Coercion: container, contents and measure readings

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1 Count and mass readings for pseudo-partitive DPs

It has been long observed that pseudopartitive DPs (*two glasses of beer*) have at least two readings (Doetjes 1997; Rothstein 2011, i.a): (i) a container reading (*two glasses containing beer*); (ii) a measure reading (*beer to the amount of two glassfuls*). Indeed, Landman (2016) argues that pseudopartitive DPs (*two glasses of beer*) formed with extensive measure expressions derived from container Ns (*glass*) have four readings: three count and one mass. An example of each is given in Table 1. (However, for reasons to be made explicit below, we focus only on the container, contents, and measure readings, and skip the portion reading, in this paper.)

Table 1: Readings for measure DPs

container	two glasses filled with beer	COUNT
contents	two portions of beer, each the contents of a glass	COUNT
portion	two one-glassful sized portions of beer	COUNT
measure	beer to the amount of two glassfuls	MASS

Examples in support of the contrast between container, contents, and measure readings are given in (1)-(3). Further examples can be found in Rothstein 2011 and Landman 2016.

CONTEXT: We watch Charlie pour beer from a large bottle into two glasses. We then see Charlie put them on the table, and then drink the contents.

(1) Charlie placed two glasses of beer on the table. (container)

(2) Charlie drank two glasses of beer. (contents)

(3) The bottle holds (at least) two glasses of beer. (measure)

In (1), the selectional restrictions of the verb *place* enforce the container interpretation of *two glasses of beer* (glasses can, but beer cannot, be placed on tables). In (2), *drink* selects for the contents interpretation. The sentence in (3) can be true irrespective of whether the beer in question is actually poured into glasses, so *two glasses of beer* does not have a contents reading. It is also not contextually plausible that the bottle holds the containers (the actual glasses). Instead, *two glasses of beer* in (3) has the interpretation of 'beer to the amount of (the contextually provided) two glasses-worth', namely a measure reading.[1]

2 The puzzle

2.1 Not all readings are available via coercion

This paper explores the novel observation that the readings available for full measure DPs such as those in (1)-(3), do not match up with those for the relevant *numerical + mass noun* phrase (e.g., *two beers*). For example, whereas one can quite easily coerce *two beers* into a container or a contents reading as in (4) and (5), it is much harder (if possible at all) to coerce *two beers* into a measure reading as indicated by

[1]There may also be a portion reading for (3).

(6).[2] This is despite the fact that it is felicitous to use the full measure DP *two glasses of beer* in all of these contexts (as in (1)-(3)). These facts, which, to our knowledge, have not been noticed before now, are the focus of our paper.

CONTEXT: We watch Charlie pour beer from a large bottle into two glasses. We then see Charlie put them on the table, and then drink the contents.

(4) Charlie placed two beers on the table. (container=two glasses containing beer)

(5) Charlie drank two beers. (contents=two glassfuls of beer)

(6) # The bottle holds (at least) two beers. (measure=beer of two glass-sized measures)

Although (6) is infelicitous, we do not completely exclude the possibility of some felicitous measure readings. For example, arguably (7) marginally sanctions a *measure of two glasses-worth* reading. (However, the judgements of native speakers we have consulted are not firm on this.)[3]

(7) Harry drinks two glasses of beer every night. A large bottle suffices for this very well. Sometimes she doesn't have any clean glasses, ?so she pours two beers from the bottle into a measuring jug or vase (one of which is usually clean).

Even so, with other mass nouns, such measure readings are still highly marked:

(8) Harry drinks two glasses of water every night. Sometimes she doesn't have any clean glasses, #so she pours two waters straight from the tap into a measuring jug or vase (one of which is usually clean).

The puzzle we address in this paper is as follows: Why is it much harder to coerce numerical NPs with mass terms like *two beers* into a contextually determined measure interpretation ('beer to the measure of two contextually specified amounts') than into a container or a contents interpretation, even though the units of measure are easily retrievable from the context?

2.2 An aside on portion readings

Portion readings do seem to be available for constructions like *two beers*. The following is adapted from Landman's (2016, p. 44) portion example:

(9) Billie is a skilled bartender. With two successive flicks of the wrist, she can *pour two vodkas into a cocktail mixer in seconds*. She doesn't need to use measuring cups or optics, she can pour *them* straight from the bottle.

If felicitous, *two vodkas* counts as having a portion reading because is is not mass (she can pour *them*), and is not a container reading (she poured two measures, but no cup or measure was used). Such examples need a lot of context, and are complex to analyse. We also note that such readings are highly dependent on background knowledge about a standard portion.[4] We hope to extend the analysis we give in this paper to such examples in future work.

[2] As further evidence, in the context of a wine bottle, there is a marked contrast between: *One bottle is about six glasses/glass of wine* versus *# One bottle is about six wines*.

[3] In 7, a kind reading is also ruled out unless one bottle can hold two kinds of beer.

[4] Landman's (2016, p. 44) original soy sauce example related to pouring three cups of soy sauce into a brew (each at different times). Note that, if the DP is replaced with *three soy sauces*, the resulting sentence is not felicitous (*pour three soy sauces in the brew* $\neq$ *pour three cups of soy sauce in the brew*).

3 Analysis

We extend the analysis of pseudopartitives and measure DPs in Sutton and Filip 2016a and Filip and Sutton 2017 to also cover contents and measure readings of DPs formed with classifier-like expressions. We take much inspiration and adopt many insights from Rothstein (2010, 2011) and Landman (2016).

The basic (simplified) lexical entry for a CN like *glass* is a λ-abstraction over a tuple of type $\langle e, \langle\langle e,t\rangle \times t \times t\rangle\rangle$, a template for which is given in (10).

(10) $$\lambda x_{\langle e\rangle}. \left\langle \begin{array}{l} \textbf{Property}_{\langle e,t\rangle}, \\ \textbf{Counting base}(x)_{\langle t\rangle}, \\ \textbf{Preconditions}_{\langle t\rangle} \end{array} \right\rangle$$

Property stands for a predicate capturing qualitative properties (Krifka 1989). **Counting Base** stands for a predicate that picks out individuals for counting, possibly relative to an individuation function *IND*, and a counting context (this builds on i.a. Rothstein (2010); Sutton and Filip (2016a,b)). **Precondition**, which will be used (mostly for complex Ns), states restrictions and presuppositions coming from lexical items and their combination (for example as a type restriction on nouns for classifiers in e.g. Japanese (Filip and Sutton 2017)).[5]

For example, the entries for *glasses*, *beer*, and *three glasses* are given in (11)-(13). Note that, as argued in Sutton and Filip 2016b, substance denoting nouns such as *beer*, do not specify an individuation scheme via *IND* in their lexical entries. For *three glasses* in (12), we assume that *three* can shift from a numeral reading to a numerical determiner (which also carries a presuposition that the argument is quantized (Filip and Sutton 2017)).

(11) $$[\![\text{glasses}]\!]^c = \lambda x. \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ c(\textit{IND}(\mathbf{glass}))(x), \\ \varnothing \end{array} \right\rangle \text{ or } = \lambda x. \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ {}^*c(\textit{IND}(\mathbf{glass}))(x), \\ \varnothing \end{array} \right\rangle$$

(12) $$[\![\text{three glasses}]\!]^c = \lambda x. \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ \mu_{\text{card}}(x, \lambda y.c(\textit{IND}(\mathbf{glass}))(y)) = 3, \\ \text{QUA}(\lambda y.c(\textit{IND}(\mathbf{glass}))(y)) \end{array} \right\rangle$$

(13) $$[\![\text{beer}]\!]^c = \lambda x. \left\langle \begin{array}{c} \lambda y.\mathbf{beer}(y), \\ \mathbf{beer}(x), \\ \varnothing \end{array} \right\rangle$$

In the following, we make extensive use of projection functions π_1, π_2, π_3, and such that if $X = \langle \phi, \psi, \tau\rangle : \langle a \times b \times c\rangle$, then: $\pi_1(X) = \phi : a$, $\pi_2(X) = \psi : b$, $\pi_3(X) = \tau : c$.

3.1 Container readings

We argue that CNs denoting vessels etc. have a licensed CONTAINER shift (in English, triggered in measure DPs, for example). This view is also adopted by Rothstein (2011) and Landman (2016). On our account, this container shift function, CTR, takes a container expression of type $\langle e, \langle\langle e,t\rangle \times t \times t\rangle\rangle$, like $[\![\text{glass}]\!]$, a contents expression of the same type, (e.g., $[\![\text{beer}]\!] : \langle e, \langle\langle e,t\rangle \times t \times t\rangle\rangle$), and yields an expression also of type $\langle e, \langle\langle e,t\rangle \times t \times t\rangle\rangle$. Intuitively, this forms e.g., the set of entities that are a glass which contains some beer. (We use '$\sqsubseteq$' for the mereological part of relation.) $\mathbf{contain}(x, z, d)$ means that x contains z to (contextually specified) degree d.

(14) $$\text{CTR} \quad = \quad \lambda P\, \lambda Q\, \lambda x \left\langle \begin{array}{c} \pi_1(P(x)), \\ \pi_2(P(x)) \wedge \exists z.\pi_2(Q(z)) \wedge \mathbf{contain}(x, z, d), \\ \pi_3(P(x)) \end{array} \right\rangle$$

(15) $$\text{CTR}([\![\text{glasses}]\!]^c) \quad = \quad \lambda Q\, \lambda x \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ c(\textit{IND}(\mathbf{glass})(x) \wedge \exists z.\pi_2(Q(z)) \wedge \mathbf{contain}(x, z, d), \\ \varnothing \end{array} \right\rangle$$

[5] This method of using tuples as entries, also adopted in Landman's work can arguably be seen as the adoption of a form of frame semantics in which each position in the tuple records some aspect of the lexical meaning of an expression.

(16)

$$\begin{aligned}[\![\text{glasses of beer}]\!]^c &= (\textsc{ctr}([\![\text{glass}]\!]^c))([\![\text{beer}]\!]^c) \\ &= \lambda x \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ c(\mathit{IND}(\mathbf{glass})(x) \wedge \exists z.\mathbf{beer}(z) \wedge \mathbf{contain}(x,z,d), \\ \varnothing \end{array} \right\rangle\end{aligned}$$

So for *glasses of beer*, the relevant perceptual/functional properties are given by **glass**, these are individuated at c, and restricted such that we count the individual glasses which contain beer to degree d. With a numerical determiner such as *three*, the cardinality of entities with respect to this base must equal 3. Furthermore, there is a precondition that the counting base predicate is quantized. (An alternative analysis that we are not opposed to is that the counting base could be presumed to be disjoint (Landman 2011, 2016).)

(17)

$$\begin{aligned}&[\![\text{three glasses of beer}]\!]^c = \\ &\lambda x \left\langle \begin{array}{c} \lambda y.\mathbf{glass}(y), \\ \mu_{\text{card}}(x, \lambda y.c(\mathit{IND}(\mathbf{glass})(y) \wedge \exists z.\mathbf{beer}(z) \wedge \mathbf{contain}(y,z,d)) = 3, \\ \text{QUA}(\lambda y.c(\mathit{IND}(\mathbf{glass}))(y) \wedge \exists z.\mathbf{beer}(z) \wedge \mathbf{contain}(y,z,d)) \end{array} \right\rangle\end{aligned}$$

In the case of e.g., *three beers*, there is a type clash between the numerical determiner *three* which demands a quantized predicate (or, alternatively, one with a disjoint base), and the non-quantized (non-disjoint) predicate *beer*. To resolve this type clash, agents search the context for a relevant container concept (e.g. **glass**), and use the CTR shift to provide a content which can be inserted to resolve the type clash.

3.2 Contents readings

We also assume a shift from a common noun to a container reading. This shift is the same type as CTR but has a different semantics. Applied to [[glass]] and [[beer]], it yields the set of entities that are beer that are also the contents of some glass:

(18)

$$\textsc{cts} = \lambda P\, \lambda Q\, \lambda x \left\langle \begin{array}{c} \pi_1(Q(x)), \\ \pi_2(Q(x)) \wedge \exists z.\pi_2(P(z)) \wedge \iota u.\mathbf{contain}(z,u,d) = x, \\ \pi_3(Q(x)) \end{array} \right\rangle$$

(19)

$$\textsc{cts}([\![\text{glass}]\!]^c) = \lambda Q\, \lambda x \left\langle \begin{array}{c} \pi_1(Q(x)), \\ \pi_2(Q(x)) \wedge \exists z.c(\mathit{IND}(\mathbf{glass}))(z) \wedge \iota u.\mathbf{contain}(z,u,d) = x, \\ \pi_3(Q(x)) \end{array} \right\rangle$$

(20)

$$\begin{aligned}&[\![\text{glasses of beer}]\!]^c = (\textsc{cts}([\![\text{glass}]\!]^c))([\![\text{beer}]\!]^c) \\ &= \lambda x \left\langle \begin{array}{c} \lambda y.\mathbf{beer}(y), \\ \mathbf{beer}(x) \wedge \exists z.c(\mathit{IND}(\mathbf{glass}))(z) \wedge \iota u.\mathbf{contain}(z,u,d) = x, \\ \varnothing \end{array} \right\rangle\end{aligned}$$

Notice that for e.g. *three glasses of beer* on this reading, the base is still quantized (and disjoint), since beer is partitioned into separate parts in virtue of being the contents of individual glasses (the number of glasses of beer will be counted in terms of the numbers of portions of beer, each of which is *the* contents of a glass).

In the case of e.g., *three beers*, to resolve the type clash, agents search the context for a relevant container concept (e.g. **glass**), and use the CTS shift to provide a content which can be inserted to resolve the type clash.

3.3 Measure readings

Key to our analysis is that measure readings of DPs are the result of two shifts. First, one must shift e.g. **glass** to a contents reading, then a context-specified measurement function is formed that measures in terms of the amount specified by the contents reading. In other words, the measure reading is obtained by shifting e.g., *glass* to a contents reading, applying *beer*, then shifting that whole thing to a measure with a scale of beer of a glass's-worth.

Semantically, we propose that this shifting operation takes the entire property $\mathcal{P}$ of being e.g. BEER, THE CONTENTS OF A GLASS, and uses this as an argument for a measure function $\mu_{gl\_be}(x, \mathcal{P}) = n$ which is of type $\langle n, \langle e, t\rangle\rangle$. The shifting function also requires that, for any n, the measure function denotes a set that is not disjoint (e.g., the set of measures of two glasses-worth of beer is not disjoint).[6] If a bottle contains two glasses of beer, then there are multiple ways of dividing up the beer into two glass-sized measures (Landman 2016). This prohibits singular count concepts from being measured, since there is only one way to split up, e.g., two cats into two one-cat sized entities (the set of single cats is disjoint (Landman 2011, 2016)).

(21) $$\text{MSR} = \lambda P\, \lambda n\, \lambda x \left\langle \begin{array}{c} \pi_1(P(x)), \\ \mu_{\text{gl\_be}}(x, \lambda y.\pi_2(P(y))) = n, \\ \forall n\, \neg\text{DISJ}[\lambda z\, (\mu_{\text{gl\_be}}(z, \lambda y.\pi_2(P(y))) = n)] \end{array} \right\rangle$$

(22)
$$\text{MSR}((\text{CTS}([\![\text{glass}]\!]^c))([\![\text{beer}]\!]^c)) =$$
$$\lambda n\, \lambda x \left\langle \begin{array}{c} \lambda y.\mathbf{beer}(y), \\ \mu_{\text{gl\_be}}(x, \lambda y.\mathbf{beer}(y) \wedge \exists z.c(\mathit{IND}(\mathbf{glass}))(z) \wedge \iota u.\mathbf{contain}(z, u, d) = y) = n, \\ \forall n\, \neg\text{DISJ}[\lambda z\, \mu_{\text{gl\_be}}(z, \lambda y.\mathbf{beer}(y) \wedge \exists z.c(\mathit{IND}(\mathbf{glass}))(z) \wedge \iota u.\mathbf{contain}(z, u, d) = y) = n] \end{array} \right\rangle$$

3.4 Restrictions on coercion for measure readings

For expressions such as *two beers*, the result of applying a numerical to a mass noun results in a type clash. This can be resolved in at least three ways: (i) find a contextually salient entity concept (like GLASS), shift it to a container reading, and apply it to the entry for beer; (ii) find a contextually salient entity concept (like GLASS), shift it to a contents reading, and apply it to the entry for beer; (iii) find a contextually salient entity concept (like GLASS), shift it to a contents reading, and apply it to the entry for *beer*, *then* shift it a second time, now to a measure reading (pure measured quantity of stuff reading, abstracting away from the contextually salient entity concept).

The reason why, we propose, route (iii) is blocked for constructions such as *three beers* is derived from the fact that the measure reading takes an extra step of shifting. Since the initial type clash is resolved after the first (stage (ii) shift), there is no driving force to shift again (hence (6) is infelicitous). Furthermore, we suspect that applying two shifting operations is cognitively harder to do.

This account predicts that if there is extra reason to shift again, such as the singular marking on the verb, the felicity should improve. For example, (23) can be interpreted as meaning the same as (24) and seems to be better than e.g. (6).

(23) (Around) two beers was missing from the keg.

(24) (Around) two glasses of beer was missing from the keg.

The singular marking on the verb yields a type mismatch with *two beers* if *two beers* is interpreted with either a container or a contents reading.

Importantly, our analysis is driven by a *type-clash, then coerce to repair* strategy. As we argue in Section 4.1, this gives us a window on one aspect of whether the mass/count distinction rests on a misunderstanding.

4 Conclusions and discussion

We have presented an account of new data regarding restrictions on the available coerced readings for *numerical + mass noun* phrases like *two beers*. We have established the need for different kinds of shifting operations for these data (not all coercions are the same (i.a., Asher 2015)). Furthermore, we have argued that a two-step shifting operation is required to obtain measure readings of pseudo-partitive DPs, namely one that is parasitic on the contents reading. This, we contend, is why such readings are hard to access in phrases such as *two beers* in examples such as (6) and (8).

4.1 The mass/count distinction in doubt?

An alternative analysis of phrases such as *three beers* is the following: there may not be any mass-to-count coercion involved in expressions such as *three beers*. Rather, *beer* has at least one mass sense (the stuff), and at least one count sense, e.g. *glass/standardised portion of beer* (the original proposal for listing COUNT and MASS as properties of senses was given in Pelletier 1975, a more recent proposal in terms of unions of interpretations is given in Pelletier

[6]We note that this restriction could not be formulated in terms of e.g. *not-quantized*. A fixed amount of beer can be divided up into e.g. one glass-sized measures many ways, but these competing partitions are not disjoint with respect to each other. However, for any amount of beer, these competing partitions would not fail to be quantized (no one glass-sized measure of beer is the proper part of another). These insights are those of Landman's (2016), and are coopted by us.

2012). However, we contend that the puzzle we address here gives us some reason not to adopt this alternative analysis.

If substance denoting nouns such as *beer* have count senses, then, given the data in (4) and (5) this sense cannot be as simple as e.g., STANDARD SERVING OF X, since, this would be ambiguous between a container and a contents reading. So, by assumption, such nouns have at least two count senses, a container and a contents sense. However, if that view is correct, *the puzzle* can now be put in different terms: Why, in languages such as English, do such nouns *routinely* lack a measure mass sense in the lexicon?

On our view, since coercion is driven by the resolution of type clashes, and since coercing e.g. *beer* into a count reading resolves the type clash in e.g. *two beers*, there is no need to coerce again into a mass measure reading. A view on which nouns have numerous count and mass senses in the lexicon cannot make use of a coercion and type-clash-resolution mechanism, and so the fact that substance denoting nouns routinely seem to lack a mass measure sense in the lexicon demands an explanation, the mechanism behind which is far from obvious.

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