

Negative Inversion

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1 The Phenomenon

1.1 Basic Data

Negative Inversion (NI), illustrated in (1) through, has been discussed widely in the syntactic literature, but has received very little attention from semanticists:¹

- (1) a. Not until the next morning did she realise how serious it was.
b. Seldom has so much been owed by so many to so few. (BNC)
- (2) a. None of them did he find useful.
b. Nowhere does he mention my book. (CGEL)
- (3) a. Never had the Cardinal's policy been more triumphantly vindicated.
b. Nowhere is this so noticeable as in the South of France.
c. In no case can such a course be justified merely by success. (KE)

I will term the constituent preceding the auxiliary in these cases the *negative phrase*. Negative phrases include what I call *no*-DPs and PPs such as *never*, *nowhere*, *no NP*, *none of*, overtly negated phrases such as *not until*, *not even*, phrases prefixed with *only*, DPs headed by *fewer than*, *less than*, *at most*, *n or less*, and PPs containing such DPs or *no*-DPs.

¹Examples are from the British National Corpus (BNC), Huddleston and Pullum (2002) (CGEL), Google searches (GGL), and H.W. Fowler (1908) *The King's English* (KE); all other examples are made up, unless otherwise noted.

1.2 Negativity

What makes a phrase negative in this sense? First note that many of these phrases are downward entailing (DE):

- (4) a. None of them did he find useful \Rightarrow None of them did he find useful and interesting.
- b. Nowhere does he mention my book. \Rightarrow Nowhere does he praise my book.
- c. With no woman was he content \Rightarrow With no woman was he happy.

Some of the elements above are not DE, but nonetheless license NPIs; these include *only*, and, at least for some speakers, non-monotonic DPs expressing low numbers (% marks examples that not all speakers accept):

- (5) a. Only two of them did he find useful. (CGE)
- b. Only two of them **lifted a finger** to help.
- (6) a. %In exactly two of these cases did we find traces of the virus.
- b. %Exactly two of the cases **ever** showed traces of the virus.

In sum, DE-ness seems a sufficient condition for NI, but more in general, all NPI licensing phrases are negative phrases in our sense (this is essentially the generalization argued for in Klima (1964)).

1.3 Negative Inversion v. Topicalization

Non-negative phrases do not trigger inversion when preposed; for those cases I will speak of (*plain*) *topicalization* (i.e. preposing without inversion):

- (7) a. Nowhere does he mention my book. (CGE)
- b. *Somewhere does he mention my book.
- c. Somewhere, he mentions my book.
- (8) a. In no case can such a course be justified merely by success. (KE)
- b. *In some cases can such a course be justified merely by success.
- c. In some cases, such a course can be justified merely by success.

Apart from inversion, plain topicalization and NI differ in their intonational properties. Though I haven't investigated these systematically, it seems accurate to say that topicalization typically shows an intonational phrase break

(‘comma intonation’, indicated by %); NI doesn’t tolerate that kind of separation:

- (9) a. Nowhere does he mention my book.
b. Somewhere % he mentions my book.
c. ?*Nowhere % does he mention my book.
- (10) a. In no case can such a course be justified merely by success.
b. In some cases, such a course can be justified merely by success.
c. ?*In no case % can such a course be justified merely by success.

1.4 Arguments v. Adjuncts

Do all negative phrases trigger inversion? At least for non-arguments, inversion seems obligatory with preposing:

- (11) a. *Not until the next morning she realised how serious it was.
b. *Seldom so much has been owed by so many to so few.
- (12) a. *Never the Cardinal’s policy had been more triumphantly vindicated.
b. *Nowhere this is so noticeable as in the South of France.
c. *In no case such a course can be justified merely by success.

Examples of NI with arguments are rare, and most speakers find them formal, literal, or stilted (I use § to indicate that):

- (13) a. § None of them did he find useful. (CGEL)
b. § None of them can we afford to loose. (Google)
c. § To none of them could she have begun to say what was on her mind.
d. § At none of them did I seem to do well. (BNC)

Some speakers accept argument examples without inversion like (14a) (in sharp contrast to adjunct examples like (14b)), others reject them, too:

- (14) a. %None of them he found useful.
b. *Nowhere in there he mentions my book.

It is worth noting, though, that for those speakers who do accept examples like (14a), the intonation of the non-NI examples doesn’t involve a separated

intonation:

- (15) a. Most of them % he found useful.
b. ?*None of them % he found useful.
c. None of them he found useful.

In what follows, I will only consider adjunct examples. I tentatively assume that examples with preposed negative argument have the semantic properties of inverted structures, whether inversion takes place or not.

2 Optional Inversion

Given what was said so far, we should expect that at least with adjuncts, inversion occurs with all and only the negative phrases. And this is indeed what I think is correct. On the face of it, though, this picture is challenged by examples of what appears to be optional inversion. In the following sections and subsections I will discuss and explain some of these cases.

2.1 *Not even 10 years ago*

My first example has been brought to my attention by Ivano Caponigro (p.c.), who attributes them to Jon Sprouse, who attributes them to Edwin Williams. Consider (16):

- (16) a. Not even 10 years ago, **you could** buy a house for less than 50k.
b. Not even 10 years ago **could you** buy a house for less than 50k.

Native speakers find both of these examples fully acceptable, but report a clear meaning difference (which, incidentally, non-native speakers generally find harder to discern): The topicalized version (16a) says that less than 10 years ago, you could buy a house for less than 50K (and probably something like: even if it had been 10 years ago, that would be remarkably short). The NI version (16b) on the other hand means that even 10 years ago, you could not buy a house for less than 50k.

Tellingly, only the inverted example behaves like a *bona fide* negative sentences, both with regard to DE-ness, and according to standard tests (Klima (1964); Huddleston and Pullum (2002)):

- (17) Not even 10 years ago **could you** buy a house for 10k.

- a. \Rightarrow Not even ten years ago could you buy a craftsman house for less than 10k.
 - b. **Nor/neither/*as/*so** could uncle Charles.
 - c. Not even a shack.
- (18) Not even 10 years ago **you could** buy a house for 10k.
- a. \nRightarrow Not even ten years ago could you buy a craftsman house for less than 10k.
 - b. ***Nor/*neither/as/so** could uncle Charles.
 - c. **#Not even** a shack.

The reason for this becomes clear if we compare this example with one involving a *preposition*:

- a. In not even ten years, **you will** be able to buy a house for 50k.
(*... **will you** be ...)
- b. Not even in ten years **will you** be able to buy a house for 50k.
(*... **you will** be...)

What these examples reveal is that in the non-inverted sentence, *not only* modifies the DP within the PP (or perhaps the numeral within that DP), whereas in the inverted cases, *not only* modifies the entire PP. The structures for those are thus:

inversion	topicalization
not even [PP in [DP 10 years]]	[PP in [DP not even 10 years]
not even [PP [DP 10 years] ago]	[PP [DP not even 10 years] ago]

When embedded within the PP, *not even* does not negate the main clause, and the entire PP is not negative. Whence the lack of inversion. When modifying the PP, *not even PP* is equivalent to *even PP ... not*, hence negative, and worthy of inversion.² The apparent optionality of inversion is thus reflective of two structurally different sentences, which happen to be string-identical with a postposition like *ago*.

²I don't know exactly how *not even ten years* comes to mean what it does; fortunately, this question, very interesting though I find it, is orthogonal to the issue at hand.

2.2 *with*

Examples involving *with* have been discussed in Klima (1964); the following are variants on Liberman (1974)'s:

- (19) a. With no job, **Kim would** be happy.
 b. With no job **would Kim** be happy.

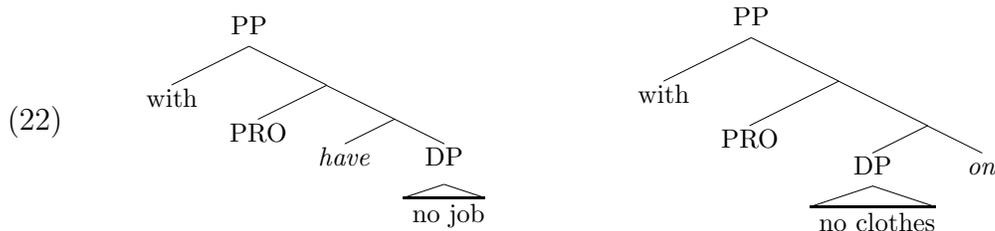
Again, these sentences are all equally acceptable, but differ in meaning: (19a) (topicalization) is synonymous with *If Kim had no job, Kim would be happy*, or simply *Without a job Kim would be happy*. (19b), with NI, means that there is no job Kim would be happy with. Similarly for the examples in (20):

- (20) a. With no clothes, **Jo will** look good.
 b. With no clothes **will Jo** look good.

Intuitively, there is a scopal difference here. In the inverted examples, ‘there is no job’ seems to scope outside of the modal, whereas in the topicalized example, it appears to be within the modal’s scope. But I believe that more is going on here; note that in the non-inverted case, the PP is interpreted ‘propositionally’:

- (21) a. with no job = having no job = if Kim had no job
 b. with no clothes = with no clothes on = wearing no clothes = when Jo wears no clothes

If we take this observation into account, we arrive at a picture not unlike the case of *not even 10 years ago*: The negative DP does not scope over the PP, and *a fortiori* not over the entire clause (this is effectively the conclusion reached by Liberman (1974), and, for comparable examples, McCawley (1988)). And indeed I want to suggest to take this quite literally and assume structures along the lines of (22) for these examples:



The preposed PP is a simple modifier, and the rest of the clause is in fact an upward entailing context.

It is worth noting that this ‘hidden embedding’ is a peculiarity of the English preposition *with* on its ‘given that’ meaning. Other prepositions do not allow similar construals, and hence require NI:

- (23) a. With no job, Kim would be happy.
b. ?*In no job, Kim would be happy
c. *After no party, Kim would be happy.

In the inverted version of these sentences, on the other hand, the *with* PP is a VP adverbial or even an argument to *happy*. Accordingly, this construction is marginal with verbs that don’t go well with such adverbials:

- (24) *?With no job did Kim forget the answer.

2.3 *less than*

The two cases discussed thus far have illustrated the general strategy, as well as some analytical specifics, I intent to use in the analysis of optional inversion in the rest of this paper: Look for meaning differences between the two version, account for them, and then show that the two construals differ in the crucial property: Negativity (i.e. DE-ness, or whatever the best characterization of this class will turn out to be). This sets the stage for the discussion of my last and most recalcitrant set of data, which haven’t been discussed in the literature at all: Downward monotonic DPs such as *Less than n. . .*:³

- (25) a. In less than 5% of these sentences **can you** see a truth conditional difference.
b. In less than 5% percent of these sentences **you can** see a truth conditional difference.
c. *In none of these cases **you can** see a truth conditional difference.

What makes these cases hard is that no meaning difference seems discernible in (25). It is also worth noting that unlike in the previous examples, *no-*

³Some speakers prefer *fewer than* with count nouns; the following discussion applies to those cases as well.

DPs are not allowed without inversion here, cf. (25c). *In less than* is much more frequent with plain topicalization, cf. (26), but can be found with NI as in (27) as well:

- (26) a. After less than three weeks a squirrel chewed thru the gas line.
(GGL)
- b. Within less than two generations they had transferred their faith to socialism. (BNC)
- c. For less than £10 you can buy an approved 80mm (3inch) tank jacket to cut down on heat loss. (BNC)
- d. In less than a year I would reach retirement age and I had nothing to fall back on. (BNC)
- (27) In less than 4 per cent of cases did teachers think that teachers and schools contributed to problems of disruption. (BNC)

In what follows, I will analyze two cases in which inversion with *less than* does produce a truth conditional difference. It is shown how a proper analysis of the two readings yields an account of the inversion facts that is in keeping with our hypothesis that negative phrases must trigger inversion, and additionally suggests an explanation for the intonational facts.

3 *In less than 30 lockers*

Let us start by observing that (28) has two different readings, as paraphrased below:

- (28) We found more than 10 adult magazines in less than 30 lockers.
- a. independent/cumulative reading: with less than 30 lockers searched, the total of adult magazines found is more than 10
- b. dependent/distributive reading: the number of lockers that contained more than 10 adult magazines was less than 30 (still probably about 300 magazines found)

Strikingly, each of the two preposed variants has only one of these two readings:

- (29) a. In less than 30 lockers, **we found** more than 10 adult magazines.
(non-NI: cumulative)

- b. In less than 30 lockers **did we** find more than 10 adult magazines.
(NI: distributive)

3.1 The dependent reading, first stab

It is easy to derive the dependent or distributive reading of (28)/(29b) (with NI). We assume that the DP is scoped out of the clause, yielding a logical form as in (30):

- (30) [less than 30 lockers] [λx .there are more than 10 adult magazines we found in x]

If we assume a standard meaning for *less than 30 lockers* — λP . there are less than 30 lockers x such that $P(x)$ (a.k.a. $\lambda P. |locker \cap P| < 30$) — we derive the correct reading: the property of having more than 10 adult magazines (found by us) in them is one that less than 30 lockers have.

Given that *less than 30 lockers* is interpreted as a standard DE quantifier, we straightforwardly derive that the main clause is a DE environment, as is indeed the case:

- (31) In less than 30 lockers did we find adult magazines. \Rightarrow In less than 30 lockers did we find Swedish adult magazines.

Furthermore, *less than 30 lockers* is a genuinely singular/atomic quantifier; it will therefore automatically yield a distributive/dependent reading: there are more than 10 magazine in *each* locker.

To get this reading, the DP and its containing PP must be separated at LF. Furthermore, it needs to be assumed that inversion is triggered because the DP is downward entailing, i.e. surface inversion has to be triggered by a constituent that is available only at LF. Both these points don't strike me as very attractive, but since this will not be my final analysis of the distributive reading, I will not dwell on them any further here.

3.2 Cumulative readings with *less than*

Turning to the other reading, it is well known that sentences with two (or more) numeral quantifiers can be interpreted *cumulatively* readings. A cumulative reading for (32) is one on which it means that ten lockers between them contained 42 adult magazines:

(32) Ten lockers contained 42 adult magazines.

The standard way to derive such a reading is to *cumulate* the transitive predicate ‘contain’ by a cumulation operator **, which is defined in (33), where $a \cup b$ is the smallest group containing a and b (‘the sum of a and b’):

(33) for any 2-place predicate Q, **Q is the smallest relation such that
 a. if Q(a)(c) then **Q(a)(c)
 b. if **Q(a)(c) and **Q(b)(d), then **Q($a \sqcup b$)($c \sqcup d$)

We then say that a group of ten lockers **contained a group of 42 magazines, formally (where AM abbreviates ‘adult magazine’):

(34) $\exists X, Y [*locker(X) \wedge 10 = |X| \wedge *AM(Y) \wedge 42 = |Y| \wedge **contain(Y)(X)]$

$|X| = n$ is true if the group or individual X has 10 atomic parts. The predicates **locker** and **AM** are pluralized by the *Link star*, which is defined as:

(35) for any one-place predicate Q: $*Q = \{ \sqcup X \mid X \subseteq Q \}$

Cumulative readings occur with *less than* (and other DE quantifiers) as well. For example, (36) says that the richest four-point-some percent *between* them control 80% of the wealth, not that *each of them* does:

(36) Less than 5% of the population control 80% of the wealth.

(37) Less than 10 lockers contained 42 adult magazines.

Similarly, (37) has a prominent reading that involves less than 10 lockers and 42 magazines. A lf analogous to (30) above — **less-than-10(*locker)($\lambda X. \exists Y [*AM(Y) \wedge |Y| = 42 \wedge **contain(Y)(X)]$)** — will not at all yield that reading. Rather, we want a lf like (38):

(38) $\exists X [*locker(X) \wedge |X| < 10 \wedge \exists Y [*AM(Y) \wedge |Y| = 42 \wedge$
 a. $**contain(Y)(X) \wedge$
 b. $X = \sqcup (\lambda Z. [**contain(Y)(Z) \wedge *locker(Z)])]]$

‘There is a group X of less than 10 lockers, and a group Y of 42 adult magazines, and (a) X between them contained Y, and (ii) X is the collection of all locker groups who between them contained these adult magazines.’

As the paraphrase suggests, this If consists of an existential statement (that less than 10 lockers between them contain 42 magazines), and a maximality statement (that those are the only lockers that contain those magazines).⁴

One worry about this treatment may be whether *less than* still yields a DE quantifier. The answer will be that it depends. Look at a distributive case first:

- (39) Less than ten lockers have two locks.
 $\exists X[*locker(X) \wedge |X| < 10 \wedge *have2locks(X) \wedge X = \sqcup(\lambda Y.*locker(Y) \wedge *have2locks(Y))]$

At first glance, the new If appears to contain an existential statement: there is a group X of less than ten lockers. But this is effectively neutralized by our treatment of pluralization. By the definition of the star operator, $*P$ will contain any plurality that corresponds to a subset of P . This includes $\{\}$, the empty set, which is a subset of every set. I will call the individual $\sqcup(\{\})$ the *zero-group*. So to say that there is some group of lockers that have two locks isn't saying much: it is trivially true since the zero-group has any property $*P$.⁵ We will say that the $*$ -operator is *not existential*.

To say that that group has less than 10 atomic parts is trivial, too. The only bite in this formula comes from the maximization clause: the group in question must be the biggest group of lockers with two locks. There can't be more than 9 such lockers. This is exactly what we want the meaning of this sentence to be. For a more detailed exposition of this analysis, I have to refer the reader to Landman (2004).

Let us then turn to the cumulative case:

- (40) Less than 10 lockers contained 42 adult magazines.
 $\exists X, Y[*locker(X) \wedge X < |10| \wedge *AM(Y) \wedge |Y| = 42 \wedge **contain(Y)(X)] \wedge$

⁴The latter seems redundant in this example: if a magazine is contained in one of the lockers mentioned, how would it be contained in any other lockers in addition? But consider a situation in which we have to open four doors to get to the treasure. In this situation it would be false to say *less than three doors separate us from the treasure*, though of course there is *some* group of less than three doors between us and the treasure; the maximization clause will take care of this, since it demands that that group be the biggest group of doors between us and the treasure.

⁵It doesn't have any singular properties, since singular predicates don't contain the zero-group in their extension. Note, too, that plural *some* and its ilk will have to be interpreted as 'one or more', lest sentences like *some mean arrived* be trivially true; see, again, Landman (2004).

$$X = \sqcup(\lambda Z. **contain(Y)(Z) \wedge *locker(Z))]$$

Will this zero-group make this true on the cumulative reading? If so, this would yield rather bizarre truth conditions; among other things, the sentence would be true if there is a set of 42 magazines that are not contained in a locker (since the zero-group would be the largest locker group containing them). Fortunately, this won't happen, for the following reason: The cumulation operator ** in (33) is defined in such a way that it won't include the zero-group in any tuple in the extension of a cumulative predicate **P. As a result, (40) will only be true if there is a group of 42 magazines that is **contained in a group of less than 10, *and more than zero* lockers. In other words, the **-operator is *existential* (but see the aside below).

One might think that these truth conditions are too weak. Shouldn't the sentence say that no other lockers contain adult magazines, or at least not 42 of them? I submit that it shouldn't. Consider the sentences in (41):

- (41) a. Less than 300 Americans control half of the country's wealth.
 b. Less than 3 authors wrote half of the episodes.

Clearly, there must be other Americans who, between them, control the other half of the country's wealth, and other authors who wrote the other half of the episodes. All it takes for these sentences to be true is that you can find a group *Y* containing half the episodes (the country's wealth), and another group *X* of less than three authors (300 Americans), such that *X* between them wrote (control) *Y*. These are precisely the truth conditions our treatment of cumulation and *less than* delivers.

In a nutshell, then, cumulative readings always have an existential impact, but distributive readings do not. In a slogan:

Distribution: one star Q
 Zero Group will make it true
 Cumulation: star is double
 Zero Group will make no trouble

As an aside, we might ask whether the definitions of * and ** could be otherwise, say so as to make *, but not **, existential. The answer is that * would be existential, too, if defined analogously to **: *P is the smallest set such that i) if $x \in P$, then $x \in *P$, and ii) if $x, y \in *P$, then $x \sqcup y \in *P$.

Obviously, we can't opt for this definition if we want to treat *less than* the way we do, and we need to treat *less than* the way we do if we want to get cumulative readings for it.

As for the cumulation operator, suppose that we represent predicates in a neo-Davidsonian way, e.g. as $\lambda\mathbf{x}\lambda\mathbf{y}\lambda\mathbf{e}.\mathbf{find}(\mathbf{e}) \wedge \mathbf{AG}(\mathbf{e}) = \mathbf{y} \wedge \mathbf{TH}(\mathbf{e}) = \mathbf{x}$. We can then pluralize the event predicate as usual, yielding $\ast\mathbf{find}(\mathbf{e})$, which does include the zero-group (of events). Assume then that AG maps any event plurality E onto the set of all agents of atomic events $e \sqsubseteq E$, i.e. $AG(E) = \sqcup(\{AG(e) \mid e \sqsubseteq E\})$, and analogously for TH. Then the triple \langle zero-group, zero-group, zero-group \rangle will be in the extension of $\lambda\mathbf{X}\lambda\mathbf{Y}\lambda\mathbf{E}.\ast\mathbf{find}(\mathbf{E}) \wedge \mathbf{AG}(\mathbf{E}) = \mathbf{Y} \wedge \mathbf{TH}(\mathbf{E}) = \mathbf{X}$ (since $AG(\sqcup(\{\})) = \sqcup(\{\})$).

This does not, however, change our result from above, that sentences like (40) on their cumulative reading are existential, simply because the object *42 adult magazines* is existential. The only way such a sentence could be true by virtue of zero groups is if both quantifiers are DE; I am inclined to think that that is correct. For example, if I predict *If they keep on cutting the budget like this, in ten years less than 10 libraries will hold less than 10,000 books*, and subsequently all libraries close within the next 10 years, was I right? I think so, though I would want to study sentences like that more thoroughly before attaching much weight to this claim.

In any event, neo-Davidsonian cumulation would treat \ast and $\ast\ast$ on a par by including zero-groups in their extension, but cumulative sentences would be existential still, unless all arguments are DE. I will thus stick with simple cumulation as defined in (33) throughout this paper, if only for the sake of simplicity. End of aside.

3.3 A cumulative lf for the *in less than* sentence

With a semantics for cumulative readings in place, we can now go back to our original example — *In less than 30 lockers, we found 52 adult magazines*. — which receives the lf in (42):

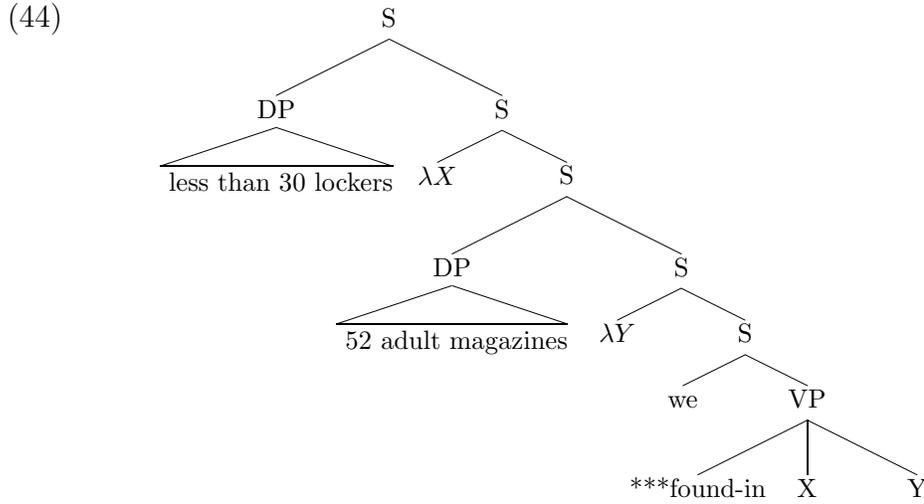
$$(42) \quad \exists X, Y [\ast\text{locker}(X) \wedge |X| > 30 \wedge \ast AM(Y) \wedge |Y| = 52 \wedge \ast\ast\ast \text{findin}(Y)(X)(we) \wedge X = \sqcup(\lambda Z. \ast\ast\ast \text{findin}(Y)(Z)(we) \wedge \ast\text{locker}(Z))]$$

‘there is a group X of less than 30 lockers, and a group Y of 52 adult magazines, we found the magazines in those lockers (and those are all the lockers in which we found those magazines)’

Due to the nature of cumulation, this sentence entails that there is at least one locker in which we found magazines. As a consequence, the sentential argument to *(in) no locker* is no longer DE; this seems adequate:

- (43) a. In less than 30 lockers, we found 52 adult magazines.
 $\not\Rightarrow$ In less than 30 lockers, we found 52 Swedish adult magazines.
 b. *In less than 30 lockers, we found any adult magazines.

It stands to hope that we can derive the lack of inversion with this construal from this fact. As a first stab, consider LF (44):



- (45) less than 30 lockers: $\lambda P.\exists X[*locker(X) \wedge |X| < 30 \wedge P(X) \wedge X = \sqcup(\lambda Z.P(Z) \wedge *locker(Z))]$

- (46) x 52 adult magazines $_Y$ we ***found Y in X:
 $\lambda Y.\exists Y[*AM(Y) \wedge |Y| = 52 \wedge ***findin(X)(Y)(we) \boxed{=find52AMin}]$

- (47) S: $\exists X[*locker(X) \wedge |X| < 30 \wedge$
 a. $find52AMin(X) \wedge$
 b. $X = \sqcup(\lambda Z.find52AMin(Z) \wedge *locker(Z))$]

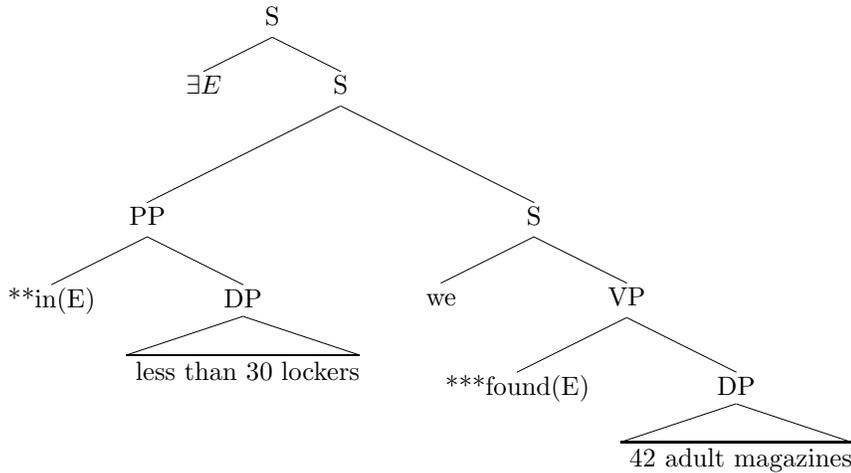
'there is a group of less than 30 lockers, we found 52 adult magazines in them, and those are all the lockers in which we found 52 adult magazines'

As the paraphrase indicates, this sentence entails that no other lockers contained 52 magazines. I argued above that this is too strong and runs into

problems with sentences like those in (41) above. I suspect, though, that this can be remedied by scoping *52 adult magazines* above *less than 30 lockers*. My main worry with this LF is rather that the DP that is fronted here is still DE. It is merely a property of the predicate **find52AMin** that it doesn't hold of zero-groups. How, then, are we going to specify the conditions on negative inversion, if in each case the preposed phrase (at LF) is DE? I will therefore refine the analysis one last time.

3.4 The final proposal: *in...* as an event modifier

On the final proposal, the entire PP stays in preposed position; it denotes a predicate of events and functions as a modifier, composed with the main clause denotation by predicate modification/set intersection:



In denotes a relation between individuals and events; we cumulate its meaning and then combine it with *less than 30 lockers*:

- (48) a. *in*: $in(= \lambda x \lambda e.in(x)(e))$
 b. ****in**: $**in(= ** [\lambda x \lambda e.in(x)(e)])$
 c. ****in less than 30 lockers**:
 $\lambda E.\exists X[*locker(X) \wedge |X| < 30 \wedge **in(X)(E) \wedge X = \sqcup(\lambda Y. *in(Y)(E) \wedge *locker(Y))]$

‘E is a group of events such that there is a group of less than 30 lockers, each $e \sqsubseteq E$ takes place in one of those lockers, each of those lockers hosts one $e \sqsubseteq E$ (, and those lockers are all the lockers that hosts these events)’

The meaning of the main clause is simply a set of event-groups:

- (49) we ***found(E) 42 adult magazines:
 $\lambda E. \exists Y[*AM(Y) \wedge |Y| = 42 \wedge ***found(E)(Y)(we)]$
 ‘E is a group of events s.t. there are 42 adult magazines, each $e \sqsubseteq E$ is a finding of one or more of those magazines (by us), and each of those magazines is found in some $e \sqsubseteq E$ ’

These two simply combine by modification/intersection, to yield the meaning in (50):

- (50) E is a group of events such that there is a group of less than 30 lockers, each $e \sqsubseteq E$ takes place in one of those lockers, each of those lockers hosts one $e \sqsubseteq E$, and there are 42 adult magazines, each $e \sqsubseteq E$ is a finding of one or more of those magazines (by us), and each of those magazines is found in some $e \sqsubseteq E$

On this, final, analysis, the preposed PP is of type $\langle e, t \rangle$, a property of events; therefore, it is not (and could not be) DE, and hence no inversion is triggered. Given the way I’ve set things up, we also get existential impact: if there is an event group E s.t. $***in(X)(E)$, there has to be at least one finding event $e \sqsubseteq E$, and one locker $x \sqsubseteq X$.⁶

Given that the PP is a modifier, we also get a handle on the intonation facts. As is well known, coordinative and modificational structures in general show separated intonation (references).

3.5 The distributive reading once more

We can derive the dependent reading without separating DP and P, too. The event-analysis makes that very easy. All we need is a regular Geach/shift operation (‘don’t be looking for me — I’m looking for you’).

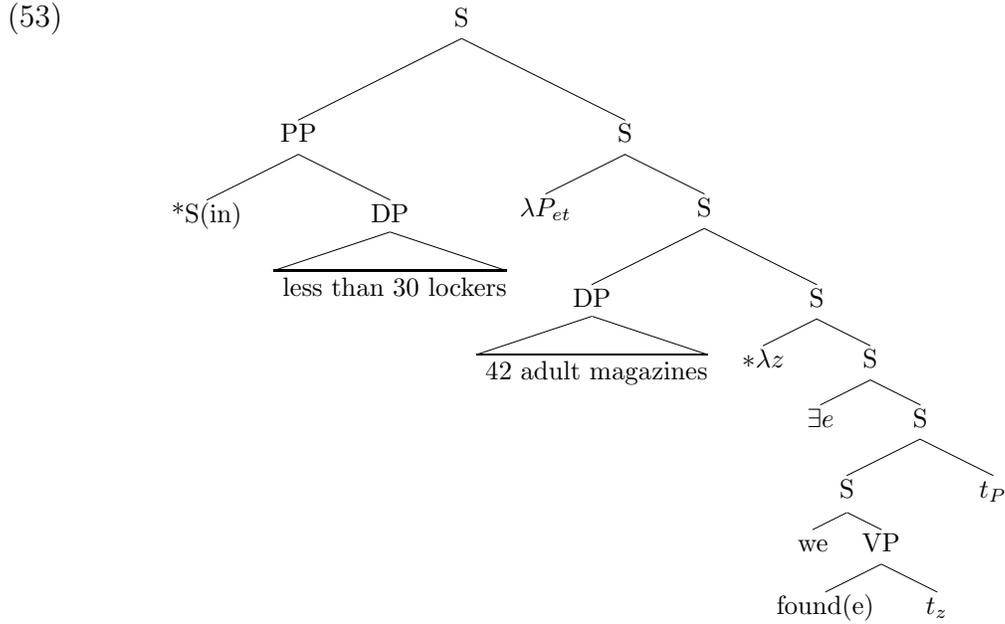
- (51) in every locker
- | | | |
|----|--|--|
| a. | $in(= \lambda x \lambda e.in(x)(e))$ | $\langle e, \langle e, t \rangle \rangle$ |
| b. | $S(in): \lambda x \lambda P.P(\lambda e.in(x)(e))$ | $\langle e, \langle \langle e, t \rangle, t \rangle \rangle$ |

⁶By the same token, the PP denotation is not **downward closed**: it doesn’t follow from $PP'(E)$ that $PP'(E^*)$ for all $E^* \sqsubseteq E$.

On this construal, a PP like, say, *in five lockers*, on its distributive reading, is a predicate of predicates of events:

- (52) a. $*S(\text{in}): *[\lambda x \lambda P. P(\lambda e. \text{in}(x)(e))]$
 b. $*S(\text{in}) \text{ five lockers}: \lambda P. \exists X [*locker(X) \wedge |X| = 5 \wedge *[\lambda x. P(\lambda e. \text{in}(x)(e))](X)]]$

The LF for the distributive construal looks as in (53):



Note that here, the PP scopes over the event quantifier. It is extracted from the main clause, and leaves a trace of type $\langle et \rangle$ (event modifier). The meaning of the PP, after undergoing the shift rule S, is not of type $\langle et \rangle$, however; rather, it is a predicate of things that are looking for an event modifier (it is to type $\langle et \rangle$ what a generalized quantifier is to type e). The denotations for the PP, S, and the whole sentence are given below:

- (54) $*S(\text{in}) \text{ less than 30 lockers}: \lambda P. \exists X [*locker(X) \wedge |X| < 30 \wedge *[\lambda x. P(\lambda e. \text{in}(x)(e))](X) \wedge \sqcup(\lambda Y. *[\lambda x. P(\lambda e. \text{in}(x)(e))](Y) \wedge *locker(Y))]$

- (55) $\text{we found}(e) \text{ 42 adult magazines}$
 $\lambda p_{et}. \exists Z [*AM(Z) \wedge |Z| = 42 \wedge [* \lambda z. \exists e [\text{found}(e)(z)(\text{we}) \wedge P(e)]](Z)]$

- (56) $*S(\text{in}) \text{ less than 30 lockers}: \exists X [*locker(X) \wedge |X| < 30 \wedge$
 a. $*[\lambda x. [\exists Z [*AM(Z) \wedge |Z| = 42 \wedge [* \lambda z. \exists e [\text{found}(e)(z)(\text{we}) \wedge \text{in}(x)(e)]](Z)]]](X) \wedge$

- b. $\sqcup(\lambda Y. *[\lambda x. \exists Z[*AM(Z) \wedge |Z| = 42 \wedge [* \lambda z. \exists e[found(e)(z)(we) \wedge in(x)(e)](Z)](Y) \wedge *locker(Y)]) = X$
‘there is a group of less than 30 lockers, (a) in each of them, we found 42 adult magazines, and (b) those are the only lockers in which 42 adult magazines were found’

This analysis preserves all the properties if the first stab in subsection 3.1. The proposed PP is downward entailing. There is no existential impact, since the predicates are simply pluralized, not cumulated. Finally, the proposed phrase takes scope over the rest of the clause, in fact: takes it as its argument; one consequence of that is that we get integrated intonation.

4 *No*

As observed in section 2, *no*-quantifiers do not ever occur in plain topicalization structures, but always trigger inversion.

- (57) a. In no locker **did we** find adult magazines.
b. *In no locker **we found** adult magazines.

The inversion examples work exactly like the case of *in every locker* or the distributive construal of *in less than 30 lockers*. What we should look into, though, is if we couldn’t, falsely, derive a cumulative meaning with *no*-DPs which wouldn’t trigger inversion. All other things being equal, (57b) should get the interpretation in (58):

- (58) $\neg \exists x[locker(x) \wedge \exists E, Z[*AM(Z) \wedge ***found(E)(Z)(we) \wedge **in(x)(E)]]$
‘We found adult magazines, but not in a/one locker.’

As indicated by the paraphrase, this would be true if we found adult magazines, but not in any lockers, or in more than one locker. Clearly not an available reading for this sentence with or without inversion.

The reason this reading doesn’t exist is likely to be related to the reason why a sentence like (59) cannot mean that I talked, but not to someone you know.⁷

- (59) I talked to no one you know.

⁷To be sure, the sentence is *compatible* with such a scenario, but doesn’t require it; it is not false, not on any reading, if I didn’t talk to anyone at all.

The absence of such a reading is standardly taken to indicate that *no*-DPs cannot scope underneath $\exists e$, the event quantifier. No similar restrictions are observed with other DE quantifiers such as *in less than*...

The cumulative versions of *In no locker*... sentences, (58), would be of that structure. I thus submit that whatever blocks the pertinent construal of (59) also blocks a cumulative reading of *in no locker*, and hence forces inversion.

5 *after less than 30 experiments*

Let us finally look at the examples involving temporal PPs. As in the *locker* examples, we start by observing two distinct readings for non-preposed examples:

- (60) We found radioactive residue after less than 30 experiments.
- a. ‘sequential’ reading: less than 30 experiments had been conducted when radioactive residue was (first) found
 - b. proportional reading: out of all the experiments, less than 30 resulted in radioactive residue

Again, preposing with and without inversion disambiguates between the two readings:

- (61) a. After less than 30 experiments, **we found** radioactive residue.
(sequential)
- b. After less than 30 experiments **did we** find radioactive residue.
(proportional)

The analysis I offer proceeds just as with *in*: QDP and P are kept together in both structures. The inverted structure is the regular distributive construal, on which PP is a predicate of predicates of events, and DE. The non-inverted structure is a cumulative construal, on which PP is an intersective modifier of an event predicate. The novelty is that the cumulative readings ends up being ‘sequential’, which is a consequence of the nature of time.

5.1 The distributive reading

Let us start by looking at the distributive/proportional reading:

- (62) a. after: $\lambda x \lambda e. \tau(x) < \tau(e)$
 b. S(after): $\lambda x \lambda P. P(\lambda e. \tau(x) < \tau(e))$
 c. *S(after): $*[\lambda x \lambda P. P(\lambda e. \tau(x) < \tau(e))]$
 d. *S(after) less than 20 experiments:
 $\lambda P. \exists X [*experiment(X) \wedge |X| < 20 \wedge$
 (i) $[\lambda x. P(\lambda e. \tau(x) < \tau(e))](X) \wedge$
 (ii) $X = \sqcup [\lambda Y. [*[\lambda x \lambda P. P(\lambda e. \tau(x) < \tau(e))]](Y) \wedge *experiment(Y)]]$

Let P be the property of finding radioactive residue, then we get the correct meaning that the overall number of experiments that produced radioactive residue is less than 30. Those less than 30 experiments may be distributed in any way across the total number of experiments, i.e. the first 25, the last 25, every third experiment, etc. etc.

5.2 The sequential reading

For the sequential reading, we start again by cumulating the relation denoted by the P, and then combine that with the DP meaning:

- (63) a. **after: $[** \lambda x \lambda e. \tau(x) < \tau(e)]$
 b. **after less than 30 experiments:
 $\lambda E. \exists X [*experiment(X) \wedge |X| < 30$
 (i) $\wedge [** \lambda x \lambda e. \tau(x) < \tau(e)](E)(X) \wedge$
 (ii) $X = \sqcup [\lambda Y. [** \lambda x \lambda e. \tau(x) < \tau(e)](Y)(E) \wedge *experiment(Y)]]$
 ‘there is a group E of less than 20 experiments, each event $e \sqsubseteq E$ took place after one of those experiments, each experiment preceded one of the events, and no further experiments preceded any of these events’

Now again we take the property P of being an event of us finding radioactive residue, and intersect that with (63), followed by existential closure. For the whole sentence *After less than 30 experiments, we found radioactive residue*, we then get the following denotation:

- (64) There is a group of less than 20 experiments, each event $e \sqsubseteq E$ took place after one of those experiments, each experiment preceded one of the events, and no further experiments preceded any of these events.

At first glance, this looks like a uselessly weak statement. In short, it says that radioactive residue was found at least once before experiment #30. It may have been found any time before experiment #30, radioactivity may have been found after later experiments as well, as long as it has been found at least once before experiment #30.

But if you think about it, this is exactly what this sentence actually says: That there was *a* finding before experiment #30. (64) does sound ‘more plural’ than that, but of course the statement that there is a *group* of such events entails the simple version. (64) indeed is the sequential reading.

6 Summary

In this paper I set out to explore the conditions under which preposed phrases trigger inversion. Pushing the hypothesis that all and only those phrases that can license NPIs trigger inversion, I was then forced to come up with a story for all those cases in which an otherwise attestedly negative element seemed to fail to trigger inversion. This strategy revealed a number of straightforward ambiguities that distinguished seemingly minimal pairs such as the *with no clothes* and *not even ten years ago cases*.

Extending this line of analysis to the case of *less than* and its kin (*at most, not more than...*) lead to the discovery of two distinct semantic construals of these quantifiers, modifying and cumulative v. scope taking and distributive. The analysis I provided for these cases maintains the initial hypothesis that all negative phrases obligatorily trigger inversion, and that, conversely, the non-inverted cases are not DE. An account was given for the subtly, yet clear meaning-differences, the lack of DE, and the difference in prosodic patterning. Finally, the impossibility of *no*-quantifiers in plain topicalization was traced back to a more general restriction on the relative scope of these and the event quantifier.

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