

## The topology of distributivity and epistemic containment phenomena\*

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### 1. Introduction: Scope, and the epistemic containment principle

Scope ambiguities between quantificational expressions are often evinced when more than one is present in a single clause, leading many researchers to suppose that the means of scope-taking for these elements is relatively free. Such interactions are not limited to quantificational noun phrases (QPs): indeed, QPs and modal expressions sometimes scopally interact, e.g. as in (1).

- (1) Mary can lift every box in this room

**can** > **every**: *Mary has the ability to lift all  $x$ ,  $x$  a box in this room*

**every** > **can**: *For all  $x$ ,  $x$  a box in this room, Mary has the ability to lift  $x$*

Scope interactions between QPs first influenced the proposal of the syntactic mechanism of the quantifier rule (QR; May (1977), (1985)), whose relatively free application treated QPs uniformly, in line with a view as in (2). Much work since, however, has argued that different types of quantificational expressions take scope differently, leading to an alternative view that may be formulated as in (3) (Beghelli & Stowell 1997, henceforth B&S; Szabolcsi (1997)).

- (2) **Scope Uniformity**

Quantifier Raising (QR) applies uniformly to all QPs. Neither QR nor any particular QP is landing-site selective; in principle, any QP can be adjoined to any (non-argument) XP.

(B&S (1997), p.72)

- (3) **Scope Diversity**

Distinct QP types have distinct scope positions and participate in distinct scope assignment processes.

(Beghelli (1997), p.369)

In this paper, we pursue the latter perspective, and consider the predictions it makes for accounting for phenomena first discussed by von Stechow and Iatridou (2003; henceforth F&I). In particular, those authors sought to explain why only an inverse scope reading obtains with QPs in the environment of epistemic modals (EMs), e.g. as in (4).<sup>1</sup>

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<sup>1</sup> That only an inverse scope reading obtains in any environment is surprising given that, with most examples of quantificational expressions exhibiting a scope ambiguity, the surface scope is generally highly preferred, e.g. *Some girl likes every professor*.

- (4) Every girl in this room might have kissed John yesterday

**\*every** > **might**: *for all x, x a girl in this room, it is possible that x kissed John yesterday.*

**might** > **every**: *it is possible that, for all x, x a girl in this room, x kissed John yesterday.*

To see that only the inverse scope obtains between the *every*-QP and *might* in (4), consider a context in which, of the 5 girls in the room, we know that 2 definitely kissed John, and 2 definitely did not, but we haven't yet been able to figure out which girls kissed him and which girls didn't. In this case, the surface scope *every* > *might* would be true if it were available; yet, the only reading of that sentence corresponds to the inverse scope, which in this context is false. The observation of this fact led F&I to propose the ECP as a condition on QR affecting strong quantifiers.<sup>2</sup>

- (5) **Epistemic Containment Principle (ECP):**

A QP cannot bind its trace across an epistemic modal.

(F&I, p181)

If the ECP constrains the application of a relatively free QR, then it should apply to any QP that is thought to take scope by means of this rule. We observe that *each*-QPs, despite being very similar in meaning to *every*-QPs, behave differently with respect to EMs.<sup>3</sup> In particular, if we set up a similar context to the one above, namely one in which it is certain that some number of the girls are in love with John, but some number most certainly aren't, while the identity of the lovers and the non-lovers is unknown, (6a) is anomalous where (6b) is not.

- (6) a. #Every girl might be in love with John, but some of them aren't  
b. Each girl might be in love with John, but some of them aren't

The cause of this is that, in (6a-b), the second conjunct is only compatible with a surface reading of the first conjunct, where the QP scopes over the EM (*for every girl x, it is possible that x is in love with John*). The inverse scope reading (the only reading predicted to exist by the ECP) is incompatible with the second conjunct (*it is possible that for every x, x loves John*). The fact that the sentence with *each* is not anomalous, we contend, is due to this QP's ability to take scope above the EM, whereas the *every*-QP is not so able.

That *each* and *every* behave differently in this way is unexpected if the ECP is a real grammatical constraint; we thus question whether the differential facts with *each*- and *every*-QPs in the environment of EMs can be given an alternate explanation.

<sup>2</sup> F&I observe the ECP holding for QPs headed by *every*, *most*, *fewer than half*, and *two*. Given space constraints, we will not consider all of these QPs here, only *every* and *each*.

<sup>3</sup> This was similarly observed by Tancredi (2007) and Huitink (2009), although these authors did not explore an explanation for this fact.

## 2. Non-uniform epistemic containment

Our proposal is similar in some aspects to one that F&I briefly discuss in their paper. In particular, we question their intuition that a clause topology account of the non-interaction between QPs with *every* and EMs could not adequately account for the relevant data. Combining a theory like that of B&S, in which QPs take scope at different syntactic heights, with the idea that there are two syntactic positions for modals – a high one for EMs, and a low one for root modals – we show that F&I’s conjecture cannot be correct once the details are worked out.

B&S observed that *each*- and *every*-QPs show different scope-taking possibilities in certain configurations (e.g., in the environments of negation, *wh*- and generic operators). One crucial assumption they make is that these differential patterns of behavior are due to the fact that, while both *every*-QPs and *each*-QPs contribute a ‘set variable’ as part of their interpretation, that contributed by an *every*-QP may be bound by various operators, and thus is interpreted as having lower scope than *each*-QPs in these environments. We show that the mechanisms they invoke to account for these differences can also explain the differential behaviour of these QPs w.r.t. the ECP phenomena. In particular, we pair these mechanisms with two independently motivated assumptions about modals, namely that epistemic and root modals appear in fixed structural positions, and that modals are able to bind free variables.

We first locate EMs and RMs in B&S’ relative topology, and then detail how the differential behaviour of *each*- and *every*-QPs follows from their featural content and thus how they interact with other elements in the topology. Following this, we motivate our proposal by showing how the behaviour of these QPs in the environment of certain operators is paralleled in the environment of EMs.

### 2.1 The topology

To account for the differential behaviour of *every*- and *each*-QPs w.r.t. EMs, we augment the topological approach of B&S, observing, as mentioned above, that *each*-QPs do not respect F&I’s ECP.

- (7) a. #Every boy might love Mary, but some of them don’t  
 b. Each boy might love Mary, but some of them don’t

The literature points to two syntactic heights for modals, the lower corresponding to root interpretations, the higher to epistemic ones (see, a.o., Jackendoff (1972), Piccolo (1990), Cinque (1999), Butler (2003), Hacquard (2006)). One type of evidence for this is the fact that, in a construction with two modal expressions appearing together in a single clause, the higher is always interpreted epistemically, while the lower takes a root interpretation.<sup>2</sup>

- (8) John may have to be home

<sup>2</sup> The evidence for two syntactic positions for modals is many and varied, but for reasons of space we do not review them here. See the works cited in the text for more details.



of operators identified by B&S (as well as Beghelli 1997 and Szabolcsi 1997) that bind a set variable introduced by *every*, and argue that it is for this reason that the ECP effect is seen to obtain with this QP-type but not the *each*-QP type.

## 2.2 *Each vs. every*

B&S argue that *each*- and *every*-QPs sometimes pattern differently in terms of scope, despite their often similar interpretation as strong distributive quantifiers. B&S observe that in certain environments, *every*-QPs can get a collective interpretation, where *each*-QPs cannot. That is, in a number of cases where a collective (and exhaustive) interpretation is available for *every*-QPs, it is never available for *each*-QPs, suggesting that the latter **must** be interpreted distributively.

- (11) a. It took all the boys to lift the piano.  
 b. It took every boy to lift the piano.  
 c. \*It took each boy to lift the piano.

(B&S 1997, p.98)

The ability of *every*-QPs to pick out a group or collective is corroborated by Matthewson ((2001)),<sup>5</sup> who cites these examples, among others:

- (12) a. \* In this class I try to combine each theory of plurality.  
 b. In this class I try to combine every theory of plurality.

(Landman 2000, p.10)

- (13) a. ? She counted each of the proposals.  
 b. She counted every proposal.

(Dowty 1987, p.106)

- (14) a. ?#Jake photographed each student in the class, but not separately.  
 b. Jake photographed every student in the class, but not separately.

(Tunstall 1998: 99)

B&S argue that both *each* and *every* contribute a ‘set variable’ to the semantic interpretation (à la Szabolcsi 1997, described further below), yet other differences impact how they interact with other expressions in the clause. While both are in the category of what they call distributive-universal quantifiers (DQPs), there are important lexical specifications that play a role in how each are interpreted. In (15), we consider B&S’ formulation of this class and the individual lexical properties ascribed to its members. While our main focus is on these DQPs, we will briefly mention ‘group-denoting QPs’ (GQPs), as they will figure in our illustration of the availability of distributive readings.

<sup>5</sup> For simplicity, we will not review or consider the alternative account of this difference that Matthewson argues for; for details, see her paper, as well as Davis (2010).

(15) **QP-Types**

- a. **Distributive-Universal QPs (DQPs)**. QPs headed by *every* and *each* which occur only with singular nouns. Have, to a first approximation, a distributive feature [+Dist(ributive)]. Both usually interpreted as universal and distributive.
- e. **Group-Denoting QPs (GQPs)**. To this large class belong indefinite QPs headed by *a*, *some*, *several*, bare-numeral QPs like *one student*, *three students*, ..., and definite QPs like *the students*. Their fundamental property is that they denote *groups*, including plural individuals.

Importantly, B&S' account requires that DQPs must move to the specifier of a DistP projection if they are to be semantically interpreted distributively. This possibility is further predicated on the presence in a given structure of a ShareP projection (see the tree in (9)), which in turn requires either a GQP or an event variable in its specifier. It is this expression in [Spec, ShareP] that the DQP distributes over. If these conditions are not met, the distributive reading is in principle unavailable.

B&S propose a number of licensing conditions for *every*- and *each*-QPs.

(16) Licensing of *every N*

- a. *every*-QPs are underspecified for [distributive]. They can, but need not, move to [Spec, DistP] at LF.
- b. *every*-QPs move to [Spec, DistP] **only** when the set variable they introduce is bound by an existential operator in [Spec, RefP].
- c. When a negative or question operator is closer than that existential operator, these bind *every*-QPs which in turn cannot move to [Spec, DistP].

(17) Licensing of *each N*

- a. *each*-QPs are specified [+distributive] and **must** move to [Spec, DistP] at LF.
- b. *each*-QPs always support Strong Distributivity.
- b. Semantically, the set variable introduced by *each*-QPs must be bound by an existential operator.

A critical piece of B&S' proposal (also found in Szabolcsi 1997) is that DQPs introduce set variables: restricted group variables that range over the witness sets of the QPs in generalized quantifier-theoretic terms. Intuitively, for e.g. *every boy*, the variable introduced ranges over sets of boys. The crucial difference between the DQPs is that listed in (16b): *every*-QPs support strong distributivity **only** in a highly restricted circumstance, namely when it sits in the Spec of DistP,

and its set variable is bound by an existential operator at the top of the clause. *each*-QPs, on the other hand, can only be interpreted as strongly distributive, and thus always must move to [Spec, DistP] and its set variable bound by an existential operator.

The empirical data that B&S use in support of these lexical specifications and licensing conditions is the differential behaviour of *each*- and *every*-QPs w.r.t. collective/distributive readings, and their interpretation when other operators such as *wh*- or negation are present. In particular, they argue that the lack of distributive readings of *every*-QPs in these environments may be accounted for by supposing that, in these cases, the set variable introduced by *every*-QPs is bound by these operators, which occur lower in the clause than the high existential operator. If *each*-QPs must move to [Spec, DistP], but *every*-QPs may do so only when their set variable is not bound by a lower operator, then this differential behaviour is predicted.

We will review B&S' data in support of this analysis, and then show how the differential behaviour of these DQPs is paralleled in the environment of EMs.

First, *every*- and *each*-QPs behave differently with respect to negation. Consider the data in (18) and (19), which differ only in whether the DQP appears in subject or object position.

- (18) a. ?? Every boy didn't leave.  
       b. ?? Each boy didn't leave.
- (19) a. John didn't read every book.  
       b. ?? John didn't read each book.

(B&S 1997, p.95)

B&S analyze the badness of (18a-b) as follows: the DQPs are higher in the structure than the NegP projection, and thus the negative operator binds a lower event variable that, in the absence of this operator, would raise to [Spec, ShareP], thus licensing a DistP. If there is nothing to raise to the specifier of ShareP (the event variable being already bound by the negative operator, and no GQPs being present) for DQPs to distribute over, then DistP cannot be generated: its selectional restrictions are not satisfied, thus correspondingly these QPs cannot raise to its specifier. The result is relative unacceptability.

In contrast, in (19a-b), the DQPs appear *below* NegP, in which case the negative operator binds the set variable of *every*-QP which is then interpreted collectively, and in the scope of negation. Crucially, the *each*-QP is lexically specified to raise to [Spec, DistP] and thus obligatorily moves to [Spec, DistP], where it is interpreted distributively and as taking scope over negation. Contrast (18a-b) and (19a-b) with *all*-QPs in the same contexts:

- (20) a. All the boys didn't leave.  
       b. John didn't read all the books.

(B&S 1997, p.96)

*All*-QPs do not require raising to DistP, and are felicitous in both subject and object position; they are always interpreted collectively. The meaning of (20b) is thus parallel to that of (19a).

Interestingly, DQPs *can* distribute when an overt indefinite GQP is present in the context of negation. In these cases, the negative operator still binds a lower event variable, but there is another expression, the GQP, that can raise to [Spec, ShareP] and license the distributive reading.

- (21) a. Every boy didn't read one book.  
b. Each boy didn't read one book.
- (22) a. One boy didn't read every book.  
b. One boy didn't read each book.

(B&S 1997, p.96)

Here, the GQPs can raise to the specifier of ShareP, and the DQPs can move to DistP. Thus B&S' account predicts the differential acceptability between (18-19) and (21-22).

Similar facts obtain with *wh*- operators. In (23), we see that a subject *wh*-question with an *every*-QP in object position does not license a pair list reading, whereas the corresponding structure with *each* does.

- (23) a. Who read every book? \*pair-list  
b. Who read each book? <sup>ok</sup>pair-list

(May 1985, Beghelli 1996)

We again see the *every*-QP interpreted collectively in a context where an *each*-QP is interpreted distributively. These data support the idea that *each*-QPs are strongly distributive, in environments where *every*-QPs may be analyzed as a set variable bound by another operator.

Another important piece of data for our purposes is binding by a generic operator. B&S observe that *every*-QPs can be unselectively bound by a generic operator, whereas *each*-QPs cannot.

- (24) a. Every dog has a tail.  
b. Each dog has a tail.

(B&S 1997, p.100)

Here (24a) can be understood as a claim about dogs in general, whereas (24b) can only be a claim about a specific set of dogs made salient in the context of use. Following B&S, we take it that we are here faced with a case where the *every*-QP's set variable is bound by a generic operator, whereas the *each*-QP scopes higher than this operator.

Yet another such case is provided by the following contrast taken from Gil ((1992)) and cited by B&S: in (25), the context strongly biases towards a generic reading and thus may be followed felicitously with an *every*- or *all*-QP, but not by a QP headed by *each* or the definite determiner:

- (25) After devoting the last three decades to a study of lexical semantics, George made a startling discovery.
- a. Every language has over twenty color words.
  - b. All languages have over twenty color words.
  - c. ?Each language has over twenty color words.
  - d. ?The languages have over twenty color words.

(B&S 1997, p.100)

The converse of this situation, where the relevant domain of quantification is strongly contextually biased, the *each*-QP is preferred over the *every*-QP:

- (26) George has just discovered ten hitherto-unknown languages in the Papua New Guinea highlands.
- a. ?Every language has over twenty color words.
  - b. ?All languages have over twenty color words.
  - c. Each language has over twenty color words.
  - d. The languages have over twenty color words.

(B&S 1997, p.100)

Gil (1992) accounted for this distinction by attributing a [+Definite] feature to *each*-QPs, which *every*-QPs lack. B&S suggest that while both *every*- and *each*-QPs introduce set variables, since only *each*-QPs bear a [+Definite] feature, only a limited range of operators may bind them. In fact, only the existential operator heading RefP, or a version of Beghelli (1993)'s silent existential quantifier (construed as an existential counterpart of the generic operator), may bind *each*-QPs. Following B&S, we take the contrasts with negation, *wh*- and generic operators to suggest that the set variable introduced *every*-QPs may be bound by any of these operators, but that introduced by *each*-QPs may only be bound by the existential operator.

We have seen that the two DQPs pattern differently w.r.t. their acceptability and interpretation in the environment of negative, *wh*-, and generic operators. Foreshadowing the arguments presented in the next section, let us revisit the examples discussed in (7), reproduced as in (27):

- (27) a. #Every boy might love Mary, but some of them don't  
 b. Each boy might love Mary, but some of them don't

As discussed, the *each*-QP is able to obviate the ECP, whereas the *every*-QP fails to do so. Given the high placement of the EM, we suggest that it performs the role of an intervener for *every*-QPs just as with the other operators that B&S discussed. It thus appears sensible to argue that the EM can bind the set variable



- (30) a. A dog can bite  
b. A dog will bite

(Portner 2009, p.214)

For both adverbs of quantification and quantificational modals, we see similar behaviour with bare plurals. Neither (31a) nor (31b) mean that a given Texan is tall on some days and not on others, but just that some Texans are tall.

- (31) a. Texans are sometimes tall  
b. Texans can be tall

((b) attrb'd to Carlson 1977, Heim (1982))

We have seen that *every*-QPs may contribute a set-variable and be interpreted as a collective, and that they pattern in some cases with bare plurals rather than with a truly distributive quantifier. It is thus natural to expect that they also may be interpreted as bound by quantificational modals.

Sentences with *might* behave somewhat differently from sentences with *can*: in particular, the former only has epistemic interpretations, and the latter never has epistemic, but only circumstantial, interpretations. As indicated in the topology given in (9), these two types of modal interpretations correspond to different syntactic heights. We can see this with the following example from Brennan (1993): (32a) with *can* is interpreted as a contradiction, since it asserts both a capacity and an incapacity to get Chicago stations for each radio. In contrast, in (32b) the sentence is fine, since all of the radios receiving Chicago stations is possible, but all of them not receiving Chicago stations is also possible.

- (32) a. #Every radio can get Chicago stations, and no radio can get Chicago stations.  
b. Every radio might get Chicago stations, and no radio might get Chicago stations.

(Brennan (1993), ch.3)

In the examples below with *might*, we do not observe a difference in force, but it's clear that (33a-b) pattern together in that they are interpreted as a possibility about a collection of Texans, to the exclusion of (33c) with *each* which asserts possibilities about individual Texans.

- (33) a. Texans might be tall  
b. Every Texan might be tall  
c. Each Texan might be tall

Differences in between sentences with *can* (a root modal) and *might* (an EM) w.r.t. *each*- and *every*-QPs will be discussed in much greater detail in Gagnon and Wellwood (in preparation). What we claim is that the ECP reports the phenomenon of an EM binding an *every*-QP in subject position,<sup>6</sup> while root modals

do not. In this way, the fact that these QPs display differential behaviour with EMs, just as with negative, *wh*-, and generic operators – *each* distributes while *every* does not – is captured. We thus include modals in the class of expressions that can bind the *every*-QP's set variable.

### 3. Conclusion

We argued that the ECP effect is a consequence of the syntactic and semantic behavior of particular QPs. Our account is cast in a *scopal diversity* approach to quantifier scope: instead of a representational constraint that applies to an arbitrary subset of QPs, the ECP effects are accounted for derivationally.

We introduced EMs to B&S' relative topology, following the assumption that EMs and root modals occupy different syntactic heights. Adopting the idea that *every*-QPs can be bound by a variety of operators, we proposed to include modal operators in the class of potential binders. Our proposal, which we see as a synthesis of disparate, independently-motivated analyses by a variety of authors, was motivated by a consideration of the data F&I used to motivate their ECP that was shown to parallel quite closely the facts B&S discussed w.r.t. negative, *wh*- and generic operators. Coupled with the idea that modals may bind free variables, the ECP facts follow without added stipulation.

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<sup>6</sup> There are a number of predictions that follow from this account. Recall that the ECP effect that F&I identified applies only to EMs, which may be seen to occur high in the structure. The majority of the examples we have been considering (as did F&I) have had QPs in subject position, and we have seen that these are able to scope over the root modal *can*, e.g. (1). Given what we have seen, there are three main predictions that our account generates. The first one, which relates directly to F&I's proposal, is that *each*-QPs are unaffected by the ECP – this is certainly borne out. Potential further predictions are 1) a subject-object asymmetry for DQPs in the environment of root modals, depending on where the Case positions for object NPs are located w.r.t. the syntactic height of root modals; and, 2) *every*-QPs will be unable to distribute over a GQP whenever it is bound by EM or RM, so for example *every*-QPs in subject position with an EM, or in object position with an RM, should not be able to distribute over a *some*-QP. In contrast, *each*-QPs will be able to distribute over these expressions regardless of position or modal environment. These predictions are explored in greater detail in Gagnon & Wellwood (in preparation).

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