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Pseudo-scoping out of relative clauses: an 'individual concept' approach*

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Abstract Sentences where a definite DP is modified by a relative clause containing a universal quantifier (relative clause DPs), like *the supervisor that each volunteer reported to*, license readings which carry separate presuppositions of uniqueness and existence for each volunteer—henceforth, 'varying definite readings' (VDRs). Barker 2022 argues that these readings involve the universal DP scoping out of the relative clause and above the definite and proposes to analyze them using a non-local scope shifting mechanism, like quantifier raising (QR). In this paper, we argue that this is a case of pseudo-scope. Instead, we argue for a functional interpretation of the DP and propose that VDRs result from the definite DP denoting an $\langle e,e \rangle$ function, from volunteers to supervisors. As support for this claim, we draw a parallel between relative clause DPs and 'bare DPs' (the same definite DP but without the relative clause/embedded universal). We observe that both kinds of DPs license VDRs and thus should be analyzed in the same way—yet bare DPs have no universal to undergo QR. Further support for a pseudo-scope analysis comes from one undergeneration and one overgeneration challenge for the QR approach.

Keywords: quantifier raising (QR), universal quantifiers, relative clauses, scope (island).

1 Introduction

This paper addresses whether universal quantifiers can covertly move out of relative clauses for scope taking purposes. More specifically, we explore whether relative clauses impose a locality constraint and block quantifier raising (QR) of universal quantifiers (for previous discussion, see Rodman 1976; May 1977; Cooper 1979; Sharvit 1999; Hulsey & Sauerland 2006). While it has often been claimed that universal quantifiers cannot QR out of relative clauses (Rodman 1976; May 1977; Cooper 1979; Sharvit 1999), Barker 2022 (a.o.) provides several examples suggesting otherwise. A variation of one such example is provided in (1).[1]

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1 It is worth noting that one common challenge for the claim that universals undergo QR out of relative clauses is that this is only possible when the universal quantifier is in the embedded subject position

(1) John included the supervisor that each volunteer reported to. (c.f. Barker 2022: 637)
Intended interpretation: for each volunteer x, John included the supervisor that x reported to.

Under one reading, (1) conveys a global presupposition of uniqueness and existence concerning supervisors: there is a single supervisor which all volunteers reported to. Under another reading (the reading we're interested in), the supervisor can vary by volunteer: for each volunteer x, John included the supervisor that x reported to—henceforth, 'the varying definite reading'. This reading carries separate presuppositions of uniqueness and existence for each volunteer. Barker (2022) takes the varying definite reading as evidence that the embedded universal DP scopes out of the relative clause and above the definite determiner and proposes to capture this reading using a non-local scope shifting mechanism, like QR, as illustrated in (2).

(2) *LF:* [each volunteer] λ_1 [John included [the supervisor [that t_1 reported to]]]

The motivation for the QR approach is straightforward: the varying definite reading is exactly what one obtains if *each volunteer* underwent QR out of the relative clause since this yields a universally projected uniqueness presupposition. In this paper, we make novel observations to argue that varying definite readings are in fact a case of pseudo-scope: even though it may appear as such, they do not actually involve QR of the embedded universal DP but result from a different mechanism, namely, a functional interpretation of the definite DP. More specifically, we propose that the observed variation is due to the definite DP denoting an $\langle e,e \rangle$ function—what I will refer to as the 'individual concept approach' (ICA). This is not a novel idea but has already been proposed in some form in Jacobson 1994, Sharvit 1999, Barker 2018, Jacobson 2018, a.o. We come to this conclusion by looking at novel data which supports the ICA. In Section 2, we look at a variant of (1) which suggests that the universal quantification in varying definite readings is not contributed by the embedded universal quantifier. In Section 3, we provide supporting evidence for the ICA by looking at how the definite DP in (1) combines with predicates like *vary*. In Section 4, we present an undergeneration challenge for the QR approach. In Section 5, we outline what a compositional implementation of

(as opposed to the object position). However, Barker 2022 also provides examples where the universal quantifier is in the embedded object position, as illustrated in (1).

(i) Yet at the time [that we devised each plan], we were confident it would succeed. (c.f. Barker 2022: 637) the ICA would look like. In Section 6, we present an overgeneration challenge for the QR approach. Finally, in Section 7, we offer some concluding remarks.

2 Varying definite readings without relative clauses

Under the QR approach, the crucial assumption is that the varying definite reading involves the DP, *each volunteer*, undergoing QR to take wide scope over the definite determiner. In this section, we argue against this claim. Instead, we propose that the universal quantification present in examples like (1) is not actually due to *each* but a covert universal operator. We build up to this conclusion in steps. First, we look at a variant of the sentence in (1), but without the relative clause containing the universal quantifier (henceforth, the 'bare DP' case). The logic is as follows: if a varying definite reading is still licensed, this suggests that we may want to analyze the bare DP cases and the modified cases in the same way—since they both give rise the same reading. But in the bare DP case, there is no longer a universal quantifier that can undergo QR to derive variation. This would provide a first reason for suspecting that the universal quantification in (1) is not due to *each* itself. To this end, consider (3), where the bolded target sentence is just (1) without the relative clause.

(3) *[John is updating the student files with each student's supervisor and student ID. Since John is a sloppy worker, Mary is skeptical that he included these pieces of information on each file. Bill says:]*
Bill to Mary: He forgot to include the student ID, but at least **John included the supervisor**.

Like (1), variation is permitted: *the supervisor* in (3) doesn't refer to a single individual as the intended interpretation in (3) wouldn't be satisfied if John included a single supervisor. In addition, like (1), we feel the presence of universal quantification even though no universal quantifier is present in (3): the target sentence is true iff for each contextually relevant student x, John included the supervisor of x, as in (4).

(4) $[\![\text{John included the supervisor}]\!] = 1$ iff
$\forall x \in \{\text{student}_1, \text{student}_2, \ldots\}$: include(John)(the supervisor of x) = 1

So even without a relative clause containing a universal quantifier, we still observe the same reading that we did with (1), which makes one wonder whether the QR approach is insufficiently general. But since (3) can't involve QR, one then wonders where the universal quantification comes from. Since the sentence doesn't overtly contain a universal quantifier, one possibility is to posit a covert universal operator, which attaches at the matrix level. But simply positing a universal operator, while necessary, is not in itself sufficient to derive the intended truth conditions; there are two components that are involved in deriving the intended truth conditions.

First, the truth conditions for (3) involve universal quantification over the set of students. Second, the target sentence in (3) is context dependent: it relies on the context to establish that the referent of *the supervisor* depends on the particular student in question. This suggests an analysis where the definite DP, *the supervisor*, denotes a context-dependent $\langle e,e\rangle$ function, from students to supervisors. Therefore, for interpretability, we want the universal to quantify over the domain of this $\langle e,e\rangle$ function, i.e., the set of students, so that for each student x, we get the supervisor of x (in Section 4, we discuss how this can be implemented). This will allow us to capture the intended truth conditions (and the observed variation of supervisors). With these assumptions in place, in effect, we mimic the effects of QR with the following two components together capturing the varying definite reading in (3):

i. *the supervisor* denotes an $\langle e,e\rangle$ function from students to supervisors.

ii. (3) involves a matrix level covert universal operator which quantifies over the domain of the $\langle e,e\rangle$ function (i.e., students).

The parallel between (1) and (3) raises the question of whether we should analyze both cases in the same way. This is an appealing option, but nothing we have seen forces us to do so. In principle, it is possible to analyze (1) using QR and (3) using a covert universal operator. In the next section, we look at data which further suggests that we should analyze the bare and relative clause cases in the same way. This data also provides supporting evidence for a functional analysis of the definite DP.

3 Supporting evidence for the ICA

In the previous section, we provided initial evidence that the locus of universal quantification is not *each* itself but a covert universal operator. The evidence for this assumption came from the observation that varying definite readings, as observed in (1), are available even in the absence of an embedded universal quantifier. In this section, we strengthen the parallel between the bare DP case and the relative clause case. Furthermore, in this section, we also provide supporting evidence for the assumption that the definite DP denotes an $\langle e,e\rangle$ function by looking at a different kind of varying definite reading where we predicate something of the $\langle e,e\rangle$ function directly. We start by considering the example in (5a).

(5) a. The supervisor varied (from volunteer to volunteer).

b. *Intended interpretation:* different volunteers had different supervisors

In (5a), a varying definite reading is available: *the supervisor* can refer to multiple individuals since each volunteer can have a different supervisor. Like (3), there is no universal quantifier in (5a), again suggesting QR is not the source of variation.

Next, consider (6a), which now contains the same DP as in (1): *the supervisor that each volunteer reported to*. Even after adding the relative clause back in, we observe that (6a) licenses the same varying definite reading as (5a), as paraphrased in (6b).

(6) a. The supervisor that each volunteer first reported to varied.

b. *Intended interpretation:* different volunteers had different supervisors that they first reported to.

As the paraphrase in (6b) illustrates, the referent of *the supervisor that each volunteer first reported to* depends on the volunteer. In this sense, the DP in (6a) involves a mapping from volunteers to the supervisor that they first reported to.

We now turn to the crucial observation. For (1), QR of *each volunteer* out of the relative clause delivered the intended reading. For (6a), QR of *each volunteer* doesn't even derive the right truth conditions. The intended interpretation of (6a) conveys variation of supervisors across volunteers. This differs from the truth conditions resulting from *each volunteer* undergoing QR, as illustrated in (7).[2]

(7) a. *LF:* [[each volunteer] λ_1 [the supervisor [that t_1 first reported to]]] [varied]

b. *Result:* for each volunteer x, the supervisor that x first reported to varied

After QR, the resulting interpretation is one where, for each volunteer x, x's supervisor varied (over time). In fact, QR doesn't even derive a sensible interpretation in this case since the predicate *first reported to* cannot vary over time. Thus, unlike (1), we can't rely on QR in this case.

(5a) and (6a) together suggest that we should analyze the bare DP case and the relative clause case in the same way to derive variation: they both receive the same reading, but now, in the relative clause case, QR doesn't deliver the right truth conditions. We already outlined what one analysis could look like in the previous section when we assumed that variation is built into the definite DP itself since it

2 Another example which makes a similar point is provided in (1a). Once again, the time can vary by participant, so this is another instance of a varying definite reading. At the same time, QR cannot deliver the right truth conditions. The LF after *each participant* undergoes QR is provided in (1b) and the resulting interpretation is provided in (1c).

(i) a. John sorted the time that each participant took (in descending order).

b. *LF:* [[each participant] λ_1 John sorted [the time [that t_1 took]]]

c. *Result:* for each participant x, John sorted the time that x took denotes an $\langle e,e \rangle$ function. The data with *vary* now provides further support for this assumption.

The evidence stems from the observation that the predicate *vary* is not a predicate of individuals, as shown by the infelicity of (8).

(8) # John varied.

Rather *vary* is a predicate of functions: it tells us something about the mapping between volunteers and supervisors, namely, that the volunteers don't all have the same supervisor. For *vary* to be a predicate of functions, the DP that serves as its argument must denote a function. This means the definite DP in (6a) must be a function from individuals to individuals, of type $\langle e,e \rangle$.[3] Therefore, sentences involving *vary* make direct use of this $\langle e,e \rangle$ function in the semantic composition by predicating something of it (whether the DP has been modified by a relative clause or not), providing support for a functional interpretation of the definite DP.

To summarize, we propose that the variation in (5a) and (6a) results from:

i. *the supervisor* denotes an $\langle e,e \rangle$ function from volunteers to supervisors, (9a).

ii. *vary* is a predicate of functions, (9b–c).

(9) a. $[\![$the supervisor$]\!]$ = λx: x is a volunteer. the supervisor of x

b. $[\![$the supervisor varied$]\!]$ = 1 iff
$\exists$x,y$\in$\{volunteer$_1$, ...\} : the supervisor of x $\neq$ the supervisor of y

c. $[\![$the supervisor that each volunteer reported to varied$]\!]$ = 1 iff
$\exists$x,y$\in$\{volunteer$_1$, ...\} : the supervisor that x reported to $\neq$ the supervisor that y reported

Returning to the *include* cases from the previous section, we see that the assumption required for the *vary* cases (i.e., that the DP denotes a function) makes the QR approach redundant: we independently need this kind of analysis for the *vary* cases and we can leverage the same analysis to derive the varying definite reading for *include* cases (as illustrated in Section 2). Therefore, combining the observations in this section and the previous one provides a constructive argument for an alternative path to varying definite readings which doesn't rely on QR. As a result, for all the examples we've seen up to now, we assume that the definite DP denotes an $\langle e,e \rangle$

3 It is worth pointing out that the predicate *vary* can also take intensional objects as arguments, like regular individual concepts of type $\langle s,e \rangle$. Consider (1), where variation is now over time.

(i) The supervisor varied (from year to year).

function from students/volunteers to supervisors. The difference between examples like (3) and (5a) concerns what role this function plays in the semantic composition. In the former case, the function interacts with a covert universal operator to derive the varying definite reading. In the latter case, it serves directly as an argument to the predicate *vary*.

4 An undergeneration challenge for the QR approach

Concerning the varying definite reading in (1), we can also see the need for an alternative analysis through a different route. More specifically, in this section, we argue that there are varying definite readings that the QR approach can't capture.

The example in (1) involves a universal quantifier embedded in a relative clause. In (10a), we further embed the universal quantifier in an environment where we have independent evidence that QR is not licensed (i.e., out of finite complement clauses). If a varying definite reading is still possible, this data point would further complicate the QR approach by requiring that the scope islandhood of finite complement clauses is context dependent—it is lifted if the finite complement is inside a relative clause, in which case QR can escape the finite complement and the relative clause at the same time. To this end, consider the example in (10a).

(10) a. *[At the community center, each volunteer reports to a different supervisor. John is supposed to keep track of all this in a file but he's clueless regarding who reports to who. However, he remembers that Mary claimed that Alice reports to Bill, Chris reports to Diane and Eric reports to Francine. After writing these supervisor/volunteer pairs in the file, Mary looks at it. She looks puzzled so John replies:]*
John to Mary: What? **I included the supervisor that you claimed each volunteer reported to.**

b. *Available interpretation:* For each volunteer x, I included the supervisor you claimed x reported to

The target sentence in (10a) differs from (1) insofar as the island has, in a sense, been 'strengthened' by adding another layer of embedding: in the relative clause, there's the finite complement clause of *claim*. This configuration is shown in (11).

(11) *Structural configuration in (10a):* $[\ldots\ \iota\ [_{\text{RC}}\ [_{\text{TP}}\ \ldots\ \forall\ \ldots\ ]\ ]\ ]$
'RC' = relative clause boundary; 'TP' = finite complement clause boundary

What we observe is that, parallel to (1), the target sentence can still receive a varying definite reading, as paraphrased in (10b). In order to generate the intended interpretation under the QR approach, we would need to posit an LF like (12).

(12) *LF:* [each volunteer] λ_1 [I included [the supervisor [$_{\text{RC}}$ that you claimed [$_{\text{TP}}$ t_1 reported to]]]]

The LF in (12) requires a rather radical instance of QR: the DP *each volunteer* covertly moves out of the finite complement and out of the relative clause. In principle, this kind of QR may be available in the grammar, if neither relative clauses nor finite complement clauses impose locality constraints on QR. For the sake of the argument, let's assume with Barker 2022 that relative clauses do not impose locality constraints on QR. But what about finite complement clauses? The independent baseline in (13a) suggests that universals cannot freely QR out of finite complements.

(13) a. A student claimed each invited speaker was wrong.
b. *Available interpretation:* Single student that claimed all the invited speakers were wrong.
c. *Unavailable interpretation:* For each invited speaker x, a (potentially) different student claimed x was wrong.

In (13a), the student cannot vary by speaker; the only interpretation is provided in (13b). If *each volunteer* were to QR out of the finite complement clause of *claim*, then there should be an interpretation of (13a) as paraphrased in (13c)—contrary to fact (also see Palucci 2024 for further evidence that finite complements do impose locality constraints on QR of universal quantifiers. Even Barker (2022), who argues that finite complements are not scope islands for QR per se, assumes that the complement of *claim* is.) We are left with two options: i) either posit that universals can QR out of finite complements of *claim*, but only when the finite clause is itself embedded in a relative clause, or ii) conclude that the varying definite reading in (10a) is not derived through QR, but another mechanism. While in principle possible, the first option seems unlikely. Therefore, we take the availability of a varying definite reading in (10a) as evidence for an alternative analysis of (1).

5 Sketching a compositional analysis

In this section, we sketch in more detail the underlying idea that, to capture the varying definite readings we have seen, the semantic composition makes use of definite DPs which denote $\langle e,e\rangle$ functions (with or without a relative clause). We then turn to how these functions compose with different predicates. On the one hand, predicates like *vary* directly take $\langle e,e\rangle$ functions as arguments. On the other hand, predicates like *include* take arguments of type *e*—which raises a compositionality problem. Thus, we need a way to shift from definite DPs which denote functions to definite DPs which denote individuals of type *e*. In order to resolve this tension, we need to posit some hidden structure. But first, we take a look at one possible way of compositionally deriving these $\langle e,e\rangle$ functions.

5.1 Deriving $\langle e,e \rangle$ functions

Analyzing definite DPs as functions whose referent depends on some input argument is reminiscent of Montague 1973's solution to Partee's well-known temperature paradox, illustrated in (14). The challenge stems from the fact that, intuitively, the truth of (14a) and (14b) does not guarantee the truth of (14c).

(14) a. The temperature is ninety.
b. The temperature rises.
c. Ninety rises.

To analyze these sentences, Montague (1973) treats the definite DP as an individual concept: an $\langle s,e \rangle$ function from indices (a combination of world and time) to individuals, and *rise* as a property of individual concepts (i.e., a property of functions of type $\langle s,e \rangle$)—similar to what we assumed above. For *rise* to be true of one such function at a given index i, one compares the value of the function at i with the value of the function at a different index, say i'.

We opted for a similar approach to analyze (5a): treat the definite DP as a function that outputs individuals and the predicate *vary* as a property of this kind of function. But what kind of function is the definite DP in (5a)? We have assumed that it is a function from individuals to individuals. This creates somewhat of a tension though: normally, intensional objects are created by abstracting over parameters on the interpretation function (like time or world parameters)—but in our case, there is no parameter to abstract over. So where does this $\langle e,e \rangle$ function come from?[4]

We propose to build on an observation made in Partee 1989 to derive our $\langle e,e \rangle$ functions. Partee argues that some nouns, like *enemy*, contain implicit variables that

4 One alternative worth considering is that the variation in (1) is the result of the object being a concealed question; especially since one prominent analysis of concealed questions analyses the DP as an individual concept of type $\langle s,e \rangle$. For example, (1a) may actually be understood as in (1b), in which case, one might conclude that the object DP is acting as a concealed question.

(i) a. John included the supervisor that each volunteer reported to.
b. *Interpretation:* John included which supervisor each volunteer reported to.

One reason to believe that varying definite readings are not merely instances of concealed questions is that we observe varying definite readings with predicates which don't license concealed questions, like *invite*. In (2a), a varying definite reading is still possible even though the object DP cannot be construed as a concealed question, as illustrated in (2b).

(ii) a. John invited the supervisor that each student works with.
b. # *Interpretation:* John invited which supervisor each student works with.

can be bound by operators higher in the structure. To illustrate, consider (15).

(15) Every participant had to confront and defeat an enemy.

Partee observes that the sentence in (15) can receive a bound variable interpretation where the enemy can be a different individual for every participant. She proposes that one way to make sense of the intended reading in (15) is that the noun *enemy* contains an implicit variable in the syntax which ranges over participants, as illustrated with the variable 'x' in (16).

(16) $[\![$enemy x$]\!]$ = λz. z is an enemy of x

The implicit variable remains free and can get bound by the universal quantifier in the subject position, as shown by the LF in (17), deriving a bound variable interpretation.

(17) *LF:* [every participant] λx. t_x had to confront and defeat an enemy of x

In what follows, we build off this intuition to capture varying definite readings. Rather than the implicit variable being bound higher up in the structure (i.e., by a universal quantifier), we will abstract over this implicit variable at the DP level to create an $\langle e,e\rangle$ function.[5] However, before getting further into the compositional implementation, we briefly turn to the domains of these $\langle e,e\rangle$ functions.

5.2 Domain of the function

One detail which we have glossed over so far concerns the domain of these $\langle e,e\rangle$ functions. For example, consider (18) again.

(18) John included the supervisor.

In examples like (18), there is no explicit restriction on the domain of the function. This would suggest that the functions under question are total functions on the

5 Another approach derives the $\langle e,e\rangle$ function as a kind of contextual restriction on the definite determiner (Von Fintel 1994). The idea is that quantifiers are indexed with complex variables which contextually restrict them. To illustrate, consider (1) where the contextual restriction on the quantifier *no student* is something like "in class x" and the variable 'x' is bound by the higher quantified subject.

(i) [Only one class]$_6$ was so bad that [no$_{f_{12}(\upsilon_6)}$ student]$_9$ passed the exam. (Von Fintel 1994: 31)

In (1), the intended value of the variable f_{12} is a function that takes classes and returns the students in that class. The argument variable υ_6 is bound by the higher quantifier *only one class*. In our examples, the contextual restriction on the quantifier *the supervisor* is something like "of volunteer/student x" where the variable x would still be bound higher up by a lambda abstract to yield an $\langle e,e\rangle$ function. This alternative would work just as well for our purposes.

domain D_e, mapping every individual to their supervisor. But many individuals don't have supervisors, so we don't want this to be a total function. Rather, the functions that we are concerned with seem to be partial functions. But which partial functions are we talking about, and how can we capture this partiality?

With bare DPs, we don't have compositional access to anything that explicitly restricts the domain. Rather, we have to rely on some covert method of narrowing down the domain of the function. For (3), this was supplied by the context, which established that we are concerned with the supervisors of a particular group of students. In what follows, we will derive partial functions by assuming that the implicit variable which is abstracted over is a contextually restricted variable. This means the function is only defined for certain values of x—which, in our case, is the set of contextually specified students. Note also that this function is defined for *all* contextually relevant students. This is illustrated in (19) for the example in (3).

(19) $[\![$the supervisor$]\!]$ = λx: student(x). the unique supervisor of x

Things are different when we turn to examples with relative clauses. Comparing (20a) and (20b), we observe that they convey roughly the same meaning, the only salient difference concerns how the domain of this function is established. In constructing the $\langle e,e \rangle$ function in (20b), we do have compositional access to something which restricts the domain of the function, namely, the NP restrictor of *each*.

(20) a. John included the supervisor.
b. John included the supervisor that each student works with.

Furthermore, we observe that the domain of the function can't be too small. The domain in (20b) has to be maximal over the NP restrictor: each student in the restrictor of the universal must have a unique supervisor, as illustrated in (21).

(21) *[Only half the students in LING 660 have a supervisor. To keep track, John wrote the names of all the supervisors down.]*
#John included the supervisor that each LING 660 student works with.

(21) illustrates that it is not sufficient for merely every individual in the domain of the function to be a student, but rather every student needs to be in the domain of the function. This would be captured if a partial function is derived through *each*'s NP restrictor, as illustrated in (22) for the DP in (20b).[6]

(22) $[\![$the supervisor that each student works with$]\!]$ =
λx: student(x). the unique supervisor that x works with

6 Under a QR based approach, this falls out naturally given universal presupposition projection of universal quantifiers (Heim 1983).

Therefore, even though the same kind of varying definite reading is available with bare DPs, the presence of a relative clause containing a universal quantifier provides explicit information concerning the construction of the $\langle e,e\rangle$ function. This is why varying definite readings with bare DPs are only available insofar as the context establishes the domain of the $\langle e,e\rangle$ function.

5.3 Capturing varying definite readings with bare DPs

In this section, we outline the machinery that is necessary to capture varying definite readings. We start by looking at varying definite readings without relative clauses and then turn varying definite readings with relative clauses in Section 5.4. We begin by assuming that the noun *supervisor*, like *enemy*, comes with an implicit free variable, as in (23). Note that the function we are constructing does not necessarily need to map supervisees to their supervisor. In a context in which everyone in the department nominated a supervisor for an award, one could use *John included the supervisor* to report that John included, on a list of department members, the respective supervisor that each one nominated. The fact that *supervisor* is a relational noun is not essential or necessary. It seems that we are free to construct relatively arbitrary $\langle e,e\rangle$ functions from individuals to supervisors to license such readings; a relational noun simply suggests an obvious way to construct such a function.[7]

(23) $[\![$supervisor x$]\!]$ = λz. supervisor-of(z, x)

After combining with the definite determiner, the result is in (24).

(24) $[\![$the supervisor x$]\!]$ = ιz[supervisor-of(z, x)]

(24) refers to a specific individual: the supervisor of x. But the denotation for the DP still contains the implicit free variable, x. In the examples discussed in Partee 1989, this variable remains free and only gets bound by an external operator higher in the structure, like a universal quantifier. We propose that this implicit variable can also be abstracted over locally, at the DP level, in order to derive an $\langle e,e\rangle$ function. We capture this by positing a lambda abstract at LF, as in (25) (recall, the partiality of the function arises from the contextual restriction on the free variable).

(25) $[\![\lambda_x$ the supervisor x$]\!]$ = λx: student(x). ιz[supervisor-of(z, x)]

7 We can even license varying definite readings with bare DPs that don't involve relational nouns, like *book*. Consider (1).

(i) *[Context: Today is show-and-tell and every student brought in a movie and a book.]* What a coincidence, every student brought in the same movie. **At least the book varied.**

The next question concerns how this function composes with the rest of the sentence. We start with the sentence in (26).

(26) The supervisor varied.

We will assume that *vary* has the denotation in (27).[8]

(27) $[\![\text{vary}]\!] = \lambda f_{\langle e,e \rangle}.\ \exists$y,z[f(y) $\neq$ f(z)]

As (27) illustrates, *vary* takes an $\langle e,e \rangle$ function as its argument. Combining (27) with the function in (25) results in (28), which is the intended interpretation.

(28) $[\![\text{vary}]\!]([\![\lambda_x$ the supervisor x$]\!])$ =
$\exists$y,z[ιx[supervisor-of(x, y)] $\neq$ ιx[supervisor-of(x, z)]];
if y and z are students, otherwise undefined
$\approx$ there exist two students y and z s.t. they have different supervisors

Next, we consider the sentence in (29).

(29) John included the supervisor.

We will assume that include has the denotation in (30).

(30) $[\![\text{include}]\!] = \lambda x \lambda y.$ y included x

In this case, when we try to combine *include* with the function in (25), we get a type-mismatch: *include* expects an argument of type *e*, but the DP, *the supervisor*, denotes a function of type $\langle e,e \rangle$. To resolve this type mismatch, we will assume the function gets saturated by a covert pronoun (Heim 2018), resulting in (31).

(31) $[\![$included [[λ_z the supervisor z] (pro$_x$)]$]\!]$ = λy. y included the supervisor of x

Furthermore, in Section 2, we proposed that the LF for (29) also contains a covert universal operator. In addition to conveying universal quantificational force, we assume that this covert operator is an unselective binder which binds the covert pronoun. As a result, we end up with the LF in (32).

(32) *LF:* $\forall_x$ [John included [[λ_z the supervisor z] (pro$_x$)]]

The binding that occurs between $\forall_x$ and pro$_x$, in effect, achieves the same result as if a universal quantifier underwent QR to take wide scope. In addition, the matrix universal must itself be restricted. For interpretability, it must be restricted to students. The set of all students is the largest possible domain it can have and intuitions indicate that the domain cannot in fact be understood to be smaller than that. Combining all these pieces, we end up with the truth conditions in (33).

8 We are not too concerned with the lexical semantics of *vary* here. What is crucial for the discussion is that it takes an $\langle e,e \rangle$ function as its argument and predicates something of this function.

(33) $[\![(32)]\!] = \forall$x[student(x) $\rightarrow$ John included the unique supervisor of x]

5.4 Adding the relative clause back in

In the bare DP case, we posited that the noun *supervisor* contains an implicit free variable, which we abstracted over to create an $\langle e, e\rangle$ function. For concreteness, we now present one way to analyze the relative clause cases which is analogous to the bare DP cases: we assume *each* now contributes a variable which we can abstract over, as in (34a) (there are alternative ways of analyzing the relative clause cases which don't make this assumption, such as Sharvit 1999; Jacobson 2018. We briefly compare the variable approach with these approaches at the end of this section). This means the denotation for the DP, *each student*, will be as in (34b).

(34) a. $[\![$each$]\!] = \lambda$P: P(x). x

b. $[\![$each student$_x]\!]$ = the student x   cf. trace conversion (Fox 2002)

Again, a lambda abstract at LF creates an $\langle e, e\rangle$ function ranging over students due to the variable introduced by *each* being restricted to students. As a result, the DP, *the supervisor that each student works with*, denotes the function in (35).

(35) $[\![\lambda_x$ the supervisor that each student$_x$ works with$]\!]$ =
λx: student(x). ιz[supervisor-of(z, x) & works-with(x, z)]

Capturing the truth conditions for (20b) involves an analogous LF as (20a), as illustrated in (36a) with the truth conditions provided in (36b). Once again, the matrix universal must itself be restricted. For interpretability, it gets restricted to the set of all students—which, in this case, is supplied by the universal's NP restrictor.

(36) a. *LF:* $\forall_y$ [John included [[λ_x the supervisor that each student$_x$ works with] (pro$_y$)]]

b. $[\![(36a)]\!] = \forall$y[student(y) $\rightarrow$ John included the supervisor y works with]

Note that, in (36), *each* itself doesn't contribute wide scope universal quantificational force. In the truth conditions in (36b), the universal force that we would normally achieve through QR now comes from the operator $\forall_y$ binding the covert pronoun, pro$_y$.

In summary, by analyzing the definite DPs (both the bare and the relative clause cases) as $\langle e, e\rangle$ functions, we provided a unified analysis of varying definite readings and the *vary*-sentences introduced in Section 3. This unified analysis comes with some costs though. One drawback is that we posited a covert universal operator and made use of covert pronouns. Another drawback is that we made a non-standard assumption concerning the denotation of *each* when it is embedded in the relative clause, namely, that it denotes a variable. While the proposed unified analysis is appealing, there is evidence that the variable analysis of *each* may not be on the right track. Consider the contrast between the two target sentences in (37b) and (37c).

(37) a. *[John works at an all boys school and is updating the students' files. Each student has a different supervisor but this information was missing. So, on the different files, John wrote down the respective supervisor.]*

b. # John included the supervisor that he works with.

c. John included the supervisor that they work with.

Assuming pronouns also denote variables (like we proposed for *each*), we expect (37b) to be acceptable. But we can't get a varying definite reading in (37b), suggesting that singular pronouns do not pattern like *each*—contrary to what we predict. In contrast, a varying definite reading is available with a plural pronoun, as in (37c). One possible explanation for this contrast is due to the observation that plural pronouns can be interpreted distributively in certain contexts (Dimitriadis 2000; Rullmann 2002; Heim 2008). If this is the case, it provides evidence that we need a distributive/universal quantifier in the relative clause to get the varying definite reading, which provides an argument against the variable analysis in the relative clause case and suggests that *each* should receive a standard interpretation as a universal quantifier. This means the internal composition of the $\langle e,e \rangle$ function could be different in the relative clause cases (from the bare DP cases), but we leave a proper examination of this to future research. What is important for the discussion at hand is that both bare DPs and relative clause DPs denote $\langle e,e \rangle$ functions.

Finally, we also note that the analysis opted for in this paper assumes that function formation happens at the DP level: we insert a lambda abstract above the definite determiner which binds a free variable within the DP, deriving an $\langle e,e \rangle$ function. This means we can rely on a standard denotation of the definite article. However, there is a family of related alternative analyses in the literature which are also 'functional' in that they assume the DP denotes an $\langle e,e \rangle$ function. The difference is that these analyses assume that function formation happens at the NP level, meaning that NPs denote sets of functions rather than sets of individuals (Sharvit 1999; Jacobson 2018). The definite determiner is then assumed to be polymorphic and picks out the unique function from this set of functions. It would be interesting to compare these two approaches in more detail to see if they make any diverging predictions, but for reasons of space, we leave this to future research.

6 An overgeneration challenge for the QR approach

In this section, we show that QR out of relative clauses overgenerates an unattested reading, further strengthening the case for a pseudo-scope analysis. Consider the example in (38). The baseline observation is that the example can receive two different interpretations, what I will refer to as a 'low *each* reading' and a 'high *each* reading'. The two readings are paraphrased in (39a) and (39b) respectively.

(38) John refused to invite each supervisor.

(39) a. *Low each reading:* John refused to invite some of the supervisors.
b. *High each reading:* for each supervisor x, John refused to invite x

These two readings can be analyzed as a scope ambiguity between the universal quantifier and the embedding predicate *refuse*. The low reading involves an LF where *each volunteer* undergoes QR to a position below the embedding predicate, (40a), while the high reading involves an LF where *each volunteer* undergoes QR to a position above the embedding predicate, (40b).

(40) a. *Low reading LF:* John [refused [each supervisor] λ_1 to invite t_1]
b. *High reading LF:* [each supervisor] λ_1 [John [refused to invite t_1]]

Next, consider the example in (41).

(41) John refused to invite the supervisor that each volunteer reported to.

This example differs from that in (38) only in that the universal DP in the object position has been replaced by a definite DP with a relative clause containing the universal quantifier *each*. If universal quantifiers can freely QR out of relative clauses, then the prediction is that the examples in (41) should pattern like those in (38): we should observe a scope ambiguity between *each volunteer* and the embedding predicate. The two readings would be captured through the DP undergoing QR to different positions, as shown in the LFs in (42a) and (42b).

(42) a. *High reading LF:* [each volunteer] λ_1 [John [refused to invite the supervisor that t_1 reported to]]
b. *Low reading LF:* John [refused [each volunteer] λ_1 to invite the supervisor that t_1 reported to]

However, the crucial observation is that, unlike (38), this sentence receives a single interpretation, paraphrased in (43a); the reading in (43b) is no longer available (these represent the author's judgments—which several English native speakers agreed with—though the judgments are admittedly subtle in this case).

(43) a. *Available reading:* for each volunteer x, John refused to invite the supervisor that x reported to.
b. *Unavailable reading:* John refused to invite some of the supervisors.

The unavailability of the reading in (43b) can even be stressed through the continuation in (44b), which is meant to force the reading in (43b). In particular, there is a relative contrast between the felicity of the continuation in (44a) and the one in (44b).[9]

(44) a. John refused to invite each supervisor; he only invited half of them.

b. John refused to invite the supervisor that each volunteer reported to; #he only invited half of them.

To account for this observation, one would need to stipulate that the LF in (42b) is blocked for some reason, which leads to the reading in (43b) being unavailable. However, there's no principled reason why *each volunteer* would be able to undergo QR above the matrix predicate, but not below it. Therefore, it seems that the QR approach generates an unattested reading in this case.

7 Concluding remarks

In this paper, we have argued that varying definite readings do not involve *each* DPs undergoing QR out of the relative clause to a position above the definite determiner. One implication of this is that one can maintain that relative clauses do in fact impose locality constraints and block QR of universal quantifiers. We proposed an alternative analysis in which varying definite readings arise from the way the definite DP is interpreted: as an $\langle e,e\rangle$ function, where the referent of the definite DP depends on the input of the function. The argument for this analysis came in several steps. First, varying definite readings are available with bare DPs (when there is nothing to QR). Second, there are cases of varying definite readings with predicates like *vary* where QR doesn't even deliver the right truth conditions. In both cases, treating the definite DP as an $\langle e,e\rangle$ function allows us to capture the intended interpretation.

Now, we would like to conclude by making one final observation. To analyze (3), we posited a covert universal operator in order to capture the intended truth conditions. Even once we added the relative clause containing a universal quantifier back in, we still assumed that in examples like (1), the universal force came from a covert operator and not *each* itself. Here, we present one piece of evidence that supports this conclusion. More specifically, we observe that *include* doesn't always combine with the object DP with universal quantificational force. To this end, consider (45).

9 According to the native English speakers I have consulted with, the judgments for (44b) are split: some speakers agree with the reported judgment while others find (44b) acceptable. The point is that, if the reported judgment is borne out, this would be an overgeneration challenge for the QR approach.

(45) a. *[There are 6 students. John was updating the student record. He was supposed to create a file and add the supervisors that the students report to. Unfortunately, John didn't complete his task as he only wrote down 4 out of the 6 supervisor/student pairs. But at least:]*
John mostly included the supervisor that each student reports to.

b. *Intended:* John included most of the supervisor/student pairs

In (45), an overt adverbial quantifier, *mostly*, is present and we no longer observe universal quantificational force. Rather, the sentence as a whole gets the quantificational force of the adverbial quantifier, resulting in a 'partial inclusion' interpretation, as illustrated in (46).

(46) ⟦John mostly included the supervisor that each student reports to⟧ = 1 iff for most x $\in$ ⟦student⟧: include(John)(the supervisor that x reports) = 1

In other words, when we insert an overt matrix level quantifier, the covert universal operator is no longer present. We could capture this interpretation through the LF in (47), if we assume that *mostly* can also behave as an unselective binder.

(47) *LF:* most_y [John included [[λ_x the supervisor that each student_x reports to] (pro_y)]]

In (47), instead of the pronoun being bound by a covert universal operator, we assume that it is bound by *mostly* itself. As a result, *mostly* quantifies over students. We also note that it isn't straightforward to capture this partial inclusion interpretation under the QR approach. Consider the two LFs for (45) in (48).

(48) a. *LF 1:* [each student] λ_1 [[mostly] [John included the supervisor that t_1 reports to]]

b. *LF 2:* [mostly] [[each student] λ_1 [John included the supervisor that t_1 reports to]]

In (48a), *each student* undergoes QR to a position above *mostly*, resulting in the following interpretation: for each student x, for the most part, John included the supervisor that x reports to. In (48b), *each student* undergoes QR to a position below *mostly*, resulting in the following interpretation: for the most part, for each student x, John included the supervisor that x reports to. Both interpretations do not quite capture the partial inclusion interpretation that is intended in (45). Therefore, if wide scope universal force in (1) did come from *each* itself (as the QR approach predicts), one would need to explain why the truth conditions for (45) don't seem to involve wide scope universal quantification.

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