Quantified indicative conditionals and the relative reading of *most*[1]

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Abstract. Kratzer (in press) notes a curious 'reverse' reading for certain quantified conditionals with *most*. The existence of this reading is problematic for accounts that aim at compositionally deriving the perceived interpretation of quantified conditionals, especially for those that take *if*-clauses to semantically restrict the domain of nominal quantifiers. We show how the reverse reading can be derived on such a restrictor account, as an instance of the relative reading of *most*. The derivation closely parallels a recent account of the 'reverse proportional' reading of *many* (Romero, 2015). Our account is entirely compositional and draws on independently motivated assumptions about the interpretation of *most*.

Keywords: conditionals, quantifiers, *most*, superlatives

1. Introduction: an old 'embarrassment'

Conditionals that appear to be embedded under other operators present a difficult testing ground for semantic theories of the natural language conditional. In this paper, we are concerned with quantified indicative conditionals (QICs), which combine an *if*-clause and a nominal quantifier:

(1) a. Every student passed if she studied hard.
  b. No student failed if she studied hard.

Although (1a) and (1b) are intuitively paraphrases (assuming that failing is not passing), analyses of QICs which simply embed an *if*-conditional under the quantifier have struggled to produce equivalent interpretations for these statements: "The embarrassment had been known for a long time, but nobody dared talk about it. Then Higginbotham (1986) dragged it into the open" (Kratzer, in press), by demonstrating the insufficiency of the classical material conditional analysis of *if* for interpreting the sentences in (1). While $\supset$ arguably produces acceptable truth conditions for (1a), the interpretation that results for (1b) is not equivalent — and, moreover, is patently inappropriate: (1b) does not entail that all students studied hard.

(2) a. (1a) $\equiv \forall[\text{STUDENT}][\text{STUDY-HARD} \supset \text{PASS}]$
  All students are such that studying hard ensured passing.
  b. (1b) $\equiv \neg\exists[\text{STUDENT}][\text{STUDY-HARD} \supset \neg\text{PASS}]$
  $\equiv \forall[\text{STUDENT}][\text{STUDY-HARD} \,\&\, \text{PASS}]$
  All students are such that they both studied hard and passed.

This unfortunate result arises from the (now unpopular) identification of the material conditional $\supset$ with *if*. However, simply embedding the influential 'restrictor' conditional of Kratzer

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(1986) does not fare much better. Kratzer treats *if*-clauses as restricting the domain of a (covert) universal modal quantifier; (3) shows the results of embedding this under nominal quantifiers.

(3) a. (1a) $\equiv \forall[\textsc{student}][\Box[\textsc{study-hard}][\textsc{pass}(x)]]$
All students are such that studying hard must have resulted in success.
b. (1b) $\equiv \neg\exists[\textsc{student}][\Box[\textsc{study-hard}][\neg\textsc{pass}]]$
$\equiv \forall[\textsc{student}][\Diamond[\textsc{study-hard}][\textsc{pass}]]$
All students are such that it is possible that studying hard resulted in success.

1.1. The 'folkloric' solution: *if*-clauses restrict nominal quantifiers

One route around this problem questions whether QICs truly comprise embedded structures *à la* (2)-(3). A suggestion in the spirit of the Lewis-Kratzer conditional comes from von Fintel (1998). He suggests interpreting the *if*-clauses as restricting the nominal quantifiers directly. This yields the truth conditions in (4), which are both intuitively sensible and equivalent.

(4) a. (1a) $\equiv \forall[\textsc{student}\ \&\ \textsc{study-hard}][\textsc{pass}]$
All students who studied hard passed
b. (1b) $\equiv \neg\exists[\textsc{student}\ \&\ \textsc{study-hard}][\neg\textsc{pass}]$
No student who studied hard did not pass.

This 'folkloric' solution (named by von Fintel and Iatridou, 2002) is challenged by von Fintel and Iatridou (2002), Higginbotham (2003), and Huitink (2009). The main thrust of their objections involves comparisons between QICs and corresponding sentences where the *if*-clause is replaced by a relative clause attached directly to the overt restriction of the quantifier:

(5) a. Every coin is silver if it is in my pocket.
b. Every coin that is in my pocket is silver.

On the account in (4), these two sentences have identical truth conditions: treating the *if*-clause as restricting the quantifier domain should reduce it, functionally, to a restrictive relative clause. However, the sentences are not intuitively equivalent: (5a) suggests a non-accidental or rule-based connection between the location of a coin and its composition, which (5b) does not.

Leslie (2009) defends the restrictor analysis against this objection. She points out that the problematic QICs seem rule-oriented precisely because they appear to involve a generalization over multiple instances. That is, in the same way that (6a), on the standard restrictor account, has truth-conditions which require the specified coin to come up heads across all situations in which it is flipped, (6b) requires the same to hold of all the coins in the relevant domain.

(6) a. This coin comes up heads if it is flipped.
In all accessible worlds in which this coin is flipped, it comes up heads.
b. Every coin comes up heads if it is flipped.
In all accessible worlds, all of these coins that are flipped come up heads.

Leslie points out that a fair coin intuitively falsifies (6b), even if it happens to come up heads in a particular trial or set of trials. Thus, the truth conditions of (6) require quantification over situations, and suggest *modalizing* the restrictor account. On Leslie's proposal, *if*-clauses restrict nominal quantifiers, but, in cases like (6), this occurs below a wide-scope modal. This gives the truth conditions in (7) for our original QIC examples:

(7) a. (1a) $\equiv \Box\forall[\textsc{student}\,\&\,\textsc{study-hard}][\textsc{pass}]$
All accessible worlds are such that all students who studied hard passed.
b. (1b) $\equiv \Box\neg\exists[\textsc{student}\,\&\,\textsc{study-hard}][\neg\textsc{pass}]$
All accessible worlds are such that no students who studied hard did not pass.

As with von Fintel's (1998) solution, Leslie's *modalized restrictor conditional* provides sensible and equivalent truth conditions for these QICs. Her proposal arguably solves the problem of the contrast between QICs and restrictive relative clauses in cases like (5): the first case necessarily involves a modal quantifier, whereas the second does not.

(8) a. (5a) $\equiv \Box\forall[\textsc{coin}\,\&\,\textsc{in-my-pocket}][\textsc{silver}]$
In all accessible worlds, all coins in my pocket are silver.
b. (5b) $\equiv \forall[\textsc{coin}\,\&\,\textsc{in-my-pocket}][\textsc{silver}]$
In the actual world, all coins in my pocket are silver.

The 'non-accidental' connection in (5a) on this account emerges from quantification over accessible worlds. On the other hand, (5b) simply describes an actual-world situation.

1.2. The road ahead

Against this backdrop, Kratzer (in press) observes a new and surprising reading for certain QICs. In her examples, the conditional consequent appears to enter into the restriction of a nominal quantifier, and the conditional antecedent provides its scope (see Section 2). This seems to provide direct evidence against any kind of restrictor analysis.

This paper defends the restrictor conditional against this challenge. We argue that the key to 'reversed' readings of QICs comes from reverse proportional readings of quantified statements with *many* and *few* (Westerståhl, 1985). Building on Romero (2015), we propose that 'reverse' readings of *most*-QICs are instances of the relative reading of *most*, analyzed as the composition (Hackl, 2009; Romero, 2016) of parametrized MANY and the superlative, focus-sensitive morpheme *-est* (Heim, 1999). When composed with a restrictor analysis of conditionals, this predicts reverse readings for *most*-QICs in precisely the circumstances that Kratzer describes. We argue that our account improves on Kratzer's (in press) in terms of predictive power: reverse readings are predicted only for determiners (e.g., *most, many, few*) which contain the right focus-sensitive components, but not for other determiners (*every, all*, or *no*).

2. The reverse reading of *most*-QICs

Kratzer's empirical challenge centers on a previously unobserved reading for certain QICs:

(9) Most kids asked for calculators if they had to do long divisions. [Kratzer: pp.20-21]
  a. *Vanilla reading:* (standard)
  The majority of kids who had to do long divisions asked for calculators.
  $|\text{long-division kids} \cap \text{calculator kids}| > |\text{long-division kids} - \text{calculator kids}|$
  b. *Reverse reading:* (novel)
  The majority of kids who asked for calculators had to do long divisions.
  $|\text{calculator kids} \cap \text{long-division kids}| > |\text{calculator kids} - \text{long-division kids}|$

Given the standard interpretation (10) for *most*, the vanilla reading of (9) is easily generated. The contents of the *if*-clause appear to enter into the restriction ($A = \textsc{kid} \cap \textsc{do-long-div}$) of *most*, while the matrix clause provides its nuclear scope ($B = \textsc{use-calculator}$). This produces an interpretation equivalent to (9a).

(10) $Most[A][B] := |A \cap B| > |A - B|$

The reverse reading, on the other hand, is not so neat. Given (10), the matrix clause appears to enter the quantifier's restriction, while the *if*-clause provides its nuclear scope. This is a startling result, and it presents a serious problem for any restrictor analysis of *if*-clauses.

We concur with Kratzer that this new reading exists, and that it only emerges under very particular contextual conditions. (11) gives an appropriate context for reversal. Crucially, the matrix clause is backgrounded, while the *if*-clause provides new, or *focused* information.

(11) **You:** Did you see kids using calculators when you volunteered in your son's school yesterday? What did they use the calculators for?
Me: *Most kids asked for calculators if they had to do long divisions.* But I am pleased to report that most kids in my son's school do long divisions by hand.

The felicity of the sentence which follows (9) in the dialogue in (11) clearly demonstrates the reality of the reverse reading in this scenario. On the vanilla reading (9a), the final sentence directly contradicts the content of the QIC. On the other hand, if (9) is taken to mean (9b), it is perfectly coherent to continue with the information that the number of children doing long division by hand is greater than the number doing long division by other means.

Reverse readings do not seem to exist without the topic-focus structure illustrated in (11). In support of this point, consider (12), which backgrounds long division instead of calculator use.

(12) **You:** Did you see kids doing long division when you volunteered in your son's school yesterday? Were they able to do it by hand?
Me: *Most kids asked for calculators if they had to do long divisions.* #But I am pleased to report that most kids in my son's school do long divisions by hand.

Ultimately, the existence of reverse QIC readings in any context presents a serious challenge to restrictor analyses, whether folkloric, modalized, or otherwise. If the contents of an *if*-clause are entered into the restriction of a quantifier, it is not at all clear how they are available to provide its nuclear scope as well. Given the tools to hand, including the quantifier meaning (10) for *most*, it seems that we must give up on the concept of *if* as an operator on quantifier domains if we wish to be able to account for the empirical QIC terrain.

3. Kratzer's analysis

3.1. A bomb defused

Based on the arguments mentioned in the introduction, Kratzer's approach to the QIC problem begins from the premise that *if*-clauses do not restrict nominal quantifiers. Instead, she postulates a embedded structure in which a binary conditional operator ($\triangleright$) and its sentential arguments are fully contained in the nuclear scope of the quantifier, as shown in (13).

(13) a. (1a) $\equiv \forall[\text{STUDENT}][\text{STUDY-HARD} \triangleright \text{PASS}]$
b. (1b) $\equiv \neg\exists[\text{STUDENT}][\text{STUDY-HARD} \triangleright \neg\text{PASS}]$

Given this structure, Kratzer argues that $\triangleright$ must support the following set of logical inferences:

(14) a. **Modus ponens.** $\phi \triangleright \psi$ and ϕ jointly entail ψ
b. **Contraposition.** $\phi \triangleright \psi$ entails $\neg\psi \triangleright \phi$
c. **Conditional excluded middle.** For all ϕ, ψ: either $\phi \triangleright \psi$ or $\phi \triangleright \neg\psi$
d. **Weak Boethius' thesis.** $\phi \triangleright \neg\psi$ entails $\neg(\phi \triangleright \psi)$

The first two patterns are relatively standard assumptions in the literature on conditionals, although they are not without challenge (see McGee, 1985). (14c) follows from the structural assumption in (13), and the desired equivalence between (1a) and (1b):

(15)
$$\begin{array}{lll} & \forall x[\phi \triangleright \psi] \equiv \neg\exists x[\phi \triangleright \neg\psi] & \text{(desired equivalence, cf (1))} \\ \Longrightarrow & \forall x[\phi \triangleright \psi] \equiv \forall x \neg[\phi \triangleright \neg\psi] & \text{(DeMorgan's law)} \\ \Longrightarrow & \phi \triangleright \psi \equiv \neg[\phi \triangleright \neg\psi] & \\ \Longrightarrow & \neg[\phi \triangleright \psi] \equiv \phi \triangleright \neg\psi & \end{array}$$

(14d) follows from (14c), on the assumption that at most one of $\phi \triangleright \psi$ or its negation ($\phi \triangleright \neg\psi$) can be true. Given a bivalent logic, these inferences lead to a 'bombshell' for the semantics of conditionals (Pizzi and Williamson, 2005). Any connective $\triangleright$ which satisfies all of the properties in (14) must be equivalent to the material biconditional: $\phi \triangleright \psi \equiv \phi \supset \psi \wedge \psi \supset \phi$!

This result leaves Kratzer in a difficult position, since it is not plausible that natural language *if* ... *then* semantically expresses the material biconditional outside of QICs. The only apparent workaround is to suggest, as Kratzer does, that "some element in the syntactic environment of the embedded conditionals ... obscures their compositional meaning contribution." The particular element she appeals to is pragmatic domain restriction (von Fintel, 1994; Stanley and

Szabó, 2000), associated with the determiner. The argument proceeds as follows.

Kratzer proposes that (past-tense) QICs embed a material conditional. This leaves us with Higginbotham's original problem: (1a) and (1b) are no longer equivalent, and the truth conditions for (1b) (reproduced below) do not reflect its intuitive meaning.

(16) No student failed if she studied hard.
$\neg\exists[\textsc{student}][\textsc{study-hard} \supset \neg\textsc{pass}]$
All students both studied hard and passed.

Now, however, the quantificational determiner comes along with a domain variable. This variable is valued pragmatically, and its value ends up in the quantifier restriction.

(17) No$_D$ student failed if she studied hard.
$\neg\exists[\textsc{student}\,\&\,D][\textsc{study-hard} \supset \neg\textsc{pass}]$

Kratzer suggests that a natural default for the value of D is the *if*-clause. Since this is also part of the material conditional, this means that *if*-clauses in 'neutral' QICs perform double duty: as pragmatic restrictors of nominal quantifiers and as antecedents of embedded conditionals.

(18) No$_D$ student failed if she studied hard.
$\neg\exists[\textsc{student}\,\&\,\textsc{study-hard}(=D)][\textsc{study-hard} \supset \neg\textsc{pass}]$

If the conditional antecedent is pragmatically assigned to the domain variable, as in (18), its role in the conditional becomes redundant, and we wind up with the interpretation in (19c). von Fintel (1998)'s folkloric solution, (4), in which the *if*-clause was taken to semantically restrict the quantifier domain. As a result of this, the combination of an embedded conditional with pragmatic domain restriction does indeed produce interpretive equivalence between (1a) and (1b).

(19) Every$_D$ student passed if she studied hard.
a. **Semantic meaning:** $\forall[\textsc{student}][\textsc{study-hard} \supset \textsc{pass}]$
b. **After pragmatic restriction:**
$\forall[\textsc{student}\,\&\,\textsc{study-hard}][\textsc{study-hard} \supset \textsc{pass}]$
c. **Equivalent to:** $\forall[\textsc{student}\,\&\,\textsc{study-hard}][\textsc{pass}]$

(20) No$_D$ student failed if she studied hard.
a. **Semantic meaning:** $\neg\exists[\textsc{student}][\textsc{study-hard} \supset \neg\textsc{pass}]$
b. **After pragmatic restriction:**
$\neg\exists[\textsc{student}\,\&\,\textsc{study-hard}][\textsc{study-hard} \supset \neg\textsc{pass}]$
c. **Equivalent to:** $\neg\exists[\textsc{student}\,\&\,\textsc{study-hard}][\neg\textsc{pass}]$

The semantic meanings in (19a) and (20a) do not reflect the perceived equivalence of (1a) and (1b). This means that the conditional operator $\supset$ need not satisfy *conditional excluded middle* (14c) and *weak Boethius' thesis* (14d), and Pizzi and Williamson's bombshell does not apply.

3.2. Reversal

Reverse readings enter the picture at this point, as evidence of the process of pragmatic domain restriction. In the unmarked case, domain restriction proceeds as above: the antecedent enters into the restriction of the quantifier, and we obtain the vanilla reading for a conditional like (9).

(21) Most$_D$ kids asked for calculators if they had to do long divisions.
- a. **Semantic meaning:** *Most*[KID][LONG-DIV ⊃ CALC]
- b. **After pragmatic restriction:** *Most*[KID & LONG-DIV][LONG-DIV ⊃ CALC]
- c. **Equivalent to:** *Most*[KID & LONG-DIV][CALC]
- d. **Paraphrase:** *Most kids who had to do long divisions used calculators.*

However, since domain restriction occurs pragmatically, it should be possible for something other than the conditional antecedent to value the domain variable D. Kratzer suggests that this happens in marked (non-neutral) cases, like the context in (11). Specifically, a reverse reading is predicted if the domain variable picks up the conditional consequent as its value: this situation plausibly occurs when the consequent is backgrounded and the antecedent is focused.

(22) Most$_D$ kids asked for calculators if they had to do [long divisions]$_{\mathbf{F}}$.
- a. **Semantic meaning:** *Most*[KID][LONG-DIV ⊃ CALC]
- b. **After pragmatic restriction:** *Most*[KID & CALC][LONG-DIV ⊃ CALC]
- c. **Paraphrase:** *Most kids who used calculators either did not have to do long divisions or used calculators (to do them).*

If D is the conditional consequent, the embedded material conditional is not reducible, and we get the interpretation in (22). This is not quite the meaning we are after: note that (22) is satisfied if most of the students who used calculators simply did not have to do long-divisions. To get us to the correct interpretation, on which most of the calculator users did in fact have to do long divisions, Kratzer posits that the conditional operator in this case must be interpreted biconditionally, via an embedded application of *conditional perfection* (Geis and Zwicky, 1971).

(23) Most$_D$ kids asked for calculators if they had to do long divisions]$_{\mathbf{F}}$.
- a. **Semantic meaning:** *Most*[KID][LONG-DIV ⊃ CALC]
- b. **After pragmatic restriction:** *Most*[KID & CALC][LONG-DIV ⊃ CALC]
- c. **After embedded perfection:** *Most*[KID & CALC][LONG-DIV ≡ CALC]
- d. **Equivalent to:** *Most*[KID & CALC][LONG-DIV]
- e. **Paraphrase:** *Most kids who used calculators had to do long divisions.*

If perfection turns the embedded conditional into a biconditional, we wind up in a similar position as in (19) and (20). In this case, since it is the consequent that enters the restriction of the quantifier, it is the consequent that is redundant. This results in the interpretation indicated in (23d) and (23e), which effectively reverses the roles of conditional antecedent and consequent as compared to the neutral case in (21).

3.3. The consequences

Kratzer's approach represents a rather radical move. The account she presents is ultimately non-compositional: even the accessible vanilla interpretation of QICs like (1a)-(1b) does not result from the simple composition of a conditional with a wide-scope nominal quantifier, but also requires the input of a pragmatic operation which – crucially – can have a different outcome. In addition, the appeal to conditional perfection for the reverse reading is not wholly innocent. For one, it must be applied in an embedded position, which throws into question its widely-accepted status as a pragmatic inference. Moreover, conditional perfection in many cases strengthens a conditional to something weaker than a full biconditional: for instance, *if p, then q* may suggest that *q* is not unconditional, rather than the full converse, *if not p, then not q* (von Fintel, 2001; Franke, 2009). If conditional perfection is to unerringly produce the result required for the derivation in (23), it seems that we will require a new, more direct, mechanism.

Finally, there is a rather more immediate problem with Kratzer's account: it makes incorrect predictions. Concretely, the crucial feature in producing a reverse interpretation for a conditional is the presence of focus within the antecedent; properties of the wide-scope quantifier do not play a role. As a result, reverse readings should exist, given the right context, for QICs with any quantifier, not just with *most*. This is not the case: these readings are unattested with the universal quantifier (24), and do not arise even when the appropriate context is provided (25).[2]

(24) Every kid asked for a calculator if she had to do long divisions.
  a. **Predicted vanilla reading (attested):**
  All kids who had to do long divisions asked for calculators.
  b. **Predicted reverse reading (unattested):**
  All kids who asked for calculators were ones who had to do long divisions.

(25) **You:** Did you see kids using calculators when you volunteered in your son's school yesterday? What did they use the calculators for?
Me: *Every kid asked for a calculator if she had to do long divisions.* #But I am pleased to report that some kids in my son's school do long divisions by hand.

As in (11), a reverse reading of the conditional in (25) would be compatible with the given continuation, but the vanilla reading produces a contradiction. We find only the latter case, against the prediction made by Kratzer's account.

We suggest that it is not an accident that the first attestation of a reverse reading uses the quantifier *most*. Rather, it is because the choice of quantifier plays a role in the availability (and derivation) of these interpretations. Together with the theoretical issues noted above, Kratzer's problematic predictions make holding out for a different analysis of QICs an attractive option. A suitable analysis, we propose, should (i) derive the equivalence of (1a) and (1b) as the outcome of semantic composition. It should also (ii) account for the existence of reverse readings in the contexts described by Kratzer – but it should, crucially, only do this for the quantifiers which actually exhibit these readings.

[2]The two readings are equivalent under *no*, due to the symmetric property of this determiner.

We have already seen that a restrictor analysis can deliver on (i). In the remainder of this paper, we show that it can also deliver on (ii): when the properties that differentiate quantifiers like *most* from those like *every* (and *no*) are taken into account, a restrictor analysis is not only able to produce reverse readings but also improves on Kratzer's predictions in this regard. Crucial inspiration for our account comes from recent work on reverse proportional readings of *many*.

4. The reverse-proportional reading of *many*

Descriptively, we can distinguish at least three meanings for sentences of the form *Many Ps are Qs*. The first two are the *cardinal* reading in (27) and the *proportional* reading in (28).

(26) Many Scandinavians have won the Nobel Prize in literature.

(27) **Cardinal:** $Many_{\text{card}}[P][Q] \equiv |P \cap Q| > n$, where n is 'large' number.
The number of Scandinavians NP-lit winners is large.

(28) **Proportional:** $Many_{\text{prop}}[P][Q] \equiv \frac{|P \cap Q|}{|P|} > k$, where k is a 'large' proportion.
The ratio of Scandinavian NP-lit winners to all Scandinavians is high.

Westerståhl (1985) points out that, with 14 Scandinavian Nobel winners (as of 1984) and millions of Scandinavians, both these readings likely come out false. And yet, (26) appears to have a reading on which it is true, and this is intuitively so because 14 Scandinavians out of 81 Nobel Prize winners "seems rather (too?) many" (p. 403). But neither (27) nor (28) compares the number of Scandinavian winners ($|P \cap Q| = 14$) to the number of all winners ($|Q| = 81$). We can characterize this 'reverse proportional' reading as in (29).

(29) **Reverse proportional:** $Many_{\text{r-prop}}[P][Q] \equiv \frac{|P \cap Q|}{|Q|} > k$, where k is a 'large' proportion.
The ratio of Scandinavian NP-lit winners to all NP-lit winners is high.

Note that the reverse proportional reading is just the proportional reading with the arguments reversed, *i.e.*, $Many_{\text{r-prop}}[P][Q] \equiv Many_{\text{prop}}[Q][P]$. Just as antecedent and consequent seem to 'switch places' in the reverse readings of *most*-QICs, the nominal complement and the VP seem to 'switch places' in the reverse proportional reading of *many*.

Stipulating (29) as a separate lexical meaning of *many* is undesirable not only on general grounds (Grice's 'modified Occam's razor'), but also because, if (29) were the meaning of a lexicalized determiner, it would violate the *conservativity universal* (Barwise and Cooper, 1981; Keenan and Stavi, 1986). Consequently, several authors have sought to reduce (29) to one of the the other recognized readings. Here, we draw on Romero (2015)'s analysis of the reverse proportional reading, as it is the one most readily adapted to our purposes. Romero extends Hackl's (2000, 2009) account of *more* and *most* as the combination of an underlying operator MANY with the comparative *-er* and the superlative *-est*, respectively. Likewise, Romero takes English *many* to decompose into MANY plus the (silent) positive morpheme POS that is also present in the positive form of adjectives (von Stechow, 1984).

Romero also draws on arguments by Schwarz (2010) showing that POS displays a relative/absolute ambiguity, and combines this with Herburger's (1997) observation that the reverse proportional reading is facilitated by stress on the first argument of the determiner. Consequently, she provides a lexical entry for POS that is dependent on a set of alternatives generated by an alternative semantics (Rooth, 1992), much as in Heim (1999)'s analysis of the superlative.

Romero takes the underlying operator MANY to be ambiguous between a cardinal and a proportional reading. Both are 'parameterized determiners' in the sense of Hackl (2000), i.e., they have generalized determiner meanings with an extra (degree) argument. $\text{MANY}_{\text{card}}$ simply counts the individuals that jointly satisfy both its non-degree arguments, while $\text{MANY}_{\text{prop}}$ computes their proportion. Both of these meanings are conservative for any fixed degree d.

(30) a. $\text{MANY}_{\text{card}} := \lambda d_n \lambda P_{et} \lambda Q_{et}. |P \cap Q| \geq d$, where n is the degree-type.
b. $\text{MANY}_{\text{prop}} := \lambda d_n \lambda P_{et} \lambda Q_{et}.(|P \cap Q| : |P|) \geq d$

In order to yield a truth-evaluable statement, both these operators must combine with a degree operator like POS (for surface *many*), comparative *-er* (*more*) or superlative *-est* (*most*). POS combines with a property P of degrees and claims that there is a degree d of which P is true and which exceeds the standard of comparison θ. Crucially, this standard of comparison is calculated on the basis of a comparison class **C** (a set of degree properties):[3]

(31) $\text{POS} = \lambda \mathbf{C}_{nt,t} \lambda P_{nt}. \exists d[P(d) \wedge d > \theta(\mathbf{C})]$
where θ is a function that maps comparison classes to degrees.[4]

As in Heim (1999)'s analysis of the superlative, the degree morpheme scopes independently and uses focus structure to constrain **C**: the comparison class must be a subset of the focus-alternative value of the sister of POS.

With these ingredients, Romero derives the two proportional readings (standard and reverse) from the single lexical entry for $\text{MANY}_{\text{prop}}$, as follows: on both readings, POS moves out of the DP to the sentence level. As is standard for QR in LF-based theories, POS leaves behind a trace (of type n in this case) that is bound by a lambda abstract created by the movement operation. That is, on both proportional readings, the sentence in (32a) has a logical form like the one sketched in (32b).

(32) a. Many Scandinavians vacation in the countryside.
b. $\big[[\text{POS}\ \mathbf{C}]\ \big[1\ \big[t_1\text{-MANY}_{\text{prop}}\ [\text{ Scandinavians }]\ [\text{ vacation in countryside }]\big]\big] \sim \mathbf{C}\big]$

What differs between the two readings is the focus structure of the sentence, which results in

[3] Romero's entry is more complicated because she also aims to decompose *few* into MANY, POS and an antonymizing morpheme LITTLE, *à la* Heim (2006). To achieve this, Romero uses the analysis from von Stechow (2009), according to which POS claims that its degree property argument is true of all degrees contained in the 'neutral segment' of the scale. This complication is not relevant for our purposes here.

[4] Romero takes the value delivered by θ to be dependent on the distribution of values over its comparison class argument, *cf.* Fernando and Kamp 1996; Schöller and Franke 2015.

different comparison classes. If the focus (or contrastive topic)[5] is outside of the restriction of the quantifier, a regular proportional reading results:

(33) Many Scandinavians vacation [in the countryside]$_{\mathbf{F}}$.

a. **Logical form:**
$\big[[\text{POS}\ \mathbf{C}]\ \big[1\ \big[t_1\text{-MANY}_{\text{prop}}\,[\text{ Scandinavians }]\,[\text{ vacation in countryside}_{\mathbf{F}}\ ]\big]\big] \sim \mathbf{C}\big]$

b. **Alternatives:**

$$[\![\mathbf{C}]\!] \subseteq \left\{ \begin{array}{llll} \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Scandinavians} &][& \text{vacation in countryside} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Scandinavians} &][& \text{vacation at the beach} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Scandinavians} &][& \text{vacation in the mountains} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Scandinavians} &][& \text{vacation in urban centers} \quad], \\ \ldots \end{array} \right\}$$

c. **Truth-conditions:**
$\exists d : d\text{-MANY}_{\text{prop}}[\text{ Scandinavians }][\text{ vacation in countryside }]\ \&\ d > \theta([\![\mathbf{C}]\!])$

d. **Paraphrase:**
The proportion of Scandinavians who vacation in the countryside is high compared to the proportion of Scandinavians vacationing in other places.

The reverse proportional reading emerges if the focus/contrastive topic instead occurs within the restrictor of *many*:

(34) Many [Scandinavians]$_{\mathbf{F}}$ vacation in the countryside.

a. **Logical form:**
$\big[[\text{POS}\ \mathbf{C}]\ \big[1\ \big[t_1\text{-MANY}_{\text{prop}}\,[\text{ Scandinavians}_{\mathbf{F}}\ ]\,[\text{ vacation in countryside }]\big]\big] \sim \mathbf{C}\big]$

b. **Alternatives:**

$$[\![\mathbf{C}]\!] \subseteq \left\{ \begin{array}{llll} \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Scandinavians} &][& \text{vacation in countryside} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Mainland Europeans} &][& \text{vacation in countryside} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{Americans} &][& \text{vacation in countryside} \quad], \\ \lambda d'.d'\text{-MANY}_{\text{prop}}[& \text{East Asians} &][& \text{vacation in countryside} \quad], \\ \ldots \end{array} \right\}$$

c. **Truth-conditions:**
$\exists d : d\text{-MANY}_{\text{prop}}[\text{ Scandinavians }][\text{ vacation in countryside }]\ \&\ d > \theta([\![\mathbf{C}]\!])$

d. **Paraphrase:**
The proportion of Scandinavians who vacation in the countryside is high compared to the proportion of people from other world regions who vacation in the countryside.

Romero's truth-conditions are not exactly those characterized in (28)–(29). For example, applying the semantics of (29) to (32a) would require that the ratio comparing Scandinavian countryside-vacationers to all countryside-vacationers worldwide is 'high'. (34) instead compares the ratio of Scandinavian countryside-vacationers to Scandinavians against the analogous ratio for other world regions. Romero argues that her truth-conditions are superior.[6]

[5] Romero leaves open whether stress marks focus (as assumed by Herburger 1997) or contrastive topic (as argued by Cohen 2001). We follow her in this regard, but to ease readability we will mark the stressed constituent with **F** rather than **F/CT**.

[6] Cohen (2001) argues that the number of all Scandinavians is relevant to the inverse proportional reading. To this, Romero adds examples showing that the individual alternative ratios must be taken into account. Whether or

5. The reverse reading as a relative reading of *most*

5.1. Our proposal

In a nutshell, our proposal is that the reverse reading of *most*-QICs arises as an instance of the relative reading of *most*/*-est*, which is analyzed in the manner of Heim (1999) and Hackl (2009). The only assumption that needs to be added is that the *if*-clause restricts the underlying 'parameterized determiner.' With this, the derivation of the reverse reading of *most*-QICs is entirely parallel to Romero's derivation of the reverse proportional reading of *many*.

(35a) repeats the definition of $\text{MANY}_{\text{card}}$. In (35b), we give a Heim (1999)-style meaning for *-est*. Following Romero's analysis, *-est* moves to the sentence level to gain scope. With focus in the *if*-clause, a restrictor analysis gives us the logical form sketched in (35c).[7]

(35) a. $\text{MANY}_{\text{card}} := \lambda d_n \lambda P_{et} \lambda Q_{et}.\, |P \cap Q| \geq d$
b. $[\![\textit{-est}]\!] = \lambda \mathbf{C}_{dt,t} \lambda P_{dt}.\exists d \big[P(d)\, \&\, \forall C \in \mathbf{C}[C \neq P \to \neg C(d)]\big]$
c. Most students asked for calculators if they had to do [long divisions]$_{\mathbf{F}}$.
Logical form:
[[*-est* **C**] [1 [t_1-$\text{MANY}_{\text{card}}$ [kid & had to do [long division]$_{\mathbf{F}}$] [asked for calculator]]] $\sim$ **C**]

Again, **C** is required to be a subset of the focus-semantic value of the LF-sister of *-est*. This leads to a set of alternatives like (36), where *long divisions* contrasts with other problem types.

(36) **Alternatives:**

$$[\![\mathbf{C}]\!] \subseteq \left\{ \begin{array}{lllll} \lambda d'.d'\text{-MANY}_{\text{card}}[& \text{kid} & \& & \text{had-to-do-long-division} &][\text{asked-for-calc}], \\ \lambda d'.d'\text{-MANY}_{\text{card}}[& \text{kid} & \& & \text{had-to-do-multiplication} &][\text{asked-for-calc}], \\ \lambda d'.d'\text{-MANY}_{\text{card}}[& \text{kid} & \& & \text{had-to-do-decimals} &][\text{asked-for-calc}], \\ \ldots & & & & \end{array} \right\}$$

The resulting truth-conditions are spelled out in (37a) and paraphrased in (37b):

(37) a. **Truth-conditions**:
$\exists d : d\text{-MANY}_{\text{card}}[\text{kid}\,\&\,\text{had-to-do-long-division}][\text{asked-for-calc}]$
$\wedge \forall C \in \mathbf{C}:$
$C \neq \lambda d'.d'\text{-MANY}[\text{kid}\,\&\,\text{had-to-do-long-division}][\text{asked-for-calc}] \to \neg C(d)$
b. **Paraphrase:**
The number of calculator-using kids who had to do long divisions was larger than the number of calculator-using kids doing any other problem type.

not this dependence on ratios needs to be part of the denotation of *many* is subject to debate. For example, Penka (2018) proposes that, semantically, all three readings are derived from a version of $\text{MANY}_{\text{card}}$, and that the apparent dependence on ratios in certain examples instead results from the way the function θ determines the standard on the basis of the comparison class. For our purposes, we can set this debate aside. We will be using $\text{MANY}_{\text{card}}$ in our analysis of *most*-QICs, remaining agnostic whether there is, in addition, a $\text{MANY}_{\text{prop}}$.

[7] In our LF-sketches, we add the content of the *if*-clause as a conjunct of the restrictor of $\text{MANY}_{\text{card}}$. This is done for ease of exposition only, and we do not intend to claim that *if*-clause is actually part of the first argument of the determiner. In fact, there are good reasons to think that any workable restrictor analysis must reject this possibility, as we discuss in Section 5.2 below.

The truth-conditions in (37) importantly differ from the ones in Section 2, repeated in (38):

(38) $|\text{calculator kids} \cap \text{long-division kids}| > |\text{calculator kids} - \text{long-division kids}|$

(37) characterizes a true relative reading, which only requires that the set of kids doing long divisions contained the largest group of calculator users. By contrast, (38) requires that more than half of the calculator users were long-divisioners. It is easy to see that the two readings can come apart in a situation where there are more than two problem types, namely if the largest group of calculator users for a given problem type is less than half of all calculator users. We think that the reading we derive is at least as appropriate as the alternative.[8]

This account correctly predicts that the reverse reading is only available when material in the *if*-clause is focused. More importantly, it also correctly predicts that this reading is only available for determiners that are focus-sensitive in the right way, and hence, unlike Kratzer's account, it does not predict the reverse reading for QICs with *every*.[9]

We do predict reverse readings for *many* and *few*, paraphrased in (39) and (40), respectively, on the assumption that these contain a Romero-style parameterized determiner. According to our intuitions, (39) and (40) are true in scenarios which satisfy their putative paraphrases. It is hard, however, to evaluate what this shows, given that with *many* (unlike with *most*), truth-value judgements are dependent on judgements of what counts as a 'high' number or proportion, relative to a comparison class.

(39) Many kids asked for calculators if they had to do [long divisions]$_{\mathbf{F}}$.
Putative 'reverse' reading:
The number/proportion of calculator users among the long-division kids was high compared to the number/proportion of calculator users doing other problem types.

(40) Few kids asked for calculators if they had to do [long divisions]$_{\mathbf{F}}$.
Putative 'reverse' reading:
The number/proportion of calculator users among the long-division kids was low compared to the number/proportion of calculator users doing other problem types.

5.2. *If*-clauses vs. relative clauses

Any restrictor account has to deal with the fact that QICs are not always equivalent to the analogous sentence where a relative clause replaces the *if*-clause. Our example sentences are a case in point: (41) has the vanilla reading, but does not have the reverse reading.

[8] Suppose the speaker has visited three classes of 20 children each. Each class did different kinds of problems: long division, logarithm and multiplication. 3 students in the logarithm class and 3 students in the multiplication class asked for calculators, and 8 students in the long division class did. To our ears, (35c) can be true in this situation, but we admit that the intuitions are somewhat subtle.

[9] Hallman (2016) proposes to analyze *all* as a superlative(-like) operator. Depending on the implementation, this analysis potentially predicts the reverse reading for a sentence like *All students asked for calculators if they had to do long divisions*.

(41) Most kids who had to do long divisions asked for calculators.

The absence of the reverse reading for (41) arguably can be attributed to a constraint that is independently needed (and hence motivated, see Romero 2015, 2016):

(42) **Constraint:** On a relative reading, the **F**-associate of *-est* cannot be internal to the DP where *-est* originates.

This constraint is active in examples with adjectival superlatives and *the most* (Pancheva and Tomaszewicz 2012):

(43) John has the best albums by $[\text{U2}]_{\mathbf{F}}$.
'John has better albums by U2 than by any other band.'

(44) John has the most albums by $[\text{U2}]_{\mathbf{F}}$.
'John has more albums by U2 than by any other band.'

Pancheva and Tomaszewicz (2012) provide an account of these facts. They also account for the fact that these readings actually are available in languages like Bulgarian and Polish as long as the DP where *-est* originates is not marked as definite. This explanation obviously does not directly translate to English DPs headed by *most* without a definite determiner, but the same constraint is needed for 'bare' *most* on any analysis that allows the determiner to have relative readings.[10] Otherwise, such accounts predict the analogue of the 'reverse proportional' reading of *many* for (45), contrary to fact:

(45) Most $[\text{Scandinavians}]_F$ have won the nobel prize in literature.
'The number/proportion of Scandinavian NP-lit winners is larger than the number/proportion of NP-lit winners from any other world region.'

We want to suggest the following view. Even though in QICs, *if*-clauses restrict the quantifier in subject position, they are not 'internal to the DP' in the sense relevant to the constraint in (42), while relative clauses are. Thus, *if*-clauses allow speakers of English to circumvent the constraint and hence are the only environment where reverse readings of *most* can be produced.

Interestingly, as Romero (2016) notes, the putative ambiguity of the underlying parameterized determiner ($\text{MANY}_{\text{card}}$ vs $\text{MANY}_{\text{prop}}$) is obscured with *most* unless the focus falls within the restriction of the determiner. This means that, in English, QICs are are the only known environment where one could test whether there is a $\text{MOST}_{\text{prop}}$ ($\text{MANY}_{\text{prop}}$ + *-est*) in addition to $\text{MOST}_{\text{card}}$ ($\text{MANY}_{\text{card}}$ + *-est*). The crucial kind of scenario is given in (46).

[10] There is documented inter-speaker variation with respect to the acceptability of relative readings with bare *most*. Kotek et al. (2011, 2015) found evidence that only about a third of speakers could access a relative reading (which they dub the 'superlative reading'). To our knowledge, no speakers perceive a reverse reading for (45).

(46) In a class of 35 students, 10 had to practice long division, the rest had to practice multiplication problems. 5 of the long division kids asked for calculators, while 7 of the multiplication kids did.

According to our intuitions, Kratzer's example does not seem to have a true reading in this scenario, i.e., there is no evidence for $\textsc{most}_{\text{prop}}$. This is in line what Romero reports for Bulgarian and Polish, where the difference between $\textsc{most}_{\text{card}}$ and (putative) $\textsc{most}_{\text{prop}}$ can be tested outside of conditionals as well.

5.3. Alternative accounts?

It might be thought that all that is needed to account for reverse readings is the basic idea underlying our analysis, *viz.*, that reverse readings are relative readings. With this, one might think, any analysis of relative readings of *most* and any analysis of QICs can be combined to account for reverse readings. But this is not so: the space of options is actually quite constrained.

Our account is built on a Romero/Hackl-style analysis of *most* which has several salient alternatives that may be preferable on independent grounds. Penka (2018) develops a more parsimonious version of Romero's account, insofar as she dispenses with the need for $\textsc{many}_{\text{prop}}$ in addition to $\textsc{many}_{\text{card}}$. Likewise, Beaver and Coppock (2014) provide an alternative analysis of *(the) most*, which Coppock and Josefson (2014) have argued is better equipped to handle the crosslinguistic variation in the distribution of the different readings of *(the) most*. What both these alternatives share in common is that they analyze *most* not as a 'parameterized determiner', but instead as a noun phrase modifier. As a consequence, it is not immediately obvious that these analyses can be combined with a restrictor analysis of QICs.

The problem is that the sentences in question must contain a quantifier for *if* to restrict. Penka's analysis, in theory, features such an operator, as she assumes that sentences with bare *most* receive their quantificational force from a silent existential determiner $\emptyset$. But it is not clear that it is plausible to assume that *if*-clauses restrict $\emptyset$ in our examples, because quantifiers headed by *overt* existential determiners generally cannot be restricted by *if*-clauses: *Some students passed if they studied hard* does not have a reading on which it says that there are some students that both studied hard and succeeded. Things are even worse on Beaver and Coppock's account, where there is no quantificational operator in the structure of sentences with definites and indefinites (including *the most*)—instead, these DPs gain quantificational force (or reference) via a type-shifting operation when they are in argument position. As a consequence, it is not clear how a restrictor analysis would combine with their account. This is not to say that either of these accounts could not be made compatible with a restrictor analysis, suitably spelled out. Maybe Penka's $\emptyset$ is different from overt existentials in a way that allows it to be restricted by *if*-clauses. Likewise, a suitable specification of the syntax-semantics interface could allow *if*-clauses to restrict the output of the type shifting operation in Beaver and Coppock's account.[11] All that we want to note here is that such a combination will not work 'out of the box.'

[11] Alternatively, Beaver and Coppock allow for the possibility that bare *most* is a an operator that is not derivationally related to the *most* in *the most*-DPs. This *most* could be a *bona fide* determiner, which *if* could restrict.

Proponents of such alternative accounts may hence be especially interested in alternative accounts of QICs. Unfortunately, such alternatives do not seem workable to us. Let $\textsc{most}_{\text{rel}}$ be an arbitrary account of relative *most*, and suppose that QICs have a full conditional structure embedded under the quantifier, as in (47):

(47) $\textsc{most}_{\text{rel}}$ [kids] [had to do long divisions $\triangleright$ asked for calculators]

In order to derive the truth conditions we derive, $\textsc{most}_{\text{rel}}$ has to compare the number of calculator users that had to do long division in relation to the number of calculator users that had to do other problem types. The question is how it can do that on an analysis like (47) without assuming that *if . . . then* can mean *and* when embedded under a quantifier.

6. Conclusion and outlook

We have shown that the reverse reading does not provide an insurmountable challenge for a restrictor analysis of QICs. On the contrary, on a restrictor analysis, the reverse reading emerges rather straightforwardly as an instance of the relative reading of *most*, given a number of independently motivated ingredients. Some open issues remain.

Empirically, it is worth noting that not all speakers can access the reverse reading in *most*-QICs. Even those that can perceive the reading, do so only under favorable circumstances. This is not entirely unexpected on our account, as it has been shown (e.g., Kotek et al., 2015) that only a subset of speakers can access relative readings with bare *most*, and that even for those speakers, this reading is not dominant. Our account of the reverse reading makes a clear prediction that lends itself to experimental testing: The speakers who can access reverse readings of *most*-QICs should be the same ones that perceive relative readings with *most* more generally.

Theoretically, while Leslie's extended restrictor analysis is promising, it remains to be seen whether it can be spelled out in a way that deals with all challenges that have been identified in the literature. An additional question is why the presence of an *if*-clause restricting a nominal quantifier forces the presence of a wide-scope modal. At the same time, the interaction of *if*-clauses, the putative wide-scope modal, and tense deserves closer attention. Kratzer notes that some of the problematic differences between *if*-clauses and relative clauses disappear in the past tense. For example, consider the pair in (48). (48a) appears to quantify not only over actual goofers, but also students who *could* goof off, even though in actuality they do not (Leslie 2009). (48b), by contrast, only makes a claim about students who actually goofed off.

(48) a. Every student will fail if she goofs off.
b. Every student failed if she goofed off.

This contrast can arguably be accounted for if the wide-scope modal in Leslie's analysis quantifies over *historical alternatives* at the utterance time (Condoravdi, 2002). This quantification is trivialized in the past-tense, but not in the present and the future. More generally, we conjecture that many, if not all, apparent challenges for a restrictor analysis can be explained by a combination of (i) the presence of a wide-scope modal, (ii) temporal interpretation, and (iii) the fact that domain restriction proceeds differently with *if*-clauses than with relative clauses. We intend to investigate the details of this idea in future work.

Open issues notwithstanding, we think that the existence of reverse readings (for some speakers) evens the score a bit: As noted in Section 5.3, it is not at all clear that non-restrictor accounts can analyze reverse readings as relative readings. Such accounts consequently face the challenge of how to predict these readings in a way that accounts for their distribution across determiners. As we have shown, restrictor accounts succeed on this front: hence, even skeptics should agree that they deserve another look.

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