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The cost of raising quantifiers

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Abstract

This paper proposes that clause-boundedness effects observed for *quantifier raising* (QR) are only apparent, and that QR obeys the same syntactic locality restrictions as other A'-movement operations. Instead the difficulty associated with constructing non-clause-bound inverse scope interpretations is attributed to increased processing costs arising for covert (but not overt) movement, which is calculated based on the complexity of the structure, specifically the number of syntactic domains crossed. Based on the results of several experimental studies, speakers' acceptance of QR from different types of clausal complements is shown to be gradient, yielding a scale of difficulty which tracks syntactic complexity defined over a clausal sub-domains. An account is proposed that derives the acceptability patterns of QR from different types of infinitives and finite clauses, as well as certain differences between QR in QP»QP contexts and QR in *antecedent-contained deletion* contexts.

1. Introduction

A standard claim about the locality of QR is that it is clause-bounded. Examples such as (1) are often considered to be unambiguous.

(1) a. *#Someone said that every man is married to Sue.* *∀»∃ [Fox 2000: 62]
b. *#Someone said that Sue is married to every man.* *∀»∃ [Fox 2000: 62]
c. *I told someone you would visit everyone.* *∀»∃ [Johnson 2000: 188]
d. *A technician said that John inspected every plane.* *∀»∃ [Cecchetto 2004: 350]

Clause-boundedness effects for QR have always been puzzling, for at least three reasons. First, such judgments are not absolute but gradient and relative, and, as often stated in footnotes, speakers do sometimes allow inverse scope across finite clauses. Second, as shown in (2a,b), QR crucially differs from overt A'-movement (*wh*-movement, topicalization) in that the latter can escape from finite clauses via successive cyclic movement, raising the question of why covert movement obeys different locality constraints from overt movement.

(2) a. *It's Mary that I told someone __ you would visit __.* [Johnson 2000: 188]
b. *What did a technician say __ that John inspected __?* [Cecchetto 2004: 350]

Third, when scope in *antecedent contained deletion* (ACD) contexts is considered, QR out of finite clauses appears to be generally possible. Since examples like (3) allow a large ellipsis antecedent as indicated, assuming QR is required to resolve ACD, such examples must involve QR of *every committee/book* + the relative clause to a position above the matrix verb, thus across finite clause boundaries.

(3) a. *John said that you were on every committee that Bill did ~~say that you were on~~.*
QP » [*said that you were on* [*every committee that Bill did ~~say that you were on~~*]]
[Wilder 1997]

b. *Clifford said that Goofy read every book that Scooby did.*
[Syrett and Lidz 2011: 321 (26)]

Syrett and Lidz (2011: 326): "a third of the adults accessed the supposedly ungrammatical matrix interpretation at least once, and 4 adults accessed this interpretation at least half of the time, providing explicit justifications for doing so that referenced the matrix interpretation"

An even greater area of variation is found when QR out of infinitives is considered. Hornstein (1994, 1995) and Cecchetto (2004) state that QR is only possible out of restructuring infinitives, which are assumed to involve mono-clausal configuration. Cecchetto's evidence for this distinction in Italian is given in (4). Since infinitives combining with the modal verb *want* allow clitic climbing as in (4a), they are classified as restructuring infinitives. Such infinitives also allow inverse scope in (4b). Infinitives combining with a verb like *admit*, on the other hand, prohibit clitic climbing, (4c), hence are non-restructuring infinitives, and according to Cecchetto inverse scope as in (4d) is therefore also excluded.

(4) a. *Gianni* *lo* *vuole* *fare* Italian
Gianni it wants do.INF
'Gianni wants to do it.' [Cecchetto 2004: 371, (51)]

b. *Almeno uno studente vorrebbe licenziare ogni professore.* ∀»∃
'At least one student would like to fire every professor.' [Cecchetto 2004: 372, (52)]

c. **Almeno un poliziotto* *la* *ha* *ammessa* *di sorvegliare*
At least one policeman it has admitted to control
'At least one policemen has admitted to control it.' [Cecchetto 2004: 372, (57)]

d. *Almeno un poliziotto ha ammesso di sorvegliare ogni uscita.* *∀»∃
'At least one policeman has admitted to controlling every exit.'
[Cecchetto 2004: 372, (58)]

Regarding English, the restructuring/QR connection has, however, been contested by Kennedy (1997), Moulton (2007), as well as most of the native speakers I have consulted. Examples such as (5) allow inverse scope, although only *try* and *intend* would typically be considered as restructuring predicates.

(5) Kennedy (1997: 674): "although QR is in general clause-bounded, it can move quantified DPs out of nonfinite clauses (possibly as a marked option) […] Each of these sentences has an interpretation in which the embedded quantifier has wide scope with respect to the indefinite subject of the matrix clause"

[41] *At least two American tour groups **expect** to visit every European country this year.*
[42] *Some agency **intends** to send aid to every Bosnian city this year.*
[43] *At least four recreational vehicles **tried** to stop at most AAA approved campsites this year.*
[44] *Some congressional aide **asked** to see every report.*
[45] *More than two government officials are **obliged** to attend every state dinner.*
[46] *A representative of each of the warring parties is **required** to sign every document.*
[47] *At least one White House official is **expected** to attend most of the hearings.*

As in finite contexts, ACD with wide ellipsis resolution and resulting wide scope of the ACD containing QP is again possible for most speakers.

(6) a. *Tim believes the students to know everything Joe does* [~~*believe the students to know*~~].
b. *A middle school teacher claimed to be about to catch each problem student John did* [~~*claim to be about to catch*~~]. ?∀»∃; [Cecchetto 2004: 388, (93)]

The main issues posed for QR are thus again the speaker variation and the (apparent) difference between QR in ACD contexts and QR in contexts with two QPs. There are two basic directions for how these issues can be addressed. QR across a finite clause boundary (and possibly a non-restructuring infinitive) could be excluded by syntactic constraints, e.g., *Scope Economy* (Fox 2000, Cecchetto 2004), and ACD 'lifts' those constraints (Cecchetto 2004). I will briefly summarize this general approach in section 2 and present its challenges. Based on a preliminary experiment on QR out of different types of infinitives reported in Moulton (2007), which I summarize in section 3, I propose an alternative direction in this paper which combines conclusions about the structure and complexity of infinitives (section 4) with a processing approach (section 5). I suggest that QR across a finite clause boundary (as well as non-restructuring infinitives) is not syntactically constrained by restrictions specific to QR, but that the difficulty of inverse scope in certain configurations is the result of extragrammatical factors (see also Syrett and Lidz 2011). Specifically, I hypothesize that the difficulty of QR reflects a processing cost (similar to Anderson 2004's *Processing Scope Economy*), which is calculated based on a specific definition of syntactic complexity motivated by independent syntactic considerations. Lastly, in section 6, I discuss QR in ACD contexts and provide a possible explanation for the perceived lower difficulty in accessing inverse scope in these contexts.

2. Syntactic accounts

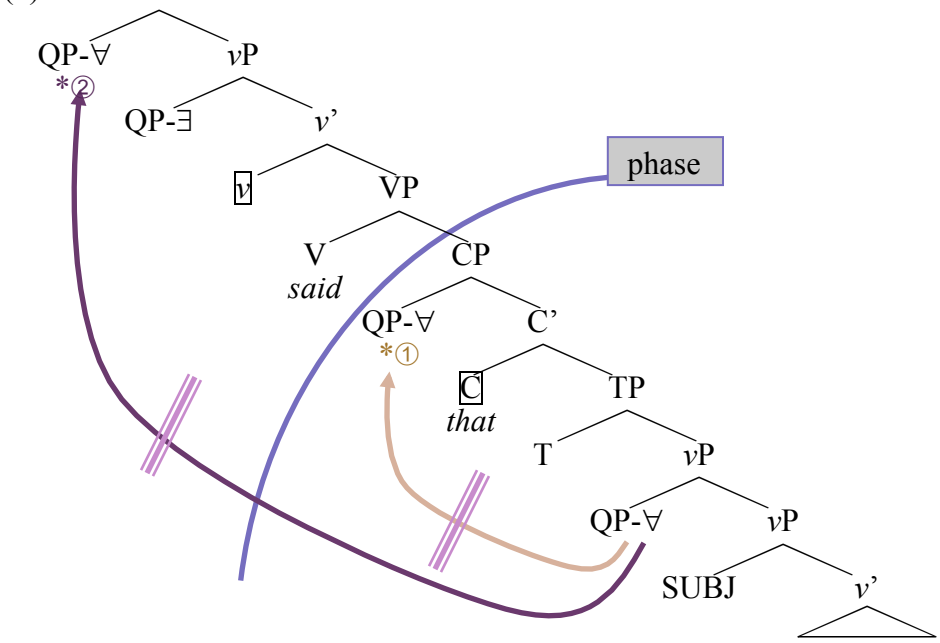
A common approach to the clause-boundedness of QR is to derive the effect from *Scope Economy* as in (7) (see Fox 2000, Cecchetto 2003, 2004, Takahashi 2011, Wurmbrand 2013b).

(7) Scope-shifting operations (SSOs) cannot be semantically vacuous (Fox 2000: 3).

Assuming that CPs are domains (e.g., phases) for syntactic movement, locality requires that movement out of a finite CP (and for Cecchetto 2004 also out of a non-restructuring CP) applies successive cyclically through Spec,CP. In other words, movement of QP-∀ from the embedded Spec,*v*P to position ② in (8) is excluded.[1] QR, in contrast to overt A'-movement, however, is subject to an additional requirement, namely *Scope Economy*—each step of QR must be motivated semantically. As shown in (8), locality and *Scope* Economy then lead to an unresolvable dilemma. Locality requires movement through Spec,CP, but *Scope Economy* prohibits this step, since this movement does not change any scope relations in the embedded clauses.

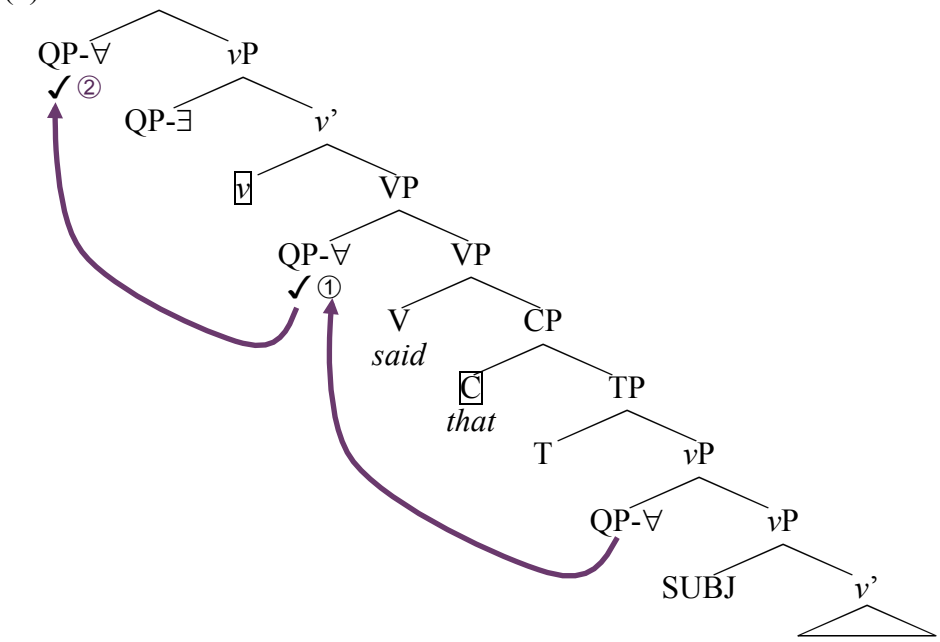
[1] Some of the specifics differ in the accounts mentioned in the text, but under both views, movement to Spec,CP is necessary to meet the locality conditions of movement. Takahashi (2011) and Wurmbrand (2013b) relate locality to the inaccessibility of material in spelled out domains (to escape Spell-Out of TP, QP-∀ would have to move to the phase edge, Spec,CP). Cecchetto (2004), on the other hand, assumes that LF Spell-Out does not apply cyclically, but that locality is defined over the number of phase heads crossed—only one phase head may be crossed in a single step of movement (in derivation ② in (8) two phase heads would be crossed—*v* and C, which is illicit).

(8)



To allow QR in ACD contexts, Cecchetto (2004) defines semantic motivation as: i) scope over another QNP, ii) resolving a type mismatch, and iii) solving an infinite regress problem in an ACD configuration. This has the welcome effect that movement of QP-∀ to Spec,CP as in (8) is excluded, but movement above the matrix V as in (9) is allowed. Crucially, this movement is only possible when it is motivated by ACD resolution. Since, for LF purposes, no Spell-Out of completed phases takes place, movement of QP-∀ from the embedded *v*P to the matrix VP is possible in Cecchetto's system. As shown in (9), this movement step satisfies locality since only one phase head (C) is crossed. It also satisfies *Scope Economy* in a context such as (3) (but crucially not (1)), since this movement serves to resolve an ACD configuration.

(9)



Cecchetto's approach thus derives the difference between (1) and (3), with the exception of the speaker variation. As for infinitives, the situation is not so clear. Restructuring infinitives are assumed to lack a clausal domain (in particular a CP), whereas non-restructuring infinitives involve a CP. The lack of clause-boundedness effects in restructuring thus follows (but see next section for a difference between restructuring infinitives and simple predicates). The behavior of non-restructuring infinitives in English, which we have seen in section 0 allow QR, is not addressed. Theoretically, the analysis raises the question of why semantic motivation to satisfy *Scope Economy* includes ACD resolution, but not, for instance, scope over an intentional matrix verb, which can also lead to a different interpretation (recall that the derivation in (9) can only apply in ACD contexts). Including ACD resolution as a way to satisfy *Scope Economy* may also pose a look ahead problem, depending on how exactly ACD resolution works—a movement step not changing the interpretation as ① in (9) is allowed if this leads to ACD resolution but crucially not when this leads to a different scope relation in the next step. In the next section, I present a further puzzle for this and similar approaches, namely an observed difference in the availability of inverse scope between restructuring infinitives and simple predicates.

3. The difficulty scale

An interesting pilot experiment conducted by Moulton (2007) shows that QR out of different types of complementation configurations is not a binary option, but ease of QR is best described in scalar terms. Based on the results of two pen-and-paper questionnaires, Moulton (2007) shows that QR out of non-restructuring infinitives is possible, but more difficult than QR out of restructuring infinitives. Crucially, the latter is also significantly more difficult than QR in simple predicates.[2]

The questionnaires followed an experimental design used by Anderson (2004), and a sample example is given in (10). The contexts given to speakers are biased towards inverse scope interpretations, which has the purpose of singling out difficulties arising due to the structural configuration rather than the non-linguistic context. As shown in (10), speakers were presented with a short story, followed by a question about the story which allowed two answers. If the answer to the question in (10) is 'several', the speaker could only have had an inverse scope interpretation in mind (the surface scope interpretation would only be compatible with a single chef; only the inverse scope interpretation *for every dish there is at least one chef who prepared that dish* is compatible with several chefs). Lastly, the counting Moulton did was done conservatively—in the results summarized below only 'several' answers were counted, which unambiguously indicate inverse scope. If a speaker gave a 'one' answer, this could still be compatible with inverse scope, and the numbers of inverse scope may thus in fact be even higher.

(10) *Sample Item*:

The restaurant was very busy on Saturday night. The head chef needed all his assistant chefs to pitch in. When he returned from the market, he was pleased that an assistant chef {prepared}/{had begun/helped/decided to prepare} every dish.

How many assistant chefs prepared/had begun/helped/decided to prepare dishes?

One Several

[2] Unfortunately, Moulton did not test QR out of finite complements (but see Tanaka 2015). The degree of difference between non-restructuring infinitives and finite clauses is thus not known at this point and subject to further testing.

The mean proportions of the different categories are given in (11), and the paired t-tests of both items analysis and subjects' performance in (12).

(11)

		Mean Proportion of inverse scope responses
a.	Mono-clausal	.71
b.	Restructuring: *begin, start, try*	.61
c.	Implicative restructuring: *dare, help, manage*	.61
d.	Non-restructuring: *choose, decide, hope, promise, want*	.49

(12) a. *Paired t-tests on an items analysis:*

Mono-clausal (a) & non-restructuring (d):	significant ($p < .003$)
Mono-clausal (a) & restructuring (b):	significant ($p < .03$)
Implicative (c) & non-restructuring (d):	not significant ($p = .087$)
Mono-clausal (a) & implicative (c):	not significant ($p = .088$)
Restructuring (b) & non-restructuring (d):	not significant ($p = .12$)
Restructuring (b) & implicative (c):	not significant ($p = .844$)

b. *Paired t-tests on subjects performance*:

Mono-clausal (a) & non-restructuring (d):	significant ($p < .001$)
Mono-clausal (a) & implicative (c):	significant ($p = .05$)
Implicative (c) & non-restructuring (d):	not significant ($p = .057$)
Restructuring (b) & non-restructuring (d):	not significant ($p = .059$)
Mono-clausal (a) & restructuring (b):	not significant ($p = .069$)
Restructuring (b) & implicative (c):	not significant ($p = .959$)

As indicated in (12), the results are not entirely conclusive, in particular, no significance was reached between restructuring and non-restructuring contexts. One fact that is very important, however, is that inverse scope from restructuring infinitives is significantly harder than inverse scope in simple predicates, in other words, inverse scope is harder out of any type of infinitive, compared to simple predicates. And, not too much of a surprise, inverse scope from non-restructuring infinitives is significantly more difficult than inverse scope in simple predicates. Although further testing is clearly necessary, these initial results can nevertheless be seen as suggestive of the following difficulty scale:

(13) Ease of inverse scope

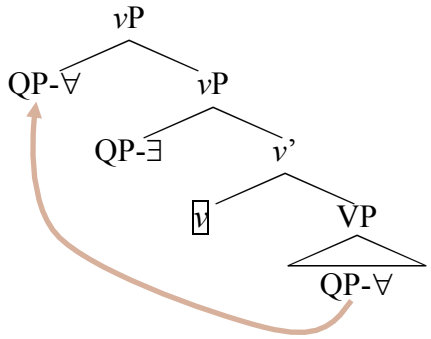
EASY simple predicate » restructuring complement » non-restructuring complement HARD

Moulton concludes that "current syntactic assumptions about QR do not predict either of these comprehension differences" [Moulton 2007: 3]. The issue arising for *Scope Economy* accounts is illustrated in (14). The structure in (14a) represents a simple predicate with a QP in subject and one in object position. Assuming that the subject can be interpreted in situ, inverse scope requires nothing beyond the first step of QR, which is motivated by type reasons. If restructuring infinitives are bare VPs as in (14b) (see Wurmbrand 2001), which is also what Cecchetto (2004) assumes, no difference arises between (14a) and (14b). In both derivations, one single step of QR takes place, and the two constructions can therefore not be distinguished in their QR potential.[3]

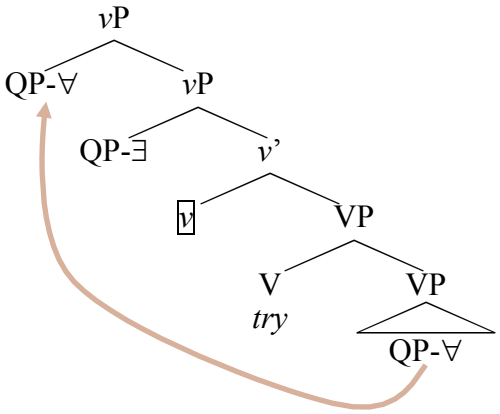
[3] A derivation such as (14b) is based on the assumption that only *v*P and CP count as phases. Under a contextual approach to phasehood, the embedded VP would also constitute a phase since it functions as the top extended projection of the embedded verb (see Wurmbrand 2013a, 2014a, Bošković 2014). This would then make (14b) identical to (14c) as far as QR is concerned.

A similar issues arise for approaches in which restructuring infinitives are *v*Ps (see Wurmbrand 2013b, Wurmbrand and Shimamura 2015 for recent analyses motivating a type of *v*P in restructuring infinitives). As shown in (14c), in this case two steps of QR would (presumably) be necessary—the first step would be motived by type resolution, the second by achieving a different scope relation. Crucially, both steps are motivated and hence pass *Scope Economy* and no locality problem arises (each step only crosses one phase head). The problem then is again the question of how the difference in difficulty between (14a) and (14c) could be explained. The obvious difference would be whether there is one step of QR or two steps, but the syntactic locality accounts offer no way to relate this difference to the attested difference in speaker performance (unless, of course, a processing component is added to the account, which is what I propose in this article, however, this processing component will then effectively eliminate the need for *Scope Economy*).

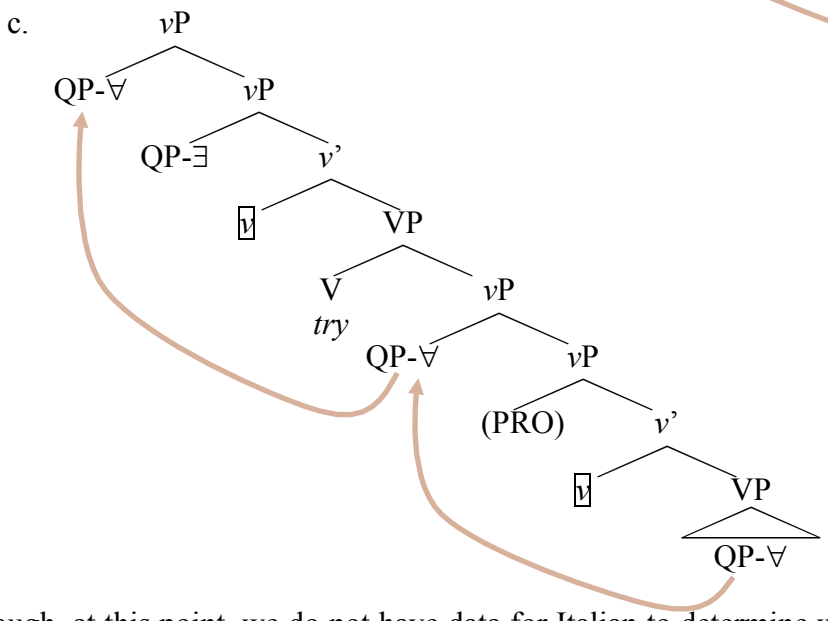
(14) a.



b.



c.



Although, at this point, we do not have data for Italian to determine whether Italian restructuring cases such as (4b) also show an increased difficulty compared to inverse scope in simple predicates, the following data provided in Cecchetto (2004) suggest that this may be the case. Cecchetto also discussed perception verb constructions (AcI constructions) which involve *v*P complementation. As shown in (15), there is a difference in the availability of inverse scope depending on whether the lower QP originates as a subject or an object. Cecchetto (2004: 369, fn. 17) notes: "I believe that inverse scope is better in (i) [=(15b), SW] than in (ii) [=(15c), SW], as the theory I am arguing for predicts. […] However, I must say that inverse scope is harder in (i) than

in (38) [=(15a), SW], in which the QNP that takes wide scope is in the subject position of the ECM clause. Presently, I have no explanation for this contrast."

(15) a. *Almeno un pacifista ha visto ognuno dei poliziotti tirare una pietra.* ?∀»∃
'At least one pacifist has seen each of the policemen throwing a stone.'
[Cecchetto 2004: 368, (38)]

b. *Almeno un giornalista ha visto il commissario picchiare ognuno dei pacifisti.*
'At least one journalist has seen the police officer beating each of the pacifists.'
[Cecchetto 2004: 369, fn. 17, (i)] ??∀»∃

c. *Almeno un giornalista ha visto che il commissario picchiava ognuno dei pacifisti.*
'At least one journalist has seen that the police officer was beating each of the pacifists.' [Cecchetto 2004: 369, fn. 17, (ii)] *∀»∃

Note first that according to Cecchetto's judgment inverse scope in (15a) is not entirely easily available (cf. the ?), which could be seen as evidence that inverse scope from a restructuring context (QR from a predicate different from the matrix predicate) is harder than QR in simple predicates. Second, (15b) corresponds essentially to the structure in (14c), namely a configuration in which two steps of QR are necessary to for the embedded object to achieve scope over the matrix subject. Thus, for both Italian and English, we can conclude that the more steps of covert movement are required, the less readily is inverse scope available. While it is difficult to see how accounts based on *Scope Economy* can implement this scale of difficulty, I disagree with Moulton who states that the (significant) difference between simple predicates and restructuring infinitives cannot be derived by syntactic accounts, nor by processing accounts. In what follows, I will show that this claim is not correct. Assuming the syntax of restructuring provided in Wurmbrand (2013a, 2014b, To appear), a syntactic complexity scale arises which exactly mirrors the difficulty scale Moulton's study yielded for QR, and which will naturally lead to a processing account operating on that syntactic structure.

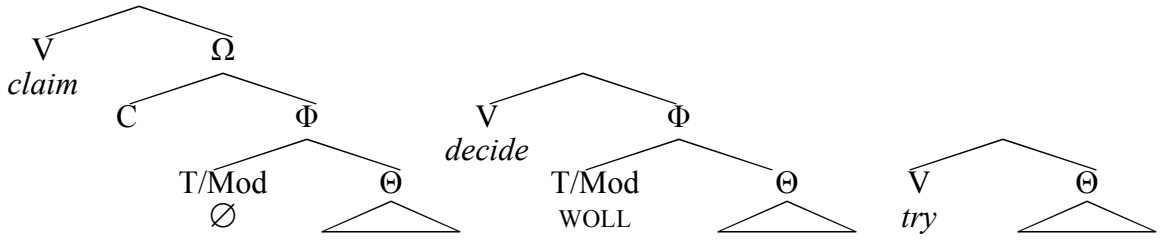
4. The domains of infinitives

Traditionally, languages have been split into restructuring and non-restructuring languages. For instance, since French does not allow clitic climbing out of any infinitive, it has been assumed that the restructuring 'parameter' is set to 'no' in French, in contrast to Italian or Spanish. In Wurmbrand (2014b, To appear), I show, based on the distribution of three restructuring criteria in 24 languages, that a simple restructuring parameter cannot cover the spectrum of restructuring.[4] Instead it is proposed that there is a universal option of size reduction in infinitives, as illustrated in (16), and that variation in the distribution of clitic climbing and scrambling arises due to variable (language-specific) positioning of the target position of clitics and scrambling. More concretely, following Grohmann (2003), clauses are built in three cycles—a Θ domain (~*v*P), a Φ domain (~TP), and an Ω domain (~CP)—and in embedded contexts, not all domains need to projected. Tenseless infinitives (typical restructuring infinitives) can consist of only the Θ domain, whereas future infinitives also require the Φ domain, which contains the source of the future interpretation (see Wurmbrand 2014c for further details of tense in infinitives). To derive differences in the availability of cross-clausal clitic climbing and scrambling, a freezing mecha-

[4] It is shown there that the varied distribution requires distinguishing two types of restructuring—*voice restructuring* and *size restructuring*—that operate independently from each other. For the current paper only size restructuring is of relevance. For the details of voice restructuring, the reader is referred to Wurmbrand (2013a), Wurmbrand and Shimamura (2015).

nism is proposed which traps these elements in the first target position they reach. If the target position is within the Θ domain, as for instance in French or Brazilian Portuguese, clitics and scrambling are necessarily clause/predicate bound, even in restructuring contexts such as (16c). Importantly, although these languages do not allow cross-clausal clitic climbing or scrambling, they can nevertheless involve restructuring in the sense that certain clausal domains are not projected as in (16b,c). Evidence for such reduced structures then must come from other properties, such as negative concord or NPI licensing (see Modesto 2013, Wurmbrand 2014b, To appear for such evidence for Brazilian Portuguese). If the target position is within the Φ domain, as in Italian or Spanish, clitic climbing and scrambling are possible in restructuring contexts, (16c), but not in future contexts, (16b). Lastly, if the target position is within the Ω domain, as in Polish or German, clitic climbing and scrambling are possible in restructuring contexts, (16c), as well as in future contexts, (16b). Finally, this approach correctly predicts that infinitives involving an Ω domain (e.g., an embedded complementizer or *wh*-phrase is present) never allow restructuring (which has been shown in several works, e.g., Wurmbrand 2001, Bondaruk 2004, Dotlačil 2004, Marušič 2005).

(16) a. *believe, claim* b. *decide, expect* c. *try, manage*



This summary of restructuring is obviously very sketchy, but for the current paper, the most important point is that different types of infinitives, in any language, can differ in size—i.e., show different structural complexity defined by the three clausal domains as in (16). This provides us with the necessary tools to tackle the question of why inverse scope shows the gradation and variability as observed.

5. The cost of QR

In this section, I provide a preliminary formalization of the idea that the scale of difficulty observed for QR tracks the complexity of the structure involved, in particular, the number of steps that are required for QR under the assumption that QR, like other A'-movement, applies successive-cyclically. I will also indicate which parts are subject to further psycholinguistic investigation, which will be undertaken in the future. The main proposal is that QR is an A'-operation with the same domain and locality restrictions as overt A'-movement, that is, there is no special clause-boundedness restriction and also no *Scope Economy* requirement for QR. Instead QR can apply in a step-by-step fashion from one cyclic domain to the next. For the moment, I leave open whether these domains are phases or domains as defined in the previous section based on Grohmann (2003). This system thus allows, in principle, an unbounded sequence of QR steps. When it comes to processing, however, steps of covert movement incur a cost along the lines of Anderson's (2004) *Processing Scope Economy* in (17), which I will lay out below in more detail for the complementation structures discussed in this article.[5] If that cost is too high for a speaker,

[5] Tanaka (2015) also proposes a general cost for QR as part of a reduction mechanism which calculates processing costs arising for various syntactic locality and economy issues: "Every instance of QR comes with a reduction in

inverse scope is rejected. The uncertainty and variability of speaker judgments in contexts with increased processing costs (finite clauses and non-restructuring infinitives—see below) is then not unexpected, since working memory and complexity thresholds can vary among individuals.

(17) *Processing Scope Economy* [Anderson 2004: 48, (46)]

> The human sentence processing mechanism prefers to compute a scope configuration with the simplest syntactic representation (or derivation). Computing a more complex configuration is possible but incurs a processing cost.

Why is the cost higher in covert movement than in overt movement? Although filler-gap dependencies also involve an increased processing burden (see Wanner and Maratsos 1978 for one of the first studies demonstrating this), sentences such as (18a) are perfectly grammatical, whereas inverse scope in the parallel (18b) is much more difficult, and, as we saw, rejected by many speakers, unless an additional cue such as ACD is present.

(18) a. *What did a technician say {what} that John inspected {what}?*
b. *{every plane} A technician said {every plane} that John inspected every plane.*

The difference lies in the way parsing has to proceed in overt vs. covert movement. Assuming that in QP»QP QR configurations, QR is movement to the left, the filler-gap dependencies is essentially reversed, and there is no cue for a long-distance dependency until the second QP is reached. Thus, in contrast to overt *wh*-movement, QR involves a retrospective search in parsing, which incurs the higher processing cost for QR than for overt successive-cyclic movement.[6]

Let us now see how successive cyclic QR applies in the different constructions discussed in this article, and how the processing costs are calculated in these derivations. I adopt a copy approach to movement (whether overt or covert), and a process such as *Trace Conversion* in (19) to resolve copy choice at LF and to create the necessary quantifier-variable (like) configuration.

(19) *Trace Conversion* [Fox 2003: 111, (50)]

a. Variable Insertion: (Det) Pred ➟ (Det) [Pred λy(y=him$_n$)]
[n is the index of the moved QNP]
b. Determiner Replacement: (Det) [Pred λy(y= him$_n$)] ➟ the [Pred λy(y= him$_n$)]

A sentence such as (20a) thus has the derivation in (20b-e). The essential part of this derivation is that both copies created by QR are relevant for the interpretation.

(20) a. *A technician inspected every plane* ∀»∃
b. [$_{vP}$ {*every plane*} *a technician v* [$_{VP}$ *inspected* {*every plane*}]] QR
c. [$_{vP}$ {~~*every plane*~~} *a technician v* [$_{VP}$ *inspected* {*every plane*}]] PF copy choice
d. [$_{vP}$ {*every plane*} λx [*a technician v* [$_{VP}$ *inspected* {*the plane x*}]]] LF copy choice
e. Spell-out of VP [$_{VP=SOD}$ *inspected every plane*] PF
[$_{VP=SOD}$ *inspected the plane x*] LF

Turning to restructuring infinitives such as (21a), we have seen in section 4 that even the largest degree of size restructuring results in a difference in the number of domains between simple

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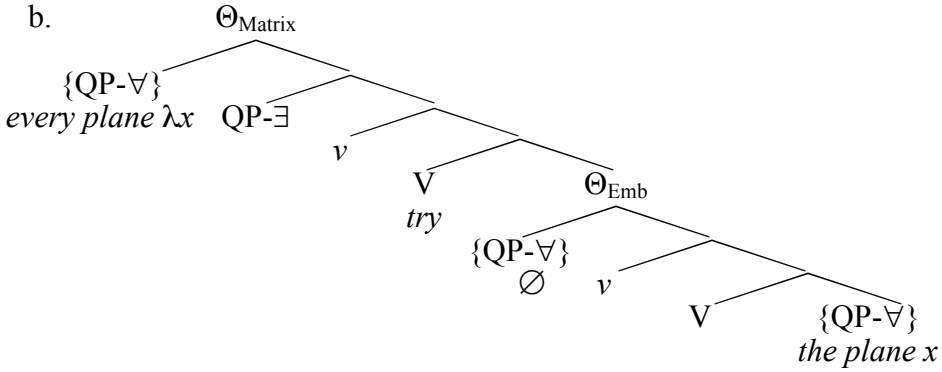
acceptability. (-0.5 reduction)" [188, (23c)].

[6] This approach predicts increased working memory requirements in QR contexts, which can be further tested.

predicates and restructuring infinitives. As illustrated in (21b), the embedded predicate constitutes an independent Θ domain, and leaving such a domain covertly, I propose, incurs a processing cost.

(21) a. *At least one technician tried to inspect every plane.* ∀»∃: harder than (20)

b.



One way to calculate the processing costs in multi-step QR constructions is to assume that movement from one domain to the next must stop over at the edge of that domain.[7] In a phasal approach, this would correspond to the restructuring complement counting as a phase, either because it is a *v*P (see Wurmbrand 2013b, Wurmbrand and Shimamura 2015) or because it is the top extended projection of the embedded V (see Wurmbrand 2013a, 2014a, Bošković 2014). As in (20), the highest copy of the moved QP in (21b) is interpreted for scope, and the lowest copy as a definite description/variable. The difference, however, concerns the middle copy. This copy is only needed to satisfy syntactic locality but semantically, it is entirely vacuous. In other words, the sole purpose of this copy is to provide a link between two other copies which would otherwise be too far away from each other. It is the presence of such linker copies which I suggest creates the additional processing costs. In (20), covert movement of the object QP to derive inverse scope is within one domain, thus no linker copy is required. In (21), on the other hand, movement exits a domain, which leads to the presence of a linker copy, making QR in restructuring infinitives more difficult.[8]

Lastly, the derivation for QR from a non-restructuring infinitive is given in (22). Since infinitives combining with verbs like *decide* involve a future interpretation, they must project a Φ domain (see Wurmbrand 2014c for motivation of a syntactic future element in infinitives). To take scope over a matrix quantifier, a QP originating in embedded object position thus has to cross two do-

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[7] Technically, this is not compatible with Grohmann's suggestion of antilocality. I leave this issue open here.

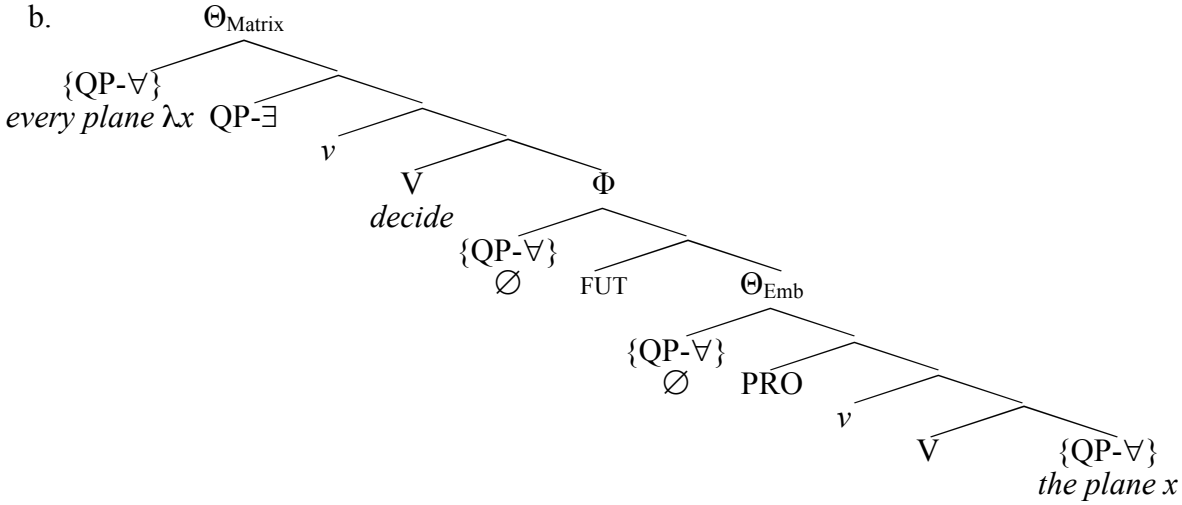
[8] A prediction of this account which is yet to be tested is that QR from multiple restructuring infinitives should incur a higher cost since more domains are crossed. Although no direct evidence is available yet, the behavior of QR from raising infinitives could be seen as indirect initial support. Raising constructions allow reconstruction of the subject, hence inverse scope between the subject and an embedded QP is not relevant for showing whether QR out of raising infinitives is possible or not, but the following examples show that QR out of raising contexts is considered to be impossible (Lebeaux 1995:65, Fox 1999:160, Fox 2000:144). In all of these examples, at least one embedded Θ and Φ domains are crossed (leaving open how PPs contribute to the processing cost), in stacked raising contexts even more, which thus correctly predicts that QR is very difficult out of raising infinitives.

i.. *Mary seems to two women* [*to be expected* [*to dance with every senator*.]] *∀»2
ii. #*This soldier seems to someone to be likely to die in every battle.* *∀»∃
iii. #*The ball seems to a boy to be under every shell.* *∀»∃
cf. *Every shell seems to a* (*different*) *boy to be over the ball*.

mains to reach a position above the matrix subject. As illustrated in (22c), this leads to two semantically vacuous linker copies, which further increase the processing costs and make inverse scope more difficult than in restructuring infinitives and simple predicates.

(22) a. *At least one technician decided to inspect every plane.* %∀»∃

b.



The properties of the derivations of the three constructions discussed above are summarized in the following table:

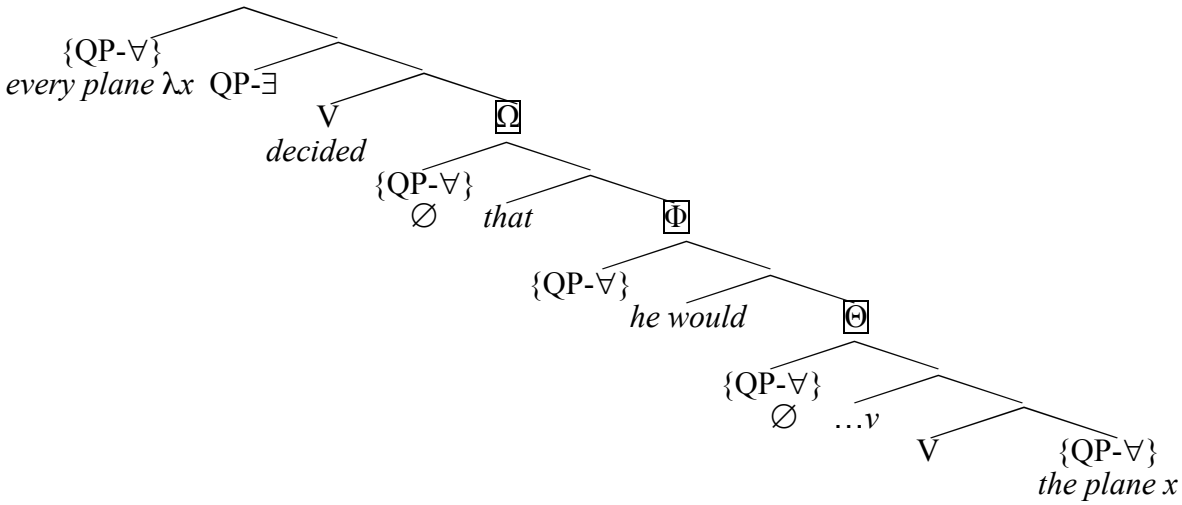
Table 1	Exx	✓/*	Phases	Domains
A technician inspected every plane	(20)	✓	∅	∅
A technician tried to inspect every plane	(21)	[?]	*v*P	Θ
A technician decided to inspect every plane	(22)	[??/*]	*v*P, TP/CP	Θ, Φ

As shown in Table 1, a (contextual) phase approach and an approach that penalizes covertly leaving Grohmann'sche domains make the same predictions regarding the difficulty of the constructions discussed so far, as long as restructuring infinitives are considered as phases and future infinitives contain two phases—the embedded *v*P and the top projection of the embedded clause, be that CP or TP. This finally brings us to QR from finite clauses. Interestingly, a phase approach and a domain approach make different predictions regarding the difficulty of QR from a finite clause compared to a non-restructuring infinitive. The difference between phases and domains is the TP/Φ domain in contexts where that domain is not the top projection/domain of a clause. As shown in (23), an embedded finite clause involves three domains, (23b), but only two phases, (23c). A phase approach thus predicts that QR from finite clauses should be similar in difficulty to QR from non-restructuring infinitives, whereas a domain approach predicts that QR from finite clauses should be harder than QR from non-restructuring infinitives. While impressionistically, speakers tend to reject QR from finite clauses more severely than from non-restructuring infinitives, this cannot be backed up with psycholinguistic data yet. To directly compare these two configurations, further experiments are thus necessary.[9]

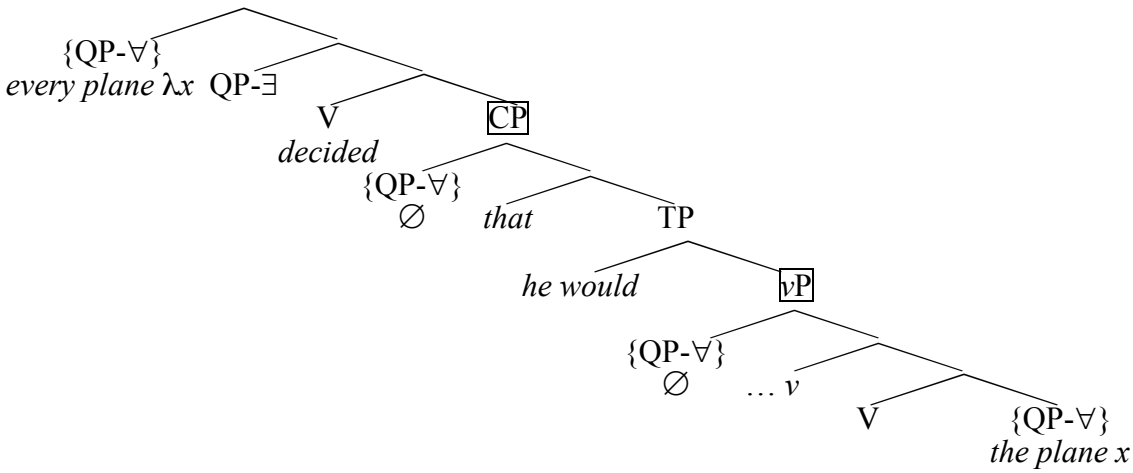
[9] Another relevant contrast that has not been explored yet is the difference between propositional infinitives and future infinitives. In Wurmbrand (2014c) and Todorović and Wurmbrand (2015) it is argued that propositional infinitives obligatorily involve an Ω domain. If this view is correct, propositional infinitives should pattern with finite clauses. The difficulty for English is that propositional control infinitives are very rare, basically only *claim* can naturally combine with a control infinitive (other propositional contexts require ECM), which restricts the options for testing this construction.

(23) a. *At least one technician decided that he would inspect every plane.* %∀»∃

b. Θ_{Matrix} Domains crossed: 3



c. *v*P Phases crossed: 2



The approach taken in this paper receives some further support from the results of a series of noteworthy experiments reported in Tanaka (2015). Tanaka examined overt and covert extraction from adjuncts, with a follow-up experiment on QR from finite and subjunctive complements. Extraction from non-finite *after* clauses (gerunds) and temporal PPs shows a milder island effect than extraction from strong islands such as complex NPs. The island conditions in (24a,b) are significantly degraded compared to non-island (locality obeying) *wh*-extraction. However, they are also judged significantly better than *wh*-constructions violating a strong island, leading to the scale in (25a) (although the difference between the two weak islands was not significant, the results weakly pointed to the ranking as given). Tanaka then shows that the same gradation is found for QR from these contexts in (24c,d), with the difference that the difference between QR from *after* gerunds and QR from *during* PPs was significant, as stated in (25b).[10]

[10] The study also contains a bare participial gerund condition which displays the same behavior as the other two weak adjunct island conditions in *wh*-extraction contexts (it ranks between *after* gerunds and *during* PPs), but which, in QR contexts, gives significantly worse results than *after* gerunds and shows no significant difference to strong island violations. Tanaka (2015) proposes that the *wh*/QR difference is due to a redefined notion of *Scope Economy* which penalizes QR in bare participial gerunds, since, by assumption, these clauses do not contain a temporal operator whereas *after* gerunds and *during* PPs do, and crossing such an operator satisfies *Scope Economy*. This analysis

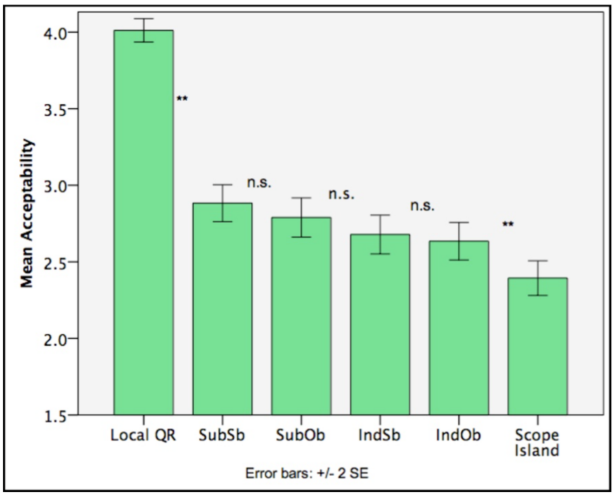
(24) a. *Which comedy film did Rob burst out laughing* [$_{PP}$ *during* t].
b. *Which student did he burst out laughing* [$_{XP}$ *after meeting* t].
c. *One of the guys burst out laughing* [$_{PP}$ *during each comedy film*]. ?∀»∃
d. *A professor burst out laughing* [$_{XP}$ *after meeting each student*]. ??∀»∃

(25) a. *wh*: absolute island »$_{sig}$ *after* gerund >$_{not\text{-}sig}$ *during* PP »$_{sig}$ no locality violation
b. QR: scope island »$_{sig}$ *after* gerund »$_{sig}$ *during* PP »$_{sig}$ no locality violation

The distribution in (25) supports the claim in this paper that QR is subject to the same syntactic locality effects as overt A'-movement. However the difference between weak and strong islands is accounted for, it applies to both *wh*-extraction and QR in the same way. The significant difference between QR from *after* gerunds and *during* PPs is also expected, since the former presumably involve at least a TP (i.e, QR would cross at least two domains, depending again on the attachment site of the adjunct), whereas the latter consists of just one domain, assuming that PPs are phases and hence require a stop-over.

Consider next the results of the follow-up study. As shown in (26),[11] QR from indicative and subjunctive clauses is graded as easier than QR out of an island (the difference is significant), but it is also judged significantly worse compared to QR within a simple predicate (local QR). Within the group of QR from finite and subjunctive complements, the only significant result is between the SubjSb and IndSb conditions ($p < 0.01$), that is, extraction of a subject was significantly easier from a subjunctive than from an indicative clause.

(26)



[Tanaka 2015: 159]

These results first of all confirm that QR from finite complements needs to be distinguished from movement that violates a clear syntactic locality condition. The processing account developed in this paper predicts exactly such a state of affairs: QR from an island triggers a syntactic violation,

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of *Scope Economy*, however, then predicts, contrary to fact, that QR out of finite clauses should only show a very mild violation, since finite clauses also contain a tense operator which would sanction *Scope Economy* (and there is no island violation). Since the structure and semantics of these types of gerunds is rather controversial, I have to set it aside in this paper. A possible direction for deriving the strong island-like violation of QR in these types of adjuncts would be to assume a sideward movement derivation for the subject, which, depending on the structure and attachment location of the adjunct could be seen to force wide scope of the subject.

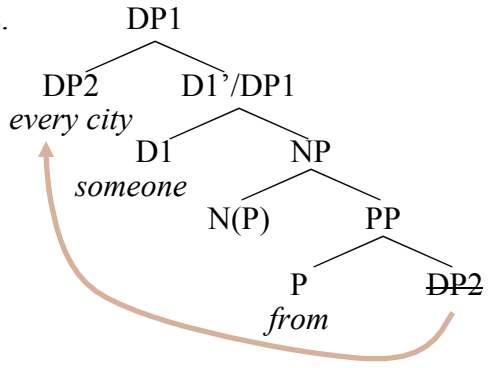
[11] SubSb/IndSb refer to QR of a subject out of a subjunctive/indicative complement; SubOb/IndOb refer to QR of an object out of a subjunctive/indicative complement; * = $p < 0.05$, ** = $p < 0.01$; n.s = non-significant.

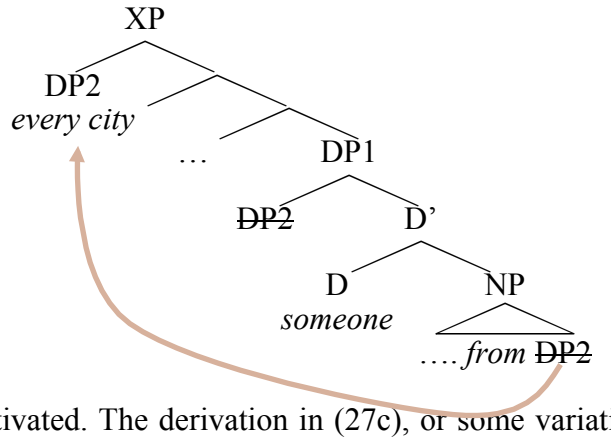
whereas QR from a finite clause only triggers a high processing cost. Second, the higher acceptance of subject QR compared to object QR in both the subjunctive and the indicative conditions in (26) would not be unexpected in the account here. Since subjects already occur in the Φ domain in overt syntax, the Θ domain is not crossed covertly. At this point, I refrain from formulating a specific algorithm for the processing cost calculation of configurations with such mixed overt and covert movement, since the subject-object comparisons in Tanaka's experiments did not turn out significant. It also remains to be determined how differences between overt subject and object extraction are encoded in a theory of locality; if there are syntactic/LF differences in the locality conditions, this would also need to be taken into consideration for covert movement.[12]

Lastly, the difference between subjunctives and indicatives in (26), although significant only for subject extraction (the difference between SubOb and IndOb was not significant), could point to a structural difference between these configurations. The syntax and semantics of subjunctives is rather controversial, but options that come to mind are that subjunctives do not involve a phasal CP (see Alboiu 2007, Wurmbrand 2013b, among others) or the CP is syntactically present but semantically vacuous, which would translate as a complement clause lacking a Ω domain at LF (i.e., the point when QR applies). If subjunctives and infinitives are similar, a claim which is often made in light of similar transparency properties, these results could point to finite clauses incurring higher costs, thus possibly to a domain approach over a phasal approach.

Before turning to ACD contexts, a final comment on the claim that QR obeys the same locality constraints as overt A'-movement is in order. A construction which potentially involves a difference in movability between overt and covert contexts is *inverse linking* as in (27a,b). To derive wide scope of DP2 (*every city*), two movement derivations are conceivable: movement to the edge of DP1 as in (27c), or movement through the edge of DP1 to a higher position in the structure as in (27d).

(27) a. *Someone from every city despises it.* [May 1977, 1985: (26)]
b. *Two politicians spy on someone from every city.* 2»∀»∃; ∀»∃»2; *∀»2»∃ [Larson 1985: 5, (12)]

c.


d.


Both derivations have been proposed and motivated. The derivation in (27c), or some variation thereof, goes back to May (1977, 1985) (see also May and Bale 2006), and is compatible with DP1 being an island since DP2 never (fully) leaves DP1 (thus, (27c) can be the structure for (27a), given that subjects are typically islands for extraction). This derivation can also account for the bound variable interpretation in (27a) if a DP specifier or adjunct is assumed to c-

[12] Kayne (1998) claims that in subjunctives, subject QR is worse than object QR, since subject QR would trigger a *that*-trace effect. The results of Tanaka's experiments show that this is not correct. As pointed out by Tanaka, such a difference would also not be expected if the *that* trace effect is seen as a PF condition.

command out of the hosting DP (see Kayne 1994). Furthermore, the scope restriction noted in (27b) can be derived since DP2 and DP1 act as a 'unit' (see May and Bale 2006 for details and a specific implementation). The derivation in (27d), on the other hand, derives bound variable interpretations under any definition of c-command and predicts that scope splitting should be possible. This has been argued to be the case in Sauerland (2005) when scope between quantifiers and intensional verbs is considered as in (28a), which, according to Sauerland, can have the interpretation in (28b). The impossibility of scope splitting in contexts such as (27b) then requires a different account (e.g., a superiority approach, following Bruening 2001, as in Sauerland 2005).

(28) a. *Mary wanted to marry someone from these two countries.* [Sauerland 2005: 306, (8a)]
b. 'For these two countries, Mary had the desire to marry someone from that country.'
(*these two* » *want* » *someone*) [Sauerland 2005: 306, (8d)]

The approach to QR taken in the current paper is compatible with both derivations in (27c) and (27d), however, the latter should only be possible if DP1 is not an island—i.e., if it does not block overt movement in the same context. Cases such as (28a), which provide the strongest argument for a structure such as (27c), readily allow *wh*-extraction of the *from* complement, as shown in (29a). The same is the case for the ACD example in (29b), in which the ACD VP can take a narrow (embedded) or wide (matrix) antecedent. Crucially, under the wide antecedent interpretation, scope splitting is still possible: the example can be interpreted with the *every* DP2 taking scope over *want* and the *someone* DP1 taking scope under *want* (i.e., 'For every city such that John has the desire to meet someone from it, Mary also has the desire to meet someone from it.' Sauerland 2005: 307, (13b)). As shown by the grammatical paraphrase of wide ellipsis in (29c), overt long-distance extraction of the *from* complement is also possible, thus the current account correctly predicts that QR is possible in this context, exactly as required to resolve ACD in (29b) and to derive the interpretation where DP1 and DP2 take separate scope. Lastly, to derive the wide scope of both quantifiers over *want* in (29b), the derivation in (27c) takes place.

(29) a. *Which countries did Mary want to marry someone from?*
b. *John wanted to meet someone from every city Mary did.* [Sauerland 2005: 307, (12)]
i. *did = met*
ii. *did = wanted to meet* ∀»∃»*want*; ∀»*want*»∃
c. *John wanted to meet someone from every city Mary wanted to meet someone from.*

Although, so far, the derivations in (27c,d) are compatible with the claim that overt and covert movement are subject to the same locality constraints, a problem could arise if scope splitting is also possible in contexts of inverse linking from subjects. If this is the case, the current approach would need to resort to a different account of scope splitting (e.g., a non-scopal account of *de re* interpretations).[13]

6. ACD

Let us finally return to the discrepancy between ACD-related and non-ACD related QR. As pointed out in section 0, even speakers who generally do not accept inverse scope of a QP across

[13] M. Križ, p.c., points out that the interpretation in (28b) for cases such as (28a) can also arise without scope splitting (i.e., without QR of *these two country* above *want*) under a *de re* construal of *these two countries* and a structure such as (27c) with DP1 in situ (since wide and narrow scope of a distributive operator over an intensional verb with universal force, such as *want*, are equivalent).

a finite clause or a non-restructuring infinitive boundary (e.g., as reported in (30a)) allow matrix ACD resolution and accompanying wide scope as in (30b), which, under the view that ACD requires QR, entails a non-clausebound multi-step application of QR. If these data reflect processing costs (note, however, that the judgments are not based on psycholinguistic experiments only reported speaker intuitions), the question for the current analysis would be why multi-step QR in QP»QP contexts appears to be harder than high ACD resolution. I propose that the difference in judgments as given in (30a,b) is masked by a property that facilitates ACD in these contexts. Specifically, for the sentence in (30b), only the matrix VP can function as the antecedent of the elided VP since the auxiliary *did* would not be compatible with the embedded VP. If a narrow antecedent is intended, the auxiliary would have to be *was* as in (30c). After a quick Italian detour emphasizing the relevance of the unavailability of low ellipsis resolution, I summarize experimental evidence which has shown that when this property is avoided, ACD with matrix VP resolution is also judged as degraded/difficult, which supports the hypothesis that ACD-related QR does indeed also impose a processing cost similar to the one we observed for non ACD-related QR.

(30) a. *A middle school teacher claimed to be about to catch each problem student.* *∀»∃
[Cecchetto 2004: 388, (92)]

b. *A middle school teacher claimed to be about to catch each problem student John did* [~~*claim to be about to catch*~~]. ?∀»∃; [Cecchetto 2004: 388, (93)]

c. *Low ACD resolution:
*A middle school teacher claimed to be about to catch each problem student John *did/✓was* [~~about to catch~~]

Cecchetto (2004) shows that in Italian, high (matrix) ACD resolution is possible in restructuring contexts such as (31a), but impossible in non-restructuring contexts such as (31b), which only allow the embedded VP to function as an ellipsis antecedent. There is one exception, however, namely cases such as (31c) where due to a tense mismatch embedded ellipsis resolution becomes unavailable. In exactly (and only) those cases, high ACD resolution is possible.

(31) a. *Sono andato a svegliare ogni ragazzo che mi aveva chiesto di farlo.* Restructuring
'I have gone to wake up every boy who had asked me to do it.'
lo = [$_{\text{VP-matrix}}$ *go to wake up* t] [Cecchetto 2004: 379, (77)]

b. *Ho promesso di interrogare ogni ragazzo che mi aveva chiesto di farlo.* Non-restr.
'I have promised COMP examine every boy who had asked me to do it'
**lo* = [$_{\text{VP-matrix}}$ *promise to examine* t]
lo = [$_{\text{VP-embedded}}$ *examine t*] [Cecchetto 2004: 380, (78)]

c. *Ammetterò di aver licenziato (senza giusta causa) ogni lavoratore che mi costringerà a farlo*. Non-restructuring
'I will admit to have fired (with no good reason) every employee who will force me to do that.'
lo = [$_{\text{VP-matrix}}$ *admit to have fired* t]
**lo* = [$_{\text{VP-embedded}}$ *fired t*] [Cecchetto 2004: 380, (79)]

Recall that in Cecchetto's account, QR from the embedded *v*P to the matrix VP is licensed in high ACD resolution contexts since *Scope Economy* can be satisfied by the need to resolve ACD. It is, however, not clear in this account why high ACD resolution is then not available in (31b), since no constraint would be violated if QR took place as in (31c). Cecchetto (2004: 380, fn 33)

states that "A legitimate question is why, if the matrix reading is possible in principle, it only emerges when the embedded reading is excluded. This seems to be a typical fact that should be accounted for by a theory of processing (the matrix reading requires a much more complicated computation than the embedded one)." As is clear from the analysis in this paper, I agree with this point. However, once we make this move, the question is whether we then still need syntactic *Scope Economy*, or whether, as hypothesized here, the other facts discussed in this paper which have been attributed to *Scope Economy* can also be seen as issues arising at the level of processing (see Anderson 2004 for a similar point regarding other scope properties).

The account of QR put forward in this paper, does not restrict ACD or multi-step QR, except in cases where syntactic locality or islands, which are defined uniformly for overt and covert movement, are violated. Differences as in (31b) vs. (31c) in the availability of high ACD resolution do not represent a syntactic difference—both cases involve the same syntactic derivation which in principle incurs the processing cost for QR typical for non-restructuring configurations. But since there is a need to resolve ACD, and this can only be done via long QR in (31c), parsing is facilitated by ACD, and the cost appears lower. Although further psycholinguistic evidence is needed to strengthen and formalize this amelioration effect,[14] some relevant results are already available as part of the experiments conducted by Syrett and Lidz (2011) and Sugawara et al. (2013). The aim and focus of these studies was different, but put together, they point to the validity of the hypothesis that ACD resolution involving multi-step QR is difficult but facilitated when more local options are excluded via a mismatching auxiliary.

First, as shown in Syrett and Lidz (2011), in contexts without an auxiliary mismatch determining which antecedent VP is possible and which isn't, ACD does pose significant processing difficulties. Syrett and Lidz (2011) tested the availability of embedded and matrix VP ellipsis and ACD in cases such as (32). The results for ambiguous VP ellipsis (see the first row of the table below) show that adults accept both embedded and matrix antecedents for VP ellipsis at a high rate (in fact the matrix readings received a higher rate than the embedded readings). However, when ambiguous ACD is involved as in (32b-d), which could be resolved in two ways, matrix readings drop significantly. In case of infinitives, matrix readings are still accepted at a rate of 50%, but in finite contexts, these rates drop to below 20%.

(32) a. *Clifford asked Goofy to read the [big/small] books because Scooby did.*
[test sentence 3: VPE]

b. *Miss Piggy wanted to drive every car that Kermit did.* [test sentence 8: ACD INF]

c. *Clifford asked Goofy to read every book that Scooby did.* [test sentence 10: ACD INF]

d. *Clifford said that Goofy read every book that Scooby did.* [test sentence 14: ACD FIN]

[14] A potential avenue to pursue is offered by the view in Fox (2003), Fox and Nissenbaum (1999) that QR can be rightward movement. This assumption is driven by a copy approach to movement, bundled with late-adjunction of adjuncts. Under this view, ACD requires that the QP modified by the relative clause containing the elided VP undergoes QR outside the antecedent VP *before* that QP merges with the relative clause. Since the relative clause appears to the right of the antecedent VP, the covertly moved QP has to also occur on the right (to be properly modified by the relative clause), and as a consequence, QR has to be seen as rightward movement in these cases. Suppose now that rightward QR *only* occurs in ACD contexts, or in other words, only when there is evidence for rightward movement—when a right-adjoined overt XP which is required to merge with the QP indicates the landing site of QR. QR which applies to take scope over another QP has to be the usual leftward movement. This has interesting consequences for the suggestion made in section 5 that QR is costly since it is not a filler-gap dependency (thanks to J. Bobaljik for sparking this idea). In 'regular' QR, the gap precedes the filler, and this is what makes processing more costly. However, if ACD-related QR is indeed rightward movement, then, for the purpose of processing, this form of QR is a filler-gap dependency, thus it would not trigger the additional cost associated with covert movement but should be more comparable to overt movement. Further experiments will show whether this hypothesis is tenable.

Adults: Percentages of acceptance of puppet's (true) statements	Embedded	Matrix
VPE (no QR)	81%	94%
ACD (infinitive)	68%	50%
ACD (finite)	88%	19%

Thus adults show a clear bias for embedded scope/ellipsis resolution, which could be taken to reflect that non-local (multi-step) QR is also difficult in ACD contexts in contrast to matrix VP ellipsis which does not require QR.

Second, addressing the question of why the acceptance rate for ACD was rather low in Syrett and Lidz (2011) experiments, Sugawara et al. (2013) tested unambiguous ACD contexts such as (33), and observed that the accuracy rates for adults are 95% for both short and long QR (p. 9). Thus the hypothesis that predetermined ACD resolution (and unavailability of a less costly derivation) voids the processing cost for multi-step QR is supported by these psycholinguistic findings.

(33) a. *Cookie Monster wanted to be the same thing that Dora is.*
b. *Cookie Monster wanted to be the same thing that Dora did.*
[Sugawara et al. 2013: 5, (10a,b)]

7. Conclusion

The main proposal of this paper is that QR is not subject to special locality or domain restrictions but that differences observed between overt and covert movement are the result of an increased processing cost associated with multiple steps of covert movement. Based on a scale of difficulty observed for QR from different types of clausal complements it was shown that speakers' acceptance of non-local QR is gradient and tracks syntactic complexity defined over clausal domains. One suggestion put forward was that syntactic complexity requires intermediate steps of movement, which yield copies that are semantically vacuous and, by hypothesis, costly. Since QR involves a retrospective search in parsing such tracing back of semantically vacuous steps is more demanding than parsing filler-gap dependencies. Many points raised still await experimental confirmation, but the paper has outlined what several of the predictions are and what to further test.

If the conclusions can be maintained, attributing the distribution of QR across different clausal domains to processing difficulties rather than 'hard' syntactic constraints captures the availability of QR as diagnosed by ACD, the variability in judgments, the gradient difficulty of QR in different syntactic contexts, and allows a uniform approach to the locality of A'-movement including QR.

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