Function Composition and the Linear Local Modeling of Extended NEG-Scope

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1 Introduction

This paper will be devoted to exploring the local modeling of non-local dependencies from the perspective of Categorial Grammar (henceforth CG). In particular, I will recapitulate and review work by Błaszczak & Gärtner (2005) on a CG-based analysis of extended NEG-scope in English. It will be shown how constraints on linear order play a crucial role in controling the main CG-tool for scope extension, i.e. function composition. These constraints are local in the sense that they restrict each step of composition as it applies to linearly adjacent constituents. The analysis is couched in the particular framework of Combinatory Categorial Grammar (CCG) as developed by Steedman (1996; 2000a) enriched with the tool of "structural inhibition" introduced in the type-logical branch of CG by Morrill (1994) (cf. Steedman and Baldridge 2007).

I will proceed as follows: Section 1 introduces the "Condition on Extended Scope Taking" (CEST), which descriptively captures crucial aspects of the scopal behavior of negative quantifiers in English. Next, CEST will be given a CG-based treatment (section 2). Section 3 will unfold some of the mechanics of CG that were taken for granted by Błaszczak & Gärtner (2005). In particular further constraints on how to block empirically inadequate alternative derivations are discussed. Also, a challenge to CEST by Wagner (2005) will be addressed. Section 4 provides some discussion embedding the current analysis within its wider context. Finally, section 5 draws some very brief conclusions.

2 The Condition on Extended Scope Taking (CEST)

Inspired by and in reaction to Kayne (1998), Błaszczak & Gärtner (2005) study aspects of the scopal behavior of negative quantifiers in English. The main controversy addressed there concerns the status of the generative "Y-model," which makes interaction between PF- and LF-properties of the grammar indirect. Particularly contentious is the proper place in grammar of linearization. Following Chomsky (1995:334), who found "[...] no clear evidence that order plays a role at LF or in the computation from N to LF," minimalist theorists have made linearization the exclusive business of PF.[1] By contrast, Błaszczak & Gärtner (2005:1) "suggest that extending the scope of negative quantifiers in English and German is sensitive to linear and prosodic, i.e. PF-properties." More specifically, they formulate the following "Condition on Extended Scope Taking" (CEST) (ibid.:9).

(1) *Condition on Extended Scope Taking* (CEST)
Extending the scope of a negative quantifier $Q\neg$ over a region σ requires σ to be linearly and prosodically continuous.

Evidence for linear continuity is provided by the contrast between sentences in (2) vs. (3).

(2) a. *She requested that we read <u>not a single linguistics book</u>*

b. *They have forced us to turn down <u>no one</u>*

(3) a. *She requested that <u>not a single student</u> read Aspects*

b. *They have forced us to turn <u>no one</u> down*

The underlined $Q\neg$ in (2) can take scope over the matrix predicate. This is impossible in (3). As a consequence, (2a) can be used to report on an absence of requests for the reading of linguistics books, while use of (3) would limit the speaker to reporting on a request for students to refrain from reading a particular linguistics book, namely, Aspects. In terms of CEST, this contrast can be illustrated as follows.

[1] "N" refers to the "numeration," i.e. the lexical repository serving as input (and "reference set") for minimalist derivations (Chomsky 1995:225). An early plea for linearization-free "tectogrammatics" was made by Curry (1961). Dowty (1982; 1995) pursues this idea further in a Montagovian setting. Within GPSG, linearization was given greater autonomy through the ID/LP-format (Gazdar et al. 1985) and HPSG has seen further radicalizations in terms of "word order domains" (Reape 1994). For recent intensive discussion one can also consult work by Fox & Pesetsky (2005) and Müller (2007).

(4) a. *($_\sigma$ She requested that we read)* <u>*not a single linguistics book*</u>

b. *($_\sigma$ They have forced us to turn down)* <u>*no one*</u>

(5) a. *($_\sigma$ She requested that)* <u>*not a single student*</u> *($_\sigma$ read Aspects)*

b. *($_\sigma$ They have forced us to turn)* <u>*no one*</u> *($_\sigma$ down)*

(4) shows continuous and (5) discontinuous σ-regions. This corresponds to the possibility vs. impossibility of wide scope for $Q\neg$ in (2) vs. (3), respectively.

The prosodic evidence for CEST is based on examples like (6).

(6) a. *She requested || that we read* <u>*not a single linguistics book*</u>

b. *She requested that the students who finish first | read* <u>*not a single linguistics book*</u>

Inserting prosodic boundaries of type intonational phrase (||) or intermediate phrase (|) - the latter induced by an additional relative clause - into (2a) eliminates the wide scope option for $Q\neg$. (7) illustrates the corresponding discontinuities predicted by CEST.

(7) a. *($_\sigma$ She requested) || ($_\sigma$ that we read)* <u>*not a single linguistics book*</u>

b. *($_\sigma$ She requested that the students who finish first) | ($_\sigma$ read)* <u>*not a single linguistics book*</u>

As a brief aside, let me stress that CEST is explicitly designed to capture *extended* scope, not "standard" scope. This subtlety can be brought out by considering ECM structures such as (8).

(8) *We expect* <u>*not a single student*</u> *to have read Aspects*

(8) can be used to report on the absence of expectations regarding the reading of Aspects by linguistics students. This means that wide scope is an option for $Q\neg$ in (8) in spite of the fact that the σ-region *($_\sigma$ We expect) ($_\sigma$ to have read Aspects)* is discontinuous. To reconcile (8) with CEST one can adopt a "raising-to-object" approach to ECM, according to which *not a single student* is part of the matrix clause at surface structure already. Consequently, wide scope in (8) would be a "standard" or "local" effect, not an instance of non-local extended scope taking (cf. Błaszczak & Gärtner 2005:10).

3 CEST and Categorial Grammar: The Basics

What makes categorial grammar attractive for capturing CEST is the fact that linear order is a key ingredient of all standard CG-frameworks, given the way categories are defined.[2] In addition, among the main principles of CCG is a condition on (linear) adjacency as formulated in (9) (Steedman 2000a:54).

(9) *The Principle of Adjacency*
Combinatory rules may only apply to finitely many phonologically realized and string-adjacent entities.

This means that non-adjacency, i.e. discontinuity, will crucially affect syntactic derivations.[3] In particular, extended scope taking can be treated by "assembling" σ-regions via function composition. Given (9), function composition will be disrupted where σ-regions are discontinuous. This simple fact leads to an extremely elegant analysis of CEST, the details of which we turn to next.

To begin with, we have to introduce the rule of forward function composition (Steedman 2000a:40).

(10) *Forward Composition* ($\mathbf{C}_{>}$)
$X/Y \quad Y/Z \quad \Rightarrow_C \quad X/Z$
$\boldsymbol{C}fg \equiv \lambda v.f(g(v))$

The workings of (10) are best explained by going right into the analysis of wide scope in (2a).

[2] Muskens (2007) develops a categorial approach that separates linearization from hierarchical organization. Kracht (2003: chapter 5) provides additional pertinent discussion.

[3] As it stands, the *Principle of Adjacency* is a methodological assumption in the same way that assuming Merge to be binary is a tenet of minimalism. Steedman (1996:6; 2000a:268, fn.3) points out that this principle is a counterpart to a ban on the use of variables in structural descriptions of transformation rules in TG. That the use of such variables has to be constrained has - famously - been argued by Ross (1967).

(11) 1. **she**: S/(S\NP)
2. **requested**: (S\NP)/S
3. **that**: S/S
4. **they**: S/(S\NP)
5. **read**: (S\NP)/NP
6. **not.a.single.lb**: S\(S/NP)
7. **she+requested**: S/S | $\mathbf{C}_{>}$ 1,2
8. **she+requested+that**: S/S | $\mathbf{C}_{>}$ 7,3
9. **she+requested+that+they**: S/(S\NP) | $\mathbf{C}_{>}$ 8,4
10. **she+requested+that+they+read**: S/NP | $\mathbf{C}_{>}$ 9,5
11. **she+requested+that+they+read+not.a.single.lb**: S | $\mathbf{E}\backslash$ 10,6

Steps (11.7) to (11.10) are all applications of forward composition. Each time, the output category of the second constituent - written to the left of its main dividing line - is identical to the input category - written to the right of the main dividing line - of the first constituent. Forward composition is applied due to the rightward orientation (/) of the first constituents. Application of the rule leads to cancelation of the shared identical "output-input-categories" plus preservation of the remaining categorial structure. The final step, (11.11), consists of a leftward function application (or "elimination") rule, ($\mathbf{E}\backslash$). Here, the negative object quantifier *not a single linguistics book*, which has a leftward orientation (\), takes the remainder of the sentence as its argument. As we are going to see presently, this results in the desired wide scope interpretation.

Let us therefore turn to another attractive feature of CG, its transparent way of relating syntax to semantics. Each syntactic rule is accompanied by a structurally corresponding semantic rule.[4] In the case of composition, this rule, as indicated in (10), amounts to feeding an appropriate variable v to the lower functor g, making the result *g(v)* the argument of the higher functor *f*, and finally λ-abstracting over v from the outside. The resulting functor will then require arguments of the type originally required by the lower functor g and yield something of the type that would have been yielded by the higher functor *f*. (12)-(15) show this process for (11.7)-(11.10), respectively.[5]

[4]The correspondence is due to the so-called "Curry-Howard Isomorphism," for which I refer readers to Morrill (1994: chapter 2). For the same purpose, Steedman (2000a:37) formulates the following "transparency" principle:

(i) *The Principle of Type Transparency*
All syntactic combinatory rules are type-transparent versions
of one of a small number of simple semantic operations over functions.

[5]$\mapsto$ denotes the translation relation, $\circ$ stands for semantic composition. For the sake of brevity, the semantics contains various obvious simplifications.

(12) a. **she+requested**: S/S $\mapsto$

b. λP.P(she) $\circ$ λp.λx.REQUESTED(x, p) =
λq[λP.P(she)(λp.λx.REQUESTED(x, p)(q))] =
λq[λP.P(she)(λx.REQUESTED(x, q))] =
λq[λx.REQUESTED(x, q)(she)] =
λq.REQUESTED(she, q)

(13) a. **she+requested+that**: S/S $\mapsto$

b. λq.REQUESTED(she, q) $\circ$ λp.p =
λr[λq.REQUESTED(she, q)(λp.p(r))] =
λr[λq.REQUESTED(she, q)(r)] =
λr.REQUESTED(she, r)

(14) a. **she+requested+that+they**: S/(S\NP) $\mapsto$

b. λr.REQUESTED(she, r) $\circ$ λP.P(they) =
λQ[λr.REQUESTED(she, r)(λP.P(they)(Q))] =
λQ[λr.REQUESTED(she, r)(Q(they))] =
λQ.REQUESTED(she, Q(they))

(15) a. **she+requested+that+they+read**: S/NP $\mapsto$

b. λQ.REQUESTED(she, Q(they)) $\circ$ λy.λx.READ(x, y) =
λz[λQ.REQUESTED(she, Q(they))(λy.λx.READ(x, y)(z))] =
λz[λQ.REQUESTED(she, Q(they))(λx.READ(x, z))] =
λz[REQUESTED(she, λx.READ(x, z)(they))] =
λz.REQUESTED(she, READ(they, z))

Finally, (16) shows the crucial step of semantic application corresponding to (11.11). This amounts to wide scope taking for $Q\neg$.

(16) a. **she+requested+that+they+read+not.a.single.lb**: S $\mapsto$

b. λP.$\neg\exists$x.[LB(x) $\wedge$ P(x)](λz.REQUESTED(she, READ(they, z))) =
$\neg\exists$x.[LB(x) $\wedge$ λz.REQUESTED(she, READ(they, z))(x)] =
$\neg\exists$x.[LB(x) $\wedge$ REQUESTED(she, READ(they, x))]

Section 3 will give a detailed account of why wide scope is not an option for $Q\neg$ in (3a). Before turning to that, let me address the effect of prosodic discontinuity illustrated in (6). Here, the analysis proposed by Błaszczak & Gärtner (2005) makes appeal to the technique of "structural inhibition"

(Morrill 1994). The key assumption is that prosodic boundaries possess the following kind of category.[6]

(17) **%**: $[]^{\varphi}$X/X

This has the effect that a prosodic boundary applies to a neighboring constituent of category X and converts it into a "structurally inhibited" constituent of category $[]^{\varphi}X$. Two additional assumptions are then necessary. First, $[]^{\varphi}X$ shows up nowhere else in the grammar. Accordingly, no constituent can directly combine with anything of type $[]^{\varphi}X$. Second, there is a (semantically vacuous) one-place elimination rule for $[]^{\varphi}X$. This is given in (18).

(18) *$[]^{\varphi}$-Elimination* ($\mathbf{E}[]^{\varphi}$)
$$[]^{\varphi}X \quad \Rightarrow_{E} \quad X$$

Let us study the workings of (17) and (18) by having a look at the analysis of (6a).

(19)

1.	**she**: S/(S\NP)	
2.	**requested**: (S\NP)/S	
3.	**that**: S/S	
4.	**they**: S/(S\NP)	
5.	**read**: (S\NP)/NP	
6.	**not.a.single.lb**: S\(S/NP)	
7.	**%**: $[]^{\varphi}$S/S	
8.	**they+read**: S/NP	$\mid \mathbf{C}_{>}$ 4,5
9.	**they+read+not.a.single.lb**: S	$\mid \mathbf{E}\backslash$ 8,6
10.	**that+they+read+not.a.single.lb**: S	$\mid \mathbf{E}/$ 3,9
11.	**%+that+they+read+not.a.single.lb**: $[]^{\varphi}$S	$\mid \mathbf{E}/$ 7,10
12.	**%+that+they+read+not.a.single.lb**: S	$\mid \mathbf{E}[]^{\varphi}$ 11
13.	**requested+%+that+they+read+not.a.single.lb**: S\NP	$\mid \mathbf{E}/$ 2,12
14.	**she+requested+%+that+they+read+not.a.single.lb**: S	$\mid \mathbf{E}/$ 1,13

Crucially, given (18), *$[]^{\varphi}$* can only be eliminated if it shows up on the main functor, S in the case of (19). It follows that the complement S has to be fully assembled before it can combine with material of the matrix clause in step (19.13). As a consequence, $Q\neg$ has to be built in before the matrix predicate, and this necessarily results in narrow scope for $Q\neg$. (20) gives the semantics for building in $Q\neg$ at step (19.9).

[6] Steedman (2000b) provides a different, more comprehensive, treatment of prosodic boundaries in CCG.

(20) a. **they+read+not.a.single.lb**: S $\mapsto$

b. λP.$\neg\exists$x.[LB(x) $\wedge$ P(x)](λy.READ(they, y)) =
$\neg\exists$x.[LB(x) $\wedge$ λy.READ(they, y)(x)] =
$\neg\exists$x.[LB(x) $\wedge$ READ(they, x)]

Let me reiterate that function composition from the matrix clause into the subordinate clause is blocked in the presence of **%**:$[]^{\varphi}S/S$. Direct composition is ruled out due to categorial mismatch: $[]^{\varphi}S \neq S$, and composition of **(she+)requested** with **that**, skipping **%**, would violate adjacency, i.e. condition (9).

As a caveat it has to be added that the relevant prosodic boundaries have to be of a low enough type such as sentential or *VP*-boundaries.[7] Higher types, combinable with individual lexical items directly, would be eliminable without the desired blocking effect. This is shown for the relevant subpart of (6a) in (21).

(21)
1. **that**: S/S
2. **%**: $[]^{\varphi}$(S/S)/(S/S)
3. **%+that**: $[]^{\varphi}$(S/S) | **E**/ 2,1
4. **%+that**: S/S | **E**$[]^{\varphi}$ 3

If this were allowed, deriving a wide scope reading of $Q\neg$ in (6a) would be possible since (21) could serve as a building block for a derivation similar to (11).

4 CEST and Categorial Grammar: Some Refinements

Let me turn to two areas in which refinements of the analysis by Błaszczak & Gärtner (2005) are called for. First, a more in depth analysis of how the system prevents wide scope for $Q\neg$ in (3) can be given. Secondly, a challenge to CEST discovered by Wagner (2005) should be addressed and disposed of.

4.1 Linear Discontinuity and Narrow NEG-Scope

It is sometimes objected to CG-approaches that they are overly powerful and unrestriced.[8] To counter such an impression, this section will provide a

[7]For the naturalness of this assumption, see discussion by Ladd (1996).

[8]For much more specific and highly relevant criticism of CG-style linguistics, see von Stechow (1989). It should be noted that variants of CCG have been shown to belong

(somewhat pedantic and therefore potentially tedious) account of why wide scope is not an option for $Q\neg$ in (3a), repeated below for convenience.

(3) a. *She requested that <u>not a single student</u> read Aspects*

I will look at five potential alternative derivations and show why they don't lead to undesirable consequences. The gist of this manoeuver is given in (22).

(22) a. Rightward function application: fixes local scope
b. Forward function composition: fixes local scope
c. Function composition of discontinuous σ-regions: disturbs word order
d. Backward (crossed) function composition: is not possible
e. Type raising over matrix: must be ruled out

To begin with, let's look at the effect of introducing $Q\neg$ via rightward function application. This requires an argument of type *(S\NP)*. (23)-(25) show the crucial syntactic and semantic steps.

(23)
1. **she+requested+that**: S/S
2. **not.a.single.student**: S/(S\NP)
3. **read+Aspects**: S\NP
4. **not.a.single.student+read+Aspects**: S | **E**/ 2,3
5. **she+requested+that+not.a.single.student+read+Aspects**: S | **E**/ 1,4

(24) a. **not.a.single.student+read+Aspects**: S $\mapsto$

b. λP.$\neg\exists$x.[STUDENT(x) $\wedge$ P(x)](λy.READ(y, a)) =
$\neg\exists$x.[STUDENT(x) $\wedge$ READ(x, a)]

(25) a. **she+requested+that+not.a.single.student+read+Aspects**: S $\mapsto$

b. λp.REQUESTED(she, p)($\neg\exists$x.[STUDENT(x) $\wedge$ READ(x, a)]) =
REQUESTED(she, $\neg\exists$x.[STUDENT(x) $\wedge$ READ(x, a)])

to the "mildly context-sensitive" grammar formalisms (cf. Joshi, Vijay-Shanker & Weir 1991), so premature discarding of this kind of approach to grammar would seem to be rather unmotivated. A similar complexity result for minimalist grammars is now available due to work by Michaelis (2001a; 2001b).

Clearly, the scope of $Q\neg$ is fixed within the subordinate clause in (24). The resulting formula serves as an unalterable building block for embedding within the matrix clause.

Derivation (22b) has similar consequences. Introduction of $Q\neg$ by forward function composition with the matrix clause assigns $Q\neg$ the role of "lower" argument functor in the semantics. Again, narrow scope is an irrevocable consequence. The crucial steps are provided in (26)-(28).

(26)
1. **she+requested+that**: S/S
2. **not.a.single.st**: S/(S\NP)
3. **read+Aspects**: S\NP
4. **she+requested+that+not.a.single.st**: S/(S\NP) | $\mathbf{C}_{>}$ 1,2
5. **she+requested+that+not.a.single.st+read+Aspects**: S | **E**/ 4,3

(27) a. **she+requested+that+not.a.single.st**: S/(S\NP) $\mapsto$

b. λp.REQ(she, p) $\circ$ λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)] =
λQ[λp.REQ(she, p)(λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)](Q))] =
λQ[λp.REQ(she, p)($\neg\exists$x.[ST(x) $\wedge$ Q(x)])] =
λQ.REQ(she, $\neg\exists$x.[ST(x) $\wedge$ Q(x)])

(28) a. **she+requested+that+not.a.single.st+read+Aspects**: S $\mapsto$

b. λQ.REQ(she, $\neg\exists$x.[ST(x) $\wedge$ Q(x)])(λy.READ(y, a)) =
REQ(she, $\neg\exists$x.[ST(x) $\wedge$ λy.READ(y, a)(x)]) =
REQ(she, $\neg\exists$x.[ST(x) $\wedge$ READ(x, a)])

Quite obviously, forward composition of $Q\neg$ with smaller constituents on its left doesn't change anything. Thus, composing **that+not.a.single.student** would receive the semantics in (29), continuations of which will lead to narrow scope again.

(29) a. **that+not.a.single.st**: S/(S\NP) $\mapsto$

b. λp.p $\circ$ λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)] =
λQ[λp.p(λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)](Q))] =
λQ[λp.p($\neg\exists$x.[ST(x) $\wedge$ Q(x)])] =
λQ.$\neg\exists$x.[ST(x) $\wedge$ Q(x)]

Method (22c) starts from the insight that successful wide scope taking for $Q\neg$ in (2a) depends on assembly of the entire σ-region before $Q\neg$ is introduced. This was shown in (11)-(16). So, why don't we start by building **she+requested+that+read+Aspects**? The semantics for the required composition step is given in (30).

(30) a. **she+requested+that+read+Aspects**: S\NP $\mapsto$

b. λp.REQ(she, p) $\circ$ λx.READ(x, a) =
λy[λp.REQ(she, p)(λx.READ(x, a)(y))] =
λy[REQ(she, READ(y, a))]

Indeed, if we now use the result as input argument for the generalized quantifier **not.a.single.student** the undesirable wide scope reading arises, as shown in (31).

(31) λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)](λy[REQ(she, READ(y, a))]) =
$\neg\exists$x.[ST(x) $\wedge$ λy[REQ(she, READ(y, a))](x)] =
$\neg\exists$x.[ST(x) $\wedge$ REQ(she, READ(x, a))]

However, syntactic word order will revolt against this approach to (3b). Consider the derivation in (32).

(32)
1. **she+requested+that**: S/S
2. **not.a.single.st**: S/(S\NP)
3. **read+Aspects**: S\NP
4. **she+requested+that+read+Aspects**: S\NP | $\mathbf{C}_{>}$ 1,3
5. **not.a.single.st+she+requested+that+read+Aspects**: S | **E**/ 2,4

Given the rightward orientation of $Q\neg$, and given the constraint on adjacency, (9), the rightward application in step (32.5) yields a "topicalized" position for $Q\neg$ corresponding to an overall structure that in addition violates the *that-t* condition, as shown in (33).

(33) * *Not a single student, she requested that read Aspects*

Clearly, method (22c) is not suited for providing (6b) with its proper linearization.[9] So, yet another way of violating CEST is blocked, given the CG-approach.

The previous point also serves as an indication that the technique of "wrapping," used in various branches of CG for scope taking (Moortgat

[9] It should be stressed that the *that-t*-violation is not the issue here but a purely coincidental side effect. Nothing is changed - i.e. method (22c) still puts $Q\neg$ in the wrong position - if the *that*-less variant in (i) is chosen, which incidentally seems to be quite unacceptable too.

(i) ?? *Not a single student she requested read Aspects*

It is an independent question whether topicalization has an impact on scope, a question that I won't pursue in this paper. Thanks to the anonymous reviewer for raising this issue.

1988; Morrill 1994), must be avoided in the analysis of extended scope taking. Thus, consider the derivation in (34).

(34) 1. **she+requested+that+⇓+read+Aspects**: S↑NP
2. **not.a.single.st**: S↓(S↑NP)
3. **she+requested+that+not.a.single.st+read+Aspects**: S | **W** 2,1

⇓ serves as a placeholder for which a quantifier will be substituted by wrapping prefix and suffix of ⇓ around it. $S{\uparrow}NP$ is the category of a predicate which combines with its argument by wrapping and $S{\downarrow}(S{\uparrow}NP)$ is the category of a generalized quantifier to be wrapped into a "wrapping" predicate. The semantics of the wrapping step in (34.3) would, of course, have to be identical to the one in (31). Clearly, discontinuity of the σ-region would no longer be an obstacle to extended scope taking for $Q\neg$, an unwelcome result given CEST.

The careful reader will have observed a subtlety of derivation (32), discussion of which will serve as introduction to the more involved argument related to technique (22d). Forward composition as introduced in (10) requires both functors to be of equal linear orientation, namely, rightward. This requirement was actually violated in (32.4) where categories S/S and $S\backslash NP$ were composed. The rule that does this properly is a minimal variation on (10) called "forward crossed composition," as stated in (35) (cf. Steedman 2000a:55).

(35) *Forward Crossed Composition* ($\mathbf{C}_{\times>}$)
$X/Y \quad Y\backslash Z \quad \Rightarrow_C \quad X\backslash Z$
$\boldsymbol{C}fg \equiv \lambda v.f(g(v))$

As we have seen, $\mathbf{C}_{\times>}$ has a reordering effect such that an argument of the second constituent that should have been placed in between the two constituents in fact precedes them both. This brings us to method (22d) of analyzing (3a). It has to be shown that *Backward Crossed Composition*, as given in (36), cannot be used to derive the undesired wide scope reading for $Q\neg$ either.

(36) *Backward Crossed Composition* ($\mathbf{C}_{\times<}$)
$Y/Z \quad X\backslash Y \quad \Rightarrow_C \quad X/Z$
$\boldsymbol{C}fg \equiv \lambda v.f(g(v))$

Of course, the idea is to try to make $Q\neg$ into the higher functor of composition while preserving its position in the middle of the σ-region. Semantically, the crucial composition step would have to be (37).

(37) a. **requested+that+not.a.single.st** $\mapsto$

b. λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)] $\circ$ λp.λy.REQ(y, p) =
λq[λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)](λp.λy.REQ(y, p)(q))] =
λq[λP.$\neg\exists$x.[ST(x) $\wedge$ P(x)](λy.REQ(y, q))] =
λq.$\neg\exists$x.[ST(x) $\wedge$ λy.REQ(y, q)(x)] =
λq.$\neg\exists$x.[ST(x) $\wedge$ REQ(x, q)]

But this does not work! Through backward composition, $Q\neg$ will bind the variable of the matrix subject, so it ends up with wide scope but in the wrong argument position. Moreover, problems arise in the syntax already.

(38)
1. **requested+that**: (S\NP)/S
2. **not.a.single.st**: S/(S\NP)

For $\mathbf{C}_{\times<}$ to apply, $Q\neg$ should be leftward oriented, which it isn't. Also, for simple backward composition to apply, both functors should be leftward oriented, which they aren't. And even if (38.1) and (38.2) were allowed to combine by "funny" backward composition, problems would arise further down the line, since the resulting category should be *S/S*. But in order to create an argument of type *S* from the remaining materials, we would have to combine *she* with *read Aspects*, which would yield the preposterously garbled string in (39) and would suffer from the semantic problem illustrated in (37) in addition.

(39) * *Requested that not a single student she read Aspects*

We can therefore conclude that the only sensible and grammatical way of applying composition to matrix constituents and subject $Q\neg$ is by standard forward composition, as we have seen. And this we have shown in (26)-(28) to lead to narrow scope. Thus, method (22d) is equally unavailable for deriving a violation of CEST for (3a).

Finally, let us consider type raising as another means of giving $Q\neg$ in (3a) scope over the matrix. (40) and (41)-(42) provide the required syntax and semantics.

(40)
1. **not.a.single.st**: (S/(S\NP))\(S/S)
2. **she+requested+that**: S/S
3. **read+Aspects**: S\NP
4. **she+requested+that+not.a.single.st**: S/(S\NP) | **E**\ 2,1
5. **she+requested+that+not.a.single.st+read+Aspects**: S | **E**/ 4,3

(41) a. **she+requested+that+not.a.single.st**: S/(S\NP) $\mapsto$

b. $\lambda\wp.\lambda$P.$\neg\exists$x.[ST(x) $\wedge$ $\wp$(P(x))](λp.REQ(she, p)) =
λP.$\neg\exists$x.[ST(x) $\wedge$ λp.REQ(she, p)(P(x))] =
λP.$\neg\exists$x.[ST(x) $\wedge$ REQ(she, P(x))]

(42) a. **she+requested+that+not.a.single.st+read+Aspects**: S $\mapsto$

b. λP.$\neg\exists$x.[ST(x) $\wedge$ REQ(she, P(x))](λy.READ(y, a)) =
$\neg\exists$x.[ST(x) $\wedge$ REQ(she, λy.READ(y, a)(x))] =
$\neg\exists$x.[ST(x) $\wedge$ REQ(she, READ(x, a))]

However, in CCG - as in most other standard calculi for semantics - type raising is only allowed to raise arguments over the functions they are arguments of. (43) provides the appropriate rule (cf. Steedman 2000a:44).

(43) *(Backward) Type Raising* ($\mathbf{T}_<$)
$X \quad \Rightarrow_T \quad \underline{T}\backslash(\underline{T}/X)$
$\boldsymbol{T}a \equiv \lambda f.f(a)$

$\underline{T}$ is a variable standing for result types of functions over X. We have already used object generalized quantifiers as a raised type derivable via (43): Subject plus transitive verb constitute a predicate of type *S/NP*. Therefore, any object argument of type *NP* can be lifted to type $S\backslash(S/NP)$. Here $\underline{T}$ has been instantiated by *S*, the result type of function *S/NP*.

Let us now reconsider (40). Clearly, the type assignment for $Q\neg$ in (40.1) is in violation of $\mathbf{T}_<$, given that $S/(S\backslash NP)$ - or *NP* for that matter - is not an argument of *S/S* nor is it the result type of an appropriate function. Therefore, even method (22e) won't be available for deriving a violation of CEST for (3a).

Although we have no formal proof that such a violation cannot be derived by some other means within the sketched version of CCG + structural inhibition, I hope to have shown that such a violation will be hard to derive by any obvious means. I conclude that the CG-based analysis of CEST provided by Błaszczak & Gärtner (2005) is not only elegant but also essentially formally sound.

4.2 An Apparent Violation of CEST

Wagner (2005) discusses CEST within a full-fledged theory of grammar-prosody interaction. This leads him to hypothesize that relative strength of prosodic boundaries should play a role overlooked by Błaszczak & Gärtner

(2005). And indeed, in examples like (44), ”wide scope is possible, at least if the prosodic boundaries in the underlined domain are not stronger than the boundary that sets off the negative quantifier” (Wagner 2005:113).

(44) *She expected the students who failed the mid-term to take none of the advanced tutorials, did she?*

What this shows is that the formulation of ”prosodic continuity” as subpart of CEST needs some refinements. (45) can serve as a first step toward such a reformulation.

(45) A linearly continuous string σ is *prosodically discontinuous* iff there is a prosodic boundary φ such that

1. φ breaks up σ into a non-vacuous prefix σ_1 followed by φ followed by a non-vacuous suffix σ_2 (σ = [σ_1 φ σ_2]), and
2. φ is stronger than prosodic boundaries φ' and φ” setting off σ from its immediate surroundings ([... φ' [σ_1 φ σ_2] φ” ...]).

For CG-implementation it suffices to assume that only locally strongest boundaries, i.e. those that induce prosodic discontinuity according to (45), function as structural inhibitors. Thus, only these strongest boundaries are of category $[]^{\varphi}X/X$ as stated in (17). All others are ”trivial” in the sense of bearing category X/X. Such a trivial boundary can be taken to intervene between *mid-term* and *to* in (44), which means that forward composition will not be interrupted and scope-taking for $Q\neg$ remains a possibility.

5 Discussion

Let us now try to put the above analysis into a somewhat larger perspective. To begin with, it should be noted that there are other more general attempts to combine CCG with type-logical CG. In particular, Steedman & Baldridge (2007) introduce ”modalizing features” on slashes that control the combinatorics of categories by constraining the type of operations applicable to such categories. Thus, they ”assume that function categories may be restricted as to the rules that allow them to combine with other categories, via slashes typed with four feature values: $\star$, $\Diamond$, $\times$, and $\bullet$” (ibid.:7). For our purposes it suffices to note that ”the $\star$ lexical type is the most restricted and allows only the most general applicative rules” (ibid.:8). It follows that structurally inhibitory prosodic boundaries, as introduced in (17), could be given the alternative analysis in (46).

(46) **%**: $X/_\star X$

This would equally prevent function composition across such boundaries. The only way of introducing (46) will be via **E**/, i.e. rightward application. The analysis of (6a) given in (19) will then carry over straightforwardly.[10]

Next, let us turn to the status of the "Y-model" in Chomskyan generative grammar and the proper place of linearization. Based on the analysis by Kayne (1998), Błaszczak & Gärtner (2005) present and discuss a "Y-model"-preserving minimalist implementation of CEST in which all linearization can be done at PF. The present CG-analysis, on the other hand, profits from incorporating linear order into syntactic derivations directly. One concession to the spirit of the Y-model, which lies in keeping PF and LF separate as far as possible, consists in the fact that the rule of *$[]^\varphi$-Elimination* does not come with a corresponding semantic interpretation. Use of an identity function could, of course, provide a trivial semantics to that rule if such a concession is deemed undesirable.

It should also be pointed out that, in a pre-minimalist version of generative syntax, Koster (1987) presented a theory that comes very close to the CG-analysis above. Central to that approach is the notion of "dynasty" as characterized in (47) (ibid.:36).

(47) A *dynasty* is a chain of governors such that each governor (except the last one) governs the minimal domain containing the next governor.

Dynasties are the counterparts of extended domains and thus relevant to an implementation of CEST. The second ingredient introduced into "dynasty-theory" is the idea that there are "certain types of agreement among the successive domain governors" one of which being "directionality" (ibid.). Extended NEG-scope in (2a) could therefore be put to the fact that all governors in the "chain" ⟨*requested,that,read*⟩ govern rightward. Koster (1987: chapter 5) successfully applied his system to differential "restructuring" effects in OV vs. VO languages. Thus, to the extent that the minimalist abandonment of linearization and government in "narrow syntax" is not taken to be irreversible, this theory should be reconsidered as an interesting rival to the CG-approach outlined above.

[10] It has to be assumed in addition that there is no category that takes $X/_\star X$ as an argument. Steedman & Baldridge (2007) do not discuss any such category, nor do they formally exclude its existence, as far as I can see.

6 Conclusion

The present paper has demonstrated how to treat NEG-scope extensions in English, which are sensitive to linear and prosodic continuity, within categorial grammar. Core ingredient of the account is the operation of (forward) function composition which is responsible for "assembling" extended domains over which negative quantifiers can scope. We have seen how constraints on linear consistency as well as prosodic continuity make the right predictions as to the applicability of function composition. C(C)G should therefore be taken seriously as a framework for the (linear) local modeling of non-local dependencies.

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7 References

1. Błaszczak, Joanna, and Hans-Martin Gärtner. 2005. "Intonational Phrasing, Discontinuity, and the Scope of Negation." *Syntax* 8:1-22.

2. Chomsky, Noam. 1995. *The Minimalist Program*. Cambridge MA: MIT Press.

3. Curry, Haskell B. 1961. "Some Logical Aspects of Grammatical Structure." Pp. 56-68 in *Structure of Language and its Mathematical Aspects*, edited by Roman Jakobson. Providence RI: American Mathematical Society.

4. Dowty, David. 1982. "Grammatical Relations in Montague Grammar." Pp. 79-130 in *The Nature of Grammatical Representation*, edited by Pauline Jacobson and Geoffrey Pullum. Dordrecht: Reidel.

5. Dowty, David. 1995. "Toward a Minimalist Theory of Syntactic Structure." Pp. 11-62 in *Syntactic Discontinuity*, edited by Harry Bunt and Arthur van Horck. The Hague: Mouton.

6. Fox, Danny, and David Pesetsky. 2005. "Cyclic Linearization of Syntactic Structure." *Theoretical Linguistics* 31:1-45.

7. Gazdar, Gerald, Ewan Klein, Geoffrey Pullum, and Ivan Sag. 1985. *Generalized Phrase Structure Grammar*. Cambridge MA: Harvard University Press.

8. Joshi, Aravind, K. Vijay-Shanker, and David Weir. 1991. "The Convergence of Mildly Context-Sensitive Grammar Formalisms." Pp. 31-81 in *Foundational Issues in Natural Language Processing*, edited by Peter Sells, Stuart Shieber, and Thomas Wasow. Cambridge MA: MIT Press.

9. Kayne, Richard. 1998. "Overt vs. Covert Movement." *Syntax* 1:128-191.

10. Koster, Jan. 1987. *Domains and Dynasties*. Dordrecht: Foris.

11. Kracht, Marcus. 2003. *The Mathematics of Language*. Berlin: Mouton de Gruyter.

12. Ladd, D. Robert. 1996. *Intonational Phonology*. Cambridge: Cambridge University Press.

13. Michaelis, Jens. 2001a. "Derivational Minimalism is Mildly Context-Sensitive." Pp. 179-198 in *Logical Aspects of Computational Linguistics* (LACL '98), edited by Michael Moortgat. Heidelberg: Springer.

14. Michaelis, Jens. 2001b. "On Formal Properties of Minimalist Grammars." *Linguistics in Potsdam* 13.

15. Moortgat, Michael. 1988. *Categorial Investigations*. Dordrecht: Foris.

16. Morrill, Glyn. 1994. *Type Logical Grammar*. Dordrecht: Kluwer.

17. Müller, Gereon. 2007. "Towards a Relativized Concept of Cyclic Linearization." Pp. 61-114 in *Recursion + Interfaces = Language? Chomsky's Minimalism and the View from Syntax-Semantics*, edited by Uli Sauerland and Hans-Martin Gärtner. Berlin: Mouton de Gruyter.

18. Muskens, Reinhard. 2007. "Separating Syntax and Combinatorics in Categorial Grammar." *Research on Language and Computation* 5:267-285.

19. Reape, Michael. 1994. "Domain Union and Word Order Variation in German." Pp. 151-197 in *German in Head-Driven Phrase Structure Grammar*, edited by John Nerbonne, Klaus Netter, and Carl Pollard. Stanford CA: CSLI Publications.

20. Ross, John Robert. 1967. "Constraints on Variables in Syntax." Ph.D.Dissertation, MIT, Cambridge MA.

21. Steedman, Mark. 1996. *Surface Structure and Interpretation*. Cambridge MA: MIT Press.

22. Steedman, Mark. 2000a. *The Syntactic Process*. Cambridge MA: MIT Press.

23. Steedman, Mark. 2000b. "Information Structure and the Syntax-Phonology Interface." *Linguistic Inquiry* 34:649-689.

24. Steedman, Mark, and Jason Baldridge. 2007. "Combinatory Categorial Grammar." Unpublished manuscript, Edinburgh.

25. von Stechow, Arnim. 1989. "Categorial Grammar and Linguistic Theory." *Arbeitspapiere der Fachgruppe Sprachwissenschaft der Universität Konstanz* 15.

26. Wagner, Michael. 2005. "Prosody and Recursion." Ph.D. Dissertation, MIT.