AMOUNT RELATIVES

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Abstract

We introduce amount relatives by discussing three types of relatives: those with a lexically realized amount head (d-headed relatives); those without such a head, but with an amount interpretation (d-interpreted relatives); and relatives with an individual interpretation, but with the gap in a position that does not support an individual variable (ep-relatives).

We discuss in some depth several diagnostic tests - proposed in and modified from Carlson 1977a - which distinguish these types of relatives from ordinary restricted relatives. We argue that together these tests justify Carlson's claim that these constructions need to be treated as a coherent subtype of relative clauses, *amount relatives*.

We discuss the strengths and weaknesses of earlier proposals for the syntax and semantics of amount relatives (Carlson 1977a, Heim 1987, Grosu and Landman 1998), and then provide a syntax and semantics for the three types of amount relatives (extending and modifying the analysis of ep-relatives in Grosu and Landman 1998, and providing detailed analyses of d-headed and d-interpreted relatives, which were barely touched on in Grosu and Landman 1998).

This analysis covers more types of constructions than that in Grosu and Landman 1998, addresses a broader set of data, and links the syntax and semantics of amount relatives to recent thinking on syntactic and semantic heads in measure and classifier constructions.

In an appendix we discuss the complexities arising when the gap of the amount relative is in a modal context (including problems relating to issues of relative-internal interpretation of relative-external material). In a second appendix, we evaluate some later work on amount relatives (von Fintel 1999, Herdan 2008, and McNally 2008) in the light of the proposals made here.

1. Introduction

Prior to the publication of Carlson's 1977a seminal paper, the traditional wisdom was that there are two semantic types of relative clause constructions, *restrictives* and *appositives*, which in at least some languages with externally-headed post-nominal clauses are also distinguishable in terms of their syntactic and/or morphological properties. Carlson's article was, to our knowledge, the first study that prominently drew attention to a number of (English) constructions that have the essential *prima facie* appearance of restrictives, but that, upon closer consideration, do not comfortably fit into either of those two traditionally recognized classes. Carlson pointed out that one of the characteristics that distinguishes these relatives from restrictives is their incompatibility with existential force: unlike restrictive relatives, the constructions Carlson discusses are restricted as to what external determiners they can felicitously combine with.

Subsequently, several studies pointed out that this property also characterizes a number of relative constructions other than externally-headed ones, in particular, English-type free relatives (Jacobson 1988, 1995), Hindi-type correlatives (Dayal 1991a,b, 1995), and Japanese-type internally headed relatives (Hoshi 1995). Grosu and Landman 1998 named this entire class *maximalizing relatives*, and proposed that, unlike in the case of restrictive relatives, an operation of *maximalization* takes place in the semantic derivation of these relatives, turning the predicate denoted by the relative CP into a singleton predicate.

The constructions discussed by Carlson seemed to be special in that amounts could be argued to be part of their syntactic and/or semantic make-up, and it is for this reason that Carlson dubbed them *amount relatives*. Heim 1987 observed that the kind of constructions discussed by Carlson involved not only amounts in a narrow sense, but also cardinalities, durations, weights, distances, and she used the more general term *degree relatives*. We follow Carlson's terminology here (for no better reason than that it is established custom in Taxonomy to follow the initial baptism), but we will locate the class of amount relatives in a spectrum of relatives determined by three oppositions: one concerning the *head* of the relative [whether or not the head denotes a predicate of amounts or of individuals], one concerning the *interpretation* of the relative [whether the relative itself is interpreted as a predicate of amounts or of individuals], one concerning the *gap* of the relative [whether the gap is in standard argument position or not].

The remainder of this paper is organized as follows. In section 2.1, we introduce amount relatives and draw some terminological distinctions. In section 2.2 we introduce Carlson's diagnostic tests for amount relatives, with some critical discussion, and sketch those aspects of the analysis that were proposed by Carlson and by Heim. In section 2.3 we discuss a number of additional empirical issues that concern the diagnostic tests. In section 3 we present a substantially improved version of the analysis of Grosu and Landman 1998, providing an analysis of the basic cases discussed, including cases of which the analysis was only rudimentarily sketched in Grosu and Landman 1998, and taking into account empirical facts brought up in Grosu 2000, 2002. Section 4 extends the analysis of section 3 to cases that involve intensional, in particular modal, operators inside the relative. Section 5 contains a critical discussion of some of the literature on amount relatives which appeared after Grosu and Landman 1998. Sections 4 and 5 can be seen as appendices: 4, because it is both more technical and more tentative, 5, because it rather takes the form of a 'reply to critics'.

Before proceeding, we wish to note that space limitations will prevent us from discussing in detail the ways in which (some) amount relatives relate to other constructions that Grosu and Landman 1998 call maximalizing relatives. In particular with respect to Japanese and Korean internally-headed relatives our views have evolved considerably. For extensive discussion of these constructions, see Grosu and Landman 2012, Landman 2013, Grosu and Hoshi 2013, and also the typology of internally-headed relatives in the languages of the world in Grosu 2012, where both restrictive and maximalizing constructions are examined. For correlatives and free relatives, we maintain our earlier view that they are invariably maximalizing, with the *proviso* that the variety of free relatives called *transparent* (Wilder 1998) are invariably indefinite (see Grosu 2010, 2013).

2. Amount relatives and Carlson's diagnostics.

2.1. Introducing amount relatives: some terminology.

The italicized expressions in (1) are examples of restricted relative clauses headed by a degree head like ***amount, number***…

d-headed relatives:

(1) a. We will need the rest of our lives to drink [*the* ***amount*** *of wine they spilled – that evening*].
b. The organizer fitted in the auditorium [*the* ***number*** *of people that he could –*].
c. [The ***amount*** *of money this car cost –*] could have fed 1,000 hungry children for a whole year.
d. Huns will exhibit [*the* ***amount*** *of courage they find –necessary to conquer the palace*].
e. I hope you'll make on this project [*the* ***amount*** *of progress you made – on your last one*].

We will assume a type d of degrees, amounts and numbers, and call the relatives in (1) ***d-headed relatives***, meaning that their head is interpreted as a predicate of type <d,t>, a set of degrees, numbers, amounts…

(2) a. [The ***books*** *that I bought –*] are lying on the table.
b. Mary did [*some****thing*** *that John always wanted to do –*]

We assume, as usual, type e of entities, individuals. Relatives with heads like *books* in (2a) we will call ***e-headed relatives***. The head of these relatives is interpreted as a predicate of type <e,t>, a set of individuals. Relatives can be unspecified for the e-headed vs. d-headed distinction: ***thing*** is unspecified for type and ranges in (2b) over properties or actions, which we will think of as of a different type. We will here only be concerned with d-headed and e-headed relatives.

The relatives in (1) are all ***d-interpreted relatives,*** meaning that the relatives themselves are interpreted as predicates of type <d,t>. The relative in (2a) is an ***e-interpreted*** relative, the relative is interpreted as a predicate of type <e,t>. The relative in (2b) is neither. Again, we will here only be concerned with d-interpreted and e-interpreted relatives.

Carlson 1977a and Heim 1987 pointed out connections between d-interpreted relatives and comparatives and equatives. (1b) can be paraphrased naturally as the equative in (3):

(3) We will need the rest of our lives to drink ***the same amount of wine as*** [the ***amount*** of wine they spilled – that evening].

This connection is strengthened by the observation that d-interpreted relatives allow what we can call von Stechow-Heim interpretations (von Stechow 1980, Heim 1987, and in particular Heim 2006). Look at (4):

(4) a. This Pesach I drank the amount of wine that *everybody* drank - and not more.
b. John is taller than he *has to be* to get accepted for the police academy.

Heim 2006 pointed out (for examples similar to 4b) that on its most natural interpretation (4b) means that John is taller than the *minimal height* required to get accepted. She argues that this is a maximalization effect: such readings are very hard to account for without postulating a maximalization operation, and, as we will see below, readily accounted for with such an operation.

We point out here that the relative in (4a) has two interpretations: one where everybody drank the same amount of wine at Pesach, and another where, unlike other years and unlike other people present, I did not drink wine with dinner, and so I only drank the four glasses of wine that one drinks as part of the ceremony. Again, on this latter reading I drank as much as the person that, of the other persons present, drank *the least wine*.

With Heim we assume (following von Stechow) that this is a maximalization effect, an effect that is absent in normal restrictive relative clauses.

We note that d-headed relatives only allow interpretations as d-interpreted predicates. For instance, while (4a) expresses that Fred drank wine, it does *not* express that he ingested the actual stuff the others had already ingested: the interpretation is quintessentially equative.

Carlson 1977a pointed out that relatives can be d-interpreted even if they are e-headed (all the following examples are adapted from Carlson, except (5b), which is adapted from Heim 1987):

d-interpreted relatives:

(5) a. We will need the rest of our lives to drink [the ***wine*** *they spilled – that evening*].
b. John put in his bag [every ***book*** *he could* –].
c. [The ***money*** *it cost* –] could have fed 1,000 hungry children.
d. Huns will exhibit [the ***courage*** *they find – necessary to conquer the palace*].
e. I hope you'll make on this project [the ***headway*** *you made – on your last one*].

(5a) and (5b) are obviously e-headed relatives . The natural interpretation of (5a) is that it will take us a long time to drink *as much wine* as they spilled: it does not contemplate how long it would take us to slurp the wine they spilled off the ground. Similarly, (5b), on its most natural interpretation, says that John put in his bag *as many books as* he could fit in. This makes (5a) and (5b) d-interpreted relatives.

Note that, unlike the d-headed relatives in (1), the e-headed relatives in (5a) and (5b) are actually *ambiguous***:** they allow both a d-interpretation and an e-interpretation. (5a) clearly does allow the unsanitary reading which requires identity of substance.

The cases in (5c-e) seem to allow only d-interpretations. The heads here are mass nouns for which substance-identity is typically irrelevant or even dubious.

(6) The book costs twenty five euros

Thus in (6), in the context of ***cost***, ***twenty five euros*** does not mean ***25 individual euro coins*** to start with, so an e-interpretation of the relative as a set of coins is unlikely for independent reasons. Similarly, ***courage*** and ***headway*** are abstract mass nouns that are equative by nature: the courage that I find is *my* courage, and mine only: you can have similar courage, but you can't have mine; the same for the *headway* we make on our respective projects.

Note that while we focus on amount-interpretations here, the mass noun cases in (5d) and (5e) also prominently have *kind*-interpretations:

(5) d. Huns will exhibit [the ***courage*** *they find – necessary to conquer the palace*].
f. Huns will exhibit [the ***kind*** *of courage they find – necessary to conquer the palace*].

The difference between amount interpretations and kind interpretation is not so clear as one would think at first sight, because *kinds* themselves are often *scalarly ordered* in the context of such examples, leading to *kind-amount* interpretations. This means that we may expect the data for abstract mass nouns to be harder to interpret, which in fact is what we find.

In general then, e-headed but d-interpreted relatives are ambiguous, unless the e-interpretation is implausible for independent reasons.

Grosu and Landman 1998 mention the fact that, for potentially ambiguous e-headed relatives, d-interpretations are only possible under certain circumstances (those that disallow an e-interpretation, such as (5c-e), unproblematically allow a d-interpretation). Grosu and Landman proposed that the presence of a modal in the matrix may have a licensing effect, and they pointed out the contrast between (7a) and (7b), where (7b) is not d–interpreted:

(7) a. It *would* take us a year to drink the wine they spilled - at the party.
b. We drank the wine they spilled – at the party.

However, McNally 2008 points out that modals are not in general necessary, she gives (8a) as an example without a modal that allows a d-interpretation, and we add (8b) as another example:

(8) a. I am amazed at the wine he managed to drink at the party.
b. It took me a whole year to drink the wine you drank in an hour.

What the examples that license d-interpretations have in common is that they pragmatically facilitate a comparison of different amounts, e.g. in (8a) the amount he drank is compared with amounts I would find normal. No such comparison is facilitated in (7b). We do not know of research on the pragmatics of the licensing conditions, and will not pursue the issue here beyond the current suggestions.

For e-headed d-interpreted relatives, we have maximalization effects as well:

(9) At Pesach, I drink the wine that everybody in my household drinks and not more.

(9) means that, like everybody else, I drink four glasses of wine; it does not mean that the others don't drink more wine, say, with their meal.

We will use the term ***d-relative*** for relatives that are either d-headed or d-interpreted.

We turn to the relativization gaps.

(10) a. [The ***people*** *that there were – at that time*] only lived a few decades.
b. [Those ***hours*** *the movie lasts – beyond my bedtime*] make little difference.
c. John is not quite [the ***doctor*** *that his father was –*]
d. Neil is finally [the ***naturalized American citizen*** *that his mother always hoped he would be – some day*].
e. Last year, [all the ***days*** *that Fred was in Paris* -], Susan was in Rome.

Carlson 1977a studied relatives in which the gap is in the position that is open to definiteness effects, like the ***there***-insertion example in (10a). Higginbotham 1987 proposed that this position is not an argument position, but a predicate position, and he assumed that what fills this position must be semantically interpreted as a *predicate* (of type <e,t>). Landman 2004 took no position on the syntactic status of this position, but proposed that what fills the position must be semantically interpreted as an *adjunct* (of type <<e,t>,<e,t>>). Carlson himself related the relatives in (10a) to relatives like (10b), where the gap is in a measure or extent phrase position, which is generally assumed to be interpreted as a measure predicate or measure adjunct (cf. Dowty 1991). Grosu and Landman 1998 relate these relatives to relatives like (10c,d), where the gap is in predicate position. We add to this example (10e), where the gap is in adverbial adjunct position.

Without wanting to commit ourselves here to the details Higginbotham's or Landman's analysis of the definiteness effect as predicates or adjuncts, we will assume that *predicate-related* is a useful *diagnostic* label for these cases. We will call a gap that is in a normal argument position an ***a-gap***, and a gap that is in one of the positions in (10) a ***p-gap***. We will call the latter ***p-gap relatives***.

Note first that d-relatives allow p-gaps. For instance, it can be argued that the relatives in (10b) and (10c) have d-interpretations. A natural interpretation for (10c) is one where we interpreted ***doctorhood*** as a *scalar property*, and we interpret (10c) as expressing that John's father was *more of a doctor* than John is. This is a d-interpretation, so indeed, we have a d-relative with a p-gap.[1]

Not all p-gap relatives are d-relatives. In particular, (10a) is e-headed (***people***) and e-interpreted. (10a) does not mean *as many people as there were at that time* only lived a short time, (10a) means that *the people that lived then* lived a short time. Similarly (10d) and (10e) are not d-relatives. They are not d-headed and they are not interpreted as sets of degrees.

We will use the term ***ep-relative*** for a p-gap relative which is e-headed and e-interpreted (and extend this terminology to ***ea-relatives,*** which are a-gap relatives that are e-headed and e-interpreted).

[1]As a language-specific curiosity, we note the following Spanish example, kindly brought to our attention by Maria-Luisa Rivero (p.c.), which is analogous to (10c), except that the lexical head of the construction is an adjective, rather than a noun.

[i] Maria es dos veces lo guapa que era su madre.
Maria is two times the[Neut] beautiful[Fem] that was her mother
Maria is twice the beauty that her mother was

With this terminology in place, we can express Carlson's observations as follows. What Carlson argued was that there is a battery of diagnostic tests, on which ***d-relatives*** and ***ep-relatives*** pattern alike, and which distinguish them from normal restrictive relatives, which pattern differently. These diagnostics, Carlson argues, show that what looked like a homogenous class of restrictive relative clauses actually contains two diagnostically different subtypes, ***restrictive relatives*** and ***amount relatives*** and these classes can now be identified as:

Restrictive relatives**:** ea-relatives
Amount relatives**:** d-relatives and ep-relatives.

Before ending this section we point out that, although the diagnostic tests in the next subsection are not relevant for free relatives, in that they cannot tell amount free relatives from other free relatives, we do find d-headed free relatives and d-interpreted free relatives. Furthermore, the reasons for providing an analysis of ep-relatives along the line of d-relatives extend to p-gap free relatives as well, so that we can include the cases in (11) as amount free relatives:

(11) a. I dread to think [*what **number** of people they tried to fit – into the auditorium*]
b. We will need an eternity to drink [what they drank – last night]
c. Kindly remove [what there is/ whichever books there are – on the desk].

2.2. Carlson's diagnostics for amount relatives.

Carlson discusses four diagnostic tests that distinguish amount relatives from restrictive relatives. We will present these here with brief comments. More detailed discussion is given in section 2.3.

Diagnostic 1: In English, restrictive relatives allow a variety of relativizers: ***who, which, that***, Ø.
Amount relatives only allow ***that*** or Ø, they disallow wh-forms.

d-headed relatives

(12) a. We will need the rest of our lives to drink [the amount of wine ***#which/ ✓that/ ✓Ø*** they spilled – that evening].
b. The organizer fitted in the auditorium [the number of people ***#which/ ✓that/ ✓Ø*** he could –].
c. [The amount of money ***#which/ ✓that/ ✓Ø*** this car cost –] could have fed 1,000 hungry children for a whole year.
d. Huns will exhibit [the amount of courage ***#which/ ✓that/ ✓Ø*** they find – necessary to conquer the palace].
e. I hope you'll make on this project [the amount of progress ***#which/ ✓that/ ✓Ø*** you made – on your last one].

d-interpreted relatives

(13) a. We will need the rest of our lives to drink [the wine ***#which/ ✓that/ ✓Ø*** they spilled – that evening].
b. John put in his bag [every book ***#which/ ✓that/ ✓Ø*** he could –].
c. [The money ***#which/ ✓that/ ✓Ø*** it cost –] could have fed 1,000 hungry children.
d. Huns will exhibit [the courage ***#which/ ✓that/ ✓Ø*** they find – necessary to conquer the palace].
e. I hope you'll make on this project [the headway ***#which/✓that/✓Ø*** you made – on your last one].

p-gap relatives (including ep-relatives)

(14) a. [The people ***#which/ ✓that/ ✓Ø*** there were – at that time] only lived a few decades.
b. [Those hours ***#which/ ✓that/ ✓Ø*** the movie lasted – beyond my bedtime] were the worst I had ever experienced.
c. John is not quite [the doctor ***#which/ ✓that/ ✓Ø*** his father was –]
d. Neil is finally [the naturalized American citizen ***#which/ ✓that/ ✓Ø*** his mother always hoped he would be – some day].
e. Last year, [all the days ***#which/✓that/✓Ø*** Fred was in Paris -], Susan was in Rome.

Comments:

The usefulness of this diagnostic is limited by the fact that it concerns a very language specific distinction: we haven't found many languages besides English, where these facts can be replicated (Yadroff and Billings 1998 report related facts in Russian).

Also, one cannot expect lexical distinctions like this one to be very robust and stable across the whole language, in particular not in a language where for restrictive relatives, a prescriptive debate has been raging for a long time concerning the appropriateness of ***which*** versus ***that***. Nevertheless, impressionistic search for counterexamples on the internet brings out (only) one main dialect in which Carlson's distinctions are systematically violated, namely, the language of legal discourse, the language in which laws are written. An illustrative example is (15):

(15) Hence too, if a *constitutum* is made by a *paterfamilias* or by the owner of a slave of a debt for which he can be sued in an action *de peculio* the liability will extend to ***the amount which there was in the peculium*** when the *constitutum* was made;
William Warwick Buckland, The Digest of Justitian, Cambridge University Press, 1909, p. 343.

Nothing we have to say in this paper applies to this dialect.

Note that this diagnostic applies to p-gap relatives in general (including the ones with an e-head illustrated here). The relative in (14a) is an ep-relative. The one in (14d) is similar to this, in that the full DP in predicate position is itself an e-predicate, a non-gradable property of individuals. The relative in (14c) may well involve a kind interpretation: the full DP in predicate position is interpreted as a gradable property, ordered on a *scale* of *kinds of doctors*, an in this it is closer to a d-relative. (We are not analyzing such kind-interpretations in this paper).

Note further that we count (14b) and (14e) as ep-predicates, because we count the head nouns ***hours*** and ***days*** as e-predicates, though they denote sets of *temporal*

individuals. For the present purposes we include times and places among the individuals, using the label ***e-predicate*** for predicates of *non-scalar* individuals.

Concerning, (14e), note that the *piep piped*-form ***on which*** is felicitous (as in 16a). This felicity says very little, because there is no alternative piep-piped form available, and we have not been able to get comparable data with the preposition stranded, because our informants just didn't like preposition stranding in this context (as shown by the infelicity of all forms in 16b):

(16) a. Last year, [all the **days *on which*** Fred was in Paris -], Susan was in Rome.
b. #Last year, [all the **days *which/ that/ Ø*** Fred was in Paris **on** -], Susan was in Rome.

Diagnostic 2: Amount relatives allow externally definite and universal determiners, but not indefinite ones. Restrictive relatives have no such restrictions.

d-headed relatives

(17) a. We will need the rest of our lives to drink [✓***the/ #some*** amount of wine they spilled – that evening].
b. The organizer fitted in the auditorium [✓***the/ #a*** number of people he could –].
c. [✓***The /#an*** amount of money this car cost –] could have fed 1,000 hungry children for a whole year.

d-interpreted relatives

(18) a. We will need the rest of our lives to drink ✓***the/ #some*** wine they spilled – that evening].
b. John put in his bag [✓***every book/#three books*** he could –].
c. [✓***The/#some*** money it cost –] could have fed 1,000 hungry children.
d. Huns will exhibit [✓***the/ #much*** *courage* they find – necessary to conquer the palace].

p-gap relatives (including ep-relatives)

(19) a. [✓***The/#some*** people there were – at that time] only lived a few decades.
b. [✓***The many/ #three*** hours Bondarchuk's *War and Peace* lasted – beyond my bedtime] make me sleepy all week.
c. John is not quite [✓***the/#a*** doctor his father was –]
d. Neil is finally [✓***the/ #a*** naturalized American citizen his mother always hoped he would be – some day].
e. His sons never became [✓***the three/ #three*** successive presidents their father had fantasized they would become -].

The contrast between restrictive relatives and amount relatives is shown in (20):

(20) a. ✓There are *two* graduate students that - weren't yet in this department two years ago. ***restrictive relative – indefinite head***
b. #There are *two* graduate students that *there* weren't yet - in this department two years ago. ***amount relative-indefinite head***
c. ✓*The two* graduate students that - weren't yet in this department two years ago are phonologists ***restrictive relative – definite head***
d. ✓*The two* graduate students that *there* - weren't yet in this department two years ago are phonologists. ***amount relative – definite head***

Comments: These contrasts require some caveats.

In section 2.3.1 we present cases that look like felicitous ep-relatives with indefinite external heads. We argue there that there is good reason to assume that the determiners involved are *partitive* determiners, which arguably makes them fall under Carlson's observation.

In section 2.3.2 we present cases that look like felicitous d-headed relatives with indefinite external heads, which do not seem to involve a partitive interpretation. We point out there that the semantics of these cases involves both amounts and temporal individual concepts, and we provide an analysis in section 4 where the indefinite quantification concerns the latter rather than the first.

Diagnostic 3: Unlike restrictive relatives, amount relatives may not stack.

(21) a. ✓This desk weighs every pound *they said it would weigh –*.
b. # This desk weighs every pound *they said it would weigh –* ***that I had hoped it wouldn't (weigh) –*** (= Carlson's (68b))

(22) #All the tourists that *there were – on the boat at 3 pm* ***that there had been – on the island at 2 pm*** returned home late.

Comments: The diagnostic should read: *may not stack with proper intersective import*. While Carlson doesn't express this specification, we think it was implicitly assumed by him. One limitation of this diagnostic is that in certain idiolects, and in fact in certain languages, stacking is generally degraded, i.e., also in restrictive relatives (this is the case, according to one of the referees of this paper in certain Slavic languages). Furthermore, as for diagnostic 2, the presence of readings that involve temporal individual concept may affect the judgments. More discussion in section 2.3.4.

Carlson proposes some more diagnostic tests, one concerning *Antecedent Contained Deletion* and one concerning a constraint against singular heads. We do not regard these as proper diagnostics for amount relatives. We explain our reasons in section 2.3.3 for the first kind, and in section 5.1 for the second.

Carlson's subsumption of ep-relatives under *amount relatives* is not just diagnostic, but follow from some of the suggestions that Carlson makes as to where the diagnostic differences come from.

Carlson 1977a and Heim 1987 propose that the relativizer diagnostic ***that/Ø*** *versus* ***who/which*** reflects a sortal constraint on the variable that the relativization operation abstracts over:

> **Sortal restriction:**
> ***who/which*** indicate that the abstraction is over a variable over *individuals*.
> ***that/Ø*** are not sortally restricted. (and are compatible with abstraction over individuals, amounts, but also kinds, properties, etc.)

Arguably, the abstraction in d-interpreted relatives is not over individuals, but over amounts. Carlson speculates that maybe in ep-relatives the abstraction is also not over individuals, but likewise over amounts.

And the nature of the position of the p-gap gives reason to think that indeed the abstraction is not over individuals. Consider the ***there***-insertion context. Carlson follows Milsark 1974 in assuming that an individual variable in that position is bound by a local existential quantifier, and hence cannot be simultaneously bound by the relativization operation. Heim does without this assumption, but assumes that

variables are themselves open to the definiteness effect and count as strong, which means that an individual variable in that position is infelicitous, and hence cannot be bound either.

Carlson's next assumption is that if the variable bound by abstraction is in fact not an individual variable but a *degree variable,* we can actually assume that *it* is not *in* the position open to the definiteness effect, but *part of* an indefinite expression or a predicate (of type <e,t>) which itself *is in* that position.

The idea is made explicit in (23): in (23b) ***that*** is in the position open to the definiteness effect, and the sentence is infelicitous. In (23c-f), ***that*** is part of a measure phrase and it is not in a position that is open to the definiteness effect, as shown by the felicity of the examples involved:

(23) a. ✓There was *a horse* in the pasture.
b. #There was ***that*** *horse* in the pasture.
c. ✓There were ***that*** *many horses* in the pasture.
d. ✓There was ***that*** *number* of horses in the pasture.
e. ✓There was ***that*** *amount* of wine in the vat.
f. ✓There was ***that*** *kind* of wine in the vat.

The idea then is that the analysis of ep-relatives runs *via* the semantic mechanism that derives d-interpreted relatives. So ep-relatives are given an analysis that subsumes them under amount relatives.

The degree variable is not *in* the position open to the definiteness effect, but part of an expression in that position. Carlson assumes that the external head originates from inside the relative, and more precisely, from inside the p-gap. Carlson suggests a *head raising* analysis for amount relatives, in the sense that the external head noun is base-generated within the relative clause and is raised to its surface position in the syntax (he remains agnostic on whether such an analysis must also be allowed for some restrictive relatives). At the time when Carlson's article was written, this type of analysis had the semantic implication that the raised head was necessarily interpreted in its initial position, hence as part of the interpretation of the p-gap.

Carlson uses the fact that the head noun of idioms like ***make headway*** can occur as the external heads of amount relatives, as in (24), as evidence for the head raising analysis.

(24) On this project, they made [the ***headway*** we hoped they would make –].

Such data have played an important role in numerous studies that have debated the advantages of doing reconstruction in the syntax or the semantics. In Grosu and Landman 1998, we followed the syntactic approach to reconstruction in relation to ep-relatives. In the present article we will assume with Grosu and Landman 1998 that the external head is interpreted inside the relative (though not always only there), and we will allow for other external material to be interpreted internally, but at this point, we stay agnostic with respect to the question of whether this reconstruction is syntactic or semantic (see Krifka and Schenner, to appear, where scholars from both sides of the reconstruction debate discuss the issues involved). We don't think that Carlson's (24) is a very convincing piece of evidence for reconstruction, because, ***headway***, although an idiom-chunk, is interpretable in isolation as denoting *a gradable property*, just like

progress and ***courage***. Below we will argue for d-predicates in general, for an analysis that assumes that the head is interpreted both inside and outside the relative.

Concerning Carlson's analysis, Grosu and Landman argue that, while the suggestions for amount relatives outlined here form an inspiring set of ideas, turning them into an analysis is not straightforward, because of the fact that ep-relatives ultimately usually *do* have interpretations as predicates of individuals (type <e,t>) rather than predicates of degrees (type <d,t>), and neither Carlson nor Heim show how an analysis that abstracts over a degree variable of type d can derive an interpretation as a predicate of individuals (of type <e,t>).

2.3. Comments on Carlson's diagnostics

2.3.1. Violations of diagnostic 2: ep-relatives and partitive reinterpretation.

According to diagnostic 2, amount relatives allow definite (and universal) determiners, but are not felicitous with indefinite determiners. However, there are cases in which indefinite determiners do not seem to be as infelicitous as Carlson's diagnostics 2 (and the account in terms of maximalization that we will present below) predicts. For instance, the cases in (25), with contrastive stress on the indefinite, are felicitous:

(25) a. ***Some*** students that there were – at the party left early, but the remainder stayed past midnight.
b. ***Three*** books that there were on the table yesterday were *Ulysses*, *Finnegans wake* and *Dubliners*.

Now, the indefinites in (25) with contrastive stress, are instances of what Rullmann 1989 calls *strong indefinites*: *indefinites with a partitive interpretation*. That is, the examples in (25) have the same interpretation as the examples in (26) in which ***some*** and ***three*** are replaced by ***some of the*** and ***three of the***:

(26) a. ***Some of the*** students that there were – at the party left early, but the remainder stayed past midnight.
b. ***Three of the*** books that there were on the table yesterday were *Ulysses*, *Finnegans wake* and *Dubliners*.

Following similar suggestions for different examples in footnotes in Carlson 1977a and in Rothstein 1995, Grosu and Landman 1998 propose that the felicity of the examples in (24) comes about precisely because, as strong indefinites, they are semantically analyzed as the partitives in (26). This means that in (25a) it isn't the normal indefinite determiner meaning ***some*** that applies to the NP-interpretation ***students that there were – at the party***, but the strong indefinite meaning ***some of the***. But obviously, diagnostic 2 should be understood as being satisfied by the partitive interpretation.

Can we find independent evidence for the assumption that the cases in (25) are felicitous due to partitive reinterpretation? Keenan 1987 notes that for many speakers, strong indefinites – in particular, partitive indefinites – show a weak form of definiteness effects, in that they are not as felicitous in ***there***-insertion contexts as normal indefinites (though, one should add, not as bad as normal definites, see the discussion of this in Landman 2004). The examples in (27a,b) are normal indefinites in a ***there***-insertion contexts, and they are perfectly felicitous. The examples in

(27c,d) are partitive indefinites in the same context, and they are not felicitous according to our informants, in agreement with the judgments reported by Keenan (we have four examples instead of two to show that the facts are independent of the absence/presence of a relative clause):

(27) a. ✓There are *three books* missing from the bookshelf.
b. ✓There are *three books that Bill admits to have read* missing from the bookshelf.
c. ??There are *three **of the** books* missing from the bookshelf.
d. ??There are *three **of the** books that Bill admits to have read* missing from the bookshelf.

The crucial judgement concerns the felicity of (28), where an indefinite ep-relative construction is itself placed in a ***there***-insertion context, where partitive constructions are infelicitous (as shown in 27c,d):

(28) a. #There are *three books that there were on the bookshelf* missing now
b. #There are THREE *books that there were on the bookshelf* missing now, the other ten are still there.

According to our informants, the examples in (28) are infelicitous, and the contrastive stress in (28b) does not improve the felicity of the example. If the indefinites in (25) are normal indefinites, then the examples in (28) should be as felicitous as the felicitous examples in (27a-b). On the other hand, if the examples in (24) are felicitous due to partitive reinterpretation, the examples in (28) should be at least as infelicitous as the infelicitous examples (27c-d). And in fact, one can expect them to be more infelicitous, because the felicity in (25) is due to an interpretation strategy that the hearer is unlikely to apply in (28), where it leads to infelicitous results.

The infelicity of the examples in (28), then, supports the hypothesis that the felicity of the cases in (25) is due to partitive reinterpretation, and with this, it supports the validity of Carlson's diagnostic 2.

2.3.2 Violations of diagnostic 2: d-headed relatives.

Grosu 2000 observes that there is a class of examples of d-headed relatives that allow the full range of determiners, without there being any evidence of a partitive reinterpretation. These are the cases in (29).

(29) a. There is now in this vat ***an amount of wine*** that there has ***never*** been – in it before.
b. There is now in this vat ***an amount of wine*** that there has ***never*** been in this vat before 1990.
c. There is now in this vat ***an amount of wine*** that there has been in this vat ***three times*** before 1990.
d. ***Two amounts*** of wine that there have been in this vat before 1990 are the amount that there was in it yesterday and the amount that there was in it last year. (So, all years after 1990 have been better than the years before 1990, except for the last two years.)
e. There is now in this vat ***an amount*** of wine that the regulation committee doesn't believe there should be - in it

f. At the point where it splits into a delta, the Danube carries ***an amount*** of water per second that it does not carry at any other point of its course.
g. This TV set has cost me ***a sum of money*** that ***no earlier*** TV set has cost – me.

What these examples have in common is that amounts of wine/money/water are compared *across* indexical parameters: time in (29a-d), worlds in (29e), locations in (29f).

We will give in section (3.1) a semantics for d-headed relatives which involves degree maximalization, which interprets the d-relative as the singleton set containing the maximal amount in the set of amounts denoted by the relative. The external definiteness effects are related to the fact that the relative is interpreted as a singleton set. We will develop in section (4) an analysis for amount relatives like (30) where the p-gap is in the scope of a modal operator:

(30) The three books that there may have been on the table yesterday, are in any case gone now.

We will argue there for an analysis that involves individual amount concepts (functions from indices to amounts, or individual amount pairs). Maximalization, in such an analysis takes place pointwise, i.e. per index. We will suggest an extension of the analysis given for cases like (30) which derives for the CP interpretation of (29a) a singleton set containing a function from indices to degrees. A function from indices to degrees is itself a set of index-degree pairs. We suggest that the d-head ***amount*** allows a simple shift from the singleton set containing the function, to the function contained in the singleton set, interpreted as a set of index-degree pairs. With that shift, the derived interpretation is not a singleton set and allows the full range of determiners (The details are worked out in section 4).

This means that, while it seems superficially as if the sentences in (29) quantify over amounts of wine – and do so freely with the full range of quantifiers – they really quantify over *different amounts of wine at different moments of time* (which are time-substance pairs). On this analysis, we do not expect external definiteness effects for the cases in (29).

We assume that d-heads have the capacity to transform the function from indices to amounts into a set of index-amount pairs. We assume that in this respect, gradable abstract mass nouns like ***courage*** and ***headway*** pattern with d-heads, and indeed, they too allow indefinite heads in similar constructions:

(31) a. On this project, they made [***a progress/ a headway*** that they had **not** made – on any of their earlier projects.
b. My soldiers have exhibited [***a courage*** that your soldiers **never** have –.]

We further assume that nouns that are predicates of indices to start with, like the temporal predicate ***days***, can easily turn individual concepts into a non-singleton set of index-value pairs, and we don't necessarily expect external definiteness effects:

(32) [***Many*** days that Fred was in Paris - last year] Susan was in Rome.

On the other hand, we assume that normal e-interpreted nouns do not allow this transformation. This means that the d-headed examples in (29) do not have felicitous d-interpreted counterparts with an e-head:

(33) There is now in this vat ***a wine*** that there has ***never*** been – in it before.

(33) has a kind-interpretation, not an amount interpretation. Also ep- relatives do not allow for a similar strategy to escape from external definiteness effects, as shown in (34b). Importantly, the definite version of this example, shown in (35b), is just as bad as (34b). We discuss the nature and causes of these effects in section 5.

(34) a. ✓A student who has ***often*** been – in my seminars is Galit.
b. #A student that there has ***often*** been – in my seminars is Galit.
(35) a. ✓The only student who has ***never*** been – in any seminar of mine is Irina.
b. #The only student that there has ***never*** been – in any seminar of mine is Irina.

2.3.3 Violations of diagnostic 2: Antecedent contained deletion.

Carlson included cases involving Antecedent Contained Deletion (ACD) like (17b) above (here renamed 36a) as amount relatives:

(36) a. John put in his bag [✓***every book/#three books*** he could –].
b. John put in his bag [✓***every book/✓three books*** he was allowed to –].
c John put in his bag [✓***every book/#three books*** he could – put in his bag].
b. John put in his bag [✓***every book/✓three books*** he was allowed to – put in his bag].

Grosu and Landman 1996, 1998 and Grosu 2000 pointed out that one of the reasons for the infelicity of the indefinite versions of (36a) seems to be that no item within the relative is naturally stressable, and provided data like (36b), where ***allowed*** can receive what they viewed as an appropriate measure of stress, and in which the indefinite versions are acceptable.

Now, Carlson was concerned with the amount interpretation of (36a), and the data in (36a) should be related to that interpretation. McNally 2008 and Herdan 2008 pointed out that in this respect (36b) doesn't seem to be a very relevant example, because it doesn't seem to have the amount interpretation that (36a) does. So the determiner facts in (36b) don't seem very surprising.

What the pair of examples in (36a,b) show is that examples with the auxiliary modal ***could*** allow for an amount interpretation that is absent for cases with non-auxiliary modal ***be allowed to***. The facts are exactly the same in (36c-d), so clearly whatever is going on in (36a) has nothing to do with antecedent contained deletion *per se*, but has to do with the auxiliary modal.

The proper place to look for an account for the facts in (36a) is their similarity to cases that involve measure predicates, as in (37):

(37) a. The movie ***lasts*** *seven hours – The seven hours* that the move lasts
b. The egg box ***fits*** *twelve eggs – The twelve eggs* that the egg box fits
c. John ***could put*** *twenty books* in his bag –
The twenty books that John could put - in his bag

Thus we assume that the auxiliary modal ***could*** can be interpreted as composing with ***put*** to form a predicate ***could put*** that can take a measure complement, like ***fit*** does. It is this that creates the amount interpretation in (36a).

Once we are this far, we can observe that the readings are not actually restricted to auxiliary modals, also for ***allowed*** we can have an interpretation that involves a measure predicate, namely a limitative interpretation. This interpretation is facilitated in (38a) by ***at a time***:

(38) a. Twenty five people are allowed in the bus at a time.
b. The twenty five people that are allowed in the bus at a time must have a valid ticket.
c. #Twenty people that are allowed in the bus at a time can go for half fare.

2.3.3. Comments on diagnostics 3 - stacking and comma intonation.

Grosu and Landman 1998 propose an analysis for amount relatives which involves maximalization at the CP level, and which hence produces an interpretation of the relative clause as a *singleton predicate* (see section 3). They propose that maximalization is the source for Carlson's diagnostics 2 and 3, where diagnostic 3 says that amount relatives may not be felicitously stacked with intersective import.

On this view, the felicity problem has to do with intersecting two singleton sets. This means that, if you can give an interpretation strategy which is not intersective, there may not be a felicity problem. This is relevant both for the interpretation of stacking (discussed below) and for the interpretation of coordination. While intersection is a standard interpretation of coordination, coordination allows other standard interpretations as well (like sum interpretations). This is a general reason why cases with coordination can be felicitous even if cases of stacking are not. But the assumption is that, *if* the coordination for independent reasons has to have an intersective interpretation, *then* cases with two coordinated singleton predicates are predicted to be infelicitous. This is relevant for idiolects or languages in which stacking is degraded for restrictive relatives in general. The relevant facts can still be checked for conjunction, *if* you are able to control for intersective readings.

The rationale for the infelicity of intersecting singleton predicates is an informativeness condition: intersection of predicates should be informative. Normally, when we intersect P and Q, $P \cap Q$ is assumed to be distinct from P and from Q. If we intersect P with a singleton predicate Q, the intersection (when defined) is not going to be different from *both* P and Q (it is going to be Q), but this arguably provides enough (extensional) information about P to count as informative. However, if we intersect P with Q_1 and with Q_2, where both Q_1 and Q_2 are singleton predicates, then the second intersection (when defined) is no longer informative:
$P \cap Q_1 = Q_1$ (when defined), and $Q_1 \cap Q_2$ (when defined) is Q_1.

So we can formulate the following informativeness condition:

Informativeness of intersection condition:
In a situation where two predicates must be interpreted through intersection, they cannot both be singleton predicates.

There is a caveat here: for relative clauses, the Informativeness of intersection condition applies to the situation where the two relative clauses are understood *symmetrically*, as *simultaneous intersecting adjuncts*, that is, as predicates that mutually restrict each other. This means that we need to make sure that they are not interpreted *asymmetrically*, with one relative interpreted as an appositive. Appositives

allow a variety of interpretations beyond intersection, and hence do not fall under the above condition.

Appositives are usually marked by comma intonation, but comma intonation can be very subtle. This means that one needs to be very careful in evaluating data with stacked examples, to make sure that there isn't an incy-wincy tiny bit of comma intonation slipping into the examples.

In (39) we have a case with two stacked (non-amount) relative clauses. (39) *without intervening comma intonation* has an intersective interpretation for the relatives, and (39) is perfectly felicitous:

(39) The only member of the department who attended today's meeting who also attended last week's meeting is John. ← ***intersective***

If, however, we allow an intervening comma intonation, a variety of appositive construals becomes available for cases like (39). Two kinds of appositive construals for stacked relatives are illustrated in (40), the first with a reinforcing meaning, the second with a corrective meaning:

(40) a. John, who never attended high school**,** who can't ever read or write properly**,** wants to teach at Harvard! ← ***reinforcing***

b. John, whom I introduced to Jackie yesterday**,** (I mean,) whom I introduced to ***you*** yesterday**,** is an excellent programmer. ← ***corrective***

The relevant observation for our purposes is the following observation about stacking:

Stacking assumption:
Stacked relative clauses without comma intonation must be interpreted through intersection.

In this light, diagnostic 3 becomes:

Diagnostic 3:
Stacked amount relatives without comma intonation are infelicitous.

Grosu and Landman 1998 propose that this holds because the derivation of amount relatives involves a maximalization operation, which turns the amount relatives into singleton predicates. With that, the infelicity follows from the Informativeness of intersection condition and the stacking assumption.

For amount relatives, Carlson observed that the examples in (21b) and (22), without comma intonation, are infelicitous:

(21b) #This desk weighs every pound they said it would weigh – **,** that I had hoped it wouldn't weigh –

(22) #All the tourists that there were – on the boat at 3 pm**,** that there had been – on the island at 2 pm**,** returned home late.

Note that the absence of comma intonation is essential here. Also amount relatives are perfectly felicitous with comma intonation, when other interpretations besides intersection become available:

(41) a. This desk weighs every pound they said it would weigh**,** that I had fervently hoped it wouldn't weigh. ← ***reinforcing***

b. All the tourists that there were – on the boat at 3 pm**,** (I mean,) that there were at ***2 pm***)**,** returned home late. ← ***corrective***

It is also instructive to compare the cases in (21b) and (22) with examples with the coordinated relatives as in (42):

(42) a. ✓This desk weighs every pound [[that they said it would weigh –] and [that I had fervently hoped it wouldn't weigh –]].

b. ✓All the tourists [[that there were – on the boat at 3 pm] and [that there were – on the island at 2 pm]] returned home late.

Unlike stacking, explicit conjunction allows interpretations that are not intersective, and hence the construction in (42b) is not necessarily constrained by the intersectiveness condition. For instance (42b) naturally allows for a *sum* interpretation: the sum of the tourists that there were on the boat (**a⊔b⊔c**) *together with* the tourists that there were on the island (**b⊔c⊔d**) returned home. In fact, the one interpretation that (42b) does *not* seem to have is the intersective one which says only of **b** and **d** that they returned home late.

For completeness, we note that these judgments are sharpest when neither of the intersecting predicates is properly contained in the other. A reviewer observes that the relative in (43) is 'not as bad' as we take these cases to be:

(43) (All) the people that there were in Alcatraz that there were in solitary confinement developed psychological problems.

When we make sure the predicates are properly independent, we think the relative is much worse, and strongly in contrast with the coordinated case, which is salvaged by the availability of a non-intersective interpretation:

(44) a. #(All) the people that there were in Alcatraz**,** that there were in solitary confinement in some American prison**,** developed psychological problems.

b. ✓(All) the people that there were in Alcatraz ***and*** that there were in solitary confinement in some American prison developed psychological problems

Finally, let us go back to the d-headed relatives from the previous subsection. We argued that these do not denote singleton predicates. From the perspective of our concerns in the present subsection, this means that we do not expect them to be infelicitous in intersectively construed stacking either. And that seems to be the case in the two versions of (45), which may be used in situations in which more than one amount was in the vat just once in September and more than one amount was in it twice in October, the import of the bracketed expression being an amount that satisfies both characterizations:

(45) a. There is now in this vat an amount of wine that there was – in it ***only once*** before in September**,** that there was – in it ***only twice before*** in October.

b. There is now in this vat an amount of wine that there was – in it ***only once*** before in September ***and*** that there was – in it ***only twice before*** in October.

3. Analysis of amount relatives

In this section we discuss in turn the analysis of d-headed relatives, d-interpreted relatives, ep-relatives, leaving, as an appendix, for section 4 the discussion of relatives with the gap in the scope of a modal or temporal operator.

The main problem that we are concerned with is fitting an intricate semantics onto a reasonable syntax. We think that such a fit is to a considerable extent neutral with respect to many of the issues that have led to different proposals in the syntactic literature for different structures for relatives, in particular with respect to where the external head originates and where it ends up.

In fact, since the semantics is complicated, we try here to keep the syntax as simple, and even old-fashioned, as possible. This is not because we are aficionados of the Simple Life or inherently conservative, but because we think the structures we use make it easiest to see how the semantics we give fits onto a syntax for relative clauses, and makes it fairly easy to see how to modify the syntax-semantics match to fit the semantics onto a variety of different syntactic proposals.

So, even though for ease of presentation we use old-fashioned structures in which a relative CP is adjoined to the external head NP, we are in fact neutral on the details, and in particular on the issue of where the external head originates syntactically. For instance, we can fit our semantics easily on Kayne 1994's syntax, were the external head is in Spec of CP, where it was raised from the position of the gap, and even more easily on Bianchi 1999's syntax, where the external head is further raised into an NP position out of the CP, as long as we are careful about what we do and do not assume about the interpretation process in doing this (for instance, we would not be favorable to a syntax-semantics fit that forced us to assume that the external head is, by necessity, interpreted only in the position of the gap, or, for that matter, by necessity, only interpreted outside).

3.1. Analysis of d-headed relatives.

As a preamble to the analysis of d-headed relatives we make a brief excursion to classifier and measure structures, and examples like (46):

(46) a. I flushed three ***bottles*** *of wine* through the toilet.
b. I flushed three ***liters*** *of wine* through the toilet.

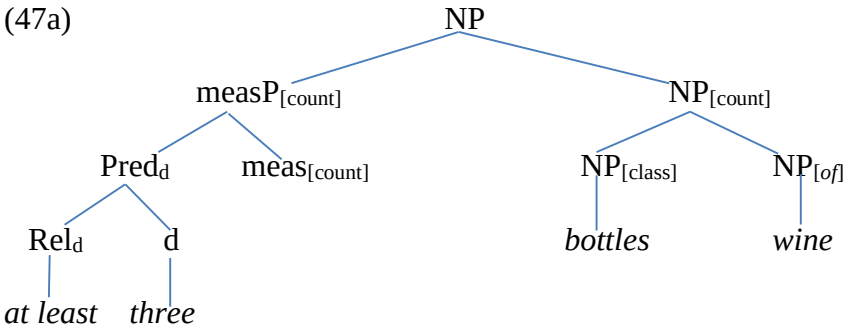
(46a) is ambiguous between an interpretation on which ***bottles*** is a classifier, and what I flushed through the toilet were *bottles filled with wine*, and an interpretation where ***bottles*** is a measure, and what I flushed through the toilet is *wine to the amount of three bottles***.** The latter interpretation is what we find in (46b), which has the measure term *liters*. As the interpretation indicates, on the classifier interpretation of ***bottles of wine, bottles*** is the *semantic head* of the construction: on this interpretation, ***bottles of wine*** is *bottles*, not *wine*. Again, as the interpretation indicates, on the measure interpretation, the *semantic head* of the construction is ***wine***, not ***bottles***: semantically, on the measure interpretation, ***three bottles*** is a numerical adjunct, just like ***three*** is in ***three boys***.

The syntactic and semantic literature on measures is particularly rich (see e.g. Bresnan 1972, Kennedy1997, Corver 1990, 1991, Schwarzschild 2005, 2008), and the situation, as far as we are concerned, is similar to what we said about the syntax of relative clauses above. We choose here the syntax for classifiers and measures

proposed in Landman 2004, because it is particularly well suited to bring out the semantic compositions that we are concerned with. But again, the semantics can be fitted (sometimes, with some work) onto other proposals as well.

With Landman 2004 we assume the following structure for ***at least three bottles of wine***, where ***bottle*** is a classifier:

(47a)



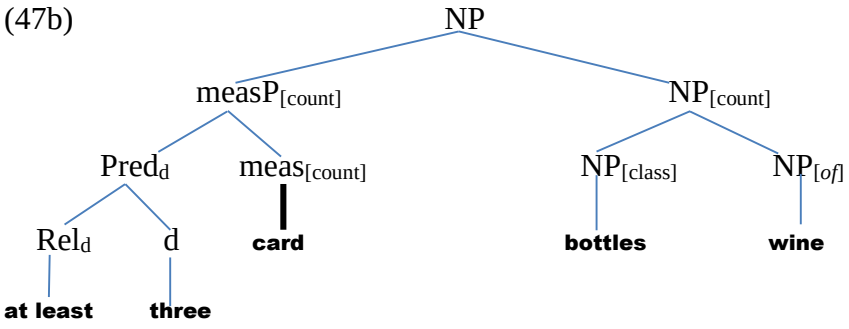
Classifiers and measures in English take complements marked by ***of***. The syntax of ***of*** is tangential to our concerns here. We assume that the semantics of the construction comes from the relation between the classifier and its complement, and not from the element ***of***.

The measure adjunct on the left side of the tree shows the assumption of Landman 2004 that the compositional semantics of number phrases is facilitated by the assumption that the number phrase is built from three components: Rel_d, denoting a relation between numbers, d, denoting a number, and $meas_{[count]}$, which denotes the cardinality function.

The rationale of assuming the node Rel_d generally is that it allows the simplest possible lexical interpretation of ***three*** as 3 of type d, and lets the semantic composition derive the more complex interpretation λn.n=3 of type <d,t>. The same rationale is behind the assumption of the node $meas_{[count]}$: it allows us to let the semantic composition derive for ***three*** the more complex lexical meaning λx.|x|=3 of type <e,t>.

We assume that in the case of the classifier interpretation, the semantics matches the syntax. In the tree below, we mark *in* the syntactic structure how the semantic composition takes place (so *boldface* stands for semantic interpretations). The tree below is for *illustrative* purposes only, it is not itself part of the grammar.

(47b)



The meanings involved are:

at least	**three**	**card**	**bottles**	**wine**
≥ <d,<d,t>>	3 d	λx.|x| <e,d>	λPλx.*bottles*(x) ∧ ∃y[P(y) ∧ contain(x,y)] <<e,t>,<e,t>>	*wine* <e,t>

≥ is the bigger-or equal than relation between degrees and numbers (λmλn.n ≥ m).

The cardinality function, λx.|x|, maps singular and plural individuals onto their cardinality, the number of their singular parts. The semantic composition involves the operations application (( )), composition ∘, and intersection ∩:

(47c) **(at least(three)) ∘ card** ∩ **(bottles(wine))**

(at least(three)) ∘ card = λx.|x|≥3 (<e,t>)
(bottles(wine)) = λx.*bottles*(x) ∧ ∃y[*wine*(y) ∧ contain(x,y)] (<e,t>)

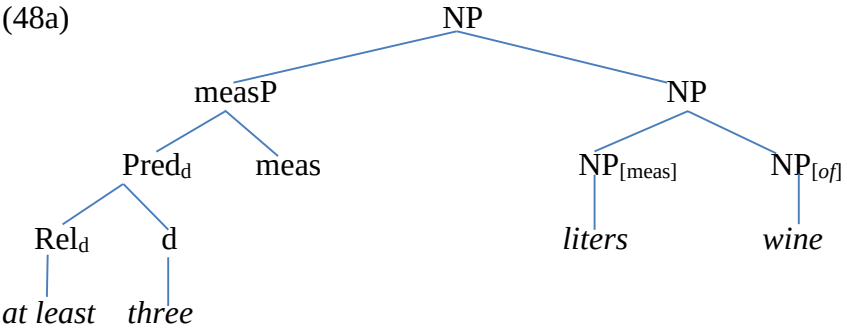
at least three bottles of wine = λx.*bottles*(x) ∧ |x|≥3 ∧ ∃y[*wine*(y) ∧ contain(x,y)]

We haven't been explicit here about plurality. When that is taken into account properly, the interpretation derived is:

> The set of pluralities x such that x is a sum of at least three bottles and the bottles that make up x contain wine.

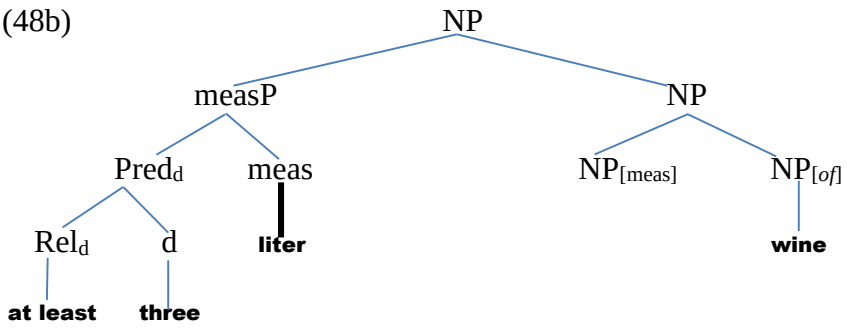
We assume the same structure for ***three liters of wine*** with measure ***liters***, except for the labels [class], [count] and [meas]:

(48a)



Following Landman 2004, we assume that the semantics of the measure structure is mismatched with the syntax. While, syntactically, ***liters*** occurs in the position of the syntactic head, semantically it is interpreted as the measure in the measure adjunct. We indicate the semantic interpretation in the syntactic tree below. Once again, the tree is for illustration purposes only:

(48b)



The meanings involved are the same as in (47) except: **liter** = volume$_{liter,w}$ (<e,d>)
The measure **liter** maps, relative to index w, individuals onto their volume in liters in w. The index, a usual, stands for world, time, world-time….
Here the semantic composition is:

(48c) **(at least(three)) ∘ liter ∩ wine**

(at least(three)) ∘ liter = $\lambda x.\ volume_{liter,w}(x) \geq 3$ (<e,t>)
wine = *wine* (<e,t>)

at least three liters of wine = $\lambda x.\ wine(x) \wedge volume_{liter,w}(x) \geq 3$
wine to the amount of at least three liters

While the syntactic head of the construction is the measure ***liters***, the semantic head is ***wine***, and ***at least three liters*** is interpreted as a measure adjunct to the semantic head ***wine***.

Rothstein 2011 argues that in Mandarin and in Hebrew construct states, the semantic distinction corresponds to a syntactic distinction: in the constructions she discusses in these languages, the syntactic structure of the measure cases, i.e. ***liters*** and ***bottles*** when it has a measure interpretation, is not the one in (48a), but that of (48b): i.e. the phrases are sitting in the syntactic positions where for illustration reasons we have put their meanings in (48b). For English (and Dutch) we think that number agreement gives some reason to think that ***bottles*** is the *syntactic head* of the construction, both when it is interpreted as a measure and when it is interpreted as a classifier (i.e. there is reason to assume (48a) and not (48b) as the syntactic structure). Look at the following example (taken from the internet):

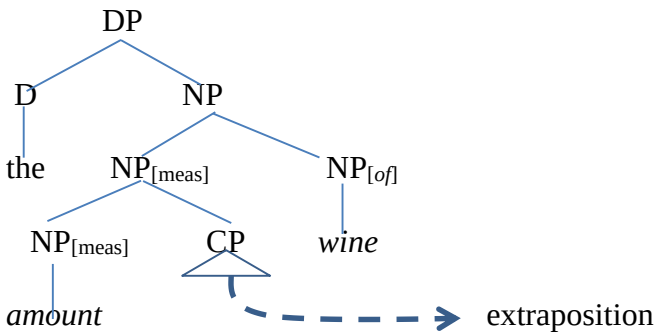
(49) Did you know that there ***are*** three ***teaspoons*** *of sugar* in one squirt of ketchup and twenty one in a glass of lemonade?

The natural interpretation of ***teaspoons*** in (49) is as a measure. But the number agreement is plural (our informants in fact don't accept replacing ***are*** by ***is*** in this context). What is important is the presence of plural agreement here. The semantic head of the construction, ***sugar***, is a mass noun that doesn't allow plural agreement. If ***sugar*** were the syntactic head as well, the plural agreement is unexplained. (Note that, though our informants didn't accept it, the *absence* of plural agreement with a measure head would have been less problematic: as Doetjes 1997 argues, measure heads in Dutch, for instance, are unspecified for number).

To be a bit more precise, what is important for the purposes of this paper is not in which of the two syntactic positions meas and $NP_{[meas]}$, the measure interpreted noun occurs, but that it relates to the position $NP_{[meas]}$ and that the position $NP_{[meas]}$ and *not* $NP_{[of]}$ is the syntactic head of the construction, despite the fact that the expression in the position $NP_{[of]}$ is the semantic head.

As explained above, for d-headed relatives, we assume as simple a syntactic structure as we can. In line with what we said about measures just now, we assume that the measure ***amount*** is the syntactic head of the construction. Besides that, we assume that the relative CP is extraposed:

(50a)



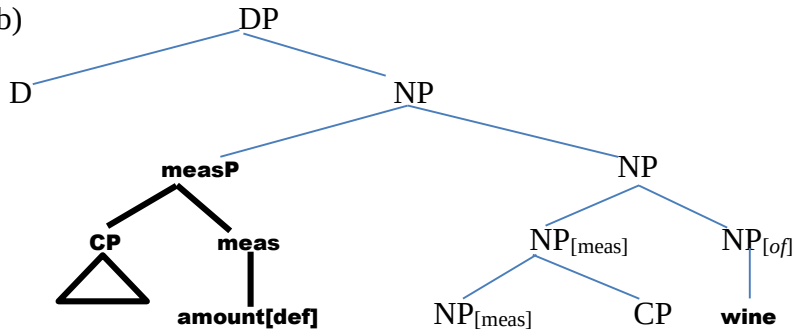
As for the semantic interpretation, we follow the semantics for measures just discussed and assume that the measure ***amount*** is interpreted as part of a measure adjunct of the semantic head ***wine***.

The amount relative CP, which is interpreted as a d-predicate of type <d,t>, is an adjunct of the syntactic head ***amount***. Adjunction cannot be interpreted here as intersection, because ***amount*** is not interpreted here as a predicate (of type <d,t>), but as a measure (of type <e,d>). We take adjunction to mean here that the CP is interpreted as the d-Pred that composes with the interpretation of the measure expression.

The external determiner ***the*** relates to the syntactic head ***amount***. Again, the type of ***amount*** as a measure differs from predicate interpretation, so here, too, we need to think about how the interpretation of the definite article on the measure takes place. We assume that, for the measure function ***amount,*** the definiteness is expressed as a *presuppositional definiteness check* on the value of the function.

Below is, once more for illustration purposes, a syntactic tree with the semantic interpretation structure added:

(50b)



The meanings involved are:

CP	**amount[def]**	**wine**
{**max**$_{\Delta}$}	amount$_{w}$	*wine*
<d,t>	<e,d>	<e,t>

amount$_{w}$, like volume$_{liter,w}$, is a measure function mapping, relative to index w, individuals (and stuff) onto their amount in w.

{**max**$_{\Delta}$} is the singleton set containing **max**$_{\Delta}$ (this set is in λ-notation: λn.n= **max**$_{\Delta}$). The derivation of the interpretation of the CP is discussed below.

The semantic composition is:

(50c) **CP** $\circ^{\mathbf{def}}$ **amount** $\cap$ **wine**

where $\alpha \circ^{\mathbf{def}} \beta = \alpha \circ \beta$ if $\alpha = \{\sigma(\alpha)\}$ and undefined otherwise.

$\circ^{\mathbf{def}}$ is the definiteness check operation corresponding to determiner *the*.
σ is the standard presuppositional sum operation: $\sigma(\alpha)$ is $\sqcup\alpha$ if $\sqcup\alpha \in \alpha$ and undefined otherwise

CP $\circ^{\mathbf{def}}$ **amount** = λx.amount$_w$(x)=**max**$_\Delta$ (<e,t>)
wine = *wine* (<e,t>)

the amount of wine CP = λx.*wine*(x) $\wedge$ amount$_w$(x)=**max**$_\Delta$
wine to the maximal amount in the CP denotation

We use this semantics for the measure to pull out the semantics of the relative.
We analyze (51):

(51) *He* drank the amount of wine that *I* drank – of beer.

step 1 $\exists$x[*drank*(*he*,x) $\wedge$ *wine*(x) $\wedge$ amount$_w$(x)=**max**$_\Delta$]

By the measure semantics given above, the measure adjunct is interpreted as:

step 2 the amount$_{[def]}$ that I drank – of beer.
λx.amount$_w$(x) = **max**$_\Delta$

Pulling away *amount$_{[def]}$* we get as the interpretation of the relative CP:

step 3 that I drank – of beer
{**max**$_\Delta$} of type <d,t>

We assume that the interpretation {**max**$_\Delta$} for the CP is derived by applying at the CP level an operation of maximalization to the interpretation derived for the relative.

maximalization
max(Δ) = {**max**$_\Delta$} for d-predicate Δ (of type <d,t>)

max$_\Delta$ = { the maximal degree in Δ if Δ contains a maximal degree
undefined otherwise

We will comment on maximalization below, but we will first continue the derivation backwards. Before maximalization, the interpretation of the relative is of the form:

step 4 that I drank – of beer
$\lambda\delta.\varphi(\delta)$ of type <d,t>, where δ is a degree variable (of type d)

We assume at this point that relativization abstracts at the CP level over degree variable δ. δ, hence, is the variable that corresponds to the gap inside the relative:

step 5 I drank – of beer
$\varphi(\delta)$

This is the point where the assumptions about what is the syntactic and what is the semantic head of the measure construction plays a role. We make the following assumption about the external head of the amount relative:

External head assumption:
The interpretation of the external syntactic head of the amount relative enters into the interpretation of the gap inside the relative.

Crucially, on the analysis of measures given, the external syntactic head is the measure ***amount*** and not the semantic head ***wine***. This means that in d-headed relatives the measure ***amount*** necessarily has an interpretation effect inside the relative, but the semantic head ***wine*** does not. In this respect, d-interpreted relatives are going to be different, because for them the external syntactic head is the semantic head, so for them it is the semantic head which has the interpretation effect inside.

As we have seen, the interpretation of the external head of d-headed relatives is used in the semantic composition of the interpretation of the measure phrase external to the relative. The external head assumption says that the interpretation is *also* used to construct a measure interpretation inside the relative. Sauerland 2000, 2002 has argued for the availability in relative clauses of 'matching' structures, structures where the external material is base generated both outside the relative and inside, is required to match, and has an interpretation effect both outside and inside. The semantics of d-headed relatives (and of d-interpreted relatives given below) can be fitted most naturally onto such structures, giving a syntactic basis to the External head constraint in d-relatives.

With ***amount*** interpreted inside, we obviously have inside a measure interpretation of the same kind that we had outside:

step 6 I drank – of beer
$\exists z[drank(I,z) \wedge beer(z) \wedge \mathbf{rel}(amount_{w}(z),\delta)]$

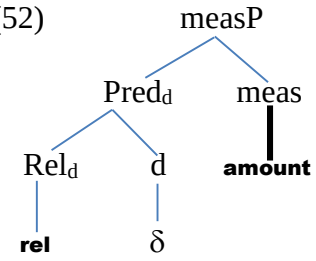
Here **rel** is a relation between numbers (to be discussed shortly).
From this, we pull out the interpretation of the gap inside the relative:

step 7 –
$\lambda z.\ \mathbf{rel}(amount_{w}(z),\delta)$

This can be thought of internally the same as externally, again putting for illustration purposes the semantic interpretations in a syntactic tree:

step 8:

(52)



The measure predicate is of type <d,t>, the variable abstracted over of type d.
Concerning Carlson's first diagnostics, relativizer ***which*** is not possible.

For numerical relation **rel** we need to choose a default value. Here we assume that we have the standard choice between an ***exactly***-interpretation and an ***at least***-interpretation. This gives two interpretation possibilities for the relative:

step 9 *that I drank of beer*

a. $\lambda\delta.\exists z[drank(I,z) \wedge beer(z) \wedge amount_w(z)=\delta]$
the singleton set containing the amount of beer I drank

b. $\lambda\delta.\exists z[drank(I,z) \wedge beer(z) \wedge amount_w(z)\geq\delta]$
the set containing the amount of beer I drank and all smaller amounts

We come to the operation **max**. When we apply **max** to either of these sets of degrees we in both cases the same interpretation:

step 10 *that I drank of beer*

a. $\mathbf{max}(\lambda\delta.\exists z[drank(I,z) \wedge beer(z) \wedge amount_w(z)=\delta])$

b. $\mathbf{max}(\lambda\delta.\exists z[drank(I,z) \wedge beer(z) \wedge amount_w(z)\geq\delta])$
the singleton set containing the amount of beer *I* drank

The rationale for assuming maximalization comes in when we look at example (4a):

(4) a. This Pesach I drank the amount of wine that **everybody** drank - and not more.

(53) *the amount of wine that everybody drank*

a. $\mathbf{max}(\lambda\delta.\forall x\exists z[drank(x,z) \wedge wine(z) \wedge amount_w(z)=\delta])$

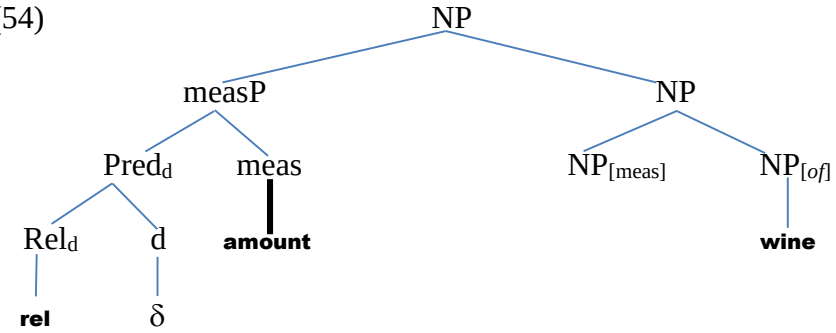
b. $\mathbf{max}(\lambda\delta.\forall x\exists z[drank(x,z) \wedge wine(z) \wedge amount_w(z)\geq\delta])$

(53a) is the empty set, unless everybody drank the same amount of wine. If everybody drank the same amount of wine, then (53a) denotes that amount. (53b) looks at the set of amounts that are such that everybody drank at least that much wine. The maximal amount in that set is the amount of wine drunk by the person who drank the smallest amount. Thus, by assuming that maximalization is part of the semantic derivation of amount relatives, we account in a straightforward way for the readings that (4a) has. Without maximalization, it is hard to see how reading (53b) can be derived.

We think that the existence of minimal amount readings is strong support for the assumption that amount relatives do indeed involve maximalization as part of their semantic derivation (just as Heim 2006 assumed that similar facts are strong evidence that comparatives involve a maximalization operation). The operator **max** has, of course, the effect of turning the relative clause interpretation into a singleton set. Grosu and Landman assume that the singleton nature of the relative clause interpretation is what is responsible for Carlson's diagnostics 2 and 3, the external definiteness effects and the stacking effects. As for diagnostic 2, indefinite determiners are not felicitous with predicates that are themselves inherently definite (singleton predicates); at best they can be made felicitous through partitive (re)interpretation. The interplay between singleton sets and stacking has been discussed extensively above.

We have taken as a basis for the discussion a case where the semantic head of the measure construction was specified independently inside the relative. When no such head is specified, this head too is taken from the outside, and the semantic interpretation of the gap is:

(54)



λz.*wine*(z) ∧ **rel**(amount$_w$(z),δ) where **rel** ∈ {≥,=} (of type <e,t>)

From there on the derivation is the same.

3.2. Analysis of d-interpreted relatives.

When we come to d-interpreted relatives (and, for that matter, ep-relatives) we notice we cannot interpret these cases as providing different semantic heads inside and outside the relative clause:

(55) a. We will need the rest of our lives to drink [the ***wine*** that they spilled – last night].
b. #We will need the rest of our lives to drink [the ***wine*** that they spilled – ***beer*** last night].

The above analysis of the amount-headed relatives directly suggest a reason for the facts in (55). If we assume that what you see is what you get in (55) – there is no (null) syntactic measure head in (55) (i.e. ***wine*** is not syntactically reconstructed as ***amount of wine*** in the position of the external head of the relative) – then the external noun ***wine*** is the syntactic head of the construction. The External head assumption says that the external syntactic head of the amount relative enters into the interpretation of the gap inside the relative. Thus the interpretation of ***wine*** enters into the interpretation of the gap, and (55b) is infelicitous.

As for the analysis of (55a), we start by pointing out that (55a), of course, does have a reading as a normal restrictive relative. This forms the interpretation:

(55c) The wine that they spilled last night
σ(λx.*wine*(x) ∧ *spilled*(*they*,x))

This is the slurping-what-they-spilled-off-the-ground reading, which is, of course, pragmatically an implausible reading.

Let us come to the pragmatically more plausible amount reading of (55a). As we explained above, we do not have a theory concerning the conditions under which d-interpretations are licensed, but we assume they involve a degree variable as part of the interpretation of the gap. This will make the relative an amount relative, and, with that, the External head assumption applies to it. This gives two assumptions about the interpretation of the gap:

assumption 1: The interpretation of the gap involves a degree variable δ of type d.
assumption 2: The interpretation of the gap involves the interpretation of the external head ***wine*** of type <e,t>.

The minimal interpretation strategy that makes this work will derive for the IP something like:

$\exists z[wine(z) \wedge spilled(they,z) \wedge REL(z,\delta)]$ for some relation REL

This means that the interpretation of the gap will be the DP-interpretation:

$\lambda P.\exists z[wine(x) \wedge REL(z,\delta) \wedge P(z)]$ (of type <<e,t>,t>)

The basis of the DP-gap then is the predicate:

$\lambda z.\ wine(z) \wedge REL(z,\delta)$ (of type <e,t>)

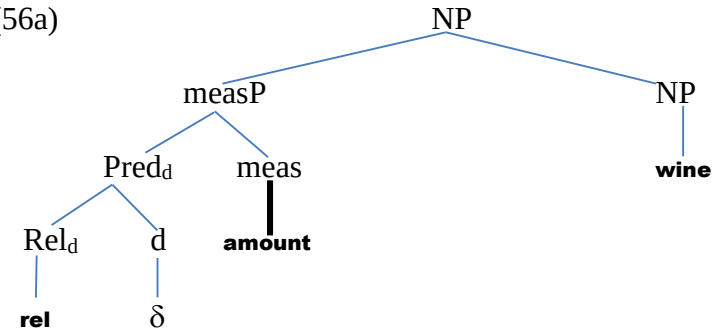
What this means is the following: if you make assumption 1 and assume a degree variable as part of the interpretation of the gap, you must accommodate *some* relation REL that connects that variable to the other predictable parts of the interpretation of the gap, i.e. that resolves the mismatch in type between ***wine*** of type <e,t> and δ of type d. The obvious minimal choice for relation REL is:

Interpreting the gap as a degree -gap:

The meaning of the gap is build from:		
-variable δ (of type d)		ass. 1
-external head interpretation *wine* (of type <e,t>)		External head assumption
$-\lambda\delta\lambda z.$ **rel**$(amount_w(z),\delta)$,	where **rel** $\in \{\geq,=\}$	accommodation to resolve the type mismatch

The assumption, then, is that the type mismatch between variable δ and predicate ***wine*** in the gap is resolved by accommodating exactly the measure phrase interpretation that we had in step 8 of the derivation of d-headed relatives above, indicated schematically) in (56):

(56a)



(56b) $\lambda z.wine(z) \wedge$ **rel**$(amount_w(z),\delta)$ where **rel** $\in \{\geq,=\}$ (of type <e,t>)

Working our way up from here, we assume the same derivation for the CP as we assumed for d-headed relatives, and derive, after maximalization, the singleton set interpretation (56c) for the CP:

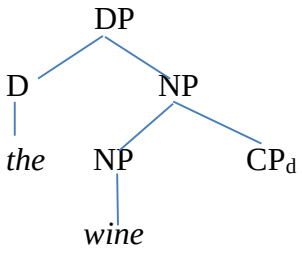
(56c) that they spilled –
{ **max**$(\lambda\delta.\exists z[wine(z) \wedge spilled(they,z) \wedge amount_w(z)=\delta)])$ } of type <d,t>.
The total amount of wine they spilled

This is not wine, but an amount. But the expression ***the wine that they spilled*** denotes wine, not an amount. Clearly, the external head ***wine*** is *not just* interpreted inside. This means that we have another type mismatch: we have head noun ***wine*** of type <e,t> and modifying relative of type <d,t>.

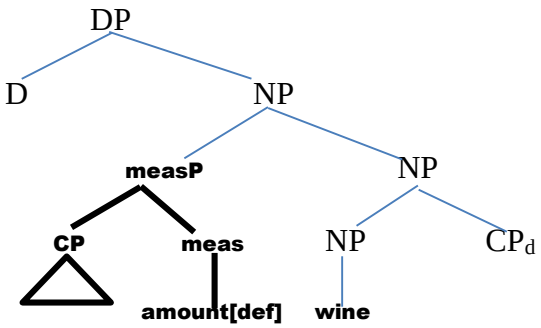
It is at this point clear what happens semantically: we accommodate the same measure interpretation **amount[def]** that we got in the derivation of amount headed relatives in (50b), and derive the same interpretation (50c).

What is much less clear in the present case is how exactly this semantics links to the syntax. Thus, one option is to assume that this accommodation is not reflected in the syntax at all, as in (57):

(57a)



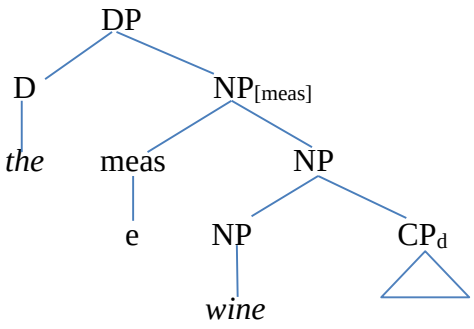
(57b)



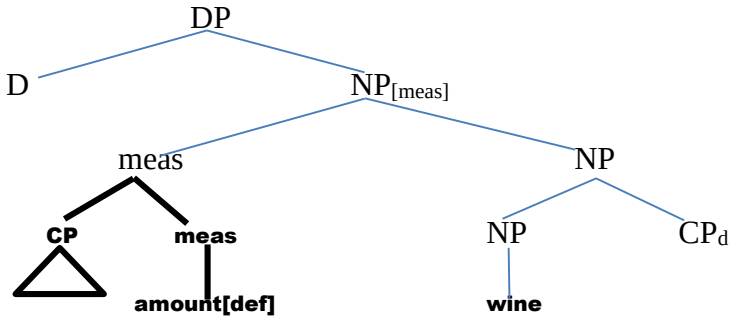
(57c) $\lambda x.wine(x) \wedge amount_w(x) = \mathbf{max}_{\Delta}$ wine to the amount of $\mathbf{max}_{\Delta}$

Another option is to assume that in d-headed relatives there is actually a *higher* null measure head in the syntax, as in (58):

(58a)



(58b)



(58c) $\lambda x.wine(x) \wedge amount_w(x) = \mathbf{max}_{\Delta}$ wine to the amount of $\mathbf{max}_{\Delta}$

The structure in (58) is attractive in as much as the null measure provides a locus for the definite interpretation induced by the external determiner: in (58) the definiteness concerns the null measure head of the construction and not the lower head ***wine***. In (57) we must make a stipulation concerning the external determiner.

(57), on the other hand, has some arguments going for it as well, in that, except for interpretation of the determiner (the feature **[def]** on the measure), agreement features like number and gender generally stay with the head (or lower head) ***wine*** in languages where these features can be checked, like e.g. German and French.

In short, there is a mismatch here, which is either resolved in the semantics (special interpretation of the determiner), or in the syntax (a higher head). We are not in a position, at this point, to suggest the best way for this mismatch to be resolved.

Finally, we evaluate Carlson's diagnostics for d-interpreted relatives. The account of diagnostic 1 is the same as for d-headed relative: d-interpreted relatives involve the same the abstraction over degree variable δ in the same structural configuration. The account of diagnostic 3 for d-interpreted relatives is also the same as for d-headed relatives: in both cases the CP denotes a singleton predicate.
As the above discussion shows, diagnostic 2 follows either from a semantic *stipulation*, which forces the case to be similar to d-headed relatives (55), or it follows from the semantics naturally imposed upon a bit richer syntax with a null measure head (56). In both cases, the external definiteness effects are attributed to the fact that the CP denotes a singleton predicate.

3.3 Analysis of ep-relatives.

We are now interested in ep-relatives: relatives that are e-interpreted, where the gap is a p-gap, like (59):

(59) I am looking for the three books that there were – on the table yesterday.

This case is different from the d-interpreted relatives we discussed in the previous subsection, in that, because of the position the gap is in, an interpretation strategy as a restrictive relative is not available. And (59) is an ep-relative, it is not d-interpreted, but e-interpreted: the relative in (59) doesn't have an amount interpretation; (59) does not mean that I am looking for *as many* books as there were on the table yesterday, it means that I am looking for *those* books.

Carlson, of course, argued that the diagnostics justified regarding (59) as an amount relative on a par with d-relatives. Both Carlson 1977a and Heim 1987 suggest

that the crux of the analysis of these cases involves abstraction over a degree variable δ of type d. Grosu and Landman 1998 argued that taking this proposal literally is problematic precisely because of the e-interpretation of the relative: the information that you need in order to construct the proper e-interpretation of the relative is no longer available if you abstract over δ, then you just get a set of degrees, numbers.

Grosu and Landman 1998 redefined the notion of degree and measure function so as to allow a notion of degrees that could encode what they were degrees of. What was hidden in that analysis is that, when it comes down to it, the abstraction in ep-relatives is neither over individuals (type e), and nor over degrees (type d), but over individual-degree pairs. We will present here a variant of the analysis of Grosu and Landman which doesn't try to hide this abstraction.

We assume a type e×d of individual-degree pairs. The type <e×d,t> is the type of sets of individual-degree pairs. For pairs <a,β> of type e×d we use superscript notation ^{n} pick out the n-th element:

Let $<\alpha,\beta>$ be of type e×d
$<\alpha,\beta>^1 = \alpha$ $<\alpha,\beta>^2 = \beta$

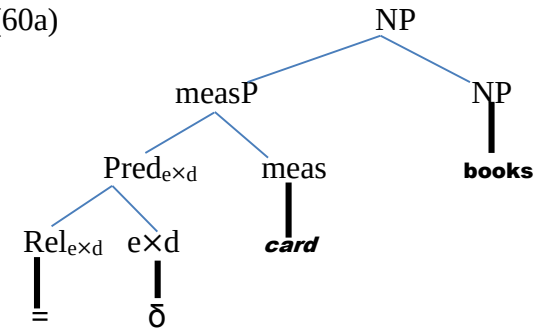
For predicates of type <e×d,t> we use superscript notation ^{n} to indicate the n-th projection:

Let Δ be a predicate of type <e×d,t>, a set of individual-degree pairs.
$\Delta^1 = \lambda x.\exists\delta[\Delta(x,\delta)]$ the first projection of type <e,t>, a set of individuals.

We are concerned with the gap in the relative in (59).

Since the gap is a p-gap we cannot abstract over a variable of type e. Since the interpretation of the relative is as an e-predicate, we cannot abstract over a variable of type d either. What do we assume?
-We assume that we can abstract over a variable δ of type e×d.
-We make the same assumption as for d-relatives, namely, that the interpretation of the external head ***books*** enters into the interpretation of the gap (the External head assumption).
-We follow the strategy of d-relatives of accommodating a measure as part of the interpretation of the gap. Since the external head ***books*** is a count noun, we assume the relevant measure is **card**, except that we adjust this to a function ***card*** of the relevant type (e ×d). With these ingredients, the minimal interpretation that forms an interpretation for the gap at type <e,t> is:

(60a)



(60b) $(=(\delta)) \circ$ ***card*** $\cap$ **books**

Here = is the identity relation between elements of type e×d.

and ***card*** is the function $\lambda x.\langle x,|x|\rangle$ of type $\langle e,e\times d\rangle$, the function that maps every singular of plural individual onto the pair consisting of that individual and its cardinality. This derives (60c) as the interpretation of the gap:

Step 1: (60c) $\lambda z.books(z) \wedge \delta = \langle z,|z|\rangle$ of type $\langle e,t\rangle$

We assume that, as far as the grammar is concerned, variables over individual-degree pairs pattern with variables over degrees. But the central notions we introduced for degrees - in particular degree relations (Rel_d) and maximalization **max** - need to be independently defined for the domain e×d. For type d, we assumed for degree relation **rel** the choices between = and ≥, and that turned out to be important to account for different readings of relatives with the gap in the scope of a quantifier. As it turns out, for the operation of maximalization on type e×d that we will define below, a similar distinction is not relevant for type e×d. For that reason we choose = as the default relation.

With this interpretation of the gap we derive for the IP:

Step 2: there were – on the table yesterday
$\exists z[books(z) \wedge o\text{-}t(z) \wedge \delta = \langle z,|z|\rangle]$ (where *o-t* is short for *on-the-table-yesterday*)

At the CP-level we abstract over δ and derive a predicate of type $\langle e\times d,t\rangle$:

Step 3: that there were – on the table yesterday
$\lambda\delta.\exists z[books(z) \wedge o\text{-}t(z) \wedge \delta = \langle z,|z|\rangle]$ of type $\langle e\times d,t\rangle$.

With the assumption that variables over individual-degree pairs pattern with degree variables, we assume that in ep-relatives too at the CP-level maximalization takes place:

Step 4: that there were – on the table yesterday
max$(\lambda\delta.\exists z[books(z) \wedge o\text{-}t(z) \wedge \delta = \langle z,|z|\rangle])$ of type $\langle e\times d,t\rangle$.

maximalization
max(Δ) = {**max**$_\Delta$} for predicate Δ (of type $\langle e\times d,t\rangle$)

Since all the pairs in Δ are pairs of the form $\langle x,|x|\rangle$, $\Delta^1 = \{x: \langle x,|x|\rangle \in \Delta\}$
max$_\Delta$ is defined as:

$$\textbf{max}_\Delta = \begin{cases} \langle\sigma(\Delta^1), |\sigma(\Delta^1)|\rangle & \text{if } \langle\sigma(\Delta^1), |\sigma(\Delta^1)|\rangle \in \Delta \\ \text{undefined} & \text{otherwise} \end{cases}$$

The intuition behind this definition is the same as before: **max**$_\Delta$ is the maximal element in Δ if Δ has a maximal element. What counts as the maximal element in Δ is lifted from Δ^1. **max**$_\Delta$ is only defined if $\sqcup(\Delta^1) \in \Delta^1$. And in that case
$max_\Delta = \langle\sqcup(\Delta^1),|\sqcup(\Delta^1)|\rangle$. Coming back to the derivation:

Step 5: $\Delta = \lambda\delta.\exists z[books(z) \wedge o\text{-}t(z) \wedge \delta = \langle z,|z|\rangle]$
$\Delta^1 = \lambda z.\ books(z) \wedge o\text{-}t(z)$

that there were – on the table yesterday
$\{\langle\sigma(\lambda z.books(z) \wedge o\text{-}t(z)), |\sigma(\lambda z.books(z) \wedge o\text{-}t(z))|\rangle\}$
The singleton set containing the pair of the sum of all the books on the table, and its cardinality.

Thus, if *Ulysses* (**u**) and *Finnegans wake* (**fw**) are the only books there were on the table yesterday, then:

$\lambda\delta.\exists z[\textit{books}(z) \wedge \textit{o-t}(z) \wedge \delta = \langle z, |z| \rangle] \quad = \quad \{\langle \mathbf{u},1\rangle, \langle \mathbf{fw},1\rangle, \langle \mathbf{u} \sqcup \mathbf{fw},2\rangle\}$

and

$\mathbf{max}(\lambda\delta.\exists z[\textit{books}(z) \wedge \textit{o-t}(z) \wedge \delta = \langle z, |z| \rangle]) \quad = \quad \{\langle \mathbf{u} \sqcup \mathbf{fw},2\rangle\}$

The relative now is a singleton predicate of type <e×d,t>, while the head noun ***books*** is a predicate of type <e,t>.

At this point, we have, as in the case of the d-interpreted relative discussed above, a semantic mismatch between the external head noun ***books*** (a predicate of individuals) and the relative clause (a singleton predicate of individual-cardinalities). But now there is a crucial difference between the present case and the d-interpreted relative.

In the case of d-interpreted relatives, we had an ambiguity: the variable in the gap could be either of type e or type d, leading to different interpretations, where the d-interpretation required accommodation of a measure to resolve a type mismatch. The choice of the variable of type d, led to an external mismatch as well, which followed the general interpretation strategy: accommodate a measure outside, to make a d-interpretation possible.

In the present case, we don't have a choice: the interpretation via a variable of type e×d is the only way we can an interpretation at all (given that a d-interpretation is not available for examples like (59)). The accommodations inside follow the strategy of using the techniques that derive d- interpretations (because there is no other derivation), but in a way that keeps track of the type e-information expressed in the relative. When we now come to the external mismatch between the CP predicate of type <e×d,t> and the head noun of type <e,t>, the obviously minimal principle to resolve the mismatch is taking at this stage the *first projection* of the relative. Grosu and Landman called this operation substance:

Substance:
books $\cap \{\mathbf{max}_{\Delta}\}^1$ where $\{\mathbf{max}_{\Delta}\}^1 = \lambda x.x = \mathbf{max}_{\Delta}{}^1$ and $\mathbf{max}_{\Delta}{}^1$ is the first element of $\mathbf{max}_{\Delta}$

Substance derives a singleton predicate:

Step 6: books there were – on the table yesterday
$\lambda x.\textit{books}(x) \wedge x = \sigma(\lambda z.\textit{books}(x) \wedge \textit{o-t}(x))$ of type <e,t>
which is:
$\{\sigma(\lambda z.\textit{books}(x) \wedge \textit{o-t}(x))\}$
The singleton set consisting of the sum of all books that were at the table yesterday

We derive here a *singleton* predicate whose single member is a plural individual.

Notice that in this case the external head has a semantic effect both inside the relative and outside the relative. The formulation of the External head assumption above was deliberately chosen so as to allow for this case: the External head assumption says that the external head *constrains* the interpretation of the gap inside the relative, it *doesn't* say that the external head is interpreted (solely) inside the relative. (But see section 4.2 for some deliberations on this issue.)

With respect to Carlson's diagnostics, we see that the story for diagnostic 1 is similar to that for d-relatives: the variable in the p-gap is not a variable of type e that gets reconstructed as a predicate of the predicative type. The variable is a variable of

type e×d and the construction of the predicate of type <e,t> follows in essence the same steps as in the case of the d-predicates (but for type e×d). Thus, we expect the ep-relatives to pattern with d-relatives on this diagnostic. With respect to diagnostic 2 and 3, we have derived a singleton predicate and assume from here that this is what accounts for the determiner restrictions and for the lack of stacking.

3.4. Summary of the analyses of the three amount relative constructions:

We have analyzed three constructions. What these analyses share with restrictive relative clauses is the fact that they are analyzed through the same relativization mechanism as restrictive relative clauses: there is a syntactic gap inside the relative clause, which is bound by a syntactic operation at the CP-level. Semantically, this gap is interpreted as a variable, which is bound by abstraction at the CP-level. In this respect, the constructions are taken to be completely normal relative clauses, and in this respect they are expected to pattern in the same way as restricted relatives, for instance with respect to island constraints. In all the cases, the abstraction is not over an individual variable, hence with the Carlson-Heim assumption that wh-relativizers are sorted for abstraction over individual variables, the facts concerning diagnostic 1 follow.

What the analyses further share is that the *syntactic* external head has a semantic effect *both* inside the relative inside the position of the gap *and* outside the relative in its external head position.

-The assumption that it is the syntactic external head was motivated by d-headed relatives with ***wine*** outside and ***beer*** inside.

-The assumption that the external head is interpreted inside is motivated by maximalization: internal interpretation is essential to get the correct restriction on maximalization (i.e. in (59) we want the maximal sum of ***books*** there were on the table, *not* the maximal sum of ***things*** there were on the table).

-The assumption that the external head is *also* interpreted outside is motivated by d-interpreted relatives. (61a) is interpreted as (61b), and cannot have interpretation (61c):

(61) a. We will need the rest of our lives to drink the ***wine*** that they spilled last night.
b. We will need the rest of our life to drink as much ***wine*** as they spilled ***wine*** last night.
c. We will need the rest of our life to drink as much ***water*** as they spilled ***wine*** last night.

We get the correct interpretation by interpreting the head noun ***wine*** *both* inside *and* outside the relative.

In all three cases, the derivation goes through a stage of maximalization, creating a singleton predicate. This accounts for diagnostics 2 and 3.

For d-headed relatives we assumed that the measure interpretation of the d-head constrains the semantic interpretation of the gap: the gap-interpretation is built from a measure phrase interpretation based on a degree variable δ, which is the input for abstraction and maximalization at the CP level. We discussed arguments for maximalization.

For e-headed but d-interpreted relatives, we argued the other way round. Here the assumption is that what allows the d-interpretation is the possibility of interpreting

the gap-interpretation as built from a measure phrase interpretation based on a degree variable δ, and we derive the d-interpretation from that.

In ep-relatives a different problem needed to be solved: here a variable of type e is not possible in a p-gap, and a variable of type d derives the wrong interpretation (a d-interpretation). Here our assumption was that the semantics allows a predicate interpretation for the gap derived from a variable over individual-degree pairs, and that the grammar treats this variable on a par with degree variables.

4. Appendix: Amount relatives and intensional operators.

In section 4.1. we show how maximalization derives for d-relatives with the gap in a modal context the interpretations that Heim 2006 discussed for comparatives.

In section 4.2, we show that the semantics of ep-relatives with the gap in a modal (or in general intensional) context is highly non-trivial: a simple-minded extension from the extensional case doesn't work, and the proper analysis involves (we think) individual concepts and a considerable amount of technique to get the right information in the right place. As we will see, the issues involved directly relate to the broader issue of internal interpretations of external material in relative clauses.

Finally, in section 4.3 we extend the discussion to the issue of why d-headed relatives allow indefinite determiners in cases where the relative contains an explicit temporal or modal operator, like in the examples discussed in section 2.3.2.

4.1. d-relatives and modals.

The examples in (62) contains d-relatives with the gap in the scope of a modal. The examples are similar to examples that Heim 2006 discusses:

(62) a. I didn't get the number of points that I *could* have got –
b. I got the number of points that I *had to* get –

The analysis presented in section 3.1 provides two possible interpretations for each of the relatives. Let MB_w be the modal basis in world w, the set of relevant accessible worlds in w. In the present example we can think of the worlds in MB_w as the worlds in which I get a passing grade, but not a grade that is impossible for me to get.

The relevant two interpretations (for each of 62a and 62b) are those in (63):

(63) a. that I *could have* got –

a_1 **max**$(\lambda\delta.\exists v \in MB_w$: $score_{point,v}(I)=\delta)$	maximal score in MB_w
a_2 **max**$(\lambda\delta.\exists v \in MB_w$: $score_{point,v}(I)\geq\delta)$	maximal score in MB_w

b. that I *had to* get –

b_1 **max**$(\lambda\delta.\forall v \in MB_w$: $score_{point,v}(I)=\delta)$	unique score in MB_w
b_2 **max**$(\lambda\delta.\forall v \in MB_w$: $score_{point,v}(I)\geq\delta)$	minimal score in MB_w

The difference between the ***exactly*** and ***at least*** interpretation is not relevant for (62a) with the existential modal: in both cases, maximalization give the score that is the maximal one among the scores in the different alternatives in MB_w. Thus, the relative in (62a) denotes the singleton set containing the biggest score I get in any world in the modal base: the maximal score possible for me. And (62a) expresses that that score I didn't get in w.

In (62b), with the universal modal, the ***exactly*** interpretation is one that is usually not very relevant, because on this interpretation, maximalization is only defined, if in all alternatives in MB_w I get the same score, which usually contradicts the natural assumptions about MB_w: i.e. the whole point about the modal base is that it shows the full range of possibilities concerning the obtainable scores, and normally, we would assume, that determines a *range* of scores and not a single score.

The *at least* interpretation specifies for each world v in MB_w the list of numbers *smaller and equal to* the score of points I get in v. The interpretation looks for the maximal shared number in those lists. This number is the *lowest* score I get in any of the alternatives, because, if I get that score in world v, no higher number than that is shared between *all* the alternatives (because such I higher number is not on the list in c). This means that the relative denotes the singleton set containing the lowest passing score. And (62b) expresses that I got that score.

A bit of pragmatic leeway is possible here: I got that score either because that's what my score in w was, or because I got a higher score in w, and we assume pragmatically that in that case I count pragmatically as having gotten all the lower passing grades as well (just as, by getting a PhD diploma, you count as having completed primary school, even if you didn't).

The examples in (62) are d-headed, but the facts are the same for d-interpreted relatives and the analysis works in the same way:

(64) a. Yesterday at Pesach I didn't drink the wine I *could* have drank –
b. Yesterday at Pesach I only drank the wine I *had to* drink -

4.2. ep-relatives and modals

We turn to ep-relatives with the gap in a modal context, like (65):

(65) a. The three books that there *might have* been - on the table yesterday, are in any case gone now.
b. The three books that there *must have* been - on the table yesterday, are in any case gone now.

In these cases, the interpretation of the relatives is an e-interpretation, and as we indicated above, since the operation of maximalization goes via the first element of the individual-degree pair, the ***at least*** operation doesn't seem to be relevant in this context (but see the remarks at the end of this subsection). So we have:

(66) a. that there *might have* been - on the table yesterday
max$(\lambda\delta.\exists v \in MB_w: \exists x[books(x) \wedge o\text{-}t_v(x) \wedge \delta=<x,|x|>])$
b. that there *must have* been - on the table yesterday
max$(\lambda\delta.\forall v \in MB_w: \exists x[books(x) \wedge o\text{-}t_v(x) \wedge \delta=<x,|x|>])$

There is a problem with these interpretations, which is a generalization of the reason that the ***exactly*** reading was disregarded in the case of the (62b): maximalization involves, in essence, the sums a_1 (for 66a) and b_1 (for 66b):

(67) a_1 $\sigma(\lambda x.\exists v \in MB_w: books(x) \wedge o\text{-}t_v(x))$
b_1 $\sigma(\lambda x.\forall v \in MB_w: books(x) \wedge o\text{-}t_v(x))$

We can show the problem for ($67a_1$).

Suppose we have two worlds v, u $\in MB_w$, and let $\mathbf{b}_v$ and $\mathbf{b}_u$ be the sets of books on the table in those worlds. For σ to be defined, what must be the case is that:

$$\sqcup(\lambda x.\exists v \in MB_w: \textit{books}(x) \wedge o\text{-}t_v(x)) \quad \in \quad \lambda x.\exists v \in MB_w: \textit{books}(x) \wedge o\text{-}t_v(x)$$

But this means that there must be a world $z \in MB_w$ such that $\mathbf{b}_z = \mathbf{b}_v \sqcup \mathbf{b}_u$.
The problem is that this is a totally implausible restriction on the modal base: we may know, that if there were books on the table there were only three, but we don't know which three. In that case, which three books they are will vary across the worlds in MB_w. But then you don't *want* there to be a world in MB_w where the across-world sum of these books is on the table, because it would consist of more than three books, violating the assumption about MB_w. The problem is the same (in fact worse) for ($67b_1$).

Clearly, then , the operation of maximalization for ep-predicates, as given, does not extend to cases where the gap is in the scope of a modal: for it to work at all, it requires conditions on the set of alternatives that are normally not satisfied.

How then to approach the problem of maximalization over predicates involving modal contexts?

We will here sketch the ingredients of a solution.

We suggest that a first ingredient of the analysis is ***individual concepts***. Grosu and Krifka 2007 provide an account of relativization that involves abstraction over individual concepts (functions from indices to individuals of type <s,e>). In this, they are in line with analyses that have made a similar assumption for wide scope readings over intensional contexts ('quantifying-in'), e.g. Hintikka 1969, Aloni 2001 and many others. Allowing for the same possibility for ep-relatives means that we allow abstraction over functions from indices to individual-degree pairs of type <s,e×d>: ***individual-degree concepts***. This means that we will at the CP level derive a set F of functions from indices to individual-degree pairs, a set of type <<s,e×d>,t>. Maximalization will turn this, as before, into a singleton set, $\{max_F\}$, a set containing a single function max_F from indices to individual-degree pairs.

We suggest that a second ingredient of the analysis is that in the cases discussed here maximalization is *pointwise* maximalization, max_F is going to be defined as a function that maximalizes *the relevant predicate* pointwise, *per index* (per world, time, world-time pair…).

What makes the analysis of the intensional case most difficult is making *the relevant predicate* available at the right grammatical level. The derivational problem is that *the relevant predicate* is generally a generous mix of external and internal material, not just the external head (which is available by the External head assumption), but *all* external NP material:

> **Internal interpretation assumption**:
> If the gap is a p-gap and the relativization variable is a functional variable, the external NP material constrains the interpretation of the gap.

Grosu and Landman 1998 made this assumption for ep-relatives in general, not just modal cases. Again, we use *constrain* here to indicate that, while we assume that the external material has an interpretative effect *inside* the relative, we do not want to make a *blanket statement* to the effect that the external material is *only and completely* interpreted inside the relative. We discuss this issue further at the end of this subsection.

The central problem in the derivation is the internal construction of *the relevant predicate.* Let us be explicitly honest at this point: we don't *have* a theory that tells us how to construct *the relevant predicate* (syntactic, semantic, or otherwise). Nor do we *know* of any such theory that works to our satisfaction. This is a point where we think much more work and insight is needed. For our present purposes, we solve the issue of determining *the relevant predicate* for the examples in question by stipulation: for the examples in (65) we assume that for world v, the relevant predicate is α_v:

(68) $\alpha_v = \lambda x.\mathit{books}(x) \wedge |x|=3 \wedge \mathit{o}\text{-}t_v(x)$
The set of sums of three books that were on the table in v yesterday

α_v enters into the semantics of the CP before maximalization. After abstraction over variable f of type <s,e×d> we derive (with $\alpha_v(x)$ italicized):

(69) a. that there *might have* been - on the table yesterday
$F_\exists = \lambda f.\exists v \in MB_w: \exists x[\boldsymbol{\mathit{books(x)} \wedge |x|=3 \wedge \mathit{o}\text{-}t_v(x)} \wedge f(v)=<x,|x|>]$
b. that there *must have* been - on the table yesterday
$F_\forall = \lambda f.\forall v \in MB_w: \exists x[\boldsymbol{\mathit{books(x)} \wedge |x|=3 \wedge \mathit{o}\text{-}t_v(x)} \wedge f(v)=<x,|x|>]$

Pointwise maximalization derives a function **m** of type <s,e×d>. This should be the function that maximally satisfies the relevant predicate. We specify it shortly, but it is easier to get there by working our way backwards. We assume, as per usual, that:

(70a) $\mathbf{max}(F) = \{\mathbf{max}_F\}$

and we propose that max_F be identified with **m**, as always, *on the condition that* $\mathbf{m} \in F$.

(70b) $\mathbf{max}_F = \begin{cases} \mathbf{m} & \text{if } \mathbf{m} \in F \\ \text{undefined} & \text{otherwise} \end{cases}$

In the context of our present example, we have set *the relevant predicate* to α_v to:

α_v $\lambda x.\mathit{books}(x) \wedge |x|=3 \wedge \mathit{o}\text{-}t_v(x)$
the set of sums of three books there were on the table yesterday in v

We take the set of worlds relevant for the examples in (65) to be MB_w^+:

$MB_w^+ = MB_w \cup \{w\}$
The set of worlds accessible to w **plus** w itself

We propose the following interpretation choice for **m**:

(70c) $\mathbf{m} = \lambda v \in MB_w^+: <\sigma(\alpha_v), |\sigma(\alpha_v)|>$
-**m** maps every relevant world in which there were exactly three books on the table onto the pair consisting of those three books and the number 3.
-**m** is undefined for every other relevant world.

When we say that we don't have a *theory* here, one of the things we mean is that, while for concreteness we propose (70c) as our choice for **m**, we really see this choice as a *starting point* for thinking about the interaction between amount relatives and modals:

experimenting with different alternatives for **m** leads to different predictions for the semantics of the examples in (65) and these alternative need to be explored.

In the meantime, we derive, with (70c), for the relative CP after maximalization singleton set $\{\mathbf{max}_F\}$ of type $\langle\langle s,e\times d\rangle,t\rangle$. The substance condition for ep-relatives derives from that a singleton predicate of ***individual concepts*** of type $\langle\langle s,e\rangle,t\rangle$:

(70d) **Substance:** $\{\lambda v \in MB_w^+: \mathbf{max}_F(v)^1\}$

The matrix predicate ***are gone now*** is a predicate of individuals (<e,t>).
We feed it the individual concept in (70a), which is not defined for every world. Obviously, applying the matrix predicate to this function, is going to say that the matrix predicate applies to *the value* of this individual concept *in world* w.

However, we need to take into consideration that the function **m** is a partial function, and may not be defined for w. This leads to a conditional meaning for the matrix (with $\perp$ the undefined value):

(71) **Matrix:** if $\mathbf{max}_F(w)^1 \neq \perp$ then *gone*$(\mathbf{max}_F(w)^1$

With this choice for **m** we derive the following interpretations for (65a) and (65b):

(65) a. The three books that there *might have* been - on the table yesterday, are in any case gone now.

-**m** is the function that maps every world in MB_w^+ where there were exactly three books on the table yesterday onto that sum of three books, and **m** is undefined for all other worlds.
- $\mathbf{max}_{F\exists} = \mathbf{m}$, on the condition that $\mathbf{m} \in F_\exists$. This brings in a presupposition:
The definedness of $\mathbf{max}_{F\exists}$ presupposes that *there is a* world in MB_w where there were exactly three books on the table yesterday.

With this we get the following presupposition and meaning for (65a):
- (65a) *presupposes* that there is an accessible world where there were exactly three books on the table yesterday.
-(65a) *expresses* that, *if* there were exactly three books on the table yesterday in w, those books are no longer there now in w.

(65) b. The three books that there *must have* been - on the table yesterday, are in any case gone now.

- $\mathbf{max}_{F\forall} = \mathbf{m}$, on the condition that $\mathbf{m} \in F_\forall$. This brings in a *different* presupposition:
The definedness of $\mathbf{max}_{F\forall}$ presupposes that *for every* world in MB_w there were exactly three books on the table yesterday.

With this we get the following presupposition and meaning for (65b):
- (65b) *presupposes* that *in every accessible world* there were exactly three books on the table yesterday.
-(65b) *expresses* that, *if* there were exactly three books on the table yesterday in w, those books are no longer there. We assume that the natural choice for the modality is epistemic modality. With that, we assume that $w \in MB_w$, and we can conclude that (65b) expresses that the three books that were on the table yesterday in w are gone now in w.

The semantics given predict the felicity judgements in (72):

(72) a. ✓The three books that there ***may*** have been on the table yesterday**,** ***may*** have been part of a pile of as much as twenty books.
b. #The three books that there ***may*** have been on the table yesterday**,** ***must*** have been part of a pile of as much as twenty books.
c. #The three books that there ***must*** have been on the table yesterday**,** ***may*** have been part of a pile of as much as twenty books.
d. #The three books that there ***must*** have been on the table yesterday**,** ***must*** have been part of a pile of as much as twenty books.

The judgements only concern interpretations where the two modals constrain the *same* modal base (otherwise you don't expect any infelicity).
On the analysis given, (72a) is felicitous, because the felicity of the definite in **m** requires *one* accessible world where there are exactly three books on the table, which is compatible with there also being a *different* accessible world in which *those books* are part of a pile of twenty books on the table. (72b) is not felicitous, on this choice of **m**, because there isn't a world in which there are exactly three books on the table, because (72b) expresses that any world in which there are three books on the table, is a world where there are 20 books on the table. But then, how can you talk about ***the three books*** *there may have been on the table*?

Strictly speaking (72b) comes out as a contradiction: applying this main clause predicate to this relative cannot be done truthfully. But the contradiction derives from a clash with the presuppositions of the relative, which, we assume, brings in the infelicity. The examples in (72c,d) suffer from similar problems: here the definedness of $\mathbf{max}_{F\forall}$ presupposes that *for every* world in MB_w there were exactly three books on the table yesterday. The main clause assertion made in (72c,d) is similarly inconsistent with this.

While we think that the predictions for the examples in (72) form a good result, we realize that it also needs to be put in context. For one thing, contextual restrictions on the nouns involved can easily affect the judgments: (72e) is perfectly felicitous:

(72) e. ✓The three books (that are special in a contextually relevant way) that there ***may*** have been on the table yesterday**,** ***must*** have been part of a pile of as much as twenty books (that are not all special in that same way).

This is of course not a counterexample to the analysis given, but a factor to take into account. Another factor is the following: if we put emphasis on the first ***must*** in (72d) we can get a felicitous reading for (72d) along the lines of (72f):

(72) d. ✓The three books that there **MUST** have been on the table yesterday**,** ***must*** have been part of a pile of as much as twenty books.
f. We have now established that the three books that we were already certain about yesterday, *Ulysses, Finnegans wake* and *Dubliners*, were in fact part of a pile of twenty books.

Now, we may try to convince you that this reading involves two related but not quite identical modal bases for the two modals, and, in fact, we think that a reasonable case can be made for such a view. But another alternative, that we do not think should be excluded *a priori*, is that the felicitous reading involves Heim-style maximalization

after all, where the relative denotes the three books that we *minimally* must assume there were on the table. Deriving that reading as a modal maximalization reading requires exactly the kind of experimental tinkering with the ingredients of the modal analysis that we think is called for at this stage.

We finally come back to the Internal interpretation assumption. While this assumption makes all the external material available for interpretation at the level of the p-gap, we do not say that the external material is *only and completely* interpreted inside the relative as part of the interpretation of the p-gap.

We assume, for one thing (with Grosu and Landman 1998) that for ep-relatives the operation ***substance*** is triggered by the external e-head. And we assume that this is the case, even when the external head is interpreted in a p-gap in the scope of a modal.

More generally, it can be observed that the external head, even when interpreted in the scope of an intensional operator, may have an effect on sortal selection outside the relative. For instance, (73) is judged odd due to sortal incorrectness (you can't drink pears), even though the head *pears* is naturally interpreted as taking scope under the modal in (73), and strictly speaking, purely semantically there shouldn't be a sortal conflict:

(73) #*John* in any case *didn't* drink the pears that Mary might have squeezed in the morning.

Thus, certain aspects of the interpretation of the external noun may well be contributed both inside and outside the relative.

Also, certain external NP material does not get interpreted inside the relative at all on most analyses, like the scopal operator *only* in (74):

(74) The *only* book that there might have been on the table was Ulysses.

We don't propose an analysis of *only* here, but we don't want to claim that it *must* be interpreted inside the p-gap.

Despite this caution, it needs to be pointed out that, when we look at the interpretations of ep-relatives with the gap in a modal or intensional context, we *do* observe that there is a *strong tendency* here for external material to be interpreted internally, in the scope of the modal or intensional operator. This can be seen most clearly in ep-relatives with the gap in a propositional attitude context as in (75). (75) does not seem to allow interpretations with the external material taking wide scope over the intensional operator:

(75) a. ✓The ***three Bordurian spies*** that Buck claimed there were - in the appartment at the time of the explosion were in fact Sylvanian diplomats.
b. #The ***three Bordurian spies*** that Buck claimed there were - in the appartment at the time of the explosion were indeed what I call them here: Bordurian spies, and not, as Buck thought, Sylvanian diplomats.

It is very difficult to construct examples in the spirit of (75b) that are felicitous.

It seems clear to us that this fact ought to be connected to the observation made by Carlson 1977b that expressions that occur in *there*-insertion contexts tend not to allow for wide scope interpretations over intensional and modal operators.

On the syntactic side, Bhatt 2002 has argued for a 'reconstruction' analysis for relatives, in which the external material is generated inside the relative, and has its

interpretation effect *either* inside *or* outside the relative. Such a syntax fits Carlson's observation very well, because you don't expect outside interpretations if these are derived via a scope mechanism from the p-gap position, because – *pace* Carlson – you can't take scope from there.

How well the semantic facts fit Bhatt's reconstruction analysis is open to debate, however. Heycock 2005 and Sharvit 2007 discuss examples of superlative interpretation in intensional contexts that are hard to fit into Bhatt's analysis (see their papers for extensive discussion). Even Carlson's generalization needs to be scrutinized in the light of examples like (76) that look much like wide scope readings:

(76) *Radio announcement*: A bear has escaped from the zoo and might be hiding in the cave.
Policeman at the cave: Don't go in there, boys. The radio announced that there might be *a dangerous beast* hiding in that cave. (The dangerous beast that the radio announced there might be hiding in the cave is a bear that escaped from the zoo.)

Very relevant is here the discussion in Grosu and Krifka 2007 on how individual concepts can be used to treat what may look like aspects of wide scope readings via constraints on different regions of worlds in the domain of individual concepts, and their discussion of the pragmatic bridging that may be involved in such interpretations.

In short and not surprisingly: more study is needed of exactly what happens when the gap of an ep-relative is in an intensional context.

4.3. d-headed relatives and indices

We finally discuss the d-headed relatives which allow indefinite external determiners, the cases discussed in section 2.3.2. We are concerned with the examples in (77):

(77) a. There is now in this vat ***an*** amount of wine that there has ***never*** been in it before 1990.
b. There is now in this vat an amount ***of wine*** that there has never been ***of beer*** in it before 1990.

We will analyze example (77b). Before we engage in an analysis involving concepts, we point out that an analysis involving abstraction over degree variable δ and simple maximalization doesn't work. It derives for the relative:

(78) $\Delta = \lambda\delta.\neg\exists t < 1990\ \exists x[\mathit{beer}(x) \wedge \mathit{in\text{-}vat}_t(x) \wedge \text{amount}_t(x)=\delta]$ of type <d,t>

This is the set of all degrees larger than the amount of beer there was in the vat at any point before 1990. This set has no maximal element, and maximalization is undefined.

Like the cases in the previous subsection, the examples that show the effect of allowing indefinite determiners involve interpretations at alternative indices (moments of time) inside the relative. We follow the semantics from the previous subsection (with the appropriate modifications).

We abstract at the CP-level over variable f of type <s,d>, a function from indices (times) to amounts:

(79a) $F = \lambda f.\neg\exists t < 1990\ \exists x[beer(x) \wedge in\text{-}vat_t(x) \wedge amount_t(x)=f(t)]$

The tricky task, as before, is to determine *the relevant predicate* to be maximalized and function **m**. As before, we don't have a theory, but determine the relevant predicate for the sake of the example by stipulation:

(79b) $\alpha_t = \lambda x.wine(x) \wedge in\text{-}vat_t(x)$

The heart of the analysis is, once again, function **m**, which we assume is:

(79c) $\mathbf{m} = \lambda t.$ { $amount_t(\sigma(\alpha_t))$ if $\exists f \in F: amount_t(\sigma(\alpha_t)) = f(t)$; undefined otherwise }

m maps any moment of time t onto the amount of the wine in the vat at that time, *on the condition that* the amount of wine there is in the vat at t is the same as the amount that some $f \in F$ assigns to t.

m, when defined, maps moment of time t on the amount of wine in the vat at t. But it doesn't, if that amount happens to be the amount of beer that there was in the vat at some time t'. In that case, **m** is undefined.

With this, we assume that $\mathbf{max}_F$ is defined as above:

(79d) $\mathbf{max}_F =$ { **m** if $\mathbf{m} \in F$; undefined otherwise }

We now derive the result that (77b) presupposes that at every moment of time t at which there is wine in the vat, the amount there is in the vat is determined by F as an amount that there never was of beer in the vat (ever).

We derive for the CP after maximalization:

(79e) that there has ***never*** been in this vat before 1990
{**m**} a singleton set of type <<s,d>,t>

In this case, **m** is itself *a set of time-degree pairs*. So we get a singleton set of time-degree pairs. What allows the indefinite determiners is:

> **Assumption of indexical shift for d-headed relatives:**
> d-headed relatives allow the relative to *shift* from a singleton set containing a set of index-degree pairs, to that set of index-degree pairs:
>
> **indexical shift**({**m**})= **m**

With this shift, we derive at an interpretation for the CP which is a non-singleton set of time-degree pairs, namely **m**. This CP is compatible with indefinite external determiners. We derive now for (77b) an interpretation:

(80) **meaning:** $\exists x[wine(x) \wedge in\text{-}vat_{now}(x) \wedge \mathbf{m}(now) = amount_{now}(x)]$
There is now **m**(now)-much wine in the vat
presupposition: $\exists f \in F: \mathbf{m}(now) = f(now)$
There never was **m**(now)-much beer in the vat

(80) doesn't by itself say that the amount of wine is bigger than the amounts of beer there have been in the vat, just different from those amounts. Such a non-maximalizing reading is shown, for instance in (81):

(81) Two amounts of wine that there have been in this vat before 1990 are the amount that there was in it yesterday and the amount that there was in it last year.

We derive the natural maximalizing reading, on which in (81) the amount of wine there is in the vat now is not just different from the actual amount of beer there was in the vat at any relevant moment of time, but is in fact bigger than all those amounts, if in F we choose $\geq$ instead of =.

We end this section on a speculative note.
We pointed out that maximalization in (77) with the gap in the scope of ***never*** is undefined. We assume that this is also true for ep-relatives with the gap in the scope of negation like (82):

(82) #The three books that there weren't - on the table yesterday

Our analysis of (82) involves the e×d-predicate:

$$\Delta = \lambda\delta.\neg\exists x[\textit{books}(x) \wedge |x|=3 \wedge \textit{o-l}(x) \wedge \delta=<x,|x|>]$$

$\max_\Delta$ would be the the pair consisting of *absolutely everything* and the cardinality of that (because for every singular object d, $<d,1> \in \Delta$). We assume that in a natural context no cardinality is assigned to the sum of *absolutely everything* (i.e. when variable δ is not contextually restricted), so that (82) is actually undefined, and comes out as infelicitous. While we think this is a good result, not all cases with the p-gap in the scope of a negation are infelicitous. For instance, (83) is felicitous:

(83) There were lots of interesting books on the list of best books, but the two books that there ***weren't*** on the list were *Ulysses* and *Finnegans wake*.

We see here that having the gap in the scope of negation is possible with constrastive focus on the negation.

What we think is going on here is the following. Rooth 1985 proposed that focus introduces a set of alternatives and that operators that associate with focus can be regarded as quantifiers over alternatives. We assume that (83) involves such a quantifier, and more in particular that (83) allows an analysis where alternatives are given the form of *indices*. This means that the focal quantifier in question is *de facto* a modal or quasi-modal operator. The modal nature is brought out in the following rough paraphrase:

(84) *In my favorite alternative v, two books are on the list of best books in v that are not on the list of best books in alternative w, namely Ulysses and Finnegans wake*.

If so, then the p-gap can be regarded as being in the scope of a modal operator, and one can attempt to provide an analysis of (84) along the lines of that for (77). Such an analysis is indeed possible, but specifying its details won't fit in the margin of this paper.

5. Appendix: Some critical discussion.

In this section, we discuss three proposals concerning certain types of amount relatives that have been made in the literature following Grosu and Landman 1998. Since we have gone through the effort of remodeling the analysis we proposed there into the new one in section 3 of this paper, the present section takes a bit the form of a 'reply to our critics'.

5.1. Herdan 2008

Not all the diagnostics and patterns that were discussed in Carlson 1977a made it into our list of diagnostics in section 2. For some, this is because we actually disagree with some of the claims that Carlson made. We have already indicated our disagreement with Carlson's proposed ACD diagnostic, and we will now briefly discuss another one, because it has played a role in later discussions of amount relatives, in particular, in Herdan 2008 and McNally 2008.

Carlson 1977a claimed that ep-relatives with a *singular* head noun are infelicitous (examples in (85)). Herdan 2008 does not support Carlson's claim to the full, but does claim that ep-relatives with a *singular* head noun are only felicitous if they are explicit superlatives (examples in (86)):

(85) a. #The ***man*** that there – is in Austria hates Bob.
b.✓The ***men*** that there are – in Austria hate Bob

(86) a. #I took with me the book that there had been – on the table yesterday.
b. #I took with me the long book that there had been – on the table yesterday.
c. ✓I took with me the *longest* book that there had been – on the table yesterday.

Herdan actually follows up on a suggestion brought up in Carlson 1977a, who proposes that superlatives and a variety of items that explicitly indicate uniqueness, e.g., ***only***, ***single***, ***unique***, can rescue examples with a singular head from infelicity (see his example (72) and his comments thereon). The effect is shown in (87):

(87) a. ✓The ***only/single*** man that there – is in Austria hates Bob.
b. ✓I took with me the ***only/single*** book that there had been – on the table yesterday.
c. ✓I took with me the ***only/single*** long book that there had been – on the table yesterday.

Herdan assumes that the felicity of the felicitous cases is due to the presence in the syntax of a phrase interpreted as a superlative operation.

We point out first that when the uniqueness of the singular definite noun phrase is made sufficiently natural and salient in the context, the examples are fine without the presence of an explicit superlative:

(88) a. The driver that there is – at the wheel of this bus worries me greatly, he looks rather drunk.
b. The woman that there is – on the throne of England at the moment is one of the longest reigning monarchs in the history of the kingdom.
c. Over the years, Billy had not been very lucky with her choice of partner, but the man that there was – in her life at that point of her career seemed like a particularly bad lot.

We do not see a good reason to assume that the data in (88) is felicitous because somehow a superlative operation is accommodated.

Herdan's specific proposal concerning p-gap relatives is that they involve a degree variable, which is abstracted over and *absorbed* into a superlative operator. The effect of this mechanism is that all p-gap relatives become ep-relatives: the absorption of the degree variable, creates *de facto* an individual interpretation for the relative. We point out that this is in fact a problem for Herdan's analysis, because p-gaps occur with d-relatives as well:

(89) a. It would take us a year to drink ***the wine/amount of wine*** *there was* – in the swimming pool after the party was over.
b. It would take the factory a month to produce the marbles that there were - on the quai after the container dropped.
c. No mathematician has been able to match the ***rigor*** that *there was* – in Euler's thinking.

5.2. von Fintel 1999

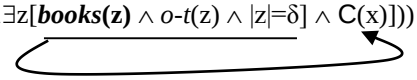
von Fintel 1999 proposes an analysis of p-gap relatives that is in many respects very close to ours. His main aim is to do away with the relativization abstraction over individual-cardinality pairs, and go back to Carlson-Heim and assume that the relativization is just over degrees. The heart of his approach is the assumption – that we make too – that the external head is interpreted *both* inside the relative and *outside*:

(90) [$_{NP}$ three books that there were [– *books*] on the table]
$\lambda x.\boldsymbol{books(x)} \wedge |x|=3 \wedge |x|= \sigma(\mathbf{max}(\lambda\delta.\exists z[\boldsymbol{books(z)} \wedge o\text{-}t(z) \wedge |z|=\delta]))$

The difference with our analysis is, of course, that maximalization now involves only the cardinality, and that the predicate derived here is not a singleton predicate, since there are many sums of three books that have the cardinality of the maximal sum of books on the table. In fact, if that cardinality is 3, *all* sums of three books have that cardinality.

Von Fintel is of course aware of this and takes his inspiration from a proposal made by Hoshi 1995 and Shimoyama 1999 concerning internally-headed relative clauses in Japanese, namely that the external DP contains a *discourse anaphor* that takes its interpretation from the relative clause, roughly along the following lines:

(91) [Ø three books that there were – on the table]
$\sigma(\lambda x.\boldsymbol{books(x)} \wedge |x|=3 \wedge |x|= \sigma(\mathbf{max}(\lambda\delta.\exists z[\boldsymbol{books(z)} \wedge o\text{-}t(z) \wedge |z|=\delta] \wedge C(x)]))$



The idea, of course, is that this reconstructs ***on the table*** externally, and in that way gets the right meaning.

It seems to us that this replaces *one* stipulation (maximalization) by *two* (degree maximalization at the CP level and individual maximalization externally). Moreover, to get the correct semantics, the external discourse anaphor must not only *obligatorily* construct its interpretation from the relative, but must construct it in essence *as the full predicate* that gets maximalized by **max**, i.e. it does not *choose* its material from inside the relative, it *must* use it all. That is, the discourse anaphor doesn't have a choice as to include *on the table* or not: if it doesn't choose that, it derives the wrong meaning. But this is a *very a-typical* constraint for discourse anaphora, which are, as we know, mainly pragmatically constrained as to what property they accommodate.

A further point to note is that, if the individual maximalization takes place at the level where there is a discourse anaphor, the relative *itself* does not have a singleton interpretation (maybe it denotes a single cardinality, but the set of individuals with that cardinality is, of course, not a singleton). But that means that it is not clear how von Fintel's account will deal with diagnostic 3, the stacking restriction, which is a restriction on the adjunction of the relatives themselves.

Apart from this, the strength of von Fintel's suggestion depends considerably on the strength of Hoshi and Shimoyama's analysis of the Japanese case. That is, the appeal of the proposal is that it uses a mechanism that, it is argued, is needed independently anyway (in Japanese). However, we think that there is no such appeal: we have argued extensively against the discourse anaphor analysis for Japanese internally-headed relatives in a series of papers. e.g. Grosu 2010, 2012, Grosu and Landman 2012, Grosu and Hoshi 2013, Grosu, Hoshi and Daeyoung 2013, Landman 2013. We think that Japanese internally-headed relatives provide no support for the interpretation mechanism that von Fintel proposes.

5.3. McNally 2008

McNally 2008, partly building on McNally 1992, recognizes a distinction between what we have called d-relatives and ep-relatives, and makes essentially the following proposals:

Assumption 1: d-relatives involve maximalization.
Assumption 2: p-gap relatives do not *always* exhibit maximalization.
(She leaves the fact that they sometimes do unexplained.)
Assumption 3: The analysis of p-gap relatives needs to make no appeal to degrees.
Rather, these constructions denote kinds.

We have shown above how we think diagnostic 2 violations for d-interpreted relatives come about, and we have argued that in the case of ep-relatives these violations are only apparent.

McNally supports her assumption 1 with the contrast in (92):

(92) a. ??The books cost the *only* amount of money we had –
b. ✓The *only* books there are on the table are the ones I put – there.

McNally provides a semantics for *only* which requires the set operated on to be non-singleton, because precisely what *only* does is restrict the set to a singleton. With this, she explains the facts in (92) by assumptions 1 and 2: (92a) is infelicitous because for d-relatives the set *only* operates on is a singleton, due to maximalization; (92b) is felicitous, because for p-gap relatives the set is not necessarily a singleton set.

The problem is that McNally's assumption about the semantics of ***only*** is more specific that the assumptions that are standardly made about ***only***, namely, that it requires access to a non-singleton set of alternatives, and that these alternatives can be provided contextually (e.g. Rooth 1984, Krifka 1991).

Thus, in contrast to the examples in (92), we find the examples in (93) where the felicity judgements are exactly inverted:

(93) a. ✓The ***only sum of*** money I would be willing to lend anybody is $20.
b. *You and I are looking on a pile of six of your books on my desk. There is no previous context of any books mentioned. There is nothing else on the desk. I say to you*:
#Please remove the ***only books*** that there are on the desk

These facts, and the known context dependency of ***only***, make it very difficult to take McNally's fact as showing what she claims they show.

McNally also brings up the examples in (94) to support her claim that p-gap relatives need not involve maximalization.

(94) a. For instance, they can observe that there's is a difference between ***reasons there are to believe P*** – where these include reasons not now available to you – and ***reasons you have to believe P***. For example, ***one reason there is*** to believe you'll soon be sick is the fact that you just drank poison.
b. ***One problem there is – with this website*** is that it does not explain what a press syndicate is.
c. ***One risk there is*** – is that these students will leave the state for higher-paying jobs.

McNally proposes that the italicized DPs in these data denote *kinds* of reasons, *kinds* of problems, *kinds* of risk, etc., and she attributes the felicity of the examples in (94) to the fact that such sub-kinds are not unique.

We agree with McNally that p-gap relatives can have kind interpretations, and we assume that kind-interpretations need not go through maximalization. We are not sure, though, that the cases in (94) are actually instances of kind-interpretation.

In the first place, we point out that if we assume, with McNally, that the examples in (94) are kind-interpretations, we will have to allow for as many *sub-kinds* of reasons, problems etc. as there are reasons, problems, etc**.** Look at (95):

(95) ***One reason there is*** for being dissatisfied with this theory is that it does not account for existential quantification, ***another reason*** is that it does not account for universal quantification either.

Examples like (95) suggest that the kinds are really irrelevant: the problem with (95) is that it is compatible with, so to speak, more than one *reason there is*. So we think that the problem should be faced head on, and not via kinds. And we think so even more strongly, because we find the same possibilities in examples like (96), which clearly cannot be reconstructed as statements over sub-kinds, as shown by the oddity of (97):

(96) a. One strong competitor there was – in yesterday's race was obviously Bill.
b. One committed participant there was – at last night's event was clearly Bill.

(97) a. ?One kind of strong competitor there was – in yesterday's race was Bill.
b. ?One kind of participant there was – at last night's event was Bill.

It would be incorrect to analyze the felicitous examples in (96) as synonymous with those in (97). Inasmuch as the sub-cases of (97) are felicitous, they clearly mean something other than the corresponding examples in (96).

Now, all the cases McNally discusses, as well as the ones in (96), use contrastive stress on ***one***. We argued in section (2.2) for a partitive interpretation of such cases, along the lines of (98):

(98) a. ***One reason there is –***
b. ***One*** *of the* ***reason****[plur]* ***there is****[plur]* –
c. *One of the reasons there are* –

And this will work for competitors and participants just as well as for reasons.

Thus we think the violations of diagnostic 2 that McNally discusses are not in fact instances of kind-interpretations, but are instances of partitive interpretations, much like the examples we discussed in section 2.2.

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