Portioning and grinding

Running head: PORTIONING AND GRINDING

Carving up word meaning: Portioning and grinding

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Abstract

Two eye-tracking experiments investigated the processing of mass nouns used as count nouns and count nouns used as mass nouns. Following Copestake and Briscoe (1995), the basic or underived sense of a word was treated as the input to a derivational rule (“grinding” or “portioning”) which produced the derived sense as output. It was hypothesized that in the absence of biasing evidence readers would immediately assign the underived sense, resulting in difficulty if this sense proved to be incorrect. In Experiment 1, which examined the portioning of mass nouns (as in She wanted beers), a small and early penalty was observed on the target noun for mass nouns appearing in a count noun context. In Experiment 2, a much larger but later appearing penalty was observed for count nouns appearing in a mass noun context (as in She wanted banana). The results are taken to support the hypothesis of immediate commitment to the underived sense of polysemous words when the two senses are related by a derivational rule and they are contrasted with the processing profile observed for other types of polysemous words.
“Clam or Cod?” she repeated.

“A clam for supper? a cold clam; is that what you mean, Mrs. Hussey?” says I; “but that’s a rather cold and clammy reception in the winter time, ain’t it, Mrs. Hussey?”

But being in a great hurry to resume scolding the man in the purple shirt, who was waiting for it in the entry, and seeming to hear nothing but the word “clam,” Mrs. Hussey hurried towards an open door leading to the kitchen, and bawling out “clam for two,” disappeared.

“Queeqeg,” said I, “do you think that we can make out a supper for us both on one clam?” (Melville, 1851)

Word meanings are notoriously shifty. They broaden, narrow and drift over time. Of course there must be a synchronic basis for these shifts (e.g., Frisson, Sandra, Brisard, & Cuyckens, 1996; Pickering & Frisson, submitted). Perhaps part of the flexibility of language is due to the ability of language users to extend word meanings, shaping them as needed using the grammatical mechanisms at hand. In the present paper, we investigate one type of flexibility in language use: treating a mass noun as a count noun (*portioning*) and treating a count noun as a mass noun (*grinding*). We follow Copestake and Briscoe (1995) in assuming that these shifts are accomplished by lexical derivational rules, at least in the domain of food and drink where these shifts commonly apply. We report two eye movement studies investigating adult processing of food and drink terms used in their underived sense and in their lexically derived sense. We expect that the underived analysis will be assigned immediately in neutral contexts for all words that participate in a rule of lexical derivation that does not alter the phonological characteristics
of the word. The question in the experiments is whether a prior context indicating that a mass or count noun will follow selectively facilitates the derived analysis of the word, as expected on this account. If so, the results will contrast with those for other types of sense ambiguities and strengthen the view that lexical flexibility comes in various forms, each typically associated with its own processing profile.

The Count Noun/Mass Noun Distinction

The distinction between count nouns and mass nouns has received considerable attention in philosophy, linguistics, and psycholinguistics. In English, a count noun like *apple* needs a determiner when used as a singular, whereas a mass noun like *water* does not; count nouns, but not mass nouns, can be pluralized; and certain quantifiers, like *many* and *much*, can be combined with one type of noun but not the other (for a more extensive cross-language overview, see Chierchia, 1994). While all languages have mass nouns, not all of them have count nouns (e.g., Chinese, Thai, some Native American languages). This has led some researchers to conclude that <mass> is a basic feature of nouns, while <count> is derived (e.g., Krifka, 1995). Nowadays, however, most researchers agree that the distinction between mass and count nouns is at least partially related to semantic-conceptual differences of word meanings. For example, the *cognitive individuation* hypothesis holds that children and adults alike possess a—rather abstract—notion of “individual”. If something—an object, a sound, an event, and so on—is seen as an individual entity, it will be referred to with a count noun; if it is seen as a kind of non-individuated entity or a “kind of stuff”, it will be referred to with a mass noun (Bloom, 1990, 1994, 1996; Bloom & Kelemen, 1995; Prasada, Ferenz, & Haskell, 2002; Samuelson & Smith,
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1999; Wierzbicka, 1988; Wisniewski, Imai, & Casey, 1996; Wisniewski, Lamb, & Middleton, 2003). We will assume throughout that an abstract conceptual difference distinguishes mass nouns (substances) from count nouns (individuals) in the domain of food and drink terms.

Only a few studies have examined the processing of existing mass and count nouns by adults. Vigliocco, Vinson, Martin, and Garrett (1999) showed that English speakers can correctly guess whether an intended noun is mass or count even when they can’t find its phonology (tip-of-the-tongue state). This may indicate that mass and count is part of a word’s abstract representation though, as one reviewer noted, the cognitive individuation hypothesis might offer an alternative account based on whether the referent is individuated or not. Steinhauer, Pancheva, Newman, Gennari, and Ullman (2001) measured brain activity using event-related potentials (ERPs) while adults read plausible and implausible sentences containing count and mass nouns. They found amplitude differences for count and mass nouns around 400 ms after target noun onset (N400 effect), which is usually associated with conceptual-semantic processing. However, the distribution was more frontal than expected if this were a conceptual-semantic effect, and in fact comparable to an anterior topographical profile linked to grammatical processing. They conclude that the count/mass distinction has primarily a syntactic basis. Finally, Gillon, Kehayia, and Taler (1999), using a simple and a primed lexical decision task, showed no differences between “non-atomic” mass nouns like oil and sugar (which are divisible: if you divide oil in two, you still have oil) and count nouns. “Atomic” mass nouns, like furniture and money, on the other hand, took longer to recognize than count nouns (see also Wiese and Piñango, 2001, 2002). Since our experiments only employed non-atomic mass nouns, this latter finding is not directly pertinent to the present studies.
The main focus of this paper is to examine how the count/mass distinction can shed light on how polysemous words are represented and processed. There has been considerable discussion, and controversy, about how polysemous words are processed (e.g., Copestake & Briscoe, 1995; Fodor & Lepore, 1998; Frazier & Rayner, 1990; Frisson & Pickering, 1999, 2001; Klein & Murphy, 2001, 2002; Pustejovsky, 1995, Klipousniotou and Baum, 2005). Our approach has been to distinguish among distinct types of polysemy, largely following the proposal set out in Copestake and Briscoe (1995). In what we call *true polysemy*, possibly systematic alternative senses of a word are distinguished, but there is no evidence that one sense is basic/underived and the other one derived. For example, the noun *book* or *dictionary* is polysemous in that it can be used to refer to a physical object or to its content (and possibly other senses). Copredication, as in (1), in which the different senses are used in the same sentence, is generally acceptable for true polysemy (but generally is not acceptable for two senses related by a derivational rule, as discussed below).

(1) The dictionary is very bulky but also very informative.

For true polysemes like *dictionary* or *book*, no discernible difficulty is found when they appear in a neutral context and are disambiguated towards one sense later in the sentence (Frazier & Rayner, 1990; Frisson & Frazier, 2004). Hence, reading a sentence like *The dictionary is bulky* is as straightforward as reading *The dictionary is informative*, even if the second, “content”, sense is the preferred interpretation for *dictionary*. This finding is strikingly different from the
pattern found for homonyms like *bank*, for which readers do select the most frequent interpretation immediately and experience difficulties later on if the intended interpretation was the dispreferred one (e.g., Frazier & Rayner, 1990; Pickering & Frisson, 2001). In the case of truly polysemous words, an underspecified lexical entry is proposed, which is the same for both senses (see Frisson & Pickering, 1999; 2001). In processing, this underspecified entry is activated first, and an immediate commitment to a single sense is not required in the absence of biasing evidence. In this respect, we differ slightly from Copestake and Briscoe (1995) who, while assuming the existence of underspecified lexical entries, argue for a “persistent default” interpretation (i.e., a dominant sense interpretation) in neutral contexts.

In contrast to words like *book*, words like *lamb* have related senses that are derived by a (semi-productive) lexical rule, in this case, the “meat sense” of *lamb*, derived by a “meat grinding” lexical rule. For these words, copredication typically fails (2a, adopted from Copestake & Briscoe, 1995). Further, if the output of the grinding rule, the derived mass noun, is used, it can only appear in a context appropriate for mass nouns, as in (2b). Example (2c) is an exception.

(2)  a.  ?Mary fed and carved the lamb.
    b.  *Mary fed and carved lamb.
    c.  “My favorite animal is bacon.” (Fran Leibowitz)

For senses derived by a lexical rule, the input to the rule is the basic/underived form, and the output is the derived form. We hypothesize that, in the absence of biasing evidence, the processor will immediately assign the underived form. Thus, the derived form should be more
costly than the underived form, at least in absence of prior evidence signaling that the derived form is appropriate. Copestake & Briscoe (1995) argue that portioning, in which a mass noun is turned into a count noun, is a lexical derivational rule, like grinding, in which a count noun is turned into a mass noun. We assume that the underived sense of “water” or “beer” denotes a substance and the underived form of these words is a mass noun, whereas the underived sense of “apple” or “pear” denotes an individuated entity and the underived form is a count noun. Hence, if this account is correct, the lexically derived “(she wanted) beers” and “(she wanted) pear” should be harder than the underived “(she wanted) beer” and “(she wanted) pears”. If, on the other hand, no immediate commitment is made to either the count or the mass sense, then no differences are expected and words like “beer” and “pear” will be accessed without a commitment to either sense.

In the present paper we test the prediction that the underived sense of a word, the sense that is the input not the output of a rule, will be assigned immediately in the absence of prior evidence favoring an alternate sense and thus the derived sense will be more costly than the underived sense in a temporarily ambiguous context. We assume that for English adults some noun senses are basically count (pear, biscuit) and others basically mass (beer, pudding). Whatever the facts are from language typology (e.g., Krifka, 1995), it is difficult to maintain that the mass interpretation is always the default in adult comprehension (see, e.g., Gillon et al., 1999, and Steinhauer et al., 2001, for evidence). Our corpus search (see below) also indicates that there was a strong bias for either a count or a mass interpretation for the nouns tested in the experiments. It is important to note that bias in itself, i.e., the observation that one sense is employed more frequently than another, does not necessarily mean that a more frequent and less frequent sense are related by a derivational rule; rather evidence of a derivational rule should
exist (see General Discussion). Nor is bias alone a predictor for “true polysemy” or “rule-derived polysemy”. Truly polysemous words like “book” also show a strong bias for one sense, though we found no processing advantage for this dominant sense (Frisson & Frazier, 2004; see also Frisson & Pickering, 1999; Pickering & Frisson, submitted). Similarly, while the denotation of a sense might influence which sense of a polysemous word is underived when a derivational rule is involved, denotation alone (in the absence of a derivational rule) does not suffice to determine processing asymmetries: “book” denotes a concrete individuated entity but this denotation alone, in the absence of a derivational rule, does not entail that the concrete sense of the word is the default sense.

Turning a mass noun into a count noun (portioning) and a count noun into a mass noun (grinding) is more common than one might think. The “Universal Grinder” and “Universal Packager” (attributed to Yngve, see Jackendoff, 1991) have been proposed as mechanisms which can turn virtually anything into a mass or a count noun respectively. For example, if one were to put a chair in the Universal Grinder which will chop it up and spit it out, one could say of the result that “there was chair everywhere”. While one could debate the generality of these principles, grinding and packaging seem to apply generally to food and drink terms. (See also Copestake and Briscoe, 1995, for an insightful discussion of this ‘grinding’ rule and the ways in which it compares to derivational rules of morphology.) Indeed, terms from these domains are the ones employed in the experiments below and it is only these terms that we take to be in the scope of the present investigation. The assumption that deriving a count (portioning) or mass (grinding) sense is relatively common with terms from the domain of food and drink terms is supported by a corpus count (see below). Our corpus search indicated that for our experimental items the derived sense was used in approximately 16-17% of the cases. In comparison, the
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dispreferred sense of the true polysemes used in Frisson & Frazier (2004) was used in about 23%.

Experiment 1: Portioning
The goal of Experiment 1 was to investigate whether an extended sense that is derived by the portioning rule, which turns a mass noun into a count noun, is harder to process than when this rule is not necessary, as is the case for underived count nouns. In addition, we wanted to find out whether having preceding contextual evidence that a noun needs to be interpreted as a count noun eliminates the expected cost of the application of the portioning rule. Determining the exact cost of the derived sense may depend on various factors: with very clear evidence that the derived sense is appropriate the cost may be very small indeed, perhaps not measurable. However, without prior evidence that a mass noun is being used in its derived count sense, a cost should exist if indeed the processor first assigns the inappropriate basic sense.

Method

Participants
Forty American English speaking students from the University of Massachusetts were paid $8 to participate in the experiment. Four further participants (one from each file) were deleted because of their high skipping rates. All had normal or corrected to normal vision.

Materials
Twenty-eight sentences with count noun syntax were constructed with four versions of each, as illustrated in (3a-d). In two forms (3a & 3b), a mass noun (beer) appeared as the critical noun; in two (3c & 3d) a count noun (pear) appeared as the critical noun. The critical nouns appeared in plural form, which, by definition, indicates a count interpretation as mass nouns are
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not pluralized except if they refer to portioned quantities/individuated entities. While the count interpretation of the plural coincides with the basic interpretation of count nouns like *pear* and should therefore be straightforward to arrive at, a mass noun like *beer* is, we propose, briefly ambiguous. Once the impact of the plural marker is recognized, the mass noun becomes disambiguated.

The mass and count nouns were controlled for length (6.9 characters on average for both mass and count nouns) and frequency in the plural form (mass: 2.1 occurrences per million; count: 1.8 occurrences per million; based on the CELEX frequency database; Baayen, Piepenbrock, & Van Rijn, 1993).

3a. Yesterday, I bought imported beers at the counter of the local supermarket.  
   (Mass noun, Neutral context)
3b. Yesterday, I bought three imported beers at the counter of the local supermarket.  
   (Mass noun, Helping context)
3c. Yesterday, I bought imported pears at the counter of the local supermarket.  
   (Count noun, Neutral context)
3d. Yesterday, I bought three imported pears at the counter of the local supermarket.  
   (Count noun, Helping context)

In two forms (3a & 3c), the context preceding the critical noun was neutral with respect to how the noun needs to interpreted; in two (3b & 3d), the context preceding the critical noun indicated, by means of a numeral or quantifier, that the critical noun needed to be interpreted as a count noun. The critical noun was preceded by the same adjective in all forms of the sentence in order
to minimize parafoveal processing of the noun while fixating the numeral/quantifier. All experimental items appear in Appendix 1.

The critical nouns were all food-related (coffee, pudding, lollipop, biscuit,…), and they were classified as being mass or count nouns on the basis of the experimenters’ intuition. We checked our intuitions against a collection of sentences compiled from the 100 million word British National Corpus (BNC) and, if this search did not provide enough classifiable examples, augmented by an internet search (mainly relying on a Google search of “blogs”). Since a mass interpretation only occurs when the word is used as a singular, we excluded all plural uses of the nouns (which makes our count a conservative measure of count-nounness). An analysis of the first 20 classifiable examples, i.e., ones with a clear mass or count usage of the noun, showed that the mass nouns were used with a mass interpretation 84.3% of the time (range: 65-100%), and the count nouns were used with a count interpretation 83.1% of the time (range: 60-95%). Hence, our classification of the critical nouns and the sample search fully converged.

Four experimental lists were set up, each containing an equal number of items of each condition, and only one version of each quartet. In addition to the 28 critical sentences, each list contained 105 filler items from different experiments. The sentences were presented in a fixed random order.

Procedure

Participants were randomly assigned to one of the four lists and were tested individually. Eye movements were recorded using a Fourward Technologies Dual Purkinje generation 5.5 eye tracker, which has an angular resolution of less than 10 min arc. Viewing was binocular, but only the right eye was monitored. Depending on their length, sentences were displayed on one or two lines, with a maximum length of 80 characters per line (the critical noun always appeared
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on the first line and never at the end of the line). Stimuli were displayed in lowercase letters, except when capitals were appropriate, on a 15-inch NEC 4FG color monitor VGA monitor 61 cm from the participants’ eyes. At this distance, 3.8 character positions equaled 1 degree of visual angle. Participants’ gaze position was recorded every millisecond. A bite bar and forehead rest were used in order to minimize head movements.

Participants were encouraged to read the sentences carefully for understanding, but to keep a normal reading rate. They were told that they could re-read sentences if they thought it was necessary. They pressed a button to terminate the trial when they had finished reading. After half of the trials, a comprehension question appeared, which they answered by pressing a yes or no button. Half of the questions required a yes response, half a no response, counterbalanced across conditions. Accuracy for the critical items averaged 92.3%.

At the beginning of the experiment, a calibration procedure was carried out. Before each trial, a calibration check was performed and participants were recalibrated if necessary. The entire experiment lasted approximately 45 minutes, including a short break.

Analyses

We report analyses on two regions: the critical noun and a spillover region. We also analyzed the adjective region preceding the critical noun, but since the results were in line with the findings for the other regions, we will not report them. The spillover region was defined as the word following the critical noun if the word was at least 5 characters long, otherwise the next two words. An example can be found in (4).

4. Yesterday, I bought imported beers at the counter of the local supermarket.
An automatic procedure combined short contiguous fixations, assimilating fixations shorter than 80 ms and within 1 character space of another fixation. Fixations shorter than 80 ms and not within one character space of another fixation were excluded (see Rayner, 1998; Rayner & Pollatsek, 1989). Fixations longer than 800 ms were also excluded (Rayner, 1998). We report the following measures: *First-fixation duration* (the duration of the first fixation on a region), *single-fixation duration* (the fixation time on a region when the region is fixated only once), *gaze duration* (the combined fixation time on a region before fixating on another word), *first-pass regressions* (the percentage of left-ward eye movements that cross a region’s left boundary and that immediately follow a first-pass fixation), *second-pass duration* (the sum of fixations in a region after having left the region to the right; this measure reflects re-reading) and *total gaze duration* (the total time spent on a region). The reported means and analyses of variance (ANOVAs) are based on reading times excluding zero fixations, except for second-pass duration.

**Results**

Prior to all analyses, sentences with major track losses, due to head movements or blinks, and sentences for which two consecutive regions were skipped, were excluded from the analyses (1.8% of the data). For each measure and each region, the data were subjected to separate Type (Mass noun vs. Count noun) X Context (Neutral vs. Helping) ANOVAs, treating participants ($F_1$) and items ($F_2$) as random effects. Since one of the questions of interest is whether context can override the expected derivation effect, we also performed separate means comparisons between the two context conditions for each word type. Table 1 presents the averages, using item means. We will discuss each measure separately.

*First-Fixation Duration*
No main effects or interactions were observed for the two regions. However, while the interaction for the reading times on the noun was not significant \[F_1(1, 39) = 1.52, p = .22; F_2(1, 26) = 1.96, p = .17\], it is still of interest to know whether context helped the interpretation of each word type. While context did not influence the reading times of count nouns (difference of 3 ms, both \(t\)s < 1), the helping context preceding the mass nouns reduced reading times by 17 ms compared to the same mass nouns preceded by a neutral context, a reliable difference: \(t(39) = 2.62, p < .02; t(26) = 2.54, p < .02\).

**Single-Fixation Duration**

For the noun region, the interaction was marginally significant \[F_1(1, 39) = 3.75, p = .06; F_2(1, 26) = 3.33, p = .08\], with the count noun conditions not differing from each other (\(t\)s < 1) but the mass nouns preceded by a neutral context producing longer single-fixation times than the mass nouns preceded by a helping context \([t(39) = 1.75, p = .09; t(26) = 3.07, p < .01]\). No significant effects emerged on the spillover region.

**Gaze Duration**

While the interaction was again not significant for the noun region \[F_1(1, 39) = 1.24, p = .27; F_2(1, 26) = 1.57, p = .22\], the 20 ms advantage for the mass nouns preceded by a helping context compared to mass nouns preceded by a neutral context was significant for the items’ analysis and marginally significant for the participants’ analysis \([t(39) = 1.80, p < .08; t(26) = 2.52, p < .02]\). The 2 ms difference between the two context conditions for the count nouns was not significant (both \(t\)s < 1). Reading time analyses for the spillover region revealed a significant effect of Type in the participants’ analysis \([F_1(1, 38)^2 = 8.23, p < .01; F_2(1, 26) = 3.12, p < .09]\), and a significant interaction in the items’ analysis \([F_1(1, 38) = 1.53, p = .22; F_2(1, 26) = 6.08, p = .02]\). Means comparisons showed that mass nouns preceded by a neutral context took
Portioning and grinding significantly longer than count nouns preceded by the same context \[t(39) = 2.96, p < .01; t(26) = 2.93, p < .01\] and count nouns preceded by a helping context \[t(39) = 2.00, p = .05; t(26) = 2.14, p < .05\]. Mass nouns preceded by a neutral context were also significantly slower than mass nouns preceded by a helping context, though this was only significant in the items’ analysis \[t(38) < 1; t(26) = 2.85, p < .01\]. None of the other comparisons were significant.

**First-Pass Regressions**

No significant effects were observed for the noun region, though the mass nouns preceded by a neutral context elicited about 30% more regressions than the other conditions. For the spillover region, no significant effects emerged, though the mass nouns preceded by a neutral context again showed a numerically higher percentage of regressions.

**Second-Pass Duration**

There were no significant effects for both regions.

**Total Gaze Duration**

The total gaze analyses revealed no significant effects for the noun region. The results for the spillover region were slightly inconsistent between the participants’ and the items’ analyses. There was a main effect of Context, with the sentences containing no numeral/quantifier being read 32 ms slower \[F_1(1, 39) = 7.79, p < .01; F_2(1, 26) = 5.71, p < .03\], a main effect of Type in the participants’ analysis with mass nouns being read 20 ms slower than count nouns \[F_1(1, 39) = 4.70, p < .04; F_2(1, 26) = 2.65, p = .12\], and a marginally significant interaction in the items’ analysis \[F_1(1, 39) = 1.87, p = .18; F_2(1, 26) = 3.14, p < .09\]. Means comparisons give a clearer view, with the mass nouns preceded by a neutral context taking significantly longer than any of the other conditions (all \(ps < .04\)), which themselves did not differ from each other (all \(ts < 1\)).
Discussion

The results of Experiment 1 were clear. Turning a mass noun into a count noun had an attendant cost when the context preceding the noun did not already dictate that the head noun of the phrase must be a count noun. The cost was small, it appeared immediately on the first fixation on the critical noun, and was also noticeable on the spillover region. However, after this early extra processing, there did not seem to be a need to spend much additional time reanalyzing the construction (as indicated by the second-pass measure). In other words, once the switch had been made from mass to count, processing continued unhampered. In addition, there was a hint that mass nouns in general required some extra processing on the spillover region, though this effect never fully realized in the items’ analyses.

We also correlated the difference scores between the mass nouns preceded by a neutral context and by a helping context with the probability of the mass noun occurring in a count interpretation (see above). The “exposure” hypothesis specifies that the more often a mass noun is used in a count interpretation, the easier it should be to arrive at this interpretation when there is no preceding helping context. If, on the other hand, turning a mass into a count noun is always hard because it involves the application of a rule, the degree of conventionality should not matter much. Correlations were not significant for the First-fixation data on the noun (Pearson’s $r$ was .05, $p = .81$), for the single-fixation data on the noun ($r = .04, p = .85$) for the Gaze duration data on the noun and the spillover region ($r = .18, p = .38$ and $r = -.27, p = .17$), and for total gaze on the spillover region ($r = -.16, p = .41$). Hence, we could not find evidence for the hypothesis that the degree of exposure to the derived sense influenced reading times.

The existence of a cost for processing a mass noun preceded by a neutral context
Portioning and grinding confirmed the hypothesis that the processor commits itself to the basic (underived) sense of a word, not a lexically derived sense (Copestake and Briscoe, 1995). The cost could not be due to it being unusual for the basic mass noun to appear in the plural, because the plural frequencies of the mass and count nouns were equated and because the cost did not appear in the mass noun, helping context condition. True polysemes like “book” also may be used more frequently in one sense than another, though unlike the words tested in the present experiments, they do not show an immediate processing cost. Therefore, it is unlikely that the present result is caused merely by the fact that the rule-extended count sense was less frequent than the basic sense. We also doubt that the availability of a type interpretation for the sentences (e.g., 5 Belgian beers, 2 German beers, and 1 English beer for “he bought imported beers”) affected our results in a systematic way since such interpretations are available for both the mass and the count nouns, and for both the neutral and the helping contexts.

The small size of the penalty for ambiguous mass items suggests that the source of the difficulty is the mismatch between the basic type of the noun and the syntactic context. There is no evidence of the massive conceptual difficulty that might be expected if the processor needed to do considerable inferencing to work out what sort of packaging of the substance denoted by the mass noun might be intended. This lack of conceptual cost fits with the intuition that the count use of the mass nouns tested here are already familiar. Conventional units are probably already available to readers for packaging the substances denoted by the mass items tested. Presumably larger and longer-lasting costs would have been observed if we had tested mass nouns for which no conventional unit already existed or could be inferred readily from context (e.g., “Give me five bloods”). Nevertheless, the familiarity of the extended sense in itself was not enough to make the cost disappear.
We now turn to *grinding* – a rule which takes a count noun as input, delivering a mass noun as output. The hypothesis that the underived sense of a word will be assigned in the absence of biasing context predicts the existence of a cost for basic count nouns when placed in an ambiguous context disambiguated eventually to a mass noun syntax.

**Experiment 2: Grinding**

Experiment 2 materials can be considered the reverse of Experiment 1 materials. Instead of turning a mass noun into a count noun, in Experiment 2 the helping preceding context makes clear that the count noun must be interpreted as a mass noun. The question is whether the reader makes an immediate commitment to the underived count sense of a word in the absence of biasing evidence. A further question is whether applying the grinding rule is as straightforward as applying the portioning rule, with only a small cost for applying the rule, or whether it involves more substantial additional processing.

**Method**

**Participants**

Thirty-six American English speaking students from the University of Massachusetts were paid $8 to participate in the experiment. As in Experiment 1, four further participants (one from each file) were deleted because of their high skipping rates. All had normal or corrected to normal vision.

**Materials**

Twenty-eight quadruples like (5a-d) were constructed with four versions of each. All sentences were eventually disambiguated to a mass noun syntax due to the lack of a determiner.
together with a lack of a plural morpheme on the critical noun. Recall that singular count nouns may not occur without a determiner.

5a. Yesterday, John wanted imported beer after the rich main course. His girlfriend didn’t want anything. (Mass Noun, Neutral Context)
5b. Yesterday, John wanted just a small amount of imported beer after the rich main course. His girlfriend didn’t want anything. (Mass Noun, Helping Context)
5c. Yesterday, John wanted imported pear after the rich main course. His girlfriend didn’t want anything. (Count Noun, Neutral Context)
5d. Yesterday, John wanted just a small amount of imported pear after the rich main course. His girlfriend didn’t want anything. (Count Noun, Helping Context)

In two versions (5a & 5c), the context up to the critical noun was ambiguous in the sense that either a count or a mass noun could appear in object position. In the other two versions (5b & 5d) an amount phrase occurred before the adjective, biasing the noun to a mass noun. The critical nouns in (5a & 5b) are predominantly used as mass nouns as attested in a database count (see below), whereas the nouns in (5c & 5d) usually occurred with a count interpretation. All experimental items appear in Appendix 2. With two exceptions (coke replaced by cola and pickle replaced by carrot), the critical nouns were the same as in Experiment 1. Mass and count nouns were controlled for length (5.9 characters for both mass and count nouns). However, since we opted to use as many nouns as possible from Experiment 1 in order to increase comparability between the two experiments, the frequency in the singular form of the nouns was not controlled, with a frequency occurrence of 32.1 per million for the mass nouns, and 1.6 per million for the
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count nouns. Therefore, any main effect of word type (mass vs. count) should be treated cautiously and means comparisons between different types are not warranted, though the discrepancy should not affect context effects or interactions. The database search (see above) revealed that the mass nouns were indeed predominantly used with a mass interpretation (83.1%, range: 65-100%) and the count nouns with a count interpretation (83.6%, range: 60-95%).

Four experimental lists were constructed, with an equal number of items per condition and only one version of each item from a quartet. The 28 experimental sentences appeared in a list with 112 sentences from other experiments. Because the items from the other experiments consisted of two sentences, we added an extra sentence (e.g., *His girlfriend didn't want anything.*) after the critical sentence. This sentence was held constant for all four conditions. Presentation of the items was randomized by the software program for each participant.

**Procedure**

The procedure was the same as for Experiment 1. Accuracy for the comprehension questions, presented after half of the items, was 94.4%.

**Analyses**

As in Experiment 1, we distinguished two regions: the noun (*beer*) and a spillover region (*after*). The same analyses as for Experiment 1 were performed.

**Results**

Sentences with major track losses were excluded from the analyses (2.4% of the data). Table 2 presents the averages for each measure, using item means.

*First-Fixation Duration*
A significant interaction was observed for the noun region \[F_1(1, 35) = 8.56, p < .01;\]
\[F_2(1, 27) = 6.28, p = .02\]. Means comparisons showed that the mass noun preceded by an
amount phrase was fixated for a shorter time compared to the same noun preceded by a neutral
context \[M-D vs. M-N: t(35) = 2.56, p < .05; t(27) = 2.48, p < .05\]. The same comparison for the
count nouns failed to reach significance \(ps > .10\). Analyses of the spillover region showed a
main effect of Type, with fixations on the mass noun conditions being 17 ms shorter on average
than fixations on the count noun conditions \[F_1(1, 35) = 8.98, p < .01; F_2(1, 27) = 3.82, p = .06\].

*Single-Fixation Duration*
Analyses for the noun region revealed a marginal effect of Type, with the mass nouns
being fixated 19 ms longer \[F_1(1, 35) = 4.00, p = .05; F_2(1, 27) = 3.31, p = .08\] and a significant
interaction \[F_1(1, 35) = 8.03, p < .01; F_2(1, 27) = 5.53, p < .05\]. Means comparisons were not
fully significant. A marginal effect of Type was also found for the spillover region \[F_1(1, 35) =
4.07, p = .05; F_2(1, 27) = 1.60, p = .22\].

*Gaze Duration*
On the noun, there was a significant effect of Type, with count nouns taking 25 ms longer
than mass nouns \[F_1(1, 35) = 5.53, p < .05; F_2(1, 27) = 4.83, p < .05\], a significant effect of
Context, with the neutral contexts taking 29 ms longer than the helping contexts \[F_1(1, 35) =
9.57, p < .01; F_2(1, 27) = 11.14, p < .01\], and a marginal interaction \[F_1(1, 35) = 3.76, p = .06;
F_2(1, 27) = 2.08, p = .16\]. Means comparisons indicated that the mass noun preceded by a
helping context was read faster than when preceded a neutral context \[t(35) = 4.00, p < .001;
t(27) = 3.60, p = .001\], but context did not affect processing of the count nouns \(ps > .24\).
Analyses of the spillover region showed an effect of Type in the participants’ analysis, with a 35
ms advantage for the mass nouns \[F_1(1, 35) = 4.07, p = .05; F_2(1, 27) = 1.60, p > .20\].
First-Pass Regressions

No significant effects were observed for the noun region. For the spillover region, main effects of Context \([F_1(1, 35) = 14.59, p = .001; F_2(1, 27) = 11.35, p < .01]\) and of Type \([F_1(1, 35) = 10.38, p < .01; F_2(1, 27) = 4.97, p < .05]\) were qualified by a marginally significant interaction \([F_1(1, 35) = 4.47, p < .05; F_2(1, 27) = 2.48, p = .13]\). No differences were found for the two mass noun conditions \((ts < 1)\), but the count nouns preceded by a neutral context elicited significantly more regressions than the count nouns preceded by a helping context \([t(35) = 3.40, p < .01; t(27) = 2.12, p < .05]\).

Second-Pass Duration

Analyses for the noun region showed significant main effects of Type \([F_1(1, 35) = 14.01, p = .001; F_2(1, 27) = 9.76, p < .01]\) and Context \([F_1(1, 35) = 4.86, p < .05; F_2(1, 27) = 7.42, p = .01]\), which were qualified by a significant interaction \([F_1(1, 35) = 9.20, p < .01; F_2(1, 27) = 6.50, p = .02]\). Means comparisons showed that the mass noun conditions did not differ from each other \((ts < 1)\) and that the count nouns preceded by a neutral context caused longer rereading times than the same nouns preceded by a helping context \([t(35) = 3.31, p < .01; t(27) = 3.70, p = .001]\). Analyses for the spillover region demonstrated a significant effect of Type, with a 14 ms advantage for the mass nouns \([F_1(1, 35) = 4.78, p < .05; F_2(1, 27) = 5.42, p < .05]\).

Total Gaze Duration

Analyses for the noun region revealed significant main effects of Type, with a mass noun advantage of 44ms \([F_1(1, 35) = 8.24, p < .01; F_2(1, 27) = 5.43, p < .05]\) and of Context, with the helping context conditions being read 51 ms faster \([F_1(1, 35) = 21.10, p < .001; F_2(1, 27) = 17.08, p < .001]\). The interaction was not significant (both \(Fs < 1\)). The spillover region showed a significant main effect of Type \([F_1(1, 35) = 10.96, p < .01; F_2(1, 27) = 7.72, p = .01]\), a near-
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significant effect of Context in the participants’ analysis \(F_1(1, 35) = 3.33, p < .08; F_2(1, 27) = 1.49, p > .20\), and an interaction between Type and Context \(F_1(1, 35) = 5.30, p < .05; F_2(1, 27) = 3.12, p < .09\). Means comparisons showed no differences between the mass noun conditions \((t < 1\) but increased reading times for the count noun preceded by a neutral context compared to count nouns preceded by a helping context \(t(35) = 2.58, p = .01; t(27) = 1.93, p = .06\).

Discussion

To summarize the basic pattern of results in Experiment 2, we found early facilitation for both helping context conditions. Count nouns preceded by a helping context generated fewer first-pass regressions compared to count nouns preceded by a neutral context. Mass nouns preceded by an amount phrase showed faster early reading times (first-fixation and gaze duration) than mass nouns preceded by a neutral context. In later measures (second-pass and total gaze durations), the count noun in the neutral context required extra processing time. We also found a processing advantage for mass nouns overall, though, as indicated above, this is very likely a mere frequency effect of the singular form. When a difference was found between the count noun conditions, correlations were performed testing the “exposure hypothesis” (see Experiment 1). Since none of the correlations approached significance (all \(ps > .28\)), we found no evidence that the probability that a count noun appeared with a mass interpretation in our corpus search affected processing.

The finding that the underived sense showed more facilitation by the helping contexts in Experiment 2 might simply be due to the contexts being semantically more constraining than those of Experiment 1. The numerals used in Experiment 1 merely indicate that a reference will be made to a plural noun, but do not narrow down the set of nouns that are likely to follow. In
contrast, contexts like “a bite of” and “a sip of” indicate that the following noun is very likely going to be an edible substance. While a comparable facilitation would be expected for the derived sense preceded by these contexts, the higher number of regressions for count nouns with a neutral preceding context might have cut short the fixation times in this condition, nullifying the expected advantage for the helping context condition.

The finding that the count noun in a neutral preceding context incurred a processing disadvantage is expected. That the processing penalty for the derived sense in a neutral context is much larger than that observed in Experiment 1 is intriguing. We attribute this to two closely related factors. In Experiment 2, it may be unclear why the author has not used the count noun whereas in Experiment 1 the familiarity of conventional units of packaging may make it obvious why the derived form of the noun (the count form) was used. Also, in Experiment 2 the conceptual cost of applying the grinding rule may be high when no prior evidence disambiguates the noun to a mass noun and no clear or conventional conceptual referent for the derived sense already exists. For at least some of our derived mass nouns, there is no corresponding readily identifiable substance in one’s conceptual representation before the derived word is encountered. Thus part of the cost in Experiment 2 may be the conceptual work of drawing the inference needed to figure out what imported pear or Guatemalan banana denotes. Consequently, we attribute the long-lasting cost of derived mass nouns in Experiment 2 to the work required to draw the necessary conceptual inferences to interpret the derived noun, inferences which are generally aided by the presence of an amount phrase. These conceptual costs also go hand-in-hand with the costs incurred by the pragmatic processing needed to determine why the author has not used the underived count form, e.g., an imported pear. When it is clear what the derived noun denotes, it presumably is clear why the author chose the derived form and, conversely,
when it is not clear what the derived form denotes, it will presumably not be clear why the author chose this form. To sum up the last two paragraphs, the nature of the disambiguation in Experiment 2 may often have led to semantic facilitation of lexical items for edible substances, but the need to do pragmatic and conceptual inferencing to determine the denotation of derived mass nouns would explain the late and large penalty for processing derived mass nouns in a neutral context.

Note that the frequency with which basic count nouns are used as mass nouns is just as high as the frequency with which basic mass nouns are used as count nouns [see discussion under example (5)], so mere frequency of occurrence of the derived mass nouns cannot explain the effect. Moreover, the fact that the cost shows up primarily in the neutral context but not in the helpful context suggests that the category change that results from applying the derivational (grinding) rule is not itself solely responsible.

General discussion

What do the experimental results tell us about the representation and processing of polysemy? Is the processing of derived count/mass nouns different than the processing of the less common sense of “book” or “dictionary”? We think the results of the present studies suggest an important difference: the processor commits itself to the underived sense of count/mass words in the absence of biasing evidence. Consequently, clear effects of a prior disambiguating context emerged in Experiments 1 and 2. This contrasts with what we have found for words with systematically related senses which are not captured by a lexical derivational rule (see Frazier & Rayner, 1990, Frisson & Frazier, 2004). For items like “book”, there is no evidence of immediate commitment to one sense of the word in neutral contexts. This
Portioning and grinding distinction between lexical derivational rules and distinct senses that are not derived by derivational rules suggests that different kinds of polysemy can involve distinct representational and processing mechanisms. For senses derived by a lexical derivational rule, we expect (i) an asymmetry between the derived and underived sense, and (ii) immediate commitment to the underived sense. For words with alternative senses not related by a derivational rule, there is no reason to expect a general asymmetry (one repeatedly going in the same direction), nor is there reason to expect an immediate commitment without evidence.

Our proposal rests on the assumption that two distinct forms of representation exist: true polysemy involving related senses but no derivation (book), and polysemy involving an underived sense and a lexically-derived sense. The evidence for a derivational rule may come from a variety of considerations. Co-predication typically fails for lexically-derived senses but not for the two senses of a true polysemy. Derivational rules are typically semi-productive, having already familiar outputs which extend to new items unevenly. Derivational rules also exhibit blocking. For example, it should be difficult to derivationally grind “cow” to derive the cow-meat sense since “beef” already exists and thus blocks or preempts application of the grinding rule. This blocking is often considered a hallmark of lexical derivational rules. Finally, in a language where one member of a derivationally-related pair is more complex morphologically than the other, it is the derived member of the pair which will be more complex. If these properties characterized the two senses of “book” and related content-container or abstract-concrete word senses, then we would treat the two senses of “book” as being related by a derivational rule like the grinding and portioning rules discussed here. However, as shown in (4), co-predication is acceptable in the “book” cases. Further, we do not know of any examples of blocking pertaining to cases like “book” or any other evidence suggesting an asymmetry in
complexity that is consistent across the entire set of container-content polysemous items with, say, the content sense always acting as the basic sense for every such item.

The size of the cost for processing the derived sense of a word varies, though, as we have seen by the contrast between Experiments 1 and 2. Applying the derivational rule itself may be relatively cheap, as in Experiment 1, providing the processor has good evidence that it is necessary to apply the rule. But finding the conceptual knowledge needed to evaluate the output of the rule may or may not be cheap, as suggested by the small cost in Experiment 1 and the larger cost in Experiment 2. We attribute this to the fact that the mass nouns tested in Experiment 1 have documented count noun uses, with attendant conventional ways of ‘packaging or individuating’. If I ask you what “three beers” means, you’ll tell me it means three bottles or glasses of beer. The mass noun analysis of the count nouns tested in Experiment 2 is also documented in the corpora we searched. However, figuring out the meaning of the adjective+noun combination, or identifying the reason why the speaker has not used the count noun, may require conceptual inferencing (Imported pear—have you tried it?) The post-linguistic aspects of comprehending these basic count nouns in mass noun contexts may be sluggish in neutral contexts where the grammar does not provide much help in pinning down the intended interpretation.

The results of the present experiments are not readily incorporated into a view where every noun has a default mass interpretation in the lexicon. Although the typological facts might lead one to expect that count nouns would always be more complex representationally than mass nouns, our results do not seem to support this view. One might argue that the larger cost of shifting from the underived-to-derived sense in Experiment 2, compared to the shift in Experiment 1, reflects the difficulty of shifting a term that has already been shifted, i.e., mass ⇒
Portioning and grinding  count → mass. But recall that the difficulty of derived mass terms appears primarily in the neutral context whereas it would have been expected to appear in all derived mass conditions if shifting of already shifted terms were the source of the cost. Given enough evidence for the derived sense, processing seems to proceed without difficulty with derived senses of either the count or the mass type. In short, in terms of the decisions required to comprehend sentences, whatever complexity a count noun may have beyond that of a mass noun, it is not at the relevant level to influence reading comprehension times.

Word meanings are very fluid. One task for psycholinguists is to identify the limits on listeners’ and readers’ decisions. Comprehenders must make some decisions about meaning and word senses as they go. Otherwise immediate memory could be overloaded waiting for some particularly helpful piece of information (that may or may not arrive) to determine the intended sense of a word. Given this, under what circumstances must the processor commit itself in the absence of evidence and under what circumstances may it delay commitments until the arrival of helpful evidence? The goal of our larger research project is to understand the answer to this question. If the obligatory choice points in language comprehension are known, presumably a theory of how context influences interpretation can be devised. But without knowing what counts as a choice point, characterizing the effect of distinct types of context is likely to be elusive. The present results are encouraging because they suggest a very strong constraint on the obligatory choice points and defaults in on-line language comprehension, namely, when lexical rules create or extend word senses, those rules are assumed to apply only when the processor has evidence that they have applied. In the absence of evidence the processor assigns the underived sense of the word.

This approach to carving up word senses/meanings makes very strong predictions in
Portioning and grinding English and other languages. Wherever there is good evidence that two senses of a word are derived by a lexical rule (e.g., a rule whose application can be blocked by the prior existence of a form with the same meaning as the output of the rule), the processor should commit itself to the underived sense immediately even if there is no evidence biasing the sentence to that analysis. This system strikes us as being reasonable on functional grounds. It guarantees that the comprehension system will have some denotation to work with in constructing an interpretation for larger constituents.
References


Appendix 1

Experiment 1: Items

For each item, the neutral preceding context conditions are listed first, followed by the helping preceding context conditions. The underived (count) target word appears before the “|”, the derived (mass) target word follows the “|”. The “/” symbols delimit the regions of analysis, the “//” symbols indicate a line break.

Yesterday John bought imported/ pears | beers/ at the/ counter of the local// supermarket.  
Yesterday John bought three imported/ pears | beers/ at the/ counter of the local// supermarket.

During the hot day, Anna had pink/ lollipops | lemonades/ while/ usually she won't touch// stuff like that.  
During the hot day, Anna had five pink/ lollipops | lemonades/ while/ usually she won't touch// stuff like that.

At dinner, the waitress brought tasty/ muffins | sauces/ to the/ table along with the// grilled meat.  
At dinner, the waitress brought five tasty/ muffins | sauces/ to the/ table along with the// grilled meat.

Last Monday, Teresa ended up eating tasteless/ flapjacks | sherberts/ at her/ friend's// house. She complained about it all week.  
Last Monday, Teresa ended up eating two tasteless/ flapjacks | sherberts/ at her/ friend's// house. She complained about it all week.

Today, Marcia served us rich/ brownies | mousses/ at her/ ocean-side house.  
Today, Marcia served us four rich/ brownies | mousses/ at her/ ocean-side house.

Today Susie only ordered plain-tasting/ bagels | waters/ for lunch/ because she's on a// diet.  
Today Susie only ordered two plain-tasting/ bagels | waters/ for lunch/ because she's on a// diet.

On her birthday, Maria had expensive/ éclairs | caviars/ with her/ dinner.  
On her birthday, Maria had two expensive/ éclairs | caviars/ with her/ dinner.

This morning John had Guatemalan/ bananas | coffees/ for his/ morning breakfast.  
This morning John had three Guatemalan/ bananas | coffees/ for his/ morning breakfast.
Last night Jason devoured delicious/ yams | stews/ instead/ of having dinner.
Last night Jason devoured several delicious/ yams | stews/ instead/ of having dinner.

Today the nutritionist suggested bland/ biscuits | risottos/ for the/ evening meal.// I guess it won't hurt my ulcers.
Today the nutritionist suggested two bland/ biscuits | risottos/ for the/ evening meal.// I guess it won't hurt my ulcers.

This afternoon Lucy prepared instant/ burritos | oatmeals/ for her/ snack.
This afternoon Lucy prepared two instant/ burritos | oatmeals/ for her/ snack.

Today Laura could only find old/ crackers | puddings/ in the/ kitchen cupboards. It's// time to go shopping.
Today Laura could only find two old/ crackers | puddings/ in the/ kitchen cupboards. It's// time to go shopping.

After the hike, Kate ended up ordering fruity/ tarts | ciders/ and then/ she felt// sick.
After the hike, Kate ended up ordering three fruity/ tarts | ciders/ and then/ she felt// sick.

Stacey tried French/ apricots | mustards/ with her/ pork sandwich.
Stacey tried two French/ apricots | mustards/ with her/ pork sandwich.

Last Saturday Sam ate healthy/ cookies | cereals/ for the/ first time. I know; I saw him// do it.
Last Saturday Sam ate two healthy/ cookie | cereals/ for the/ first time. I know; I saw him// do it.

This morning Alex consumed chocolate/ tortes | milks/ at the/ book-cafe.
This morning Alex consumed three chocolate/ tortes | milks/ at the/ book-cafe.

Late last evening, Grandma ate sugary/ donuts | jellos/ and surprised/ us all.
Late last evening, Grandma ate three sugary/ donuts | jellos/ and surprised/ us all.

Sylvia put intense/ jalepenos | vinegars/ in the/ salad, but her husband thought it was// too much.
Sylvia put three intense/ jalepenos | vinegars/ in the/ salad, but her husband thought it was// too much.

This afternoon Helen had strong/ martinis | whiskeys/ to keep/ her warm.
This afternoon Helen had several strong/ martinis | whiskeys/ to keep/ her warm.

At the beach, Andrea had spicy/ sausages | ketchups/ with her/ french fries.
At the beach, Andrea had six spicy/ sausages | ketchups/ with her/ french fries.

Last month Patrick ate ordinary/ peaches | popcorns/ at the/ Tri-County Fair.
Last month Patrick ate a couple of ordinary/ peaches | popcorns/ at the/ Tri-County Fair.

Yesterday Jim had cheap/ scones | vodkas/ after/ going home from his date.
Yesterday Jim had five cheap/scones | vodkas/ after/ going home from his date.

This morning Melissa sampled inexpensive/clams | cokes/ at the/ local Stop and// Shop.
This morning Melissa sampled several inexpensive/clams | cokes/ at the/ local Stop and// Shop.

This morning I had hot/buns | teas/ at my/ friend's house. Usually I don't have// anything before noon.
This morning I had three hot/buns | teas/ at my/ friend's house. Usually I don't have// anything before noon.

Last week Paula ate sweet/cupcakes | custards/ even though/ she's supposed to be on a// strict diet.
Last week Paula ate three sweet/cupcakes | custards/ even though/ she's supposed to be on a// strict diet.

For his dinner, Frank enjoyed thick/turnips | chowders/ sitting/ all by himself in the// kitchen.
For his dinner, Frank enjoyed three thick/turnips | chowders/ sitting/ all by himself in the// kitchen.

For breakfast this morning, Lisa had exotic/shakes | juices/ and then/ went out for a// run.
For breakfast this morning, Lisa had three exotic/shakes | juices/ and then/ went out for a// run.

At the barbecue, Bob used fresh/pickles | relishes/ on his/ hot dog, but then he made a// mess eating it.
At the barbecue, Bob used two fresh/pickles | relishes/ on his/ hot dog, but then he made a// mess eating it.
Appendix 2

Experiment 2: Items

For each item, the neutral preceding context conditions are listed first, followed by the helping preceding context conditions. The underived (mass) target word appears before the “|”, the derived (count) target word follows the “|”. The “/” symbols delimit the regions of analysis, the “//” symbols indicate a line break.

Yesterday, John wanted imported/ beer | pear/ after/ the rich// main course. His girlfriend didn't want anything.
Yesterday, John wanted just a small amount of imported/ beer | pear/ after/ the rich// main course. His girlfriend didn't want anything.

Yesterday, Melissa tasted inexpensive/ cola | clam/ at the/ local// supermarket. She likes going there because it is not a chain.
Yesterday, Melissa tasted a spoonful of inexpensive/ cola | clam/ at the/ local// supermarket. She likes going there because it is not a chain.

The woman at the stand gave the child sweet/ popcorn | peach/ for free,/ which// was nice of her. But the child's mom was not happy with it.
The woman at the stand gave the child a bit of sweet/ popcorn | peach/ for free,/ which// was nice of her. But the child's mom was not happy with it.

This morning, John had Guatemalan/ coffee | banana/ instead/ of his usual// breakfast. He was already late for a meeting.
This morning, John had too much Guatemalan/ coffee | banana/ instead/ of his usual// breakfast. He was already late for a meeting.

To keep the baby quiet, mom gave him plain-tasting/ water | bagel/ that she/ had// bought for herself. It didn't really help though.
To keep the baby quiet, mom gave him a bit of plain-tasting/ water | bagel/ that she/ had// bought for herself. It didn't really help though.

Last week, Paula tried sweet/ custard | cupcake/ but she/ had to spit it out. She// thought it was so sweet that it almost hurt.
Last week, Paula tried a bite of sweet/ custard | cupcake/ but she/ had to spit it out. She// thought it was so sweet that it almost hurt.

Last Saturday, Sam tried raisin/ cereal | cookie/ at Trader's/ Joe. I thought// this was odd because
he told me he's allergic to raisins.

Last Saturday, Sam tried a bite of raisin/ cereal | cookie/ at Trader's/ Joe.  I thought// this was odd because he told me he's allergic to raisins.

Last night, Jon devoured delicious/ stew | yam/ at the/ house of/ his mother-in-law.  His wife was out playing tennis.

Last night, Jon devoured a large portion of delicious/ stew | yam/ at the/ house of/ his mother-in-law.  His wife was out playing tennis.

During the hot day, Anna had pink/ lemonade | lollipop/ even though/ she/ usually won't touch stuff like that.  She must have had a change of heart.

During the hot day, Anna had a bit of pink/ lemonade | lollipop/ even though/ she/ usually won't touch stuff like that.  She must have had a change of heart.

This morning I had hot/ tea | bun/ at my/ friend's house.  It is a// beautiful brownstone on a quiet side street.

This morning I had a helping of hot/ tea | bun/ at my/ friend's house.  It is a// beautiful brownstone on a quiet side street.

At the banquet, Alex only had chocolate/ milk | torte/ because/ he's afraid// he will gain weight.  I think he's exaggerating though.

At the banquet, Alex only had a spoonful of chocolate/ milk | torte/ because/ he's afraid// he will gain weight.  I think he's exaggerating though.

To my dismay, I was served bland/ risotto | biscuit/ for the/ evening meal.// You can imagine I was pretty upset about that.

To my dismay, I was served a portion of bland/ risotto | biscuit/ for the/ evening meal.// You can imagine I was pretty upset about that.

On her birthday, Maria had expensive/ caviar | eclair/ that she/ didn't// want to share with anyone.  I thought that was mean of her.

On her birthday, Maria had an order of expensive/ caviar | eclair/ that she/ didn't// want to share with anyone.  I thought that was mean of her.

Frank was pleased with thick/ chowder | turnip/ for dinner,/ his// girlfriend said.  I think he is not very discerning though.

Frank was pleased with a small amount of thick/ chowder | turnip/ for dinner,/ his// girlfriend said.  I think he is not very discerning though.

To our surprise, the cat ate sugary/ jello | donut/ when we/ offered it to her.// Maybe that is why she has grown so fat lately.

To our surprise, the cat ate a bit of sugary/ jello | donut/ when we/ offered it to her.// Maybe that is why she has grown so fat lately.

After the hike, Kate wanted fruity/ cider | tart/ as a/ reward for// her accomplishment.  But she
wanted this before the hike as well.
After the hike, Kate wanted a big order of fruity/ cider | tart/ as a/ reward for// her
accomplishment. But she wanted this before the hike as well.

Last Monday, Teresa had tasteless/ sherbert | flapjack/ at her/ friend's house.// In order to make
her friend happy, she said that it was yummy.
Last Monday, Teresa had a helping of tasteless/ sherbert | flapjack/ at her/ friend's house.// In
order to make her friend happy, she said that it was yummy.

For breakfast this morning, Lisa had exotic/ juice | shake/ and then/ went out// for a run. She
came back totally dehydrated.
For breakfast this morning, Lisa had a sip of exotic/ juice | shake/ and then/ went out// for a run.
She came back totally dehydrated.

At the barbecue, Andrea wanted spicy/ ketchup | sausage/ with her/ French// fries. Her boyfriend
refused to give it to her.
At the barbecue, Andrea wanted a large amount of spicy/ ketchup | sausage/ with her/ French//
fries. Her boyfriend refused to give it to her.

This afternoon Lucy had instant/ oatmeal | burrito/ but didn't/ like it at all.// Nevertheless, she
made us eat it as well.
This afternoon Lucy had a taste of instant/ oatmeal | burrito/ but didn't/ like it at all.//
Nevertheless, she made us eat it as well.

Karen asked for buttery/ sauce | muffin/ but her/ boyfriend warned her// about health risks. I
think he should leave her alone.
Karen asked for a taste of buttery/ sauce | muffin/ but her/ boyfriend warned her// about health
risks. I think he should leave her alone.

I was disappointed when I saw unappetizing/ relish | carrot/ on my/ plate// the other day. And the
plate was dirty too.
I was disappointed when I saw a speck of unappetizing/ relish | carrot/ on my/ plate// the other
day. And the plate was dirty too.

Sam put intense/ vinegar | jalapeno/ in the/ salad, but his wife thought// it was too much. She
even refused to eat the salad.
Sam put a teaspoon of intense/ vinegar | jalapeno/ in the/ salad, but his wife thought// it was too
much. She even refused to eat the salad.

Laura thought that stale/ pudding | cracker/ was one/ of the most horrible// things imaginable. Her
dog doesn't seem to mind though.
Laura thought that a taste of stale/ pudding | cracker/ was one/ of the most horrible// things
imaginable. Her dog doesn't seem to mind though.

The toddler threw rich/ mousse | brownie/ against/ the wall in the living// room. The nanny had
to clean it all up.
The toddler threw a handful of rich/mousse | brownie/ against/ the wall in the living/ room. The nanny had to clean it all up.

At the store, Jim tasted cheap/vodka | scone/ that was/ being promoted// by a friend of his. He ended up buying from him.
At the store, Jim tasted a sample of cheap/vodka | scone/ that was/ being promoted// by a friend of his. He ended up buying from him.

This afternoon Helen had strong/whiskey | martini/ to keep/ her warm. Of course,// a blanket would have helped as well.
This afternoon Helen had a sip of strong/whiskey | martini/ to keep/ her warm. Of course,// a blanket would have helped as well.

Stacey had organic/mustard | apricot/ with her/ pork sandwich. She thinks// it is so superior that she always uses an excessive amount of it.
Stacey had too much organic/mustard | apricot/ with her/ pork sandwich. She thinks// it is so superior that she always uses an excessive amount of it.
Authors Note

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Footnote

1 Unfortunately, one item (whiskey / martini) was presented incorrectly in the eye-tracking experiment. We therefore report all means and analyses based on the remaining 27 item quartets.

2 There was one missing cell in the participants’ analysis.

3 One reviewer notes that in a number of cases, the mass form can be used to indicate that the portion that was eaten, ordered, etc., does not obviously correspond to a single instance of the term (e.g., a Guatemalan banana), and that this usage of the mass term might be conventionalized. While we agree that this might be a possible interpretation of He ate Guatemalan banana and that this usage of the mass term might not be infrequent, the data indicate that readers nevertheless still experience difficulty to attain such an interpretation.
Table 1

Experiment 1: Mean Reading Time Durations and Percentage of Regressions in Count Noun Contexts

<table>
<thead>
<tr>
<th>Measure</th>
<th>Noun (beers/pears)</th>
<th>Spillover (at the)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-Fixation Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>324 (6.6)</td>
<td>285 (8.3)</td>
</tr>
<tr>
<td>M-H</td>
<td>307 (6.0)</td>
<td>275 (6.3)</td>
</tr>
<tr>
<td>C-N</td>
<td>316 (7.7)</td>
<td>277 (5.8)</td>
</tr>
<tr>
<td>C-H</td>
<td>313 (7.8)</td>
<td>278 (5.8)</td>
</tr>
<tr>
<td>Single-Fixation Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>339 (7.0)</td>
<td>293 (11.1)</td>
</tr>
<tr>
<td>M-H</td>
<td>324 (9.0)</td>
<td>276 (6.5)</td>
</tr>
<tr>
<td>C-N</td>
<td>328 (9.2)</td>
<td>287 (6.8)</td>
</tr>
<tr>
<td>C-H</td>
<td>334 (10.3)</td>
<td>285 (7.4)</td>
</tr>
<tr>
<td>Gaze Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>373 (11.2)</td>
<td>363 (13.6)</td>
</tr>
<tr>
<td>M-H</td>
<td>353 (10.6)</td>
<td>327 (14.0)</td>
</tr>
<tr>
<td>C-N</td>
<td>363 (10.8)</td>
<td>321 (13.9)</td>
</tr>
<tr>
<td>C-H</td>
<td>361 (14.8)</td>
<td>332 (12.9)</td>
</tr>
<tr>
<td>First-Pass Regression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>12.1 (2.3)</td>
<td>7.2 (1.5)</td>
</tr>
<tr>
<td>M-H</td>
<td>9.0 (1.9)</td>
<td>5.2 (1.5)</td>
</tr>
<tr>
<td>C-N</td>
<td>9.0 (1.8)</td>
<td>5.6 (1.3)</td>
</tr>
<tr>
<td>C-H</td>
<td>9.8 (1.8)</td>
<td>5.3 (1.7)</td>
</tr>
<tr>
<td>Second-Pass Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>31 (5.5)</td>
<td>51 (9.1)</td>
</tr>
<tr>
<td>M-H</td>
<td>23 (6.8)</td>
<td>43 (8.3)</td>
</tr>
<tr>
<td>C-N</td>
<td>35 (12.9)</td>
<td>47 (8.8)</td>
</tr>
<tr>
<td>C-H</td>
<td>29 (9.1)</td>
<td>47 (7.8)</td>
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<tr>
<td>Total Gaze Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>427 (19.0)</td>
<td>406 (17.2)</td>
</tr>
<tr>
<td>M-H</td>
<td>399 (21.8)</td>
<td>354 (16.1)</td>
</tr>
<tr>
<td>C-N</td>
<td>411 (21.8)</td>
<td>367 (16.1)</td>
</tr>
<tr>
<td>C-H</td>
<td>396 (16.5)</td>
<td>356 (14.7)</td>
</tr>
</tbody>
</table>

*Note.* M-N = Mass noun – Neutral context; M-H = Mass noun – Helping context; C-N = Count noun – Neutral context; C-H = Count noun – Helping context. Reading times are in milliseconds. Standard errors are presented in parentheses.
Table 2
Experiment 2: Mean Reading Time Durations in Mass Noun Contexts

<table>
<thead>
<tr>
<th>Measure</th>
<th>Noun (beer/pear)</th>
<th>Spillover (after)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-Fixation Duration</td>
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<td></td>
</tr>
<tr>
<td>M-N</td>
<td>329 (9.2)</td>
<td>291 (6.9)</td>
</tr>
<tr>
<td>M-H</td>
<td>303 (9.4)</td>
<td>298 (9.8)</td>
</tr>
<tr>
<td>C-N</td>
<td>319 (7.3)</td>
<td>310 (10.0)</td>
</tr>
<tr>
<td>C-H</td>
<td>329 (8.4)</td>
<td>313 (8.9)</td>
</tr>
<tr>
<td>Single-Fixation Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>333 (11.1)</td>
<td>304 (6.3)</td>
</tr>
<tr>
<td>M-H</td>
<td>307 (9.6)</td>
<td>316 (14.7)</td>
</tr>
<tr>
<td>C-N</td>
<td>336 (7.5)</td>
<td>327 (10.9)</td>
</tr>
<tr>
<td>C-H</td>
<td>342 (8.4)</td>
<td>326 (10.1)</td>
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<tr>
<td>Gaze Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>359 (11.5)</td>
<td>356 (10.2)</td>
</tr>
<tr>
<td>M-H</td>
<td>317 (9.2)</td>
<td>368 (16.3)</td>
</tr>
<tr>
<td>C-N</td>
<td>371 (12.2)</td>
<td>378 (14.6)</td>
</tr>
<tr>
<td>C-H</td>
<td>355 (10.4)</td>
<td>381 (15.9)</td>
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<tr>
<td>First-Pass Regression</td>
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<td></td>
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<td>M-N</td>
<td>8.9 (2.3)</td>
<td>5.8 (1.3)</td>
</tr>
<tr>
<td>M-H</td>
<td>10.5 (1.9)</td>
<td>4.8 (1.3)</td>
</tr>
<tr>
<td>C-N</td>
<td>15.2 (2.9)</td>
<td>14.7 (2.7)</td>
</tr>
<tr>
<td>C-H</td>
<td>9.8 (2.0)</td>
<td>7.3 (1.7)</td>
</tr>
<tr>
<td>Second-Pass Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>21 (5.2)</td>
<td>34 (7.9)</td>
</tr>
<tr>
<td>M-H</td>
<td>26 (8.5)</td>
<td>30 (6.8)</td>
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<tr>
<td>C-N</td>
<td>71 (11.7)</td>
<td>53 (7.6)</td>
</tr>
<tr>
<td>C-H</td>
<td>32 (7.5)</td>
<td>40 (7.4)</td>
</tr>
<tr>
<td>Total Gaze Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-N</td>
<td>399 (18.4)</td>
<td>391 (16.0)</td>
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<td>M-H</td>
<td>359 (16.6)</td>
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<tr>
<td>C-N</td>
<td>454 (19.5)</td>
<td>469 (26.6)</td>
</tr>
<tr>
<td>C-H</td>
<td>391 (12.8)</td>
<td>423 (19.1)</td>
</tr>
</tbody>
</table>

*Note.* M-N = Mass noun – Neutral context; M-H = Mass noun – Helping context; C-N = Count noun – Neutral context; C-H = Count noun – Helping context. Reading times are in milliseconds. Standard errors are presented in parentheses.