nouns, and what provides the distinction between mixed drinks and other, non-countable drinks that are made from ingredients in specific ratios. These include nouns referring to non-alcoholic drinks like *lemonade* as well as alcoholic, punch-format drinks like *sangria*. If the semantics given above was the only criteria for mixed drink countability, this would be a case of over-generation as it would predict that, based on their structure as liquid substances composed of parts in ratios, that these would also be countable nouns, but the data only shows count uses in UNIVERSAL PACKAGER contexts. Consider (23) below.

(23) Melanie is making *lemonade* and finds a recipe that calls for 1 part lemon juice, 2 parts sugar, and 8 parts water.

Per the formula in (22), *lemonade* should be a countable mixed drink noun, as should similar drinks as well as a number of non-drink substances including chemical compounds and alloys.

An initial response might be to return to the discussion of flexibility in the ratio relationship in (22). Cases such as *lemonade* might allow a much higher degree of flexibility of the ratio between parts than cocktails or countable coffee drinks do. However, this would still include cases of chemical compounds, such as *citric acid*, and exclude some number of mixed drinks which allow for some variation of the ratio between a more standard 'base' and the 'mixer' part, like *americano* or *cuba libre*. The existence of a measured part, then, is what separates these lemonade cases from mixed-drink nouns.

The existence of measured parts is not only needed to explain why mixed drink nouns are countable while other, similar drink nouns are not, but some of the data presented in section 3.5 shows that mixed drink nouns retain their countability even when the drink-stuff the noun refers to is mixed with multiple other individual drink-stuffs. In (14a) the referent of the noun phrase *pitcher of martinis* is one large vessel filled with un-individuated martini-liquid. I used these examples to argue that the countability behavior of mixed drink nouns is not simply a case of a standard portion coercion such as the UNIVERSAL PACKAGER. However, these examples also raise an interesting question—for a sentence like (14a), a semantics using the notion of maximal strong self-connection

would be unable to account for the 'units' of martini that seem to be conceptually relevant for a count plural construction. In a comparable example, like *bucket of apples*, a mereotopological approach would be able to describe *apple* in a way where it can make contact with other apples while still maintaining its borders. But with *pitcher of martinis* there are no clear borders that touch but not overlap, as all the martini-liquid in the pitcher is intermingled. The source of countability must lie somewhere else.

So what makes the referent of *a martini* a martini, regardless of its physical arrangement? If one consumes multiple portions of liquid from a *pitcher of martinis* over the course of an evening, how many martinis have been drunk? One could argue that the number of 'standard portions' of martini-stuff is the number of martinis drunk. What about cases with highball or long drinks like cuba libres? It still seems like the number of drinks drunk corresponds to the number of 'standard portions' even if the drink is not served, glass-at-a-time, corresponding to these portions. And the volume measurements differ from drink to drink—a standard portion of a dry martini following the IBA specifications, is about 84 milliliters after being stirred with ice, while a cuba libre would be around 198 milliliters after being built in the glass. But in both cases, there seems to be an established 'standard portion' for the drink, independent of the total volume. This also seems to be reflected by cultural awareness regarding 'a standard drink' or 'unit of alcohol' where a 350 milliliter glass of beer and a 44 milliliter shot of whiskey both count as one drink. In the case of *martini* and *cuba libre*, both contain around 50 milliliters of hard liquor as the base spirit.

Without straying further into details about legislation surrounding alcohol, I argue that the notion of 'a standard drink' is very much intertwined with semantically relevant ideas of what counts as *one*. However, I don't think the solution is as simple as equating the countability of mixed drinks to concept of a standard drink. First of all, that approach would incorrectly predict that nouns like *beer* and *wine*, which can also be individuated by number of standard drinks, would have the same countability behavior as nouns for cocktails, which is not what the data shows. Secondly, it would leave out the similar grammatical behavior of certain non-alcoholic coffee drink nouns, which also seem to have a type of standard unit based on the number of espresso shots in a drink. While many coffee drinks, such as an *americano*, are portioned by total volume, such as 12 or 16 ounces, when considering a case of comparison, it seems odd to say that one person who drank two single-shot 16 ounce americanos drank *more americano* than the person who drank two quadruple-shot 12 ounce americanos. This highlights what's really the unit for individuation in the case of both coffee drinks and cocktails—shots of liquor or espresso.

A mixed drink's MEASURED PART is the ingredient part foundational to the identity of the drink. While the volume of the MEASURED PART is flexible, that volume measurement serves as the determining quantity for the rest of the drink's components. Despite being a portion of liquid, it is conceptualized as and spoken about as a unit—a unique part that can be individuated. I argue that these measured parts provide a mechanism for individuation at the level of parts. Since the ingredient parts of a mixed drink stand in a ratio relationship, the accessibility of one or more of these parts for counting serves as the basis for the countability of the whole. Not only does this analysis fit with the mixed drink data, it corresponds to the ways in which their creation and consumption differs from other beverages.

4.3 Measured parts and multiplier modification

The measured part proposal shares some similarities with recent work by Wągiel (2021) who shows that a certain class of multiplier phrases give insight into the semantic accessibility of parts of entities. Wągiel uses multiplier phrase data to argue for a semantics that moves beyond the idea of countability as corresponding to atomic units, and focuses his work on cases of subatomic quantification. In these cases, multiplier phrases like *double* and *triple* do not count entities, but instead modify parts of entities, such as in (24), where *double* modifies the number of patties in the hamburger, not the overall quantity of hamburgers, which can be shown by the felicity with *two*.

(24) a. I accidentally purchased *two double hamburgers*.

A central observation in Wągiel work is that multipliers like *double* are picking out what he calls the ESSENTIAL PARTS of an object, such as the patty in a hamburger. Formally, Wągiel introduces a measure function ⊞P(x) which counts the essential parts. His analysis shares some similarities with my proposal for the MEASURED PART in mixed drinks, though I argue that the latter is restricted to certain types of liquid substance mixtures, while essential parthood is a more broad property.

Wągiel's analysis of multiplier modification is also interesting in the case of mixed drinks. Consider the following examples with *double*.

(25) a. I have *four double Americanos* a day during the week.

b. We started with *three double mimosas* and a bellini.

It seems that in similar behavior to *double hamburger*, the multiplier in (25a) modifies the number of shots of espresso in the americano, not the total volume or number of americanos, while in (25b) it modifies the amount of champagne in the cocktail. Following Wągiel's proposal, the espresso is the ESSENTIAL PART of the americano and the champagne is the ESSENTIAL PART of the mimosa, making them accessible for counting via the multiplier phrase; meanwhile the cardinal numerals *four* or *three* count the total number of double americanos or double mimosas.

Phrases like *double americano* in (25a) are possible because there is some ingredient part of *americano* accessible for modification—the MEASURED PART. Contrast this with the unacceptability of a phrase like *four double milks*. What is being doubled in this case? Milk has no semantically accessible subatomic parts that would provide a basis for a 'double of some ingredient part' reading. However, note that only some mixed drink nouns seem to freely combine with these multiplier phases—drinks that consist of one measured part as a 'base shot' and then some flexible amount of a 'mixer' like soda, juice, or water. In the case of *americano*, for example, the espresso is the semantically salient ESSENTIAL PART for doubling, and the 'mixer' ingredient is the amount of hot water needed to bring the total volume to whatever has been specified. While the number of espresso shots can be modified by *double*, *triple*, and so forth, there does not seem to be a similar way to refer to the 'mixer' part of the drink. This makes sense, as only the MEASURED PARTS of a drink are countable.

For mixed drink nouns with multiple MEASURED PARTS—so-called 'equal parts' drinks like *negroni* or *last word*—a more strongly fixed ratio relationship exits between the ingredient parts. Thus, multiplier modification is less explicitly available, since there is no single ESSENTIAL PART but instead multiple measured parts making up the drink. For

these equal parts cocktails, a modifier like *double* usually can only mean one thing—twice the total volume of drink. In web searches I conducted, phrases like *double negroni* only turned up on cocktail forums as a tongue-in-cheek description of a negroni made to twice standard volume or when discussing the fact that you can't actually order a *double* negroni, as in (26).

(26) Most bartenders will flat-out say no if you request a *double negroni*.

These cases highlight the difference between my proposal of MEASURED PART and Wągiel's ESSENTIAL PART.

There is also a third group of mixed drinks that are not specifically equal parts but still maintain a somewhat standard balance between the measured part and other mixers. These drinks, such as *margarita* or *martini*, have rather infrequent uses of *double* modifiers. However, some other interesting and rather idiosyncratic modifiers, akin to multipliers like *double*, exist. Consider the following uses of *jumbo* and *dry*.

(27) a. The *jumbo margarita* is so appropriately named and it's definitely what you're going to want to order.

b. One of the most popular styles of this cocktail, however, is the *dry martini*.

In the mixed drinks in these examples, if any one measurement changes, the measures of the other ingredients must be adjusted or the ratio is changed. In (27a), *jumbo* increases the total number of the measured part—the shots of tequila—but as this drink has a fixed ratio between the tequila, triple sec, and lime, the volume of the other parts must correspondingly increase so that the the relationship between parts remains the same. If this ratio is not maintained, the drink could be described as *watered-down* (compare with (11a) from the discussion of distributivity above). What *jumbo* does is clarify that the drink is larger than a standard portion with the assumption that the balance between ingredient parts is maintained.

However, a modifier like *dry* in (27b) means there has been a change the ratio relationship between parts. A *dry martini* has less vermouth relative to the gin, so even if the total volume of the drink is the same as a standard *martini*, the different ratio relationship of the parts can be modeled. Interestingly, *dry* is a modifier seemingly restricted to martinis, though I was able to find occasional joking use of it with other two-part drinks like mimosas. These examples show just how fine-tuned the reference to measured parts and, by extension, the other ingredient parts, of a mixed drink can be. Collecting other examples of idiosyncratic subatomic-sensitive modifiers like these would be an avenue for further research.

4.4 Measured parts and quantity judgments

The measured parts proposal also accounts for the complicated behavior of mixed drink nouns in quantity judgment tests, as discussed in 3.4. Traditional approaches to these tests assume only two dimensions for quantity comparison—more in terms of volume and more in terms of units or portions. The data with the mixed drink noun *margarita* in (13), however, seemed less conclusive than the data in many established studies. Judgments can be given both in terms of total volume and for number of portions, usually glasses, of the drink, and in some cases additional judgments for cocktail nouns seem to be instead primarily informed by the total volume of alcohol or the number of 'standard drinks' of alcohol consumed, regardless of volume or portioning.

I believe the measured parts in mixed drink nouns are the source of this puzzling data. If mixed drinks have units accessible for counting at the subatomic level, not only can mixed drinks be measured by total volume and individuated standard portions, they can also be quantified by the number of measured parts. This reading is possible for both mixed drinks with shots of alcohol as the measured part and for some coffee drinks as well. As discussed above, compare one person who drinks two single-shot 16 ounce americanos with one who drinks two quadruple-shot 12 ounce americanos. The number of portions is the same, two in both cases. The total volume is greater for the first americano-drinker. But the total number of shots—measured parts of the drink—are greater for the second americano-drinker. Who drank more? The answer is less clear than with other paradigmatic countable or non-countable nouns. In quantity judgments, ambiguity arises between 'total volume of liquid' and 'number of measured parts' readings in addition to 'number of portions' readings. Because of this ambiguity, quantity judgment tests—at least in their current format—are not very informative for mixed drink nouns semantics and further experimental conditions controlling for all possible dimensions of quantity judgment would need to be constructed.

5 Conclusion

This paper discussed the countability of a group of nouns which, despite referencing liquid substances, are count nouns. After providing a survey of the syntactic and semantic behavior of these mixed drink nouns, I proposed an analysis of the source of their countability as due to the presence of a MEASURED PART among the mixed drink's ingredient components. This measured part—colloquially called a *shot* for both cocktails and coffee drinks—provides a unit for individuation for the mixed drink noun. The analysis presented here differs from one where a standard portion reading provides the source of the countability via a nominal coercion such as the UNIVERSAL PACKAGER, as this approach fails to account for countability being preserved in pitcher-of constructions like *pitcher of martinis*. This analysis also suggests that units for individuation for count nouns can occur as a special type of part at the subatomic level of the noun, which implies that countability cannot simply be reduced to atomicity or the lack thereof. This proposal thus expands on previous work on subatomic quantification, particularly work by Wągiel (2021) on modifiers like *double*. Additionally, the proposed analysis raises questions as to the reliability of some semantic tests for countability, such as quantity judgment tests, when these tests only compare quantity by number versus total volume. In summary, mixed drink nouns demonstrate unique countability behavior that suggests a more nuanced and complex picture that the role of parts have in nominal countability.

Competing interests

The author has no competing interests to declare.

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