Infinitivals With *too*: Degree Operator Scope and Parasitic Gaps

Jon Nissenbaum & Bernhard Schwarz
McGill University

1. Introduction

As illustrated in (1), the degree operator *too* optionally combines with an infinitival clause and this infinitival clause can contain a non-subject gap.

(1) a. John is too rich [for the monastery to hire him].
b. John is too rich [for the monastery to hire __].

Reading the object pronoun *him* in (1a) as anaphoric to *John*, (1a) and (1b) are synonymous. Two related questions arise: what makes it possible for infinitivals with *too* to contain a non-subject gap? And how do sentences like those in (1) get to be synonymous?

Chomsky (1977) argued for an approach to the first question in which the non-subject gap in an infinitival with *too* is a trace left behind by a phonetically null operator that has moved to the edge of its clause to form a predicate of individuals. While Chomsky did not address the second question, he did assume that the infinitival is a complement of *too*. Under this assumption, a straightforward extension of Chomsky's proposal would posit two homophonous degree operators *too*, one that takes a propositional infinitival clause as its complement and one that combines with a property-denoting infinitival.

In this paper we will spell out such an analysis, but then show that it is problematic in view of a number of familiar and novel observations. These observations concern the logical scope of degree phrases with *too* as well as possible antecedents of the non-subject gaps. In particular, we show that non-subject gaps in infinitivals with *too* are strikingly similar in distribution to so-called parasitic gaps.

To understand this finding, we propose an alternative to the Chomskyan analysis of gapped infinitivals with *too*. Like Chomsky, we take gapped infinitivals with *too* to be due to null operator movement. However, we suggest that the null operator moves beyond its infinitival clause, to the edge of the degree phrase. Building on Nissenbaum (2000), we argue that this assumption brings non-subject gaps in infinitivals with *too* in line with parasitic gaps found in determiner phrases.

For comments and discussion, we thank the participants of our Fall 2007 seminar at McGill, as well as audiences at SALT XVIII, WCCFL 25, the 2008 annual meeting of the CLA, the University of Ottawa, and the University of Tübingen.

T. Friedman and S. Ito (eds.), SALT XVIII, Ithaca, NY: Cornell University.

So-called parasitic gaps are often taken to be dependent on overt wh-movement elsewhere in the clause by definition. However, the data we present lead us to conclude that no principled distinction should be made between canonical parasitic gaps and gaps in infinitivals with *too* of the sort illustrated in (1b), where no wh-movement has taken place.

2. Letting *too* Fill the Gap

Based on common assumptions about gradable adjectives, we will formulate a semantics for *too* with non-gapped infinitivals that essentially follows Heim (2001). Extending this account, we then spell out the Chomskyan analysis of *too* with gapped infinitivals.

We take gradable adjectives to relate degrees and individuals (Cresswell 1976, Bierwisch 1989, von Stechow 1984, Heim 2001). Specifically, we assign gradable adjectives denotations of type d(e(st)). This is illustrated in the lexical entry in (2), where $\text{RICH}_w(x)$ refers to x's net worth in the possible world w.

(2) $[\![\text{ rich }]\!] = \lambda d_d.\ \lambda x_e.\ \lambda w_s.\ \text{RICH}_w(x) \geq d$

According to (2), *rich* relates a degree to an individual just in case the individual's net worth is at least d. So we take *rich* to relate a given individual x not only to x's net worth itself, but also to every degree on the scale of wealth below x's net worth (von Stechow 1984, Bierwisch 1989, Gawron 1995, Heim 2001).

The degree operator *too* has a modal component. Sentence (1a), repeated in (3), has the truth conditions in (4), which says that in no accessible world where John is as rich as he actually is does the monastery hire him.

(3) John is too rich [for the monastery to hire him].
(4) $\exists d[\text{RICH}_w(j) \geq d \ \&\ \sim\exists w'[w' \in \text{Acc}_w\ \&\ \text{RICH}_{w'}(j) \geq d\ \&$ m hires j in w']]

What worlds count as accessible in general depends on context. In the example at hand, the accessible worlds could be those worlds where the monastery's actual hiring policy is obeyed. (4) then says that in no such world where John is as rich as he actually is does the monastery hire him. This is true, for example, if John is a millionaire and the monastery's policy is not to hire anyone whose net worth exceeds a half a million dollars. Note also that (3) is understood to entail that the monastery will not hire John. This can be credited to the assumption that accessibility relation in question is realistic, which entails that the monastery respects its hiring policy in the actual world.

Suppose that (3) has a logical form like (5), where *too* and its infinitival form a degree phrase that has undergone covert movement to the edge of the clause. The trace of this degree phrase is interpreted as a variable ranging over

degrees. The truth conditions in (4) can be derived by assigning *too* the lexical entry in (6).

(5) [too [for the monastery to hire him]] λd[John is d rich]
(6) [[too]] = $\lambda p_{st}.\lambda f_{d(st)}.\lambda w_s.\ \exists d[f(d)(w) \ \& \sim\exists w'[w' \in Acc_w \ \& \ f(d)(w') \ \& \ p(w')]]$

Recall now that sentence (1b), repeated in (7), is judged to share with (3) the truth conditions in (4). To derive this as well, we can posit (8) as the logical form of (7) as well as the lexical entry in (9).

(7) John is too rich [for the monastery to hire __].
(8) John is [too' λx[for the monastery to hire x]] rich
(9) [[too']] = $\lambda P_{e(st)}.\ \lambda F_{d(e(st))}.\ \lambda x_e.\ \lambda w_s.\ \exists d[F(d)(x)(w) \ \& \sim\exists w'[w' \in Acc_w \ \&$ F(d)(x)(w') & P(x)(w')]]

In (8), the degree phrase remains in situ, hence below the subject, and it is headed by a *too'*, a type shifted homophone of *too*. The lexical entry in (9) lets *too'* feed the subject denotation in (8) as an input to the property denoted by the gapped infinitival (as well as to the degree relation in the scope of the degree phrase). This ensures that the gap in the infinitival is anaphoric to the subject. It thereby ensures that (8) is indeed assigned the intended truth conditions in (4).

So this analysis, a straightforward extension of the proposal in Chomsky (1977), derives the equivalence of (3) and (7). However, we will now show that *too* plus gapped infinitival is subject to restrictions that the analysis does not lead one to expect.

3. Frozen Scope of *too* with Gapped Infinitivals

Heim (2001) observes that under (certain) intensional verbs, degree phrases with *too* participate in an ambiguity that can be analyzed as an ambiguity of logical scope. To illustrate, consider sentence (10), where the degree phrase headed by *too* is embedded under *want*.

(10) John wants to be too rich [for the monastery to hire him].

Consider the logical form for (10) shown in (11), where the degree phrase takes scope within the embedded clause. Assuming that PRO refers to John, the truth conditions assigned to this logical form are those shown in (12). (12) conveys that in all of John's desire worlds he is too rich for the monastery to hire. In this predicted reading, then, the sentence entails that John wants not to be hired.

(11) John wants [[too [for the monastery to hire him]] λd[PRO be d rich]]

(12) $\forall w''[w'' \in Bul_w(j) \rightarrow \exists d[RICH_{w''}(j) \geq d \ \& \sim\exists w'[w' \in Acc_{w''} \ \& \ RICH_{w'}(j) \geq d \ \&$ m hires j in w']]]

To be sure, sentence (10) can indeed be understood in this way. However, the sentence also has another reading, one that is consistent with John having no objection to being hired by the monastery and that could even be true if John wants them to hire him. The relevant reading of the sentence would be salient in a scenario where the monastery's hiring policy makes reference to applicants' desired wealth, rather than their actual wealth, excluding every candidate whose desired net worth is a above a certain limit. Sentence (10) could then be understood as conveying that John's desired net worth is above that limit. In other words, (10) seems to have a reading with the truth conditions in (13).

(13) $\exists d \ [\forall w''[w'' \in Bul_w(j) \rightarrow RICH_{w''}(j) \geq d] \ \& \sim\exists w'[w' \in Acc_w \ \&$
$\forall w''[w'' \in Bul_{w'}(j) \rightarrow RICH_{w''}(j) \geq d] \ \&$ m hires j in w']]]

The availability of such a reading is precisely what one expects if, as Heim (2001) argues, degree phrases with *too* can take inverse scope over (certain) intensional verbs. That is, the truth conditions in (13) can be credited to the logical form (14), where the degree phrase covertly moves from the embedded clause to take widest scope.

(14) [too [for the monastery to hire him]] λd[John wants [PRO be d rich]]

Consider now sentence (15) below, which minimally differs from (10) in that the object pronoun in the infinitival clause accompanying *too* is omitted. The relevant observation, previously unnoticed, is that (15) does not share with (10) the ambiguity described above. While the sentence allows for the reading in (12), it is judged to lack the one in (13). So in contrast to (10), sentence (15) unambiguously entails that John does not want to be hired.

(15) John wants to be too rich [for the monastery to hire __].

Under the analysis given above, the availability of reading (12) indicates that it is possible for the degree phrase headed by *too'* to be interpreted *in situ*, in the scope of *want*, but that this degree phrase cannot take inverse scope over *want*. So intuitions on (15) indicate that while the logical form (16) is available, the one in (17) is not.

(16) John wants [PRO be [too' λx[for the monastery to hire x]] rich]
(17) John [too' λx[for the monastery to hire x]] λd[wants [PRO be d rich]]

It is the unavailability of (17) that comes as a surprise. What is it that keeps a

degree phrases with *too* from taking inverse scope if it combines with a gapped infinitival clause?

We begin to address this question in the next section by introducing additional relevant data. These data illustrate another type of restriction on *too* plus gapped infinitival, first proposed in Faraci (1973). The restriction in question does not concern the relative scope of the degree phrase and another operator, but the possible antecedents of non-subject gaps in infinitivals with *too*.

4. Faraci's Generalization

Faraci (1974, 188–9) observed that the distribution of gapped infinitivals with *too* is much more restricted than that of gapless infinitivals. For example, Faraci judges each of the examples in (18) to be unacceptable.

(18) a. *Mary runs too fast [for me to keep up with __].
b. *Homer eats too much [for Jim to keep up with __].

Faraci notes that the unacceptability of these cases is indeed tied to the presence of the gap. He reports that the sentences in (19), where the gaps are filled with overt pronouns anaphoric to the matrix subject, are fully grammatical.

(19) a. Mary runs too fast [for me to keep up with her].
b. Homer eats too much [for Jim to keep up with him].

Faraci takes these observations to show that a non-subject gap in an infinitival with *too* can only be anaphoric to the subject argument of the adjective that *too* combines with. This captures the fact that (18a-b) cannot mean what (19a-b) mean, since in (19a-b) the final pronoun is understood to be anaphoric to the subject of the main predicate (*run* or *eats*) rather than the adjective combining with *too* (*fast* or *much*). Moreover, since the adjectives in question do not predicate subjects, at least none that could conceivably antecede the gap in the infinitival, Faraci's generalization correctly excludes the examples in (18) as unacceptable.

Faraci's generalization also applies correctly to cases where the adjective combining with *too* is the main predicate, but has an internal argument. In the grammatical sentence (20), for example, the gap can be understood anaphoric to John, the subject argument of *angry*, but not to its complement *Mary*.

(20) John is too angry at Mary [for us to invite __].

Under the assumption we have introduced above, Faraci's generalization comes as a surprise. Assuming that degree phrases with *too′* can move covertly

just as the gapless variants with *too* can, one expects (18a-b) to have the logical forms in (21a-b), where in each case the degree phrase has landed just below the matrix subject and which would derive the very readings expressed by the non-gapped examples in (19a-b).

(21) a. Mary [too' λx[for me to keep up with x]] λd[runs d fast]
b. Homer [too' λx[for Jim to keep up with x]] λd[eats d much]

Similarly, an unattested reading of (20) could be derived from the logical form in (22), where *Mary* has covertly moved to the edge of the clause and the *too'* degree phrase has moved right below it, ensuring that *Mary* fills the gap in the infinitival.

(22) Mary [too' λx[for us to invite x]] λdλy[John is d [angry at y]]

Each of the unavailable logical forms in (21) and (22) assumes that degree phrases with *too'* can move covertly. To account for Faraci's generalization, we would accordingly have to assume that degree phrases with *too'* are not in fact scopally mobile and instead must always be interpreted *in situ*.

It is apparent that this assumption would also derive the frozen scope observation presented in the previous section. If degree phrases with *too'* cannot move covertly, then in particular they cannot take inverse scope over higher operators at logical form.

The question now is why it would be that *too* plus gapped infinitival has to be interpreted *in situ.* We will address this question shortly. But first we will show that Faraci's Generalization is actually not correct as its stands and needs to be refined.[1]

5. But Sometimes There is Movement After All

5.1. Exceptions to Faraci's Generalization

While Faraci's generalization applies correctly to the data presented above, the generalization turns out to have systematic, previously unnoticed, exceptions. A first illustration of this are the examples in (23), which differ from Faraci's examples in (18) only in that the matrix subject has been questioned.

[1] An *in situ* restriction on *too* with a gapped infinitival can not be seen as a more general restriction on degree phrases which, like *too'* degree phrases, take an individual argument after taking the denotation of a gradable adjective. Apart from hypothetical *too'*, the only degree operators we are aware of that might have to be analyzed as projecting degree phrases of such a semantic type are superlatives (e.g. Heim 1999, 2001) and reciprocal equatives (as in *equally rich*, Schwarz 2007). Neither type of degree phrase is constrained in the way *too* plus gapped infinitival is. In particular, the works cited above demonstrate that both can take inverse scope over certain intensional verbs.

(23) a. Tell me [which girl __ runs too fast [for me to keep up with __]].
b. Tell me [which girl __ eats too much [for Jim to keep up with __]].

These example are acceptable, with the gap in the infinitival understood anaphoric to the matrix subject. The gap in the infinitival is bound by the subject wh-phrase, just like an overt pronoun can be bound by the wh-phrase in the examples in (24).

(24) a. Tell me [which girl __ runs too fast [for me to keep up with her]].
b. Tell me [which girl __ eats too much [for Jim to keep up with her]].

The examples in (23), then, are clear exceptions to Faraci's generalization. The same is true for the examples in (25), where the matrix subject has been relativized rather than questioned. Again, these sentences are acceptable and the gap in the infinitival is understood as bound by the matrix subject.

(25) a. Mary, [who __ runs too fast [for me to keep up with __]]
b. Homer, [who __ eats too much [for Jim to keep up with __]]

These data suggest that it is generally possible for a non-subject gap in an infinitival with *too* to take as its antecedent an expression that has undergone overt wh-movement, irrespective of its place in argument structure. Apparently, it is only in the absence of overt wh-movement that Faraci's Generalization applies.

This characterization of the data receives further support from the examples in (26), which are to be compared with (20) above. In (26a-b), it is the internal argument of *angry* that has undergone wh-movement and, as expected, it is possible to read the gap in the infinitival as bound by the moved wh-phrase.

(26) a. Tell me [who John is too angry at __ [for us to invite __]]
b. Mary, [who John is too angry at __ [for us to invite __]]

In the terms of our current analysis, the exceptions to Faraci's Generalization indicate that a degree phrase headed by *too′*, while ordinarily frozen *in situ*, can move to adjoin to predicates of individuals derived through overt wh-movement. For example, the relative clauses in (25) have surface structures where overt movement has derived a predicate of individuals to the right of *who*. The acceptability of the examples in (25) indicate that it is possible for the *too′* degree phrase to covertly raise and attach to this predicate, yielding the logical forms in (27), which derive the readings described above.

(27) a. who [too' λx[for me to keep up with x]] λdλy[y runs d fast]
b. who [too' λx[for Jim to keep up with x]] λdλy[y eats d much]

Similarly, the relevant reading of the sentences in (26) would be due to a logical

form like (28), where again the *too′* degree phrase has targeted a predicate of individuals derived by overt wh-movement.

(28) who [too' λx[for us to invite x]] λdλy[John is d [angry at y]]

Given the unavailability of (21)-(22), the availability of the LFs in (27)-(28) is certainly puzzling. The question is why degree phrases with *too′* would want to insist on adjoining, if they move, to predicates derived by overt wh-movement. We will address this question shortly. But first, we will return briefly to the frozen scope observation presented above.

5.2. Exceptions to the Frozen Scope Generalization

Recall our suggestion that the frozen scope requirement described in section 3 above is a consequence of the assumption, motivated by Faraci's Generalization, that degree phrase with *too′* must be interpreted *in situ*. If frozen scope and Faraci's Generalization are indeed so related, we should expect exceptions to frozen scope to arise in just those environments where exceptions to Faraci's Generalization arise. Remarkably, this expectation is correct. Consider (29):

(29) Mary, who [my mother wants me to be too [angry at __]] [for me to (actually) dislike __]

In its only sensible interpretation, (29) conveys that what is incompatible with my disliking Mary is my mother's wanting me to be angry at Mary to the degree that she actually wants me to be angry at her. This is the very reading expressed by the logical form (30), where the *too′* degree phrase scopes over *want*.

(30) Mary, who [too' λx[for me to (actually) dislike x]] λdλy[my mother wants me to be [d angry at y]]

So the frozen scope observation described above is not in fact due to a restriction on the scope of *too′* plus gapped infinitival relative to other operators. Instead, it is due to a restriction on the possible landing site of the relevant degree phrases. Nothing in principle prevents *too′* plus gapped infinitival from taking inverse scope over an intensional verb. The degree phrases in question can covertly move past an intensional verb as long as they can target a position next to a predicate derived by overt wh-movement.

To summarize, under the current account of *too* with gapped infinitivals, restrictions on scope and possible antecedents suggest that *too′* degree phrases must remain *in situ* at logical form unless they can move to target a predicate of individuals derived by overt wh-movement. The obvious question is whether it is possible to explain why *too′* degree phrases should be restricted in this way. This is the question we address next.

6. Gapped Degree Phrase Movement and Parasitic Gaps

The restriction against raising of gapped degree phrases in the absence of overt wh-movement somewhere in the main clause is strikingly similar to a restriction known to apply elsewhere, namely in so-called parasitic gap constructions, illustrated in (31). An instance of overt wh-movement in the main clause makes it possible for an additional gap to appear inside an adjunct (31a) or a subject (31b) (Engdahl 1983, Taraldsen 1982). The additional gap is also possible inside an indirect object (31c).

(31) a. Mary, who John was very angry at __ [without actually disliking __]
b. Mary's a person that [no one who likes __] stays angry at __ for long
c. Mary, who we persuaded [several friends of __] to become angry at __

Like gaps inside moved degree phrases, the gaps in the bracketed phrases of (31) seem to be parasitic specifically on overt wh-(A-bar)movement; they cannot, for instance, have as their antecedents either the sentential subject or a covertly raised object (cf. the gapped degree phrases in 17 and 21-22):

(32) a. *John was very angry at Mary [without actually disliking $\_\__{(John/Mary)}$]
b. *[No one who likes $\_\__{(Mary)}$] ever stays angry at Mary for long
c. *We persuaded [several friends of $\_\__{(us/Mary)}$] to become angry at Mary

The resemblance between the environments in which parasitic gaps can appear and those in which gapped degree phrases can take both exceptional scope and exceptional antecedents suggests that the two phenomena have a common underlying basis. In the sections that follow, we argue that the right theory of parasitic gaps should derive the set of environments in which gapped degree phrases can appear. We will consider two kinds of theories of parasitic gaps. We begin by briefly considering an approach that assumes the parasitic gap shares the same antecedent as the main clause gap. We show that when applied to gapped degree phrases, this assumption would explain why the *in situ* constraint is lifted in wh-movement environments, albeit without deriving the constraint itself. We then consider a second approach, one that assumes the two gaps have separate antecedents. We argue in section 7 that an approach of the second type derives the *in situ* constraint as well as its exceptions, and moreover, eliminates the need for a special *too'* operator for gapless degree phrases.

6.1. The Shared Antecedent View

A tempting but probably wrong approach to examples like the ones in (31) would be to analyze them as instances of multiple gaps bound by the same antecedent. Such an analysis would make the construction similar (or perhaps identical) to

across-the-board (ATB) wh-movement.[2] Note, however, that if we assume ATB movement underlies both parasitic gaps and the exceptional gapped degree phrases observed in sections 4 and 5, we would have an explanation for the latter. Specifically, the assumption of a shared antecedent would allow us to regard the exceptional cases as ordinary degree phrases (i.e. with *too* instead of *too')* that simply contain a second trace of the overt wh-movement. An example like (26b) could be represented informally as (33) (corresponding to the surface order); it would have the LF in (34) rather than the puzzling one in (28) repeated below.

(33) Mary, who$_i$ John is too angry at __$_i$ [for us to invite __$_i$]

(34) … who$_i$ λx[**too** [for us to invite x]] λd[John is d angry at x]

(28) *… who [**too'** λx[for us to invite x]] λdλy[John is d [angry at y]]

The observation that the antecedent for the degree-phrase gap must be the moved wh-phrase, rather than the subject of the adjective with which the degree phrase first combines, would follow from the assumption that the gap is a trace of the wh-phrase. Since the degree phrase in (34) is formed by merging *too* with an ordinary *for*-clause, rather than by merging *too′* with a gapped *for*-clause, Faraci's Generalization would be irrelevant (since it applies only to the latter). Similarly, the ATB structure would explain the apparent exceptions to the scope freezing generalization: we would expect it to have the same options for scope-taking that degree phrases with ordinary *too* always have. The gap that it contains makes it look superficially like a *too′* degree phrase, but its scope mobility and different choice of antecedent suggest that the similarity is an illusion. The ATB approach to the exceptional cases is thus compatible with strict adherence to the stipulation that *too′* degree phrases remain in situ.

6.2. Arguments Against the Shared Antecedent Approach

As tempting as this approach to the exceptional cases might be, however, it leaves unexplained why the 'real' gapped degree phrases — those formed with *too′* — must remain in situ.

Moreover, shared-antecedent theories have been shown to make wrong predictions about binding and reconstruction effects in parasitic gap constructions, and these wrong predictions carry over to gapped degree phrases. For instance,

[2]One obvious problem for an across-the-board analysis of parasitic gaps that was pointed out by Engdahl (1983) is that in adjunct and subject cases like (31a-b), the gaps inside the bracketed phrases are not allowed independently of the main clause gaps, as shown in (i) and (ii) (hence the term "parasitic gap"). The same is true for some versions of examples involving indirect objects such as (iii) where the parasitic gap is further embedded in a relative clause:

(i) *Mary, who John was very angry [without actually disliking __]

(ii) *Mary's the kind of person that [no one who likes __] stays angry for long

(iii) Mary, who we persuaded [several people who are friends with _] to become angry *(at _)

the gaps internal to the bracketed phrases in (31) do not behave like traces of the overtly moved wh-phrase with respect to reconstruction (Chomsky 1986, Nissenbaum 2000). The examples in (35) involve reflexive pronouns whose antecedents c-command only one of the gaps. The contrast shows that asymmetric reconstruction to the main clause gap (35a) is possible (surprisingly, if movement is ATB); asymmetric reconstruction to the parasitic gap position (35b) is not.

(35) a. a picture of himself that John sold _ [before Mary could look at _]
b. *a picture of herself that John sold _ [before Mary could look at _]

A similar pattern of asymmetric reconstruction is evident for exceptional gapped degree phrases, illustrated in (36). Reconstruction is possible to the position of the main-clause gap (36a), but not to the gap in the degree phrase (36b).

(36) a. a picture of himself that John is too proud of _ [for Mary to look at _]
b. *a picture of herself that John is too proud of _ [for Mary to look at _]

This suggests that neither parasitic gaps nor the gaps in degree phrases are bound by the same antecedents as the gaps in the main clause.

6.3. An Alternative View: Separate Antecedents

An alternative assumption is that parasitic gaps have separate antecedents from the gaps in the main clause. A common approach along these lines takes the parasitic gaps in examples like (31a-c) to be the traces of null operators (Browning 1987, Chomsky 1986, Contreras 1984), which have moved to the edges of the bracketed phrases to create functions from individuals:

(37) a. λx[without PRO disliking x]
b. λx[no one who likes x]
c. λx[several friends of x]

Nissenbaum (2000) argued that sentences like those in (31) are interpreted compositionally, with each of the derived functions in (37) composing with a derived predicate formed by the overt wh-movement in the main clause. The simplest case is (31a), where the parasitic gap is inside a VP-adjunct. Nissenbaum argued that as long as wh-movement in the main clause targets a position local to the attachment site of the adjunct (which we take to be the VP in 38), the resulting derived predicate (38a) provides an adjunction site that would allow (37a) to compose with its sister by predicate modification. The outermost bracketed constituent in (38b) is interpreted as the predicate (39).

(38) a. who λy[$_{VP}$ John be angry at y]
b. who [λy[$_{VP}$ John be angry at y] λx[without PRO disliking x]]

(39) λx. John is angry at x & ~[j dislikes x]

Cases like (31b-c), in which the parasitic constituents are quantificational DPs, cannot be quite as simple; the derived functions (37b) and (37c) clearly do not compose with their sisters by predicate modification. Nevertheless, Nissenbaum (2000) argued that such examples are amenable to a compositional analysis, if the composition rules apply in a more flexible manner than is standardly assumed. Specifically, Nissenbaum argued that parasitic DPs motivate a composition rule that is, in effect, a hybrid between predicate modification and function application. Consider the node labeled α in (40), which is the relevant subpart of the LF of (31c), formed by wh-movement and QR of the parasitic DP:

(40) who [$_{\alpha}$ λ*x*[*several friends of x*] λyλz[$_{VP}$ we persuaded *z* to be angry at y]]

(41) The two daughters of α in (40):

a.	λx[several friends of x]	*type e((e(st))st)*
b.	λyλz[$_{VP}$ we persuaded *z* to be angry at y]	*type e(e(st))*

Both daughters of α denote functions from individuals (41). If each were fed an individual, the resulting denotations could then compose by function application; (41a) denotes a function from individuals to generalized quantifiers, while (41b) denotes a function from individuals to one-place predicates. The kind of rule that is needed would (like predicate modification) pass up to α the open position shared by both daughters, while also allowing the output of (41a) to take the output of (41b) as its argument. We give a version of such a composition rule in (42), modeled on the proposal of Nissenbaum (2000).[3]

[3]Nissenbaum did not propose the special rule (42) but rather that *predicate modification* divides into two independent parts: *argument identification* and *conjunction*. (See *i* and *ii*a,b below; Nissenbaum gives a single composition rule, *i,* which invokes a relation between semantic values, *COMPOSE*, defined for the three conditions in *ii*.) Argument identification is simply the sharing of the open positions of two sisters. Nissenbaum argued that factoring predicate modification into its two component parts allows the rule to generalize without further stipulation to n-place predicates. The predicate modification rule as formulated in, e.g. Heim & Kratzer 1998, is just the special case where two functions compose by (iia) and their outputs compose by (iib). The rule stated as (42) would be a special case where two functions like (41a,b) compose by (iia) and their outputs compose by *function application* (iic).

(i) If α is a branching node with daughters β and γ, then for any assignment g, $[\![\alpha]\!]^g$ = *COMPOSE*($[\![\beta]\!]^g$,$[\![\gamma]\!]^g$), where *COMPOSE* is a relation between semantic values that is defined for the three cases in (ii):

(ii) a. **Argument Identification:** For any semantic values *A* and *B*, if *A* is a function from some semantic type τ to any semantic type, and *B* is a function from τ to any semantic type, then for all $x \in D_{\tau}$, *COMPOSE(A,B)* is defined only if *COMPOSE(A(x),B(x))* is defined. Where defined, *COMPOSE(A,B)* = λx_{τ}. *COMPOSE(A(x),B(x))*

b. **Conjunction:** For any semantic values *A* and *B*, if *A* and *B* are both truth values, then *COMPOSE(A,B) = A = B* = 1.

c. **Function Application:** For any semantic values *A* and *B*, if *A* is a function whose domain contains *B*, then *COMPOSE(A,B) = A(B)*.

(42) **Flexible Composition** *(argument-sharing function application)*
If α is a branching node and $\{\beta, \gamma\}$ the set of its daughters, then for any assignment g and for any $y \in D_e$, if $[\![\beta]\!]^g$ and $[\![\gamma]\!]^g$ are both functions from D_e, and $[\![\beta]\!]^g(y)$ is a function whose domain contains $[\![\gamma]\!]^g(y)$, then $[\![\alpha]\!]^g = \lambda x.[\![\beta]\!]^g(x)([\![\gamma]\!]^g(x))$

Given this rule, the value of the node α of (40) is computed as in (43). The function (43b) would then apply to (the trace of) *who* to fill the gaps in the appropriate way.[4]

(43) a. For any assignment g, $[\![(40)\alpha]\!]^g = \lambda x.[\![(41a)]\!]^g(x)([\![(41b)]\!]^g(x))$
b. $= \lambda x.[\lambda F_{et}.\, \exists y.$ friends(x)(y) & F(x)](λz.we persuade z to be angry at x)

If this approach to canonical parasitic gap constructions is correct, and if the distributional similarities with exceptional gapped degree phrases are not just coincidental, then we need to revise our thinking about gapped degree phrases.

6.4. Gapped Degree Phrases that are Parasitic on Wh-Movement

Thus far we have been following Chomsky (1977) in taking gapped degree phrases to be formed by null operator movement to the edge of the clausal complement of the degree operator, as in (28), repeated below. But we observed that gapped degree phrases can violate the puzzling *in situ* restriction that otherwise holds, when they are able to target predicates derived by wh-movement. In light of what we have concluded about other such parasitic gapped constructions, we are led to abandon Chomsky's assumption. Instead, we posit that null operator movement targets the moved degree phrase itself, as in (44):

(28) ... [too' λx[for us to invite x]] ...
(44) λx[too [for us to invite x]]

[4]The careful reader might have noticed that the lambda operators in (41b) — i.e. the right-hand daughter of α — appear in the reverse order of what would be expected under Heim and Kratzer's (1998) theory of chain formation. Under that theory, when *who* raises, its binder index *λy* adjoins to the VP. Covert movement of the parasitic DP would then target a position between *who* and the latter's binder index. But then the new binder index *λz* would have to adjoin above the already-present *λy*. This configuration would be interpretable by means of the flexible composition rule (42), but the interpretation is not attested: it is impossible to interpret sentences like (31b,c) with the gaps filled in that way (i.e. with *who* as the indirect object of *persuade*).

We conclude that binder indices need not adjoin at the same derivational step as movement. To derive the LF (40), the binder index of the parasitic DP [*several friends of* _] would have to raise and adjoin to VP before movement of either the DP itself or *who*, to yield *λz*[*we persuaded* [*several friends of* _]$_z$ *to be angry at* [*who*]$_y$]. This index-adjunction step would be followed by movement of *who* and adjunction of its binder index, and lastly raising of the parasitic DP to a position between *who* and *λy*.

The degree phrase (44) is a derived function from individuals. Just like the parasitic DP object discussed in the previous subsection, it moves covertly to a position just below the landing site of wh-movement, where its sister is also a function from individuals (derived by the wh-movement):

(45) who [$_{\alpha}$ λx[*too* [*for us to invite x*]] $\lambda y \lambda d$[$_{VP}$ John is d angry at y]]

Parallel to what we saw in section 6.3, the meaning of the node α in (45) is determined by the flexible composition rule applying to its two daughters (46a,b), as shown in (47a). The output is the predicate (47b), which ultimately applies to the trace of *who*.

(46) The two daughters of α in (45):
a. λx[too [for us to invite x]] *type e((d(st))st)*
b. $\lambda y \lambda d$[$_{VP}$ John is ***d*** angry at y] *type e(d(st))*

(47) a. For any assignment g, $[\![(45)\alpha]\!]^g = \lambda x.[\![(46a)]\!]^g(x)([\![(46b)]\!]^g(x))$
b. $\lambda x.\lambda w.\ \exists d[\text{ANGRY}_w(x)(j) \geq d \ \& \sim\exists w'[w' \in \text{Acc}_w \ \& \ \text{ANGRY}_{w'}(x)(j) \geq d \ \&$ we invite x in w']]

Note that this is not the special degree operator *too′* that we invoked for gapped degree phrases, but rather the ordinary operator *too* that selects a (gapless) CP complement. Just like the shared antecedent theory that we considered and rejected, this approach to exceptional gapped degree phrases puts us in a position to understand why wh-movement allows moved degree phrases to have gaps that would otherwise be unexpected. Wh-movement derives predicates. Those predicates provide the right kind of attachment site for parasitic degree phrases to raise to and compose with via *flexible composition.*

6.5. What About Gapped Degree Phrases that Remain In Situ?

An important question remains. Some gapped degree phrases are not parasitic on wh-movement. Those are the ones that are subject to the puzzling constraint that forces them to remain *in situ* at LF, yielding Faraci's Generalization as well as scope disambiguation in potentially ambiguous environments. Are we still forced to countenance the special *too′* operator that selects a gapped clause, given that the external syntactic environment provides no derived predicate to raise to? If so, the explanation we advanced in the previous subsection would lose considerable force, requiring not only the *too′* variant for unmoved gapped degree phrases but also the stipulation that it can only be interpreted *in situ*.

In the next section, however, we will argue that our proposal generalizes. The lessons drawn from parasitic gaps provide a new way of looking not just at the exceptional behavior of gapped degree phrases in wh-movement contexts, but

at the composition of all gapped degree phrases. In short, we will argue that our proposal provides a wholesale alternative to our extension of Chomsky (1977), one that does not rely on a stipulated difference between *too* and a gapped-clause-selecting homonym *too'*. There is just one *too*, and the curious restrictions on optional non-subject gaps result from principles of semantic composition.

7. Just One *too*?

We argued in section 6.4 that if the operator movement in a gapped degree phrase goes outside the *too*, then the degree phrase would be expected to compose with a predicate of type (e(d,st)). Suppose adjectives (like *rich, angry at Mary,* etc.) have this type (Rett 2008, Heim 2008). Specifically, suppose we replace the lexical entry in (2) with the one in (48).

(2) $[\![\text{ rich }]\!] = \lambda d_d.\ \lambda x_e.\ \lambda w_s.\ \text{RICH}_w(x) \geq d$

(48) $[\![\text{ rich }]\!] = \lambda x_e.\ \lambda d_d.\ \lambda w_s.\ \text{RICH}_w(x) \geq d$

Then we expect degree phrases to be able to compose in situ, i.e. below the subject of the AP, but only if they have null operator movement from the for-clause to the edge of degree phrase.

(49) $[_{AP}$ John $\mathbf{[}_{\alpha}$ ***λx[too [for us to invite x]]*** $[_{A}$ rich $]_{\alpha}\mathbf{]}$ $]$

To interpret (49), we have to understand how the two daughter nodes of α, shown in (50), compose. We use *flexible composition*, as shown in (51). To derive the final intended truth conditions for (49), the resulting function (51b) is applied to the subject.

(50) The two daughters of α in (49):

a. λx[too [for us to invite x]] *type e((d(st))st)*

b. rich *type e(d(st))*

(51) a. For any assignment g, $[\![(49)\alpha]\!]^g = \lambda x.[\![(50a)]\!]^g(x)\ ([\![(50b)]\!]^g(x))$

b. $\lambda x.\lambda w.\ \exists d[\text{RICH}_W(x) \geq d\ \&\ \sim\exists w'[w' \in \text{Acc}_w\ \&\ \text{RICH}_{W'}(x) \geq d\ \&$ we invite x in w']]

Assuming gradable adjectives have the semantic type in (48), then, we have one account for the basic cases as well as for the exceptions to frozen scope and to Faraci's generalization. This improves on an analysis based on our extension of Chomsky's suggestion, which, we have seen, does not explain frozen scope or Faraci's generalization.

8. Conclusion

We started by asking about a puzzling alternation involving degree phrases with optional non-subject gaps. Current semantic approaches to degree operators provide a reasonable way to understand *too* phrases without gaps, and make correct predictions about scope ambiguities in which they participate. The gapped variants have not attracted much attention on the part of semanticists. In all likelihood, this is due to their apparent truth-conditional equivalence with their gapless counterparts; the alternation has simply been assumed to result from what Chomsky suggested was null operator movement within the clausal complement of *too*.

We showed that Chomsky's suggestion does not, in fact, square well with the otherwise successful approach to degree constructions. We demonstrated that the gapped versions of degree phrases are much more restricted than their gapless counterparts in scopally ambiguous sentences: they must remain *in situ* unless they can target a predicate derived by overt wh-movement. And we noted that this puzzling restriction is parallel with a second puzzle, namely Faraci's observed restriction on the choice of antecedent for the gap. Moreover, we showed that Faraci's restriction is lifted in exactly the same environments that our observed scope restriction is lifted.

In addition to these surprising empirical discoveries, we have presented evidence that the right explanation for them makes use of the same compositional principles that are involved in parasitic gap constructions. The surprising behavior of gapped degree phrases can be understood once we assume that that the degree phrase itself denotes a function from individuals derived by operator movement to its edge, contra Chomsky's suggestion.

The explanation that we offered provides a new form of empirical support for a *separate antecedent* approach to parasitic gap constructions, which, we argued, is what gapped degree phrases amount to. While we offered no explanation for the failure of gapped degree phrases to target predicates derived by subject movement or by covert object movement — i.e. for the ungrammaticality of LFs like (17) or (21)-(22) — the observed pattern at least tracks the canonical cases of parasitic gaps. We must assume that the grammar imposes a constraint that prevents function-denoting XPs derived by null operator movement from targeting such positions.

The notion that predicates derived by null operator movement can merge where they are able to compose is nothing new, given familiar approaches to relative clauses and various other constructions. Our account for the puzzles involving gapped degree phrases provides missing support for Nissenbaum's (2000) suggestion that parasitic gaps are interpreted compositionally: he proposed that what makes them parasitic on movement is just that movement provides an interpretable attachment site for derived functions from individuals. What we showed is that given our assumptions, null operator movement can turn an

ordinary degree phrase into derived function from individuals; if so, it would be interpretable *in situ* if it merges below the internal subject, and it would also be interpretable when moved, provided that the movement is able to target a predicate derived by overt wh-movement. Derived functions that are parasitic on movement are regarded as a special kind of construction. We have found that one and the same constituent can be parasitic or not. This finding indicates rather strikingly that there is no principled distinction among different kinds of null-operator-derived functions; their distribution is instead largely governed by semantic interpretability.

References

Bierwisch, Manfred: 1989, 'Semantik der Graduierung', in M. Bierwisch and E. Lang (eds.), *Grammatische und konzeptuelle Aspekte von Dimensions-adjektiven*, Akademie-Verlag, Berlin.

Chomsky, Noam: 1977, 'On Wh-Movment', in P. Culicover, T. Wasow and A. Akmajian (eds.), *Formal Syntax,* Academic Press, New York.

Chomsky, Noam: 1986, *Barriers,* MIT Press, Cambridge.

Contreras, Heles: 1984, 'A Note on Parasitic Gaps', *Linguistic Inquiry* **15**, 698-701.

Cresswell, M. J.: 1976, 'The Semantics of Degree', in Barbara Partee (ed.), *Montague Grammar*, Academic Press, New York, pp. 261-292.

Engdahl, Elisabet: 1983, 'Parasitic Gaps', *Linguistics and Philosophy* **6**, 5–34.

Faraci, Robert: 1974, *Aspects of the Grammar of Infinitives and* for-*Phrases*, Doctoral Dissertation, MIT, MITWPL, Cambridge.

Gawron, Jean Mark: 1995, 'Comparatives, Superlatives, and Resolution', *Linguistics and Philosophy* **18**, 333–380.

Heim, Irene: 1999, 'Notes on Superlatives', ms., MIT.

Heim, Irene: 2001, 'Degree Operators and Scope', in C. Féry and W. Sternefeld (eds.), *Audiatur Vox Sapientiae*, Akademie-Verlag, Berlin.

Heim, Irene: 2008, 'Decomposing Antonyms?', in Atle Grønn (ed.), *Proceedings of Sinn und Bedeutung* **12**, Department of Literature, Area Studies and European Languages, University of Oslo, pp. 212-225.

Heim, Irene, and Angelika Kratzer: 1998: *Interpretation in Generative Grammar*, Blackwell, Cambridge.

Meier, Cécile: 2003, 'The Meaning of *too, enough,* and *so…that'*, *Natural Language Semantics* **10**, 69–107.

Nissenbaum, Jon: 2000, *Investigations of Covert Phrase Movement*, Doctoral Dissertation, MIT, MITWPL, Cambridge.

Rett, Jessica: 2008, 'Antonymy and Evaluativity', in M. Gibson and T. Friedman (eds.), *Proceedings of SALT XVII*, CLC Publications.

Schwarz, Bernhard: 2007, 'Reciprocal Equatives', in E. Puig-Waldmüller (ed.), *Proceedings of Sinn und Bedeutung* **11**, Universitat Pompeu Fabra, Barcelona, 568–582.

Stechow, Arnim von: 1984, 'Comparing Semantic Theories of Comparison', *Journal of Semantics* **3**, 1–177.

Taraldsen, Knut Tarald: 1981, 'The Theoretical Interpretation of a Class of Marked Extractions', in A. Belletti, L. Brandi and L. Rizzi (eds.), *Theory of Markedness in Generative Grammar: Proceedings of the 1979 GLOW Conference,* Scuola Normale Superiore di Pisa.