

Epistemic Containment and the Encoding of Scope*

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1. Introduction: Epistemic Containment

There is a peculiar but well-documented constraint on the relative scope of quantified arguments (QPs) and epistemic modals, known as the Epistemic Containment Principle:

(1) *Epistemic Containment Principle (ECP)*¹

A QP cannot have scope over an epistemic modal.

(Von Stechow & Iatridou 2003: 174)

Von Stechow and Iatridou (2003) motivate the ECP with sentences like (2a) and (2b), in which a QP is unable to scope over the auxiliary verb of epistemic possibility or necessity, respectively.^{2,3} In each example, the continuation forces the wide scope reading of the QP, which – as the ECP leads us to expect – results in a contradiction.

- (2) a. #Every student may have left, but not every one of them has.
(**every > may*)
b. #Fewer than half the students must have passed, but perhaps all of them did.
(**fewer than half > must*)

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¹The ECP or an approximation of it has also been observed in other works, including Leech (1971), Piccolo (1990), Brennan (1997), and Drubig (2001).

²We avoid the combination of quantificational items with the same quantificational force in order to facilitate the diagnosis of scope (un)ambiguities. For instance, we do not combine *every* with modals of epistemic necessity, such as *must*.

³Parallel sentences with QPs and other types of modals (e.g. deontic *must*) or temporal elements (e.g. *will*) do present the expected scope ambiguities. See section 4 and von Stechow and Iatridou (2003) for discussion.

Interestingly, an ECP effect is not restricted to sentences with auxiliary verbs; it also arises with epistemic modal adverbials, as noted by von Stechow and Iatridou (2003):

- (3) #Every guest is possibly/probably/perhaps the murderer.
- a. It is possible that every guest is the murderer. inconsistent, ^{OK}ECP
 - b. For each guest *x*, it is possible that *x* is the murderer. consistent, *ECP

The ECP only allows the interpretation in (3a), where the modal out-scopes the QP, hence the infelicity of the example (unless there was a collective murder).

Finally, (4a) demonstrates that an ECP effect can also occur in a sentence containing a QP and a modal raising predicate of epistemic necessity, such as *certain*. This ECP effect does not manifest itself if the QP raises across the epistemic raising predicate, as in (4b), suggesting that the QP out-scopes the modal following A-movement.

- (4) *Context: John is hiring employees and has just interviewed 20 applicants*
- a. #John is certain to have hired fewer than half the applicants, but perhaps he hired all of them.
(*fewer than half > certain)
 - b. Fewer than half the applicants are certain to have been hired, but perhaps all of them were (hired).
(fewer than half > certain)

Note that an analysis that attributes the contrast between (4a) and (4b) to clause-boundedness of QR (or of whatever mechanism of scope extension is assumed instead) is unlikely to succeed in view of the fact that a wide range of infinitival complements are apparently transparent for QR. The following examples all permit the universal to scope over the indefinite (see Kennedy 1997, Wurmbrand 2011 and Lechner 2012).

- (5)
- a. A different student tried/wanted to read every book.
 - b. At least one professor believes Mary to have read every book.
 - c. Some actress believed every movie to be interesting.
 - d. Someone expects Sue to marry every boy.

Thus, although an epistemic raising predicate like *certain* does not prevent a QP from scoping across it through overt raising, it is nevertheless similar to the auxiliary verbs in (2) and the adverbial in (3) in being able to impose restrictions on the scope of QPs.⁴

⁴The fact that a raised QP can out-scope *certain* is an argument against the possibility raised in von Stechow and Iatridou (2003) that the ECP comes about as a result of the following restriction:

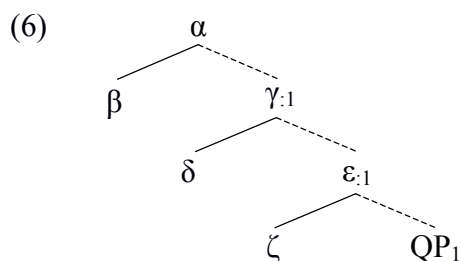
- (i) At LF, a quantifier [(i.e. QP)] cannot bind its trace across an epistemic modal.

(i) relies on two well-established facts: (a) the subject of an epistemic modal auxiliary is generated somewhere below the auxiliary (presumably in the VP) and then undergoes A-movement higher than the auxiliary (see, for instance, Wurmbrand 1999), and (b) the ability of an A-moved category to reconstruct for scope. With these in mind, (i) essentially forces a subject QP to reconstruct to its base-position and thus scope below the epistemic modal auxiliaries in (2). The state of affairs described in (a) and (b) also obtains

The goal of this paper is to demonstrate that the data just discussed, as well as other data involving epistemics, provide support for a particular theory of the syntactic encoding of scope, based on ideas in Williams (1994), as well as an accompanying condition on scope shift (the CSS) proposed in Neeleman and Van de Koot (2012) (henceforth NvdK 2012). These proposals are introduced in section 2. Section 3 returns to epistemic containment, demonstrating that natural assumptions about how epistemic categories mark their scope interact with the CSS in such a way as to yield the contrast between (2), (3) and (4a), on the one hand, and (4b) on the other. Section 4 discusses how the proposal might be extended to deal with disparate phenomena involving epistemic categories, including QP scope freezing effects and the (rare) possibility of an epistemic modal merging below a deontic one. We summarize the discussion in section 5.

2. A condition on scope shift

For reasons that will become apparent, we adopt a variant of a theory of scope shift first introduced in Williams (1994). Williams assumes that an argument QP carries a scope index that may be percolated to a dominating node to mark the QP's extended scope. Thus, the scope of QP_1 in (6) below corresponds to the largest category that carries its scope index (γ), minus the QP itself. Throughout this paper, we place inherited indices after a colon (to distinguish them from an index introduced by a quantificational category; we omit the colon when there is no inherited index).



In some languages, such as German and Japanese, a QP argument may also mark its scope through overt A'-movement, in which case scope is marked in the landing site, but this will not be relevant to what follows (but see NvdK 2012 for details). Finally, an argument QP may also fail to percolate a scope index altogether, in which case it takes surface scope.

We combine the index-based marking mechanism with the following constraint on inheritance of quantificational indices:

for the raising case in (4b) as the object QP of the complement clause A-moves past the epistemic modal *certain*.

- (ii) [Fewer than half the applicants]₁ are certain t_1 to have been hired t_1 , ...

Reconstruction of the QP for scope explains the *certain* > *fewer than half* reading, however, (i) leads to the expectation that this should be the only available reading, contrary to fact.

- (7) *Condition on Scope Shift (CSS)* (NvdK 2012)
No node may inherit two scope indices.

It is easy to see that this constraint is incompatible with the widely held view, originating in the work of Chomsky (1976) and May (1977), that there is a syntactic level of Logical Form (LF) that provides a transparent and complete representation of scope relations. A translation of this view into the index-based representations of Williams (1994) yields the representation in (8a) for a structure containing two QPs interpreted as taking surface scope and that in (8b) for the same structure with inverse scope. As the reader can easily verify, both (8a) and (8b) violate the CSS.

- (8) a. $*[_{:1} \dots [_{:1,2} \dots QP_1 [_{:2} \dots QP_2 \dots]]]$ $QP_1 > QP_2$
b. $*[_{:2} \dots [_{:1,2} \dots QP_1 [_{:2} \dots QP_2 \dots]]]$ $QP_2 > QP_1$

There is an alternative view of scope according to which LF only represents deviations from surface scope (see Reinhart 1983, 2006; see also Lakoff 1972, Huang 1982 and Hoji 1985). On this view, scope extension is limited to structures in which it generates an interpretation that is otherwise unavailable.⁵ Reinhart treats scope extension as QR; a translation of her proposal in terms of indices expresses the readings in (8) with the slightly simpler structures in (9), neither of which violates the CSS, as required.

- (9) a. $[\dots [\dots QP_1 [\dots QP_2 \dots]]]$ $QP_1 > QP_2$
b. $[_{:2} \dots [_{:2} \dots QP_1 [_{:2} \dots QP_2 \dots]]]$ $QP_2 > QP_1$

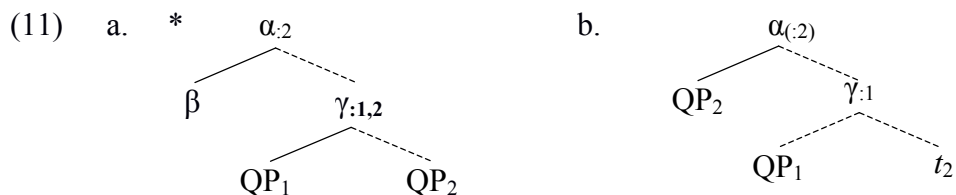
We summarize the main tenets of our approach to scope in (10). The Economy principle in (10b) is intended to block scope extension where it does not give rise to inverse scope, while (10c) is a mapping principle that, in the absence of scope extension, regulates the association of syntactic structures at LF with their semantic representations.

- (10) a. *Scope Extension*
If a QP percolates its index to a dominating node α , then its scope coincides with α minus the QP itself.
- b. *Economy*
Scope extension must give rise to an otherwise unavailable interpretation.
- c. *Default Scope Rule*
If a QP does not percolate its index, it takes scope over its c-command domain.

An important fact about the CSS is that it creates an asymmetry between covert scope shift, analyzed here as index percolation, and scope taking by overt movement. Covert scope shift involves index percolation. It is therefore incompatible with any other scope extensions in its percolation path, as these give rise to CSS violations. This is shown in

⁵The view that scope extension is subject to Economy and relativized to an interpretation has been argued for in Fox (1999; 2000). However, unlike Reinhart, Fox assumes that every QP must move.

(11a), where covert scope extension of QP₂ freezes the scope of QP₁. By contrast, overt movement of a QP cannot trigger CSS violations in the movement path, whether the moved QP marks scope in its landing site (because it has undergone overt QR) or not (because it has undergone A-movement, which does not mark scope). This is shown in (11b), where movement of QP₂ does not prevent covert scope extension by QP₁.



Thus, overt scope marking is freer than covert scope shift, a prediction that is corroborated by a range of QP interactions (see NvdK 2012 for discussion). As will be clear, this predicted difference is hard to reconcile with theories that treat overt and covert scope shift as mediated by the same operation, for example movement.

With this background, we now return to epistemic modals.

3. Epistemic Containment as a CSS effect

We follow much work in the literature, originating from Kratzer (1977), in taking epistemic modals to be propositional operators quantifying over possible worlds and relating them to the proposition under question. Possibility modals (e.g. *may*, *possibly*) are treated as existential quantifiers and necessity modals (e.g. *certain*, *must*) as universal quantifiers. On the null hypothesis that a proposition syntactically corresponds to some clausal entity (e.g. TP or CP), we defend the following:

(12) *Scope of Epistemic Modality*

A category carrying epistemic modality must mark clausal scope by percolating its quantificational index.

Taken together, the claim in (12) and the CSS predict that QPs that are clause-mates of an epistemic modal or in the c-command domain of such a modal should be unable to extend their scope across it (because the resulting structures instantiate the offending configuration in (11a)). Additionally, in the rare case in which a QP c-commands a clause-mate epistemic modal whose lexical requirement of taking clausal scope is satisfied without (extended) scope index percolation, we expect the QP to be able to out-scope the modal. As we now demonstrate, these predictions amount to an explanation of the ECP effect in (2), (3) and (4a) and its obviation in (4b).

Consider first the examples in (2) and (3), which involve an epistemic auxiliary verb and adverb, respectively. As shown in (13), these instantiate cases in which an epistemic modal merges in a position from which it has to extend its index to the top of its own clause (presumably up to the TP level) in order to satisfy (12).

- (13) a. *_{[TP:1,2 [every guest]₂ [_{T:1} must₁ ...]]} = (2b)
 b. *_{[TP:1,2 [every guest]₂ [_{T:1} is [_{VP:1} possibly₁ [_{VP} ...]]]]} = (3), on reading (3b)

The CSS prevents the subject QP in these structures from percolating its own scope index, as this causes TP to inherit a second scope index. It follows that QP in these structures is unable to outscope the modal category (which in the relevant examples gives rise to contextually inappropriate readings).

We now turn to the data in (4), containing the epistemic raising predicate *certain*. As explained earlier, a key feature of the approach to scope taking adopted here is that it predicts an asymmetry between overt and covert scope extension. This was due to the fact that displacement of a QP – whether through A-movement or A'-movement – assigns a quantificational category to its scope without index percolation in the movement path. This predicted asymmetry is borne out by the contrast between (4a) and (4b).

The labeled bracketing in (14a) below shows the pattern of index percolation that is required if the in situ QP in (4a) is to out-scope the epistemic raising predicate. Consider first the impact of the scope requirement in (12). The raising predicate will satisfy (12) if it percolates its scope index to its mother node: this one-step percolation will mark its clausal complement as its scope, as it identifies the scope of *certain* as the AP it heads minus the modal itself. However, it will also block any index percolation past this node. Thus, if the QP *fewer than half the applicants* extends its scope to a node that dominates AP, as shown in (14a), this inevitably results in a CSS violation.

A better outcome is guaranteed by A-movement of the QP to the matrix subject position, as shown in (14b). The raised QP can be assigned surface scope in its landing site by the default scope rule, correctly predicting that it can out-scope the raising modal.

- (14) a. *_{[John [_{:2} is [_{AP:1,2} certain₁ [_{:2} to [_{:2} have [_{:2} hired [_{:2} hired [fewer than half the applicants]₂]]]]]]], but perhaps he hired all of them.}
 b. _{[[Fewer than half the applicants]₂ are [_{AP:1} certain₁ to have been hired *t*₂]], but perhaps all of them were (hired).}

4. Further predictions

4.1 Additional QP freezing effects

The account outlined in the previous sections receives striking support from the facts in (15), which demonstrate that a Dutch epistemic modal adverb can give rise to scope freezing effects that go well beyond those predicted by the ECP:

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- (15) Ik vermoed dat
I suspect that
- a. mogelijk tenminste één student ieder artikel gelezen heeft.
possibly at-least one student every article read has
($\exists > \forall; \forall > \exists$)
 - b. tenminste één student mogelijk ieder artikel gelezen heeft.
at-least one student possibly every article read has
($\exists > \forall; * \forall > \exists$)
 - c. tenminste één student ieder artikel mogelijk gelezen heeft.
at-least one student every article possibly read has
($\exists > \forall; * \forall > \exists$)
'I suspect that possibly at least one student has read every article.'

In (15a), two QPs occur in the c-command domain of *possibly*. Naturally, they may receive a surface scope interpretation, but for a subset of Dutch speakers the inverse scope reading is available as well. However, for these speakers the inverse scope reading becomes inaccessible as soon as one of the quantifiers c-commands *possibly*, as in (15b). It is not difficult to see that this follows directly from the combined effect of (12) and the CSS. In (15b) the modal adverb must percolate its scope index to achieve clausal scope. It is then predicted that scope extension of the universal is blocked, since its index would travel the same path as that of the modal adverb. Most remarkably, the scope freezing effect is also present if *mogelijk* 'possibly' is c-commanded by both QPs. This falls out naturally from our proposal in much the same way: scope extension by the modal adverb freezes the scope of QPs in its percolation path.

The pattern just illustrated for Dutch can be replicated in English with examples like those in (16), involving scope extension from an ECM complement.

- (16) a. Possibly at least one actress believed every script to be interesting.
($\exists > \forall; \forall > \exists$)
- b. At least one actress possibly believed every script to be interesting.
($\exists > \forall; * \forall > \exists$)
- c. At least one actress believed every script to be possibly interesting.
($\exists > \forall; * \forall > \exists$)

As shown in (16a), the exceptionally case-marked universal quantifier may take scope over the indefinite in the matrix clause. On our assumptions, this requires percolation of the scope index of the universal to the mother node of the QP *at least one actress*. This does not interfere with the requirement imposed on the modal adverb by (12). In (16b), the configuration required for inverse scope is predicted to be unattainable: the requirement in (12) forces the modal adverb to extend its scope across the indefinite, thereby blocking percolation of the index of the universal along the same path.

The same scope freezing effect is also present if the modal adverb is attached in the lower clause, as in (16c). This can be understood as follows: the requirement in (12)

forces the modal adverb to extend its scope to the top of the embedded clause, which in turn creates a barrier for percolation of the scope index carried by the universal. It is worth noting that this scope freezing effect indicates that the ECM subject has not raised out of its clause, as it would on a ‘raising to object’ analysis of ECM (but compare Błaszczak and Gärtner 2005).

4.2 Epistemics under deontics

It is well-known that epistemic modals generally merge higher than deontics, cross-linguistically (see, for instance, Cinque 1999). Below we demonstrate the **deontic>epistemic* ordering constraint in Hawick Scots, which permits double modal auxiliary verbs (examples and paraphrases from Brown 1991).

- (17) a. He should can go tomorrow. *epistemic>deontic*
 ‘He ought to be able to go tomorrow’
- b. He’ll might can come in the morn *epistemic>deontic*
 ‘It is possible that he will be able to...’

Picallo (1990) demonstrates the same point with respect to Catalan, but examples could be multiplied at will.

- (18) En Pere deu poder tocar el piano. *epistemic>deontic*
 Peter must can play the piano
 ‘It must be the case that Peter is able/allowed to play the piano’

There is a debate in the literature as to what lies behind this templatic restriction; our aim is not to contribute to this debate but simply to show that when it is obviated, the scopal relations we get are in accordance with our expectations. In doing so, we also highlight the different scopal behavior of epistemic and deontic modals.⁶

As shown in (19), from Cinque (1999: 87), the **deontic>epistemic* ordering constraint is not absolute. An epistemic adverb like *probably* (or *possibly* or *perhaps*) may merge below a modal auxiliary with a deontic interpretation like *must*. This is perhaps not surprising. Although adverbs show templatic effects with respect to other adverbs, their distribution with respect to other categories is relatively free (see Bobaljik 1999 for discussion). What may come as a surprise though is the fact that (19) only expresses the meaning in (19a), where the epistemic adverb scopes over the deontic modal (i.e. the inverse scope reading). The interpretation in (19b) is, admittedly, nonsensical, but the question remains how the adverb manages to out-scope the higher deontic modal (and thus has the option to merge below it).

⁶Different approaches to this phenomenon can be broadly distinguished in terms of whether they take it to be a matter of a templatic restriction specified by UG (Cinque 1999) or a matter of logical/conceptual necessity that forces an epistemic to scope over a deontic (Cormack & Smith 2002).

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- (19) John must probably give his money back by tomorrow.
- a. It may be the case that John is required to give his money back tomorrow.
 - b. John is required that he may give his money back tomorrow.

The answer is straightforward for the theory outlined here: *probably* is an epistemic adverb and therefore, by (12), percolates its scope index up to the top of the clause, thereby including the higher deontic modal in its scope.

Of course, this reasoning takes for granted that a deontic modal does not itself mark scope through index percolation. If it did, the examples in (19) would incur a CSS violation. Hence, given that the interpretation in (19b) is non-sensical, the sentence should be infelicitous/ungrammatical. Indeed, there is some evidence that deontic modals differ from epistemic modals along the lines suggested here.

First of all, in their discussion of the ECP, von Stechow and Iatridou (2003) demonstrate that epistemic modals are unique in exhibiting containment effects. The combination of QPs and deontic modals do present the expected scope ambiguities, as shown in (20) below, where the continuation in (20a) makes salient the *deontic*>*QP* reading and the continuation in (20b) the *QP*>*deontic* reading.⁷

- (20) Most of our students must get outside funding...
- a. for the department budget to work.
 - b. the others have already been given university fellowships.
- (Von Stechow & Iatridou 2003: 175)

The possibility of a *QP*>*deontic* reading in (20) confirms that the deontic does not percolate a quantificational index up to the top of its clause. If it did, there would be no way for the QP to out-scope the deontic (for the reasons discussed in section 3).

Second, preliminary independent evidence suggests that deontic modals do not percolate a scope index at all and are assigned scope by the default scope rule. In particular, when a deontic verb, such as *required*, intervenes between two QPs which may exhibit inverse scope (see 21a), no scope freezing effects are observed (see 21b).

- (21) a. A doctor will make sure that we give every new patient a tranquilizer.
($\exists > \forall; \forall > \exists$) (Reinhart 1997: 350)
- b. A doctor will make sure that we are required to give every new patient a tranquilizer (by circulating the instructions for medication at the beginning of the shift).
($\exists < \forall; \forall > \exists$)

This result is in sharp contrast with the scope freezing effects observed in (15) and (16), which involved intervention by an epistemic modal.

⁷The general consensus is that the inverse scope reading results from the QP reconstructing for scope in the VP. The same reasoning cannot apply to account for the ECP effect for the reasons outlined in fn 4.

In summary, the assumption that epistemic categories mark clausal scope correctly predicts that an epistemic category may occur in the c-command domain of a deontic category, once templatic effects are neutralized.

4.3 Subjective vs objective epistemic modality

There is a class of epistemic modals that behave similarly to deontics in that they do not seem to impose obligatory narrow scope on QPs. Various authors (e.g. Tancredi 2007; Anand & Hacquard 2009) point out that the ECP may be obviated if, as a result of appropriate contextualization, the objective reading of epistemic modals is highlighted.⁸ The difference between objective and subjective readings lies in the relative reliability of the evidence one invokes to evaluate the proposition the epistemic scopes over. Subjective epistemics correspond to the invocation of less widely accepted evidence, and hence highlight someone's personal belief state, whereas objective epistemics correspond to evidence accepted by the relevant community (Lyons 1977; Anand & Hacquard 2009). The contrast between subjective and objective readings in relation to the ECP is illustrated in (22) (examples based on Anand & Hacquard 2009; see Tancredi 2007; Huitink 2008, for further examples).

- (22) a. #Every party guest might be the murderer.
 (*every* > *might* inaccessible)
- b. Given the currently available evidence/objectively speaking, every party
 guest might be the murderer.
 (*every* > *might* accessible)

Huitink (2008) elaborates on this contrast on the basis of Dutch data and illustrates that, contrary to the situation in English, appropriate contextualization is not required for certain epistemic modals, including *kunnen* 'might' in (23a), which may easily scope

⁸The ECP may also be obviated when the QP is strongly distributive. Hacquard (2006) and Gagnon and Wellwood (2010) discuss cases in which *each*-QPs, but not *every*-QPs, are able to take wide scope over the epistemic modal.

- (i) Each girl might be in love with John, but some of them aren't. (*each* > *might* accessible)
 (ii) # Every girl might be in love with John, but some of them aren't. (*every* > *might* inaccessible)

Von Stechow and Iatridou (2003) (see also Anand & Hacquard 2009) further point out that, for some speakers, a heavily stressed QP may take wide scope over the epistemic modal.

- (iii) EVERY party guest might be the murderer. (*every* > *might* accessible)
 (iv) # Every party guest might be the murderer. (*every* > *might* inaccessible)

One possibility to capture these cases under the system suggested here is to assume that an epistemic modal percolates an index up to the TP level (which semantically corresponds to a propositional entity), and no further, and that these QPs merge/move somewhere higher (e.g. the focused QP in (iii) in specCP whereas the strongly distributive one in (i) in the specifier of some projection that is higher than the TP node, such as the Dist(ributive)P postulated by Beghelli & Stowell 1997 to accommodate such QPs). We leave this for future investigation.

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below the QP. On the other hand, Dutch epistemic adverbs behave similarly to their English counterparts in consistently taking wide scope with respect to QPs, as in (23b).

- (23) a. Minstens drie mannen kunnen de vader van mijn kind zijn.
At least three men might the father of my child be
'At least three men might be the father of my child'
- b. #Iedereen heeft het misschien gedaan.
Everyone has it perhaps done
'Perhaps everyone has done it'

On the basis of this observation, Huitink suggests that epistemic modals have a default interpretation, either subjective or objective, which may be overridden given sufficient context (see also Anand & Hacquard 2009). If this analysis is on the right track, then our claim in (12) reduces to a claim regarding the scope-taking properties of subjective epistemics, as opposed to all types of epistemics. From an empirical perspective, the question is whether English has any epistemics whose default interpretation is objective and, if so, how these behave in terms of the ECP and other scope-freezing effects.

A good candidate for an epistemic with a default objective reading might be the raising predicate *appear*. As (24) shows, *appear* does not pattern with raising *certain* in taking obligatory wide scope over a lower QP, given the same context (cf (4)). (25) indicates that wide scope of the lower universal QP over the existential is possible, despite *appear* intervening between the two.

- (24) *Context: John is hiring employees and has just interviewed 20 applicants:*
John appears to have hired fewer than half the applicants, but perhaps he hired all of them.⁹
(*fewer than half* > *appear*)
- (25) a. A doctor will make sure that we give every new patient a tranquilizer.
($\exists > \forall; \forall > \exists$) (Reinhart 1997: 350)
- b. A (different) doctor will make sure that we appear to give every new patient a tranquilizer (by replacing the tranquilizer with a placebo at the beginning of the shift).
($\exists < \forall; \forall > \exists$)

These preliminary observations suggest that epistemic *appear* may be more like a deontic in its scope-taking properties, as it exhibits neither ECP nor other scope-freezing effects. Space does not permit us to delve into the subjective-objective contrast further here, but clearly these facts call for further investigation.

⁹Raising predicates 'seem' and 'likely' pattern with 'appear' in terms of ECP effects, that is, in an example like (24) they allow the QP to extend its scope past them.

4.4 Epistemic NPIs

Von Stechow and Iatridou (2003) discuss some data that present a potential challenge to our CSS-based account of epistemic containment. In the examples in (26), the epistemic modals *can* and *need* function as NPIs: they must appear in the scope of negation (Iatridou & Zeijlstra 2013 discuss these cases extensively). At the same time, they enforce epistemic containment: the modals must out-scope the universal. The conclusion therefore seems to be that both negation and the epistemic modal must extend their scope across the universal. But of course the CSS does not permit this scope extension pattern.

- (26) a. Every student can't be home. * \forall - \diamond ; only \neg - \diamond \forall
 b. Every student need not be home. * \forall - \square ; only \neg - \square \forall

Although it is beyond the scope of this short paper to provide a fully worked out analysis of such examples, we can sketch the outlines of the proposal that we think should be pursued. The apparent double scope extension appears to be limited to cases involving an NPI. It has occasionally been suggested that NPIs are dependent categories, much like, say, reflexives (Progovac 1994). There are various ways of capturing this idea. For example, Neeleman and Van de Koot (2002) suggest that an NPI introduces a selectional requirement that links it to its antecedent. The relevant mechanism makes the NPI scopally dependent on negation and in doing so fixes the scope relation between these two categories. Now suppose the epistemic modal in the examples in (26) percolates an index to the top of the clause, thereby out-scoping the universal. What are the effects of this? The answer depends on whether scope relations are transitive. Suppose we assume that they are:

- (27) *Scope Transitivity* (NvdK 2012)
 If α takes scope over β and β takes scope over γ , then α takes scope over γ .

The dependency between the modal and negation encodes scope of negation over the modal. Scope extension by the modal encodes that it has scope over the universal. Then by (27), negation has scope over both the modal and the universal, as required.

5. Conclusion

In this paper we have primarily investigated the scope interactions between epistemic modals and QPs and suggested that these are best accounted for by a theory of covert scope-extension based on index percolation and an accompanying condition on scope shift (CSS). Our proposal that (subjective) epistemic modals mark propositional scope through index percolation is supported by observations related to ECP effects, QP scope-freezing effects and the ability of certain epistemic adverbs to merge below a deontic modal. We have also briefly touched on preliminary observations suggesting that objective epistemics and deontics behave differently from subjective epistemics in that they are subject to the default scope rule. Finally, we outlined how recalcitrant data involving epistemic NPIs could be accommodated by the theory proposed here.

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