

Lucinda Driving Too Fast Again—The Scalar Properties of Ambiguous *Than*-Clauses

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Abstract

This paper presents a systematic empirical investigation of so-called Rullmann Ambiguities (*The helicopter was flying less high than a plane can fly*). It is shown that many examples constructed after this pattern are in fact unambiguous, and that some but not all examples which replace *less* with ordinary *more/-er* are ambiguous. An analysis is proposed which takes into account the inferential properties of the degree predicate in the *than*-clause plus the way contextual information can be integrated into its meaning. The analysis predicts which Rullmann examples are ambiguous and which are not. Consequences for the analysis of comparatives and for the meaning of adjectives are derived.

1 INTRODUCTION

1.1 *The problem: Lucinda examples*

The topic of this paper are data like (1) (from Heim 2007). (1) has been observed to allow the two interpretations given in (2a,b) in contexts such as the one indicated. The observation goes back to Seuren (1979) and has become prominent in the semantics literature since Rullmann (1995).

- (1) (This highway has a required minimum speed of 35mph and a speed limit of 50mph.)
Lucinda was driving less fast than allowed.
- (2) a. Lucinda was driving below the speed limit (50mph).
b. Lucinda was driving below the required minimum (35mph).

I will refer to such examples as Lucinda examples. They combine a comparative structure with a context that intuitively makes the *than*-clause describe a degree interval—a range reaching from the possible minimum to the possible maximum. In the example, that is the interval on the scale of speeds ranging from 35 to 50 mph. The original Lucinda examples are *less*-comparatives with *than*-clauses that include

a possibility modal. The observation is that they can intuitively make a comparison with either the maximum or the minimum degree in the denotation of the *than*-clause. This is spelled out below.

- (3) [[than allowed]] = [[than allowed Lu to drive ~~—~~ fast]]
 = $\lambda d.$ Lu was allowed to drive d-fast
 = [35mph, 50mph]
 “how fast Lucinda was allowed to drive”
- (4) a. Lu was driving below $\max(\lambda d.$ Lu was allowed to drive d-fast) MAX
 = Speed(@)(Lu) < 50mph
 “Lucinda was driving below the speed limit.”
- b. Lu was driving below $\min(\lambda d.$ Lu was allowed to drive d-fast) MIN
 = Speed(@)(Lu) < 35mph
 “Lucinda was driving below the minimum speed.”

The ambiguity is surprising because comparatives generally do not permit a choice w.r.t. which degree described by the *than*-clause we compare to. They are standardly taken to make a comparison to the maximal element described by the *than*-clause (Stechow 1984). So, while I will refer to the relevant interpretations intuitively as the MAX interpretation and the MIN interpretation, respectively, choice between selecting the maximum or the minimum from the set of degrees described by the *than*-clause is not a plausible analysis. Thus (1), (2) presents an interesting problem for the semantics of comparison and competing analyses have been developed (to my knowledge) by Rullmann (1995), Meier (2002), Heim (2007), Büring (2007) and Krasikova (forthcoming).

This paper contributes to the ongoing discussion in the following way: There is considerable disagreement among the authors mentioned about which comparatives exhibit this ambiguity. While Meier and Krasikova claim that the two readings MAX and MIN are also available in the case of *more*-comparatives, analyses like Heim’s are geared exclusively towards *less*-comparatives and are inapplicable to *more*-comparatives. I have conducted a more systematic investigation of the data that included a wider range of examples. The investigation has revealed the need for more fine-grained distinctions both among *more*- and among *less*-comparatives. An important factor previously neglected is the kind of scalar inferences permitted by the degree predicate in the *than*-clause. Taking this into account, I propose a novel analysis that hinges on how contextual information can be incorporated into the meanings of *than*-clauses with different kinds of degree predicates.

The structure of the paper is as follows: In the next subsection, I explain in some more detail crucial properties of previous proposals and the nature of the disagreement among them. The discussion makes it clear that there are important empirical questions regarding Lucinda sentences. I go on to present the basic empirical generalizations that this paper contributes in subsection 1.3., and a preview of the analysis in subsection 1.4., as a roadmap through the rest of the paper.

The semantic background for my proposals is described in section 2. Section 3 reports the results of a series of empirical studies on Lucinda examples. Those results motivate the analysis in section 4. Consequences and directions for future work are discussed in section 5.

1.2 Previous proposals

Previous approaches to Lucinda examples can be grouped into scopal analyses on the one hand and non-scopal analyses on the other. I present below Heim's (2007) analysis as a representative of the scopal analyses. It locates the source of the ambiguity at the syntax/semantics interface and analyses it as a structural ambiguity. Heim sees the cause of the ambiguity in the presence of *less*. *Less* is the comparative form of *little*, so *less fast* is the combination of *fast* + *little* + *-er*. The three ingredients can be combined in different ways. For the *than*-clause, in particular, Heim suggests the two Logical Forms (LFs) in (5a) and (5b). They differ in terms of the relative scopes of *little* and *allowed*. *Little* contributes negation, therefore (5a) describes degrees that Lucinda is not allowed to reach (degrees above the speed limit), while (5b) describes degrees that Lucinda is allowed to not reach (degrees above the minimum speed required).

- (5) a. *than* [little [allowed [Lu drive _ fast]]]
 than [not [allowed [Lu drive _ fast] =degrees above the
 speed limit]
- b. *than* [allowed [little [Lu drive _ fast]]]
 than [Lu allowed to drive _ slowly] =degrees above the
 minimum speed
- c. *less fast* = *-er* + *little* + *fast*; *little* = *not*

Without going into further details about the composition, we will imagine that (5a) ends up making a comparison to 50 mph, the maximum, while (5b) makes a comparison to 35 mph, the minimum. The ambiguity is analysed as a scope ambiguity in the *than*-clause. At LF, the ellipsis in the *than*-clause can be resolved in two different ways.

Other researchers have disagreed with the idea that structure is responsible for the two interpretations of (1). Meier (2002) for example suggests that two interpretations are available in *more*-comparatives as well as in *less*-comparatives. Therefore, the source of the two readings cannot lie in the complexity introduced by *less*. Her example is given in (6).

- (6) a. (This highway has a required minimum speed of 35 mph and a speed limit of 50 mph. Chuck is transporting eggs. In order not to break too many, he needs to drive as slowly as possible. But he doesn't want to get a ticket.)
 Chuck was driving faster than allowed. [Meier]
- b. Chuck was driving above $\min(\lambda d. \text{Chuck is allowed to drive } d\text{-fast})$
 $= \text{Speed}(@)(\text{Chuck}) > 35 \text{ mph}$ MIN

Meier develops an analysis based on the contribution of the modal. In a nutshell, the modal can be contextually restricted in such a way that ultimately only the maximal or only the minimal degree is relevant, depending on what the context provides. This can happen regardless of whether we have a *more*-comparative or a *less*-comparative. The judgment that a more-than-minimum interpretation is possible in (6) is, however, controversial.

1.3 Look-ahead—data

The fact that there is disagreement in the literature on important data points has inspired the series of studies reported in section 3 of this paper. Since the pattern of data they reveal is fairly complex, I present here a preview of the most important results.

A first important and unexpected outcome is that not all examples constructed after the original Lucinda pattern—*less*-comparatives with a *than*-clause that contains a possibility modal—are ambiguous between a MIN and a MAX interpretation. While (7a) (from Rullmann 1995) is judged ambiguous, the very similar example (7b) is not; only a comparison to the minimum, according to which the whistle produces an inaudible sound, is available.

- (7) a. The helicopter was flying less high than a plane can fly.
 MIN, MAX
- b. The sound that the whistle produces is less high than a human can hear.
 only MIN

The original Lucinda examples with *less* thus fall into two classes: the ones that are judged ambiguous between MIN and MAX and the ones that only permit a comparison to MIN.

The second result of the studies is that *more*-comparatives constructed in an otherwise parallel way—that is with a *than*-clause that contains a possibility modal, like (6) above—are not generally judged ambiguous, *contra* Meier's intuition regarding (6). They seem to have only the MAX interpretation. However, *more*-comparatives with a certain kind of *than*-clause are ambiguous. An example is given in (8). Imagine a context that provides a minimum and a maximum, that is there are a number of points that Lisa minimally has to have in order to achieve her goals, and there is also a maximum number beyond which she can no longer achieve her goals. Then, (8) can say that Lisa has enough points to achieve her goals (MIN), or that Lisa has too many points to achieve her goals (MAX).

- (8) Lisa has more points than are sufficient.
MIN, MAX

More-versions of Lucinda examples thus also fall into two classes: the ones that are judged ambiguous between MIN and MAX and the ones that only permit a comparison to MAX.

A third result and the final one I will mention here is that everything just said about examples being “not ambiguous” has to be taken with a grain of salt. Data of the type of (6) strongly disfavour the MIN interpretation, and data of the type of (7b) strongly disfavour the MAX interpretation. But the dispreferred interpretations are not completely impossible, as we will see in section 3.2, blurring the already complex pattern that the data form.

1.4 *Look-Ahead—Analysis*

The small set of data considered in the preceding subsection has alerted us to the content of the *than*-clause as a factor determining interpretive possibilities. This is most transparent in the case of (8): clearly, it is the occurrence of *sufficient* that makes the MIN interpretation prominent. Another illustrating example is (9).

- (9) One can bake this cake if one has at least 500 g of flour.
I have more flour than is sufficient to bake this cake.
= I have more than 500 g of flour, the minimal amount.

I will defend in section 4 below the following position: the scalar inferences that the degree predicate denoted by the *than*-cause permits determine the range of interpretations that are readily available for a given Lucinda example.

Let me first illustrate what I mean by scalar inference. In (10a,b), an inference is intuitively valid from a given element on the scale to smaller elements. In (10c), the reverse is true. This is a property of the degree predicate contained in the examples.

- (10) a. Lu is allowed to drive 45mph fast. => Lu is allowed to drive 44mph fast.
 [λd . Lu is allowed to drive d-fast]
- b. A plane can fly 1000m high. => a plane can fly 900m high.
 [λd . a plane can fly d-high]
- c. 50 points are sufficient. => 51 points are sufficient.
 [λd . d-many points are sufficient]

Beck & Rullmann (1999) distinguish between three types of degree predicates, which differ in their inferential behaviour.

- (11) a. upward scalar predicates:
 A predicate $P \langle d, t \rangle$ is upward scalar iff
 for any d, d' : $d' > d \ \& \ P(d) \Rightarrow P(d')$
- b. downward scalar predicates:
 A predicate $P \langle d, t \rangle$ is downward scalar iff
 for any d, d' : $d > d' \ \& \ P(d) \Rightarrow P(d')$
- c. non-scalar predicates:
 A predicate $P \langle d, t \rangle$ is non-scalar iff
 it is neither upward scalar nor downward scalar.

The degree predicates typically considered are downward scalar. Specifically, *than*-clauses that are typically considered contain downward scalar degree predicates, (12a,b). Suppose we know the maximal height at which a plane can fly. Then we can infer all other altitudes. The maximum is thus the natural point of comparison. The example of the ambiguous *more*-comparative (8), on the other hand, contains a *than*-clause that is intuitively upward scalar, (12c). Here, knowing the minimal number of points that is sufficient allows one to infer all other quantities. The minimum is the natural point of comparison here.

- (12) a. [[than [a plane can fly _ high]]] = [λd . a plane can fly d-high]
 = [λd . a plane can reach Height d]
- b. [[[than [allowed [Lu drive _ fast]]]]]
 = [λd . Lu was allowed to drive d-fast]
 = [λd . Lu was allowed to reach Speed d]
- c. [[than [_ many points are sufficient]]]
 = [λd . d-many points are sufficient]
 = [λd . it is not necessary to have more than d points]

The data above reflect this, in the sense that the MIN interpretation is only available in a *more*-comparative containing an underlyingly upward scalar degree predicate but not with a downward scalar degree predicate. The MAX interpretation is only available in *less*-comparatives with downward scalar degree predicates, not with other *less*-comparatives.

But this cannot be all there is to it: I claimed above that *less*-comparatives generally permit the MIN interpretation and *more*-comparatives generally permit the MAX interpretation. Given the notions of scalarity just introduced, I can be more specific about the generalizations I will argue for in sections 3 and 4:

- (13) a. In *less*-comparatives, MIN is generally acceptable.
 b. In *less*-comparatives, MAX is strongly dispreferred with non-scalar and upward scalar predicates; it is acceptable with underlyingly downward scalar predicates.
- (14) a. In *more*-comparatives, MAX is generally acceptable.
 b. In *more*-comparatives MIN is strongly dispreferred with non-scalar and downward scalar predicates; it is acceptable with underlyingly upward scalar predicates.

There is a second important factor to be taken into account besides the underlying inferential properties of the degree predicate. The contexts in which the Lucinda ambiguity can show up are all of them contexts that entail a minimum as well as a maximum value of which the *than*-clause is true (for example 35, 50 mph). Rullmann (1995) points out that this is a prerequisite for the ambiguity to arise. Now, in such contexts, scalar inferences do not generally go through; they are not valid past the minimum and maximum points.

- (15) a. Lu was driving less fast [than [allowed [~~Lu drive~~ fast]]]
 b. [[[than [allowed [~~Lu drive~~ fast]]]]] = [35mph, 50mph]
- (16) it was allowed that Lu drive 50mph \nrightarrow it was allowed that Lu drive 51mph
 it was allowed that Lu drive 35mph \nrightarrow it was allowed that Lu drive 34mph

We need to figure out how contextual information is integrated into the semantics, that is how to get from the underlyingly downward scalar predicate (12b) to the denotation (15b). This, I argue, will give us the pattern in (13) and (14).

One way to integrate contextual information in these examples is to see the context as establishing a non-scalar interpretation of the degree

predicate in the *than*-clause. We can paraphrase the so-reinterpreted *than*-clause informally as follows:

- (17) a. [[[than [allowed [~~Lu drive~~ —fast]]]]]]
 = [λd .d is a speed that Lu is allowed to drive at]
 = [35mph, 50mph]
 b. d is a speed that Lu is allowed to drive at \nrightarrow
 d' is a speed that Lu is allowed to drive at ($d > d'$ or $d' > d$)

What would be a natural point of comparison when we have such a non-scalar degree predicate? Neither the minimum nor the maximum is sufficient to give us complete information. My suggestion is that we compare with all degrees in the interval denoted by the *than*-clause in such cases:

- (18) $\forall d$ [d is a speed that Lu is allowed to drive at \rightarrow Lu was driving less fast than d] iff
 $\forall d$ [d \in [35mph, 50mph] \rightarrow Lu was driving less fast than d] iff
 Lu was driving less fast than 35mph MIN

The result is the MIN interpretation of the *less*-comparative. The same way to make the comparison, universal quantification, applied to a *more*-comparative, however, will lead to a MAX interpretation:

- (19) a. Lu was driving faster [than [allowed [~~Lu drive~~ —fast]]]
 b. [[[than [allowed [~~Lu drive~~ —fast]]]]]]
 = [λd .d is a speed that Lu is allowed to drive at]
 = [35mph, 50mph]
- (20) $\forall d$ [d is a speed that Lu is allowed to drive at \rightarrow Lu was driving faster than d] iff
 $\forall d$ [d \in [35mph, 50mph] \rightarrow Lu was driving faster than d] iff
 Lu was driving faster than 50mph MAX

Let us suppose that this strategy (let us call it 'context as non-scalarity') is always available. Then a MIN interpretation is always possible for *less*-comparatives and a MAX interpretation is always possible for *more*-comparatives (cf. (13a), (14a)). The other strategy mentioned above, according to which MAX is salient when the degree predicate is downward scalar and MIN is salient when it is upward scalar, has to also be available in order to account for the ambiguities that we find (cf. (13b), (14b)).

Both strategies are spelled out in section 4. In addition, I will ask how context may be taken into account on the second strategy since it is unlikely that we ignore it completely. I will also investigate why the

dispreferred readings are not, after all, completely impossible. And finally, I will spend more time arguing that (13), (14) are the right generalizations since it is by no means obvious that (7a,b) for instance differ in their inferential properties.

2. BACKGROUND

In this section, I first remind the reader of a standard semantics of comparatives, as a starting point. Taking into account the different kinds of degree predicates just discussed makes it necessary to modify that semantics. The result is the basis for the analysis of Lucinda examples I propose.

2.1 *A traditional analysis of than-clauses*

Let me illustrate the classical analysis of *than*-clauses in terms of maximality with (21) below [the analysis is essentially Stechow's (1984); see also Heim (2001) and Beck (forthcoming a) for a recent exposition of the version presented here].

- (21) a. Paule is older than Knut is.
 b. $[[[-er] \langle d \rangle \text{ than } \max \ 2 \text{ [Knut is } t_2 \text{ old}]]$
 $[[\langle d, t \rangle \ 2 \text{ [Paule is } t_2 \text{ old}]]]$
 c. Paule is older than $\max(\lambda d. \text{Knut is } d\text{-old})$
 $\text{Age(Paule)} > \text{Age(Knut)}$
 "Paule reaches a degree of age that exceeds the largest degree of age that Knut reaches" = Paule's age exceeds Knut's age

The intuitive truth conditions of (21a) are derived with the comparative operator defined in (22a).¹ The two degrees that this operator relates are given by the *than*-clause and the main clause, respectively. The LF for the example is given in (21b), in which according to standard interpretive mechanisms each clause provides a set of degrees. The analysis involves the maximality operator defined in (22b), which I choose to represent as part of the LF in (21b).

- (22) a. $[[-er]] = \lambda d_d . \lambda D \langle d, t \rangle . \max(D) > d$
 b. Let S be a set ordered by R . Then $\max_R(S) = \iota s [s \in S \ \& \ \forall s' \in S [s R s']]$

¹ (22a) is Heim's (2001) entry for the comparative *-er*. It necessitates adding an operator like \max into the structure of the *than*-clause in order to derive a type $\langle d \rangle$ first argument for the comparative. Given that, it is possible to rethink the role of \max for the matrix clause as well, but I will not do so here. I concentrate on the interpretation of the *than*-clause.

Note that I assume that the comparative operator requires as its first argument a type $\langle d \rangle$ category. When we have a *than*-clause, this is derived by selecting an element from the denotation of the *than*-clause. A type $\langle d \rangle$ argument is provided directly in degree denoting *than*-phrases, (23).

- (23) a. Lucinda ran faster than the world record.
 b. $[[\text{the world record}]]$ = 10.49s/100m
 c. $[[\text{-er}]](10.49\text{s}/100\text{m}) = \lambda D.\text{max}(D) > 10.49\text{s}/100\text{m}$

The analysis uses the monotonic semantics in (24a) as the lexical entry for the adjective (compare Heim 2001), in the light of which the maximality operator plays a useful role. This would not be strictly speaking necessary in (21) (suppose that the adjective instead relates each individual to a unique degree, its age, as in (24b)).

- (24) a. $[[\text{old}]]\langle d, \langle e, t \rangle \rangle = [\lambda d.\lambda x. x \text{ is } d\text{-old}] = [\lambda d.\lambda x. \text{Age}(x) \geq d]$
 b. $[[\text{old}]]\langle d, \langle e, t \rangle \rangle = [\lambda d.\lambda x. \text{Age}(x) = d]$

However, the operator can be given further motivation for example by data like (25) (imagine for example that we are talking about the men's 100 m final at the Olympic Games). The predicate in (25c) is true of more than one degree. In order to employ (22a), one particular degree has to be chosen from that set—the maximum, according to the intuitive interpretation of (25a).

- (25) a. Jamaica has a faster athlete than the US do.
 'Jamaica has an athlete who is faster than the fastest US athlete.'
 b. $[[\text{-er } \langle d \rangle \text{ than max } 2 [\text{the US do have a } t2 \text{ fast athlete}]]$
 $[\langle d, t \rangle 2 [\text{Jamaica has a } t2 \text{ fast athlete}]]]$
 c. $\lambda d.\text{the US have a } d\text{-fast athlete}$

2.2 *The three kinds of scalar predicates*

Well-motivated though the maximality operator seems to be, Beck & Rullmann (1999) have criticized an analysis in terms of degree maxima. The empirical domain they are concerned with are not *than*-clauses but *wh*-questions. Their discussion is a reply to Rullmann (1995), who proposed a maximality analysis, extending the classical analysis of comparatives to degree questions. His proposal is illustrated with the degree question below. An appropriate answer to the question names the largest degree that is a true answer, even if naming smaller amounts would also strictly speaking be true (e.g. it is also true that John bought 1 kg of flour).

- (26) a. How much flour did John buy?
 b. Which is the maximal degree d such that John bought d -much flour?
 c. Suppose that the amount of flour John bought is 2 kg.
 Answer: John bought 2kg of flour.

Beck and Rullmann observe that whether one gets a maximum interpretation depends on the degree predicate. (27) demands a minimum answer, even though naming larger amounts would strictly speaking also be correct. (28) wants to be answered by a complete list; neither the maximal nor the minimal degree is an appropriate answer.

- (27) a. How much flour is sufficient to bake this cake?
 b. Which is the minimal amount of flour sufficient to bake this cake?
 c. Suppose that you can bake this cake if you have at least 500g of flour.
 Answer: 500g of flour are sufficient.

- (28) a. How many people can play this game?
 b. Which are the numbers n such that a group of n people can play this game?
 c. Suppose 2,4,6 or 8 and no other number of people can play this game.
 Answer: 2,4,6 or 8 people can play this game.

Beck and Rullmann distinguish between the three types of degree predicates mentioned in section 1.4, which differ in their inferential behaviour.

- (29) a. downward scalar predicates:
 A predicate $P \langle d, t \rangle$ is downward scalar iff
 for any d, d' : $d > d' \ \& \ P(d) \Rightarrow P(d')$
 b. upward scalar predicates:
 A predicate $P \langle d, t \rangle$ is upward scalar iff
 for any d, d' : $d' > d \ \& \ P(d) \Rightarrow P(d')$
 c. non-scalar predicates:
 A predicate $P \langle d, t \rangle$ is non-scalar iff
 it is neither upward scalar nor downward scalar.

We have already observed that the degree predicates typically considered are downward scalar.

- (30) $[\lambda d. \text{John bought } d\text{-much flour}]$ is downward scalar; e.g.:
 John bought 1kg of flour \Rightarrow John bought 500g of flour

- (31) [λd .the US have a d-fast athlete] is downward scalar; e.g.:
the US have an athlete who can run 100m in 9.7 seconds \Rightarrow
the US have an athlete who can run 100m in 9.8 seconds

By contrast, the predicates in the data that do not give rise to a maximum interpretation are upward scalar or non-scalar.²

- (32) [λd .d-much flour is sufficient] is upward scalar; e.g.:
500g of flour are sufficient \Rightarrow 600g of flour are sufficient
- (33) [λd .d-many people can play this game] is non-scalar; e.g.:
4 people can play this game $\not\Rightarrow$ 5 people can play this game
4 people can play this game $\not\Rightarrow$ 3 people can play this game

The objection to degree maxima carries over from degree questions to *than*-clauses. The example below (with the same predicate of degrees as the upward scalar degree question) is not properly analysed in terms of a numerical maximum either.

- (34) a. I have more flour than is sufficient to bake this cake.
b. I have more flour than the minimal amount of flour that suffices to bake this cake.
c. #I have more flour than the maximal amount of flour that suffices to bake this cake.

Quite generally, an upward scalar predicate in a *than*-clause will lead to a minimality rather than a maximality interpretation. A few more examples are given below.

- (35) a. I got more points for my final exam than were sufficient for an A last semester.
= than the minimal amount of points that were sufficient for an A
b. The optical counterparts are slightly larger than visible to the naked eye.
= than the minimal size visible to the naked eye
c. This is about 200 \$ more than than you can live on in Boston.
= than the minimal amount of money that you can live on in Boston
d. In this trial we simulated a situation where a larger than lethal dose of cocaine was administered.
= than the minimal amount that is lethal

² Notice that non-scalar predicates are problematic for the otherwise obvious idea of simply choosing the maximum of the inverse relation in the cases with upward scalar degree predicates.

2.3 A revised view of the interpretation of *than*-clauses

Accordingly, I make one change to the classical analysis: instead of choosing from the set of degrees denoted by the *than*-clause the maximal element, as is standardly done and indicated in (21), I propose that the maximally informative element is chosen. Maximal informativity is defined in (36). The definition as well as the general idea follows Fox & Hackl (2007).³ I anticipate this in a different context in Beck (2010); I owe the idea of applying maximal informativity to Irene Heim and Danny Fox (personal communication).

$$(36) \text{ m_inf}(w)(p\langle s, \langle d, t \rangle \rangle) = \lambda d. p(w)(d) \ \& \ \neg \exists d' [p(w)(d') \ \& \ d \neq d' \ \& \ [p(w)(d') \Rightarrow p(w)(d)]]$$

the maximally informative degrees in a description of degrees are those whose presence in the description could not be inferred from the presence of any other element in the description.

Maximal informativity usually returns a singleton. Applied to our example in (37), we get the same result as under a classical analysis.

- (37) a. Jamaica has a faster athlete than the US do.
 b. [-er [$\langle d \rangle$ than **the m-inf** [2[the US do have a $\langle t \rangle$ fast athlete]]]]

- (37') a. Suppose that the fastest US athlete runs 100m in 9.5 s.
 b. [[-er] (the m-inf (λd .the US have a d-fast athlete)) = [[-er] (9.5s/100m) = [λD .max(D) > 9.5s/100m]

- (38) The US have an athlete who can run 100m in 9.5s \Rightarrow
 The US have an athlete who can run 100m in 9.6s etc., but not vice versa

The predicate in (37) is a downward scalar predicate, hence the maximally informative degree is the maximal degree. (39) gives an example of an upward scalar degree predicate, where the most informative degree described by this *than*-clause is not the maximum, but the minimum. This motivates the replacement of maximality by maximal informativity.

³ I use a weak notion of maximal informativity, according to which more than one element of the set that the m-inf operator combines with can be maximally informative. A stronger notion would specify that exactly one element of the set is the maximally informative element. The weak notion is needed because uniqueness is not given in the case of non-scalar degree predicates. In addition to my immediate theoretical predecessors Fox and Hackl, other authors making use of the concept of (maximal) informativity in the realm of questions include Lahiri (1991), Heim (1994), Dayal (1996) and Beck & Rullmann (1999).

- (39) a. I have more flour than is sufficient (to bake this cake).
 b. [-er [$\langle d \rangle$ than **the m-inf** [2 [t2 much flour is sufficient]]]]
- (39') a. Suppose that you can bake this cake if you have at least 500g of flour.
 b. [[-er]] (the m-inf(λd .d-much flour is sufficient)) =
 [[-er]] (500g) = [λD .max(D) > 500g]
- (40) To bake this cake it is sufficient have 500g of flour =>
 To bake this cake it is sufficient to have 600g of flour etc., but not vice versa

I follow Beck (2010) here in thinking of m-inf as semantic glue. In order to combine the comparative operator with the *than*-clause, the set of degrees described in the *than*-clause has to somehow be reduced to give us the degree we compare with. I represent the interpretive strategy of informativity as an invisible operator m-inf in the LF. This is accompanied by a definite article to resolve the type mismatch from a set of degrees to a degree.

Let us look at the final type of degree predicate next, non-scalar predicates. Maximal informativity when applied to a non-scalar predicate does not return a unique degree. Take our example from above:

- (41) Suppose that the numbers of people that can play this game are 2, 4, 6 and 8.
 m-inf(λd . d-many people can play this game) = {2,4,6,8}

This is a general effect with non-scalar predicates:

- (42) a. There are more people here than can form a soccer team.
 b. Suppose that 5, 7 and 11 and no other number of people can form a soccer team.
 c. m-inf(λd . it is possible for d-many people to form a soccer team) = {5,7,11}

In order to determine which comparison is ultimately made, informativity is not enough. It delivers still a set of degrees rather than a unique degree. Something else has to happen for us to be able to assign an interpretation to comparatives with non-scalar predicates. This is not trivial. In terms of theory, non-scalar predicates get in the way of what is otherwise a smooth compositional analysis. In terms of intuitions, data like (42) may also be a bit harder than standard examples of comparatives.

This is an important part of the question that this paper investigates. It is, I suggest, the crucial property of Lucinda examples that they involve

degree predicates that are—in the contexts given for the comparative sentences—not scalar. Therefore, maximal informativity may not return a singular degree, but a set of degrees. In example (43), that is the interval between 35 and 50 mph. (43') illustrates that the degree predicate in the *than*-clause does not generally permit scalar inferences. We will come back to how this can be derived semantically in section 4. Note here that it is a defining property of Lucinda examples that the *than*-clause intuitively describes a span on the degree scale. This is how a MIN and a MAX interpretation are possible at all, as Rullmann (1995) observes.

- (43) a. Lu was driving less fast [than [1[allowed [~~Lu drive t1 fast~~]]]]
 b. Suppose the minimum speed is 35mph and the speed limit 50mph.
 $[\lambda d. \text{Lu was allowed to drive } d\text{-fast}] = [35\text{mph}, 50\text{mph}]$
 c. $m\text{-inf}(\textit{than}\text{-clause}) = [35\text{mph}, 50\text{mph}]$

- (43') it was allowed that Lu drive 50mph \nrightarrow it was allowed that Lu drive 51mph
 it was allowed that Lu drive 35mph \nrightarrow it was allowed that Lu drive 34mph

In order to interpret Lucinda examples, we have to answer the question how a *than*-clause containing a non-scalar degree predicate, leading to a plurality of degrees as its denotation, is integrated into the further composition. Below I am going to relate this question to the question of how explicit plurals like (44b) are interpreted. If my view of the Lucinda examples is correct, (44b) should present much the same interpretive problem as (43). The DP *the permissible speeds* should directly refer to [35mph, 50mph], the same set of degrees as the meaning of the *than*-clause in (43). It will be interesting to see if (44b) shares the range of readings of (43); such data are therefore included in the studies presented in section 3.

- (44) a. Lu was driving less fast than *the speed limit*. (degree DP)
 b. Lu was driving less fast than *the permissible speeds*.
 (plural degree DP)

We will address the issue of interpreting plural *than*-constituents after we have seen the results of the empirical investigation of Lucinda examples in section 3.

To summarize this section, I propose to replace maximality in *than*-clauses with maximal informativity, extending Fox and Hackl's theory. The motivation for this move is the different kinds of scalarity that degree predicates can exhibit. Maximal informativity proves to be the

more general notion.⁴ Thus, in my view, we now have a well-motivated analysis of *than*-clauses in place. The one type of example that is not straightforwardly covered is data with non-scalar degree predicates, and those, we saw, comprise the Lucinda examples that we will examine next.

3. A CLOSER LOOK AT LUCINDA EXAMPLES

3.1 *The studies*⁵

This section reports the results of a series of four questionnaire studies conducted in order to gain a better understanding of the Lucinda data. At the outset, an important question was in how far *less*-comparatives and *more*-comparatives were parallel, that is whether both could give rise to an ambiguity between a MIN and a MAX interpretation. Furthermore, properties of the *than*-constituent were investigated. The investigation grew more detailed as results of earlier studies were taken into account. In this subsection, I describe the general procedure, which was the same in all four studies.

The studies (all conducted at the Universität Tübingen, Germany, in 2010) tested the interpretations available for German comparative sentences like (45).⁶ In order to test the availability of a particular interpretation, the comparative was put into a short text. The text unambiguously fixed the interpretation, in the sense that it was only consistent under one interpretation. For example the text in (45') (a translation of one of the texts tested), which embeds the comparative sentence in (45), is only consistent under the less-than-maximum interpretation.

⁴ Moving on from maximality to maximal informativity makes a difference for the analysis of the negative island effect (ia). Stechow (1984) and Rullmann (1995) argued that the effect is due to the fact that the maximum in (ib) is undefined. Fox & Hackl (2007) propose that scales in natural language are universally dense (their UDM), which would make (ic) also undefined. Lassiter (2010) points out that the contrast between the modal obviation effect (iia) and (iib) is a problem for a uniform analysis in terms of maximal informativity and density. I will not address this issue in this paper.

- (i) a. * Bob is driving faster than John isn't.
 b. $\max(\lambda d. \neg \text{Speed}(\text{John}) \geq d)$ undefined
 c. $\text{m-inf}(\lambda d. \neg \text{Speed}(\text{John}) \geq d)$ undefined under the assumption of UDM
- (ii) a. How fast are you not allowed to drive?
 b. * You are driving faster than you're not allowed to.

⁵ I am very grateful to Polina Berezovskaya, Michaela Meder and Konstantin Sachs for conducting the questionnaire studies.

⁶ It is my impression that intuitions for the English translations generally match the intuitions reported in this paper for the German data, and that English and German are essentially parallel w.r.t. Lucinda examples.

(45) Katrin ist weniger schnell gefahren als erlaubt.
 Katrin is less fast driven than allowed
 Katrin drove less fast than allowed.

(45') On the highway between Schusselheim and Sonderlingen there is a required minimum speed of 50kmh and a speed limit of 80 kmh. Yesterday, Katrin was in a hurry because she had an important appointment. Still she observed the traffic rules. She drove *less fast than allowed*. So she couldn't get a ticket.
 LESS; CP; MAX

Example (45) is a LESS-comparative with a clausal *than*-constituent. In (45') the availability of a maximum interpretation is tested. So (45') is a test case for the condition LESS;CP;MAX. Besides LESS-comparatives, the studies also contained MORE-comparatives, and besides *than*-clauses, they also contained degree DPs. In addition to MAX interpretations, MIN interpretations were tested, leading to a total of eight possible conditions, as illustrated in (45''). (46) gives another example of a (translation of a) text tested, for further illustration. All examples were such that in the given context both a maximum and a minimum existed.

(45'') Katrin drove {faster/less fast} than allowed/
 than the permissible speeds.
 MORE/LESS; CP/DP; MAX/MIN - 8 conditions

(46) Wir waren weniger Leute als die möglichen
 we were less people than the possible
 Spielerzahlen.
 player numbers

We were fewer people than the possible numbers of players.

At the annual charity soccer event, you can join with teams of 5, 7 or 11 players. Last year our Nordic Walking group wanted to participate. But it turned out that hardly anybody wanted to play. So we were *fewer people than the possible numbers of players*, and we couldn't participate.

LESS; DP; MIN

Participants were asked for a judgment of consistency. If they judged a given text as consistent, it was inferred that the relevant interpretation was available for them. The procedure is based on our expectation that if a potentially ambiguous sentence has a particular interpretation, then

and 'lads et jockeys'. All three thought that 'lads et jockeys' was boring, and only Anne liked 'Amelie'. But everyone enjoyed 'Les vacances de M. Hulot'. *Everyone liked one movie*, and the evening was once more very enjoyable.

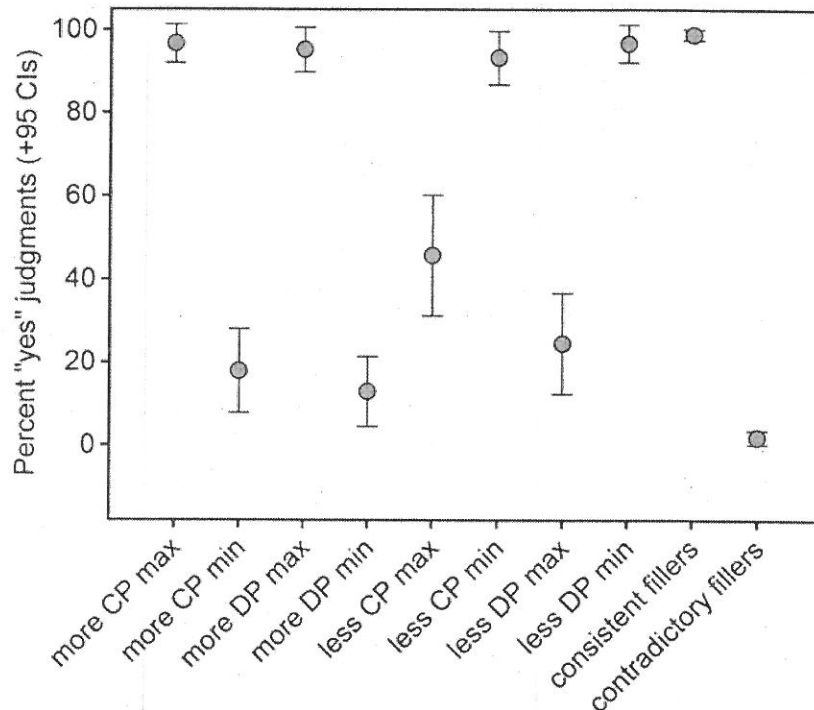
some movie >> everyone: 9/10 = 90%

The example gives us an independent baseline for what to expect. The method used in the four studies should lead to high acceptance rates for all available readings of a sentence (though perhaps not always quite as high as 90%: a variant of (47) with *alle(all)* (also generally accepted as ambiguous) got an acceptance of 70% for inverse scope, for instance).

In addition to the test items, the material in the studies contained filler texts (both consistent and contradictory). In all studies, the test items were interspersed pseudorandomly with filler items. Judgments for minimal pairs among the test items (for example the same sentence under both a MIN and a MAX interpretation) from one and the same participant were avoided. The task was explained to the participants with the help of several practice items. Participants judged between 10 and 20 texts. Maximally 50% were comparative Lucinda examples. If a participant made more than two mistakes with the filler items, that participant was excluded (this occurred only once). Participants were asked for a spontaneous response of the form "this text is consistent"/"this text is contradictory". They were then asked to explain their answer. If their explanation revealed that the judgment was based on a misunderstanding or a mistake, the judgment was not considered in any quantitative evaluation. The participants were all monolingual adult native speakers of German. Between the four studies, a total of 143 speakers were consulted.

I will report specific results of the studies in the way represented below. Together with the example, I present the condition the example represents including in particular the interpretation, and then the acceptance of the example under that interpretation among the participants in the study the example was tested in. (45) under the MAX interpretation was accepted by 6 out of 12 participants in study I, which amounts to a 50% acceptance rate. If more than one set of numbers is given for an example, the example was tested in several studies. The results are reported separately in that case.

3.2.2 *Results*⁷ The graph below summarizes the judgements collected in study I.



There are four interpretations that come close to the judgments collected for the consistent filler items, that is close to an acceptance rate of 100%. In MORE-comparatives, those are the MAX interpretations with both CPs and DPs. In LESS-comparatives, those are the MIN interpretations with both CPs and DPs. The other four interpretations received much lower acceptability ratings. In MORE-comparatives, the MIN interpretation got 18% in the CP condition and 13% in the DP condition. With LESS-comparatives, the MAX interpretation got 47% in the CP condition and 23% in the DP condition.

The data were analysed using a Logit Mixed Effects model including MIN v. MAX, LESS v. MORE and CP v. DP as fixed effects and participants and items as random effects (as suggested by Jäger, 2008). Statistical analysis revealed that there were two main effects: LESS-comparatives were judged better overall than MORE-comparatives, and MAX interpretations were judged better overall than MIN interpretations. More importantly, the analysis revealed that the

⁷ I am greatly indebted to Oliver Bott for the statistical evaluation of the data, and for his comments and suggestions on the empirical side of this project in general.

interaction between MORE v. LESS and MIN v. MAX is significant (estimate = 8.03; z -value = 7.60; $P < 0.01$), in that the MAX interpretation is good in MORE-comparatives while the MIN interpretation is not good, and the other way around in LESS-comparatives. An additional effect was found regarding the LESS; CP; MAX condition: as the graph suggests, this interpretation was judged better than the other three dispreferred readings. In particular, in a Logit Mixed Effect model analysing only the LESS; CP; MAX and the LESS; DP; MAX condition, the difference turned out to be significant (estimate = -1.13; $z = -2.40$; $P < 0.05$). All four dispreferred interpretations were judged significantly better than the contradictory filler items ($P < 0.01$ by Fisher exact test).

3.2.3 Discussion Much to my surprise, study I failed to establish that the original Lucinda examples (LESS-comparatives with *than*-CPs) are genuinely ambiguous between a MAX and a MIN interpretation. Acceptance of LESS;CP;MAX examples was on average below 50%, and this is not what we anticipated for an available interpretation. Thus, the ambiguity is by no means as clear and widespread as one would expect from the discussion in the literature [even when example and context are constructed parallel to Lucinda data like (1), as they all were]. It is also not clear how LESS-comparatives are different from MORE-comparatives, although the dispreferred reading MAX with LESS-comparatives was accepted more frequently than the dispreferred reading MIN with MORE-comparatives. But the first study also revealed the need for a more detailed look at the data because there was considerable variation in the judgments gathered for structurally parallel test items. This was confirmed in the follow-up studies.

I take study I to establish that the MORE MAX and LESS MIN interpretations are acceptable. Furthermore, I take it to establish that all four dispreferred interpretations, while not readily available, can by some marginal means be coerced into existence. Studies II, III and IV concentrate on the more fine-grained investigation and on the question of how acceptable the dispreferred readings of various example types are.

3.3 *The goals of studies II–IV*

The later three studies, also questionnaire studies, were smaller, more informal follow-up studies to the first. They can be seen simply as systematic controlled data elicitation from native speakers. The general procedure was identical to that of study I. No quantitative evaluation was intended and none was conducted.

Let me comment briefly on the methodology. My goal was to get a reliable grasp on relatively subtle data. The use of questionnaires in the way outlined above is systematic (a fair number of consultants uninformed as to the goals of the study is consulted in a parallel way about the same data) and controlled (the data are prepared in such a way that it is possible for a simple judgment of acceptability to be elicited, something that native speakers are reliably able to do). In my opinion, systematic and controlled data elicitation can usefully supplement our usual method of simply reporting introspective judgments. I see this as similar to careful fieldwork, which also does not exercise experimental standards. I would like to make the point that it is worth going to that much trouble because it may change our perception of the facts (like it did in this case). At the same time, this is a useful method for gathering data because a normal semanticist can do it reasonably easily (in contrast to a proper experiment, which it may be impossible to conduct for a variety of reasons). So, I think systematic data elicitation using for example a questionnaire study can be a big improvement over simple introspection, especially in cases where the data are murky, while still being realistically achievable. See also Matthewson (2004) for relevant discussion (with the difference that she comments on the study of underdescribed languages, not on subtle data in a well-described language; but her comments on how to gather semantic data carry over).

Now on to the studies themselves. As we saw above, study I clearly establishes four interpretations as available (the two LESS MIN and the two MORE MAX ones). Therefore, studies II–IV focused on the interpretations that emerged as dispreferred in study I: LESS;CP;MAX, LESS;DP;MAX, MORE;CP;MIN and MORE;DP;MIN. One goal was to find out what the differences are between the four conditions. Another particular focus of the later three studies was to get a grasp on why some of the examples tested for a particular condition were fairly good while other parallel ones were very bad. Below is a pair of examples that illustrates variability of acceptance for LESS;CP;MAX (this example was anticipated in section 1.3. above):

- (51) a. Der Hubschrauber flog weniger hoch als ein
 the helicopter flew less high than a
 Flugzeug fliegen kann.
 plane fly can
 The helicopter was flying
less high than a plane can fly. (LESS; CP; MAX: 26/30 = 87%)

- b. Der Ton, den diese Pfeife produziert, ist weniger
 the tone that this whistle produces is less
 hoch, als ein Mensch hören kann.
 high than a human hear can
 The sound that the whistle produces is
less high than a human can hear. (LESS;CP;MAX: 0/10=0%;11/
 30=37%)

The two *than*-clauses are quite parallel. They contain the same modal [German *kann* (*can*), with a circumstantial modal base both times] and even the same adjective. The different acceptability ratings of (51a) v. (51b) suggest that further aspects of the content of the sentence play a role. The average acceptance rate for LESS; CP; MAX of 47% in the graph above is the result of lumping together acceptance rates that were quite high with very low acceptance rates for other examples. Note that the acceptance rate of 87% for (51a) is precisely what we anticipated for a genuinely ambiguous example. The contrast suggests that (51a) is ambiguous in the expected way, while (51b) is not.

I think that it makes sense to distinguish an example type in which the dispreferred reading is acceptable from an example type in which the dispreferred reading is fairly unacceptable. Besides the variation between examples illustrated by (51), another reason for this is that even though the overall acceptance rate does not strongly support an ambiguity view of Lucinda examples, there are examples for which speakers have clear intuitions of ambiguity. This applies to the participants of the studies, in particular. I illustrate below by providing examples of comments made by our participants:

- (52) Beate is getting a PhD in a well-known Tübingen graduate program. Her topic is 'Structural Ambiguity in Elisabeth Gaskell's Work'. Next week, her program has its annual doctoral guidance day. All graduate students have to present their thesis work. Each talk has to be between 10 and 15 minutes long. Beate is very well prepared, but she is concerned that she might take too long. This morning, she has given a practice talk to her roommate. She has taken exactly 14 minutes. *Beate's talk is less long than allowed.* It can stay like this.

Participant's comment on the crucial sentence: This can refer to the 10 minutes or to the 15 minutes. If it refers to the 10 minutes, it is not consistent. And with 15 it is consistent. I would assume 15, then it would be consistent.

- (53) On the highway between Schusselheim and Sonderlingen there is a required minimum speed of 50kmh and a speed limit of 80 kmh.

Yesterday, Sarah had a box of glasses in her trunk and wanted to drive very carefully. She drove *less fast than allowed*. So she got a ticket.

Participant [judged the text contradictory] Experimenters' question: How fast did Sarah drive? Participant: Sarah drove between 50 and 80. But one could also take it to mean that she drove less fast than the minimum speed and got a ticket for that. In that case, she would have driven below 50. Then the text would be consistent.

Let us try to tease apart two types of example, therefore: 'ambiguous' v. 'fairly unambiguous' examples. Ambiguous examples are the ones in which the reading LESS;CP;MAX is relatively good. Studies II–IV attempted to find out what properties of an example make it fall into the 'ambiguous' v. the 'fairly unambiguous' group. Similarly, the studies tried to find out whether all MORE;CP;MIN examples are equally bad. To this end, the content of the *than*-clauses was varied. Different adjectives were tested (for example in addition to *fast* and *high*, we tested *warm* and *expensive*), different uses of the same adjective were tested [for example *high* for altitude and for frequency, as in (51)], and quantity examples (*more*, *fewer*) were tested in collective and distributive predication. The last point relates to the scalarity of the degree predicate denoted by the *than*-clause. We will see below that collectivity destroys scalar inferences, yielding a non-scalar predicate. Finally, upward scalar predicates (*sufficient*) were tested.

The next three subsections report the findings for LESS;CP;MAX, for MORE;CP;MIN, and for the two DP conditions, respectively.

3.4 *When is LESS;CP;MAX possible?*

I present in (54) and (55) two groups of examples: the first containing the examples in which the MAX reading was judged fairly good, and the second containing the examples in which the MAX reading was judged fairly bad. Examples from study I are also included. The lists in (54) and (55) are exhaustive in terms of the adjectives that were tested. Small variants of roughly the same comparative clause are not reported separately. The examples chosen among such variants are representative in terms of acceptance rates. I made the cut-off point for a 'fairly good' acceptability of the MAX reading at 50%. An acceptance rate of 50% may not be very strong support of the existence of a particular reading (and for everything below 50% it seems fair to me to call such an example 'fairly unambiguous'); but 50% is precisely the acceptance rate of the well-known speed example, which is explicitly judged ambiguous both by famous semanticists and several of our participants. So, I have decided to group this example with the ambiguous examples and make

the cut-off below. (It is not worth it to worry too much about this decision of mine because it will emerge from the analysis that we do not expect stable, clear-cut ambiguity v. no ambiguity judgments.)

The LESS;CP examples in which MAX is fairly acceptable ($\geq 50\%$):

(54) ambiguous examples ($\geq 50\%$ acc. in studies I, II, III, IV):

a. **length (space)**: (13/20 = 65%)

Das	Seil	ist	weniger	lang,	als
the	rope	is	less	long	than
es	sein	darf.			
it	be	may			

The rope is *less long than it is allowed to be*.

b. **width**: (6/10 = 60%)

Die	Tür	ist	weniger	breit,	als
the	door	is	less	wide	than
der Durchgang breit sein kann.					
the doorway wide be can					

The door is *less wide than the doorway can be*.

c. **height (altitude)**: (26/30 = 87%)

Der	Hubschrauber	flog	weniger	hoch	als ein
the	helicopter	flew	less	high	than a
Flugzeug fliegen kann.					
plane fly can					

The helicopter was flying *less high than a plane can fly*.

d. **length (time)**: (7/10 = 70%; 7/11 = 64%)

Der	Vortrag	ist	weniger	lang,	als	er sein	darf.
the	talk	is	less	long	than	it be	may

The talk is *less long than it is allowed to be*

e. **speed**: (6/12 = 50%; 5/10 = 50%)

Sie	ist	weniger	schnell	gefahren	als	erlaubt.
she	is	less	fast	driven	than	allowed

She drove *less fast than allowed*.

f. **price**: (17/20 = 85%)

Das	Seil	ist	weniger	teuer,	als	es sein	darf.
the	rope	is	less	expensive	than	it be	may

The rope is *less expensive than it is allowed to be*.

g. **quantity**: (17/20 = 85%)

Es	sind	weniger	Leute	durchgefallen,
it	are	fewer	people	failed

als durchgefallen dürfen.

than fail may

Fewer people failed than are allowed to.

The LESS;CP examples in which MAX is not very acceptable (<50%):

(55) fairly unambiguous examples (< 50% acc. in studies I, II, III,IV):

a. **viscosity**: (9/20 = 45%)

Die Creme ist weniger dick, als sie sein darf.
 the cream is less thick than it be may
 The cream is *less thick than it is allowed to be.*

b. **frequency (tone)**: (11/30 = 37%; 0/10 = 0%)

Der Ton, den diese Pfeife produziert, ist
 the tone that this whistle produces is
 hoch, als ein Mensch hören kann.
 high than a human hear can
 weniger
 less

The sound that the whistle produces is *less high than a human can hear.*

c. **temperature**: (13/30 = 43%)

Die Pflanzen stehen damit weniger warm, als
 the plants stand thereby less warm than
 sie dürfen.
 they may

The plants are in a *less warm place than they are allowed to be.*

d. **quantity**:

Die Gladiolen bekommen diesmal weniger Wasser,
 the gladiolas get this time less water
 als sie dürfen.
 than they may

The gladiolas are getting *less water than they are allowed to.*
 (12/30 = 40%)

[Sie waren] weniger Leute, als das Spiel spielen können.
 [they were] fewer people than the game play can

They were *fewer people than can play this game.* (1/11 = 10%)

Wir waren weniger Leute, als eine
 we were fewer people than a

Fussballmannschaft

soccer team

bilden können.

form can

We were *fewer people than can form a soccer team.* (1/10 = 10%)

What distinguishes the ambiguous from the fairly unambiguous data? I will work out the following proposal in section 4: In the ambiguous examples, the degree predicate is underlyingly downward scalar. Context

interferes with this basic character of the degree predicate, but there are two possible ways in which this can happen, leading to the MIN and the MAX interpretation, respectively. The fairly unambiguous examples, on the other hand, involve degree predicates that are not even underlyingly downward scalar. This will entail that there is no way by which the MAX interpretation can be derived.

For initial plausibility of the proposal, consider the degree predicate in the fairly ambiguous original Lucinda example. The semantics one would normally assign to the structure is downward scalar.

- (56) a. than Lu was allowed to drive _ fast
 b. $\lambda d. \exists w[wR@ \ \& \ \text{Speed}_w(\text{Lu}) \geq d]$

- (56') $\exists w[wR@ \ \& \ \text{Speed}_w(\text{Lu}) \geq 40\text{mph}] \Rightarrow \exists w[wR@ \ \& \ \text{Speed}_w(\text{Lu}) \geq 39\text{mph}]$ (a world in which Lu reaches a speed of 40mph is also a world in which she reaches a speed of 39mph)

We have yet to figure out how the Lucinda context changes this picture, to make the predicate intuitively not downward scalar. For now, let us contrast this with a fairly unambiguous example. The degree predicate in (57) is not underlyingly downward scalar.

- (57) a. than [can [~~_ many people~~] play this game]]
 b. $\lambda d. \exists w[wR@ \ \& \ \exists X[\text{card}(X) = d \ \& \ X \text{ play}_w \text{ this game}]]$

- (57') $\exists w[wR@ \ \& \ \exists X[\text{card}(X) = 4 \ \& \ X \text{ play}_w \text{ this game}]] \neq \Rightarrow \exists w[wR@ \ \& \ \exists X[\text{card}(X) = 3 \ \& \ X \text{ play}_w \text{ this game}]]$
 (a world in which a 4-membered group of people plays this game together is not necessarily a world in which a smaller group plays this game together, nor is the existence of such a world entailed)

I will have to show that all fairly unambiguous examples share the property of not being underlyingly downward scalar. I will do so in section 4 when I present my analysis of Lucinda examples. For now, I summarize the empirical situation with regard to LESS-comparatives and *than*-clauses as follows:

- (58) a. LESS; CP; MIN is generally acceptable.
 b. LESS; CP; MAX is strongly dispreferred with non-scalar and upward scalar predicates; it is acceptable with underlyingly downward scalar predicates.

3.5 *When is MORE;CP;MIN possible?*

The condition MORE; CP; MIN had an average acceptance rate of 18% in study I. While this was higher than the acceptance rate for contradictory fillers, it was significantly lower than the acceptance rate of the dispreferred reading for LESS-comparatives, LESS; CP; MAX. Indeed, many examples in which the availability of MORE; CP; MIN was tested gave a clear result of unacceptability, for instance:

- (59) On the highway between Schusselheim and Sonderlingen there is a required minimum speed of 50kmh and a speed limit of 80 kmh. Yesterday, Sarah had a box of glasses in her trunk and wanted to drive very carefully. But she drove *faster than allowed*. So she couldn't get a ticket.

MORE; CP; MIN: 0/13 = 0%

Notice that this is essentially Chuck, the egg truck driver. Not all examples yielded quite such a negative result. Below is one of the better examples.

- (60) Das Brett ist breiter, als die Mauer dick sein kann.
the board is wider than the wall thick be can
The board is *wider than the wall can be thick*.

MORE; CP; MIN: 5/13 = 38%

But only the use of an underlyingly upward scalar degree predicate with *suffice* brought this condition above the 50% acceptance rate:

- (61) Sie hat also mehr Punkte, als
She has thus more points than
für die landwirtschaftliche Erschliessung Afrikas
for the agricultural development of Africa
genügen.
suffice
She has *more points than are sufficient for 'Africa's agricultural development'*.

- (61') The goal of the board game "Out of the Ice Age" is to settle and develop a people. In order to take the next evolutionary step, players have to collect particular numbers of points, depending on which step they are aiming for. Points are collected by

trading. Lisa wants to buy 'Africa's agricultural development' for her people. One has to have 50-60 points for that. If one has too many points, one has to take the next higher developmental step directly, which can be a real disadvantage. Lisa has traded cleverly and collected 52 points. She has more points *than are sufficient for Africa's agricultural development*. She can develop her people as desired.

MORE; CP; MIN (18/20 = 90%)

It is worth pointing out that the same sentence (61) on the MAX interpretation got an acceptance rate of 15/20 = 75%, making this an ambiguous example.

(61") The goal of the board game "Out of the Ice Age" is to settle and develop a people. In order to take the next evolutionary step, players have to collect particular numbers of points, depending on which step they are aiming for. Points are collected by trading. Lisa wants to buy 'Africa's agricultural development' for her people. One has to have 50-60 points for that. If one has too many points, one has to take the next higher developmental step directly, which can be a real disadvantage. Lisa has traded too successfully and collected 62 points. She has more points *than are sufficient for Africa's agricultural development*. She has to move on to 'Artisans' directly.

MORE; CP; MAX (15/20 = 75%)

I summarize the empirical situation with regard to MORE-comparatives and *than*-clauses as follows:

- (62) a. MORE; CP; MAX is generally acceptable.
b. MORE; CP; MIN is strongly dispreferred with non-scalar and downward scalar predicates; it is acceptable with underlyingly upward scalar predicates.

The quantitative results from study I directly relate to the fact that downward scalar predicates are the majority and that the first study contained no upward scalar predicates, but mostly underlyingly downward scalar and also non-scalar predicates. The translations of the five example series from study I given below show this.

- (63) a. Katrin drove {faster/less fast} than allowed.
b. [λ d. Katrin was allowed to drive d-fast] downward scalar

- (64) a. The board is {wider/less wide} than the wall can be thick.
 b. [λ d. the wall can be d-thick] downward scalar
- (65) a. We were {more/fewer} people than can form a soccer team.
 b. [λ d. it is possible for d-many people to form a soccer team] non-scalar
- (66) a. M. got a {longer/less long} jail sentence than the law permits.
 b. [λ d. the law permits that M. get a d-long sentence] downward scalar
- (67) a. The sound produced by this whistle is {higher/less high} than a human can hear.
 b. [λ d. a human can hear a d-high sound] (to be identified as non-scalar)

Hence, the MORE data seemed overall less ambiguous. Once the different kinds of predicates are taken into account, however, we see the same distinction between ambiguous and fairly unambiguous examples in dependency of the degree predicate that we found with LESS.

3.6 *The degree DP conditions*

Finally, let us look at plural degree DPs in comparison to *than*-clauses. Study I makes it clear that they share the preferred readings with their CP counterparts, that is MORE; DP; MAX and LESS; DP; MIN are clearly acceptable interpretations. As for the dispreferred interpretations, both MORE; DP; MIN (13% as opposed to 18% acceptance) and LESS; DP; MAX (23% as opposed to 47%) are overall less acceptable than the clausal versions of the same Lucinda examples. This also holds when we look at concrete examples:

- (68) Sie ist weniger schnell gefahren als erlaubt.
 she is less fast driven than permitted
 She was driving *less fast than allowed*.
 LESS; CP; MAX: $6/12 = 50\%$
- (68') Sie ist weniger schnell gefahren als die erlaubten
 she is less fast driven than the permitted
 Geschwindigkeiten.
 speeds
 She was driving less fast than the permitted speeds.
 LESS; DP; MAX: $4/13 = 31\%$

(68') was in fact the best rated LESS; DP; MAX example in the studies. There are even clearer contrasts between ambiguous LESS; CP examples and the corresponding LESS; DP; MAX data; they show that the LESS; DP examples must all be considered fairly unambiguous. Below is a pair from study II:

- (69) Beates Vortrag war also weniger lang, als er sein darf.
 Beate's talk was thus less long than it be may
 Beate's talk was *less long than allowed*.

LESS; CP; MAX: 7/11 = 64%

- (69') Beates Vortrag war also weniger lang als
 Beate's talk was thus less long than
 die erlaubten Zeiten.
 the allowed times
 Beate's talk was *less long than the permitted times*.

LESS; DP; MAX: 2/10 = 20%

There is, of course, no such contrast between a fairly unambiguous LESS CP example and the equally unambiguous LESS DP; below is such a pair of examples from study II.

- (70) Der Ton, den diese Pfeife produziert, ist
 the tone that this whistle produces is
 weniger hoch, als ein Mensch hören kann.
 less high than a human hear can
 The sound that the whistle produces is *less high than a human can hear*.

LESS;CP;MAX: 0/10 = 0%

- (70') Der Ton, den diese Pfeife produziert, ist
 the tone that this whistle produces is
 weniger hoch als die für Menschen
 less High than the for humans
 hörbaren Frequenzen.
 audible frequencies
 The sound that the whistle produces is *less high than the frequencies audible for humans*.

LESS;CP;MAX: 0/11 = 0%

I summarize the findings on degree DPs below.

- (71) a. Degree DPs share the preference of the corresponding CPs (MORE MAX, LESS MIN).
 b. All DP examples are fairly unambiguous. While the MORE MIN, LESS MAX readings are acceptable for some CP examples, they are fairly unacceptable for parallel DP examples.

3.7 Summary

The most important results reported in this section are summarized below:

- (72) a. Two conditions yield an ambiguous Lucinda example: MORE comparatives with *than*-clauses containing an underlyingly upward scalar degree predicate; LESS comparatives with *than*-clauses containing an underlyingly downward scalar degree predicate.
 b. Other circumstances yield fairly but not completely unambiguous MORE MAX and LESS MIN comparatives.

But let me be a bit more detailed. The plural degree DP examples can serve as a baseline for the analysis of fairly unambiguous examples. They give rise to MORE MAX and LESS MIN readings. These should emerge as straightforward results of compositional interpretation. The analysis should include some marginal interpretive mechanism to derive the dispreferred readings MORE; DP; MIN and LESS; DP; MAX, to distinguish these data in the study texts from pure contradictions. Fairly unambiguous CP examples are similar in acceptance to their DP counterparts. Those examples include the CPs with the non-scalar degree predicates. I propose to model their interpretation after the interpretation of the DPs.

Next, let us consider CP examples with scalar predicates. It is here that there is a chance of a genuine ambiguity. The ambiguous examples pose the question of how the underlying scalarity of the predicate is affected by the contextual information. I will suggest below that the ambiguity results from two different possible ways this could happen. MORE- and LESS-comparatives are parallel *modulo* switching the scalarity direction of the predicate.

Further unambiguous examples are ones with scalar predicates, but where the scalarity of the predicate and the comparison operator interact in such a way as to lead to no ambiguity (MORE plus

downward scalar, LESS plus upward scalar predicate). It should follow from the analysis that there is no ambiguity here.

In the next section, I develop a semantic analysis following these generalizations.

4. ANALYSIS

This section analyses the data from section 3 according to the generalizations argued for. I proceed in the following way: In subsection 4.1, I first present the analysis I propose for the plural degree DP examples, an analysis in terms of plural predication. Plural predication—distributivity, to be precise—introduces the universal quantification over degrees presented informally in section 1.4. This analysis is applied to CPs with non-scalar degree predicates in subsection 4.2. These two subsections thus analyse (most of) the fairly unambiguous Lucinda examples.

I begin with those unambiguous data because the analysis in terms of plural predication is used also in the analysis of the ambiguous examples, as one of two interpretive options. Subsection 4.3 discusses *than*-clauses with underlyingly downward scalar predicates (ambiguous with LESS-comparatives) and proposes two semantic analyses for them. The first corresponds to what I called ‘context as non-scalarity’ in section 1.4 and follows the analysis developed for non-scalar degree predicates, distributive predication (ending up with comparisons entailing LESS MIN). The second strategy is a scalar strategy that ends up making a comparison to MAX, also anticipated in section 1.4. Subsection 4.4 analyses *than*-clauses with underlyingly upward scalar predicates (ambiguous with MORE-comparatives) in an analogous fashion. In subsection 4.5, I provide a brief summary of the analysis.

4.1 *Plural degree DPs*

The analysis I propose has as one important ingredient, the observation that Lucinda examples seem to involve pluralities of degrees. This has come up a couple of times above already, and it is most apparent with plural degree DP examples. Those will provide a baseline for the analysis.

We begin with the step from the compositionally simplest example (73) to a plural counterpart (75).

- (73) a. Lucinda drove faster than the speed limit.
 b. [[-er [the speed limit]] [2[Lu drove t2 fast]]]]
 c. [[the speed limit]] = 50mph
 d. [[-er]](50mph)(λ d.Luise drove d-fast)
 iff [λ D.max(D) > 50mph] (λ d.Luise drove d-fast)
 iff max(λ d.Luise drove d-fast) > 50mph
 iff Speed(Lu) > 50mph

(74) [[-er]] = $\lambda d_d. \lambda D_{<d,t>}. \max(D) > d$

- (75) a. Lucinda drove faster than the permissible speeds.
 b. [[the permissible speeds]] = [35mph, 50mph]

I propose that the comparative operator does not combine directly with a plurality of degrees. Instead we use plural predication parallel to the distributive predication in (76). In (76), I employ Link's (1983) star operator to capture distributivity. A preliminary definition is given in (76'). Hence, the LF in (76b) is assigned the truth conditions in (76c).

- (76) a. Lucinda graded these papers.
 b. [[these papers] [*[1[Lucinda graded t1]]]]
 c. $\forall x \in$ [[these papers]]: Lucinda graded x

(76') [*P](X)=1 iff $\forall x \in X: P(x) = 1$

We proceed in a parallel way in (75), as illustrated below. The resulting interpretation is that Lucinda drove faster than all the permissible speeds. Hence, she drove faster than the speed limit. This looks like a comparison with a maximum, but note that it is simply the universal quantification brought about by distributive predication.

- (75') a. Lucinda drove faster than the permissible speeds.
 b. [[the permissible speeds] [*[1[[-er t1] [2[Lu drove t2 fast]]]]]]
 c. $\forall s \in$ [[the permissible speeds]]: [[-er]](s)(λ d.Luise drove d-fast)
 iff $\forall s \in$ [[the permissible speeds]]: max(λ d.Luise drove d-fast) > s
 iff $\forall s \in$ [[the permissible speeds]]: Speed(Lu) > s
 iff $\forall s \in$ [35mph, 50mph]: Lu drove faster than s MAX!

Let us turn to the corresponding LESS-comparative, given in (77). Assuming that *less* is simply the inverse of *-er* leads to the derivation in (77b), (77c). The same distributive predication this time looks like a comparison to a minimum.

- (77) a. Lucinda drove less fast than the permissible speeds.
 b. [[the permissible speeds] [*[1[[less t1] [2[Lu drove t2 fast]]]]]]
 c. $\forall s \in$ [[the permissible speeds]]: [[less]](s)(λd .Luise drove d-fast)
 iff $\forall s \in$ [[the permissible speeds]]: $s >$
 $\max(\lambda d$.Luise drove d-fast)
 iff $\forall s \in$ [[the permissible speeds]]: $s >$ Speed(Lu)
 iff $\forall s \in$ [35mph, 50mph]: Lu drove less fast than s MIN!

$$(77') \text{ [[less]] } = \lambda d_d. \lambda D_{\langle d, t \rangle}. d > \max(D)$$

These two derivations give us the preferred readings of these examples. What about the dispreferred readings? Plural predication being the crucial mechanism involved here, we may wonder whether it offers any possibility of deriving the dispreferred interpretations. It turns out that it does. Brisson (1998) observes that the derivation of distributive readings sketched above cannot be the complete story. Consider (78a). Our analysis of the distributive reading of (78a) at the moment derives the truth conditions represented in (78c). This, Brisson notes, is not quite right. (78a) contrasts with (78b) since in (78b), it must indeed be the case that absolutely all children are involved. In (78a) on the other hand, we would be prepared to accept the sentence as true even if some child or other was not in fact part of the raft building. That is, we tolerate exceptions in (78a) but not (78b).

- (78) a. The children built a raft.
 b. All the children built a raft.
 c. $\forall x[x \in$ [[the children]] \rightarrow x built a raft]

To capture this, Brisson makes use of the contextual constraint on distributive predication that Schwarzschild (1996) introduces. Plural predication is sensitive to covers. A contextually given cover provides the salient subgroups in the context. The truth conditions of (78a) on the distributive reading are more accurately represented in (79a). Now suppose that there is a child which is not an element of the cover, that is we have a so-called ill-fitting cover. This child will not be required to build a raft now. The additional restriction leads to weaker truth conditions. We revise the definition of the * operator as in (80) and can derive (79a) with the help of the LF in (79b) (see e.g. Beck 2001 for such a theory of plural predication).

- (79) a. $\forall x[x \in$ [[the children]] $\&$ $x \in$ Cov \rightarrow x built a raft]
 (where Cov contains the contextually relevant subgroups)
 b. [[the children] [* Cov[1[t1 built a raft]]]]

(80) [$* \text{Cov P}$](X) = 1 iff $\forall x[x \in X \ \& \ x \in \text{Cov} \rightarrow P(x) = 1]$

Let us implement this improvement also in our analysis of the comparative data. A representation of the truth conditions of example (77) now looks as in (81a). What this means depends on the value of the cover variable. If the cover contains all relevant speeds, we derive the same truth conditions as before. Suppose however that the cover does not contain all permissible speeds. We then get a weaker reading. The extreme case would be the one in which the cover contains, of the permissible speeds, only the speed limit. In this case, we would get an apparent comparison with the maximum.

- (81) a. $\forall s[s \in \text{[[the permissible speeds]]} \ \& \ s \in \text{Cov} \rightarrow \text{Lu drove less fast than } s]$
 b. If $\text{[[the permissible speeds]]} \subseteq \text{Cov}$, MIN results.
 c. If $\text{Cov} \cap \text{[[the perm. speeds]]} = \{\text{the speed limit}\}$, MAX results.

While it is generally accepted that the cover need not contain all individuals in the domain, one may wonder how plausible it is to limit the cover to such an extreme extent. I conjecture that such a move is not completely excluded—perhaps (82) on the team credit reading from Gillon (1984), is an example—but neither is it a normal value for the cover variable. Such a value assignment should be dispreferred and require heavy contextual pressure.

- (82) The soldiers of F-troop spotted the indians. (true if one of the soldiers of F-troop spotted the indians)

Looking back at the data considered above, for example Chuck, the egg truck driver, this is precisely what happens. To the extent that the dispreferred reading is possible, it arises under severe contextual pressure, which makes just one particular speed relevant. An anonymous referee points out that it may be important in this connection that we are dealing with the domain of degrees, not individuals. The ordering that comes with the scalar domain can be expected to make certain points in an interval of degrees more salient, namely the end points. Thus, while (81c) is not totally impossible, it would be even more implausible to reduce the set of permissible speeds via an ill-fitting cover to a middle degree, say, 40 mph. Indeed, such an interpretation seems totally unavailable, and only MAX and MIN are marginally available.

I suggest that the option of an ill-fitting cover accounts for the fact that MORE; DP; MIN and LESS; DP; MAX interpretations are not completely impossible. At the same time, they represent an implausible cover choice and should be dispreferred compared to the MORE; DP; MAX and LESS; DP; MIN interpretations—as they in fact are.

Study IV contained a text with an example of plural predication that should be judged consistent only under a dispreferred cover choice. The example sentence is given in (83), the interpretation in (83') and (a translation of) the text in (83''). The choice of an ill-fitting cover is dispreferred because the women are named individually and it is a small group (cf. Brisson 1998). But the normal choice of a well-fitting cover makes the text contradictory. The acceptance rate of 20% is similar to the acceptance rates of the MORE; DP; MAX (13%) and LESS; DP; MIN interpretations (23%) and above acceptance rates for contradictory fillers (e.g. 0/80 = 0% in study IV). Nothing more specific about the analysis can of course be inferred from this one example; but I think that the reasonable match in acceptance rates is encouraging for the strategy of looking for a dispreferred value for a free variable.

(83) Die Frauen haben Bier getrunken.
the women have beer drunk
The women drank beer.

(83') a. $\forall x[x \in \text{[[the women]]} \ \& \ x \in \text{Cov} \rightarrow x \text{ drank beer}]$
b. $\text{[[the women]]} = \{\text{Annett, Jane, Lisa, Steffi}\}$
c. If $\text{Cov} \cap \text{[[the women]]} = \{\text{Annett, Jane, Lisa}\}$, (83'') is consistent.

(83'') Annett, Jane, Lisa, Timo and Steffi want to watch soccer in the pub 'Rose'. Unfortunately everyone wants to watch soccer tonight, and the 'Rose' is very crowded. The group decides to go to the 'Neckarmüller' instead. Timo has a glass of red wine with his Brezel. Steffi has no money and orders nothing at all. Lisa, Annett and Jane order a Pilsner. The women drank beer. Had they been in the 'Rose', an elderberry syrup might have been Annett's first choice.
consistent: $4/20 = 20\%$

In summary, then, plural degree DPs alert us to the possibility that we compare not to a unique degree, but to a set of degrees. Normal mechanisms of plural predication predict the interpretations that arise from this possibility. Those mechanisms derive the strong preference for

the MORE MAX and LESS MIN interpretations, as well as the fact that the dispreferred MORE MIN and LESS MAX readings are not completely unacceptable. The DP data come out as fairly unambiguous.

4.2 *Non-scalar predicates*

Turning now to *than*-clauses, Lucinda examples with underlyingly non-scalar predicates receive an analysis quite parallel to the plural degree DPs. Recall that such examples are fairly unambiguous, just like the DPs. Their interpretation will also be derived with plural predication.

I distinguish below two kinds of non-scalar degree predicates: ones in which collective predication causes a lack of scalarity, and ones in which the basic gradable predicate seems to be responsible. Let us begin by considering the familiar example (84) in more detail. Section 3 showed that (84) had only the LESS MIN interpretation (i.e. we were fewer than five people).

- (84) a. We were fewer people than can form a soccer team.
 b. Suppose that 5, 7 and 11 and no other number of people can form a soccer team.
 c. $m\text{-inf}(\lambda d. \text{it is possible for } d\text{-many people to form a soccer team}) = \{5,7,11\}$

The example involves the collective predicate ‘form a soccer team’. I analyse a simpler example with this predicate below. The plausible reading here is the one in which the possibility modal takes wide scope (plausibly, a deontic modal which quantifies over worlds accessible from the actual world by virtue of obeying the rules of soccer; this is represented as $wR@$ below). The predicate ‘form a soccer team’ holds of the group introduced by the indefinite ‘eleven people’, not of its individual members. Since the inference in (86) is not valid, I give an ‘exactly’ semantics for the indefinite.⁸

- (85) a. Eleven people can form a soccer team.
 b. $\exists w[wR@ \ \& \ \exists X[\text{card}(X) = 11 \ \& \ \text{form_a_soccer_team}_w(X)]]$
 ‘There are worlds accessible from @ in which a group of exactly 11 people forms a soccer team.’

⁸ Note that an ‘at least’ semantics for the indefinite would let the inference go through.

(i) $\exists w[wR@ \ \& \ \exists X[\text{card}(X) \geq 11 \ \& \ \text{form_a_soccer_team}_w(X)]]$
 An ‘exactly’ semantics is needed to get a plausible meaning for this example. Maybe it is derived by a combination of the ‘ \geq ’ semantics in (i) with the operator EXH that I discuss below.

- (86) Eleven people can form a soccer team $\neq \Rightarrow$ Ten people can form a soccer team. (a world in which a group of exactly eleven people forms a soccer team is not necessarily a world in which a ten-membered group forms a soccer team, nor is the existence of such a world entailed)

Note that a distributive predicate makes the parallel inference valid; we will come back to this point in the next subsection.

- (87) a. Eleven people can fail the exam. \Rightarrow Ten people can fail the exam.
 b. $\exists w[wR@ \& \exists X[\text{card}(X) = 11 \& \forall x \in X: \text{fail_the_exam}_w(x)]] \Rightarrow \exists w[wR@ \& \exists X[\text{card}(X) = 10 \& \forall x \in X: \text{fail_the_exam}_w(x)]]$ (a world in which each of an eleven-membered group of people fails the exam is also a world in which each of a ten-membered group of people fails the exam)

Transferring the semantic assumptions in (85) to the comparative, the collective *than*-clause in (84) receives the following semantics:

- (84') a. *than* [can [~~many people~~] form a soccer team]
 b. $\lambda d. \exists w[wR@ \& \exists X[\text{card}(X) = d \& \text{form_a_soccer_team}_w(X)]]$
 c. $m\text{-inf}(\lambda d. \text{it is possible for } d\text{-many people to form a soccer team}) = \{5,7,11\}$

The degrees described by the *than*-clause are the exact degrees that make it true, no inferences possible. *M-inf* will return a set of degrees, $\{5,7,11\}$ in the context described. Thus, collective predicates in *than*-clauses can destroy scalarity and lead to a situation in which *m-inf* is not able to return a singleton. Below is a parallel analysis of another example from among the fairly unambiguous LESS; CP examples identified in section 3.

- (88) a. We were fewer people than can pay this game.
 b. *than* [can [~~many people~~] play this game]
 c. $\lambda d. \exists w[wR@ \& \exists X[\text{card}(X) = d \& X \text{ play}_w \text{ this game}]]$

- (89) $\exists w[wR@ \& \exists X[\text{card}(X) = 4 \& X \text{ play}_w \text{ this game}]] \neq \Rightarrow \exists w[wR@ \& \exists X[\text{card}(X) = 3 \& X \text{ play}_w \text{ this game}]]$
 (a world in which a 4-membered group of people plays this game together is not necessarily a world in which a smaller

group plays this game together, nor is the existence of such a world entailed)

Such *than*-clauses will be interpreted by the same plural predication mechanism introduced for plural degree DPs. I illustrate below:

- (90) a. Suppose that 2,3 and 4 people can play this game.
 $m\text{-inf}(\lambda d. \exists w[wR@ \ \& \ \exists X[\text{card}(X) = d \ \& \ X \ \text{play}_w \ \text{this game}]])) = \{2,3,4\}$
- b. We were fewer people than can pay this game.
 $[m\text{-inf} [\text{than can play this game}]] \ [*[1[[\text{less } t1] \ [2[\text{we were } t2 \ \text{many people}]]]]]$
- c. $\forall d \in m\text{-inf}([\text{than can play this game}])$: we were fewer people than d
MIN!

While there are a few other examples among the fairly unambiguous Lucinda examples that may be amenable to an analysis in terms of collectivity, there are also examples that clearly are not. They are repeated in (91):

- (91) a. The cream is less thick than it is allowed to be. (viscosity)
 b. The sound that the whistle produces is less high than a human can hear. (frequency)
 c. The plants are placed less warm than they are allowed to be. (temperature)

I refer to these examples as lexically non-scalar predicates, and I make the following suggestion: These examples are to be distinguished from the fairly ambiguous examples in terms of the basic adjective that they contain. Examples that have a chance of being ambiguous contain adjectives that we might call dimensional adjectives, following Bierwisch (1987).⁹ Such adjectives are based on a rich and well-behaved scale. In particular, their scales have a natural zero point:

- (92) high (altitude): zero height = ground level
 wide: no width = no horizontal extension

⁹ Note that all adjectives tested in Lucinda examples are open scale adjectives in the sense of, Kennedy and MacNally (2005) as witnessed by the impossibility of modification with *completely*, for instance. So we are making a distinction among the relative gradable adjectives with the dimensional/non-dimensional distinction.

- (i) a. * The talk was completely long.
 b. * The tone was completely high.

expensive: no price = free
 fast: no speed = standing still

The unambiguous examples in (91) involve adjectives that are based on scales that do not have a natural zero point:

- (93) high (frequency): there is no neutral tone height
 warm: there is no zero temperature intuitively
 thick (viscosity): there is no intuitively neutral or zero viscosity

See in particular Sassoon (2009) on the different kinds of scales that underlie natural language gradable predicates. The generalization is that non-zero-scale adjectives give rise to fairly unambiguous Lucinda examples. How can this be explained?

Remember that I assumed in section 2 as the lexical meaning of adjectives a monotonic semantics:

- (94) $[[\text{old}]]_{\langle d, \langle e, t \rangle \rangle} = [\lambda d. \lambda x. x \text{ is } d\text{-old}] = [\lambda d. \lambda x. \text{Age}(x) \geq d]$

I conjecture that this kind of semantics is limited to dimensional adjectives. Non-dimensional adjectives have a non-monotonic semantics. The idea is, intuitively, that if one has a height of 1.80 m, for example then one also reaches heights between this point and the zero point on the scale. One ‘reaches’ a point on the scale from the zero point. But if something has a temperature of, say, 25 degrees, it does not make sense to say that it reaches the temperatures below that. It would not be clear from where a point is ‘reached’. Thus, I propose a different kind of meaning for the two kinds of adjectives:

- (95) a. high (altitude): $[[\text{high}_{\text{Alt}}]] = [\lambda d. \lambda x. \text{Alt}(x) \geq d]$
 b. high (frequency): $[[\text{high}_{\text{Freq}}]] = [\lambda d. \lambda x. \text{Freq}(x) = d]$

A non-monotonic semantics will have the effect of an ‘exactly’ meaning under a possibility modal and a plural meaning after application of m-inf:

- (96) The sound that the whistle produces is less high than a human can hear.

- (96') a. than [can [a human hear a ~~high~~ sound]]
 b. $\lambda d. \exists w[wR@ \ \& \ \exists x[\text{human}_w(x) \ \& \ \exists y[\text{sound}_w(y) \ \& \ x \text{ hear}_w y \ \& \ \text{Freq}_w(y) = d]]]$
 c. Suppose that a human can hear frequencies between 16Hz and 19kHz. $m\text{-inf}([[\text{than [can [a human hear a ~~high~~ sound]]]]) = [16\text{Hz}, 19\text{kHz}]$

So once more, we have to resort to plural predication to interpret such examples, and they will fairly unambiguously yield a LESS MIN interpretation (modulo the dispreferred cover choice).

- (96'') a. The sound that the whistle produces is less high than a human can hear.
 b. [m-inf [than a human can hear]] [*[1[[less t1] [2[the sound is t2 high]]]]]
 c. $\forall d \in m\text{-inf}(\text{[[than a human can hear]])$: the sound is less high than d MIN!

Since I am making a very important assumption about lexical meaning here, the two classes of adjectives are discussed further in section 5.

I have concentrated on LESS-comparatives above, but note that MORE-comparatives are completely parallel except that when we combine with the matrix clause, universal quantification leads to an apparent comparison to a maximum rather than a minimum. This is illustrated below for the example with the lexically non-scalar predicate; it would apply in the same way to the examples with the collective predicates.

- (97) a. The sound that the whistle produces is higher than a human can hear.
 b. [m-inf [than a human can hear]] [*[1[[er t1] [2[the sound is t2 high]]]]]
 c. $\forall d \in m\text{-inf}(\text{[[than a human can hear]])$: the sound is higher than d MAX!

To sum up this subsection: I propose that some degree predicates yield *than*-clauses that have to be interpreted via the distributive predication mechanism introduced for plural degree DPs. Those are *than*-clauses that are true of a particular set of degrees, with no inferences valid to other degrees. Such a non-scalar meaning for the *than*-clause can come about because (i) the basic gradable predicate is not monotonic or (ii) collective predication destroys inferential properties. These CP examples are predicted to have the same interpretive possibilities as the parallel DP data, that is yield fairly unambiguous Lucinda examples. If this is right, then matters may change when we look at dimensional adjectives and non-collective *than*-clauses.

4.3 Downward scalar predicates

Now we turn to the ambiguous examples. First we consider examples with underlyingly downward scalar degree predicates in the *than*-clause. Remember (98), for which besides the generally acceptable LESS MIN reading the LESS MAX reading was also easily available. Our task is to derive both interpretations for this example.

(98) The helicopter was flying less high than a plane can fly.

(98) contains a dimensional adjective with a monotonic semantics. A simpler example with that adjective is analysed in (99) (once more on the plausible reading the modal takes wide scope).

- (99) a. The plane can fly 300m high.
 b. $\exists w[wR@ \ \& \ Alt_w(\text{the_plane}) \geq 300m]$
 c. it is possible for the plane to reach an altitude of 300m
 \implies it is possible for the plane to reach an altitude of 250m.

Carrying the assumption about (99) over to the *than*-clause leads to the following semantics for the example, which is also downward scalar:

- (98') a. *than* [can [a plane fly ~~high~~]]
 b. $\lambda d. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ Alt_w(x) \geq d]]$

Let us see what happens if we simply use this meaning for the *than*-clause in our compositional interpretation. I illustrate below that maximal informativity will determine the maximal altitude that the plane can reach as the meaning of the *than*-clause, and the sentence ends up with a LESS MAX interpretation.

- (100) a. Suppose that the maximal altitude that the plane can reach is 10000m. Then:
 b. $m\text{-inf}(\lambda d. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ Alt_w(x) \geq d]]) = 10000m$

- (101) a. The helicopter was flying less high than a plane can fly.
 b. $[\text{less} [\text{the } m\text{-inf } \text{than} [\text{can} [\text{a plan fly } \text{high}]]] =$
 $[[\text{less}]](10000m) =$
 $\lambda D. \max(D) < 10000m$
 c. $[\text{less} [\text{the } m\text{-inf } \text{than} [\text{can} [\text{a plan fly } \text{high}]]][1[\text{the heli was flying } t1 \text{ high}]]$
 iff $[[\text{less}]] (10000m) ([[2[\text{the heli was flying } t2 \text{ high}]]])$

iff 'The helicopter was below 10000m, the maximal height
a plane can reach.' MAX

In a way, this result is fine because our example is the one that actually has this interpretation. But we are left with two related open questions. The first is how to derive the LESS MIN interpretation. The second is how to take into account the information provided by the context, which makes it clear that scalar inferences are not warranted in the general case; for example the plane cannot fly below 50 m. Contextual information has to be integrated in such a way as to make them impossible. I suggest that there are two possible ways of integrating context information, and that is the reason for the example's ambiguity.

One way to incorporate the effects of the context is to see it as making clear that we are talking about the exact altitudes at which the plane and the helicopter fly (as opposed to the altitudes that they reach). Thus (102a) would be a plausible semantics. This is not what the basic adjective will give us; but the *than*-clause can be enriched by a covert exhaustifying operator EXH that will yield just this meaning (102e) = (102a) (Fox 2006; Chierchia *et al.* forthcoming; see also Krasikova forthcoming).

- (102) a. $\lambda d. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ \text{Alt}_w(x) = d]]$
 b. *than* [2[can a plane [1[AP' EXH_C [AP t1 fly t2_F high]]]]
 c. EXH_C (p) = 1 iff p & $\forall q \in C: \neg(p \rightarrow q) \rightarrow \neg q$
 d. $C = [[AP]]_f = \{x \text{ fly } d \text{ high} \mid d \in D_{\langle d \rangle}\} = \{\text{Alt}_w(x) \geq d \mid d \in D_{\langle d \rangle}\}$
 e. $\lambda d. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ \max(\lambda n. \text{Alt}_w(x) \geq n) = d]]$

With the meaning for the *than*-clause (102a) thus derived, we are in the same position as we would have been with an underlyingly non-scalar predicate. Plural predication will rescue us from a situation in which m-inf cannot return a singleton.

- (103) a. Suppose that a plane can fly at altitudes between 50m and 10000m.
 $m\text{-inf}(\lambda d. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ \text{Alt}_w(x) = d]]) = [50m, 10000m]$
 b. [m-inf [than a plane can fly]] [*[1[[less t1] [2[the heli was t2 high]]]]]
 c. $\forall d \in m\text{-inf}([[\text{than a plane can fly}]])$: the heli was less high than d
 MIN!
 'The helicopter was below the heights of 50-10000m, i.e. below any of the heights a plane can reach.'

This semantics accounts for the intuitive lack of scalarity in the Lucinda example, and it derives the preferred interpretation, LESS MIN.

Let us now return to the derivation of the LESS MAX reading. The only thing wrong with how I presented it above is that it completely ignores the contribution of the context, which I think is implausible. Thus, I propose that there is a second way to integrate the altitude span given by the context besides exhaustification. Context may serve as a domain restriction on the *than*-clause, (104a). Within the delineated interval, the predicate is still downward scalar. The maximally informative degree within the interval is therefore the maximum, 10 000m, as before.

- (104) a. $\lambda d: 50m \leq d \leq 10000m. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ \text{Alt}_w(x) \geq d]]$
 b. If $d, d' \in [50m, 10000m]$ & $d' < d$:
 it is possible for a plane to reach an altitude of d
 \implies it is possible for a plane to reach an altitude of d'
 c. $m\text{-inf}(\lambda d: 50m \leq d \leq 10000m. \exists w[wR@ \ \& \ \exists x[\text{plane}_w(x) \ \& \ \text{Alt}_w(x) \geq d]]) = 10000m$

The comparative operator is fed a single degree, which it can combine with directly. The same standard comparative LF as before derives the LESS MAX reading.

- (105) a. The helicopter was flying less high than a plane can fly.
 b. $[\text{less} [\text{the } m\text{-inf} \text{ than} [\text{can} [\text{a plan fly } \text{—high}]]][1[\text{the heli was flying } t1 \text{ high}]]]$
 iff 'The helicopter was below 10000m, the maximal height a plane can reach.' MAX

This is the idea, then: since the degree predicate of our example is underlyingly scalar, there are two ways composition may proceed. Firstly, we can acknowledge the 'non-scalarity' of the context by optionally exhaustifying the degree predicate. We get a non-scalar predicate as a result and interpret by plural predication. This derives the LESS MIN reading. Alternatively, we can acknowledge the context as limiting scalarity to a certain interval. Then, we interpret with our normal interpretive strategy and derive the LESS MAX reading. The availability of two interpretive strategies makes the contrast to the degree predicates discussed in section 4.2, which were inherently non-scalar independently of the context, and had only the first option.

The example with altitude *high*, a dimensional adjective, contrasts with the example with frequency *high*, a non-dimensional adjective. Only the former offers a way of deriving the maximally informative

degree in the *than*-clause. Let us also look at an example that contrasts with the fairly unambiguous examples with collective predicates, namely an ambiguous example with *many* in a distributive sentence context. Firstly, I demonstrate below that the numerical indefinite in the distributive predication gives rise to an underlyingly downward scalar degree predicate.

- (106) a. Fewer people failed than were allowed to.
 b. *than* [allowed [~~many people~~] [*1[t1 fail]]]
 c. $\lambda d. \exists w[wR@ \ \& \ \exists X[\text{card}(X) = d \ \& \ \forall x \in X: x \text{ fail}_w]]$

- (107) $\exists w[wR@ \ \& \ \exists X[\text{card}(X) = 5 \ \& \ \forall x \in X: x \text{ fail}_w]] \implies$
 $\exists w[wR@ \ \& \ \exists X[\text{card}(X) = 4 \ \& \ \forall x \in X: x \text{ fail}_w]]$
 (a world in which each of a 5-membered group fails the exam is also a world in which each of a 4-membered group fails the exam.)

Similar to the above altitude example, the contextual information that we need to consider a particular span can be incorporated into the meaning of this *than*-clause in two different ways. The first is the strategy with the covert EXH. The resulting *than*-clause will be interpreted by the plural predication mechanism:

- (106') a. *than* [2[allowed [_{XP'} EXH_C[_{XP} t2_F ~~many people~~] [*1[t1 fail]]]]]
 b. $C = [[XP]]f = \{ \exists X[\text{card}(X) = d' \ \& \ \forall x \in X: x \text{ fail}_w \mid d' \in D_{\langle d \rangle}] \}$
 c. $\lambda d. \exists w[wR@ \ \& \ \max(\lambda n. \exists X[\text{card}(X) = n \ \& \ \forall x \in X: x \text{ fail}_w] = d)]$

- (108) $\exists w[wR@ \ \& \ \max(\lambda n. \exists X[\text{card}(X) = n \ \& \ \forall x \in X: x \text{ fail}_w] = 10)] \neq \implies$
 $\exists w[wR@ \ \& \ \max(\lambda n. \exists X[\text{card}(X) = n \ \& \ \forall x \in X: x \text{ fail}_w] = 9)]$

(a world in which the maximal number *n* such that each of an *n*-membered group fails the exam is 10 is not a world in which the maximal number *n* such that each of an *n*-membered group fails the exam is 9, nor is the existence of such a world entailed.)

- (109) a. Suppose that between 10 and 30 students may fail.
 $m\text{-inf}(\lambda d. \exists w[wR@ \ \& \ \max(\lambda n. \exists X[\text{card}(X) = n \ \& \ \forall x \in X: x \text{ fail}_w] = d)]) = [10,30]$

- b. Fewer people failed than were allowed to.
 $[m\text{-inf} [\text{than were allowed to}] [*[1[[\text{less } t1] [2[t2 \text{ many people failed}]]]]]$
- c. $\forall d \in m\text{-inf}([\text{than were allowed to}])$: fewer people than d failed MIN!

The second possibility is the strategy with the domain restriction. This will lead to a singleton *m-inf* and the canonical interpretation mechanism:

- (110) a. *than* [allowed [~~many people~~] fail]]
 b. $\lambda d:10 \leq d \leq 30. \exists w[wR@ \ \& \ \exists X[\text{card}(X) = d \ \& \ \forall x \in X: x \text{ fail}_w]]]$
 c. $m\text{-inf}(\lambda d:10 \leq d \leq 30. \exists w[wR@ \ \& \ \exists X[\text{card}(X) = d \ \& \ \forall x \in X: x \text{ fail}_w]]) = 30$
- (111) a. Fewer people failed than were allowed to.
 b. [less *m-inf*([[allowed [~~many people~~ fail]]])] [2[t2 many people failed]]
 c. [[less]] (30) ([[[2[t2 many people failed]]]]) = fewer than 30 people failed, the maximal permitted number. MAX!

To summarize the analysis of ambiguous LESS-comparatives: those examples involve degree predicates that are underlyingly downward scalar. Context information can be integrated in one of the two ways: firstly, it can turn the degree predicate into an ‘exactly’ predicate, thereby destroying scalarity. The resulting non-scalar degree predicate yields a plurality of degrees and will be interpreted via distributive predication. This gives us the LESS MIN interpretation. Secondly, context can be integrated as a domain restriction on the *than*-clause. The resulting degree predicate will be downward scalar within a limited range. Composition can proceed canonically and yields the LESS MAX interpretation.¹⁰

Note that this second strategy of domain restriction does not change the picture for underlyingly non-scalar predicates. (112) still does not permit inferences, and we are irrevocably stuck with having to interpret via plural predication.

¹⁰ The domain restriction as a definedness condition looks similar to a presupposition. While this may seem a little odd at first as a meaning for a comparative *than*-clause, it would amount to the intuition that the *than*-clause in these examples is used to refer back to a set of degrees already introduced, for example *than allowed* would refer to [35,50] just like the definite description in *than the permissible speeds*. This seems reasonable to me.

(112) The sound that this whistle produces is less high than a human can hear.

$\lambda d: 16\text{Hz} < d < 19\text{kHz}$.

$\exists w[wR@ \& \exists x[\text{human}_w(x) \& \exists y[\text{sound}_w(y) \& x \text{hear}_w y \& \text{Freq}_w(y) = d]]]$

Note also that both ways of adding context information to an underlyingly downward scalar predicate will yield the MORE MAX interpretation for MORE-comparatives. This is demonstrated briefly below.

(113) The helicopter was flying higher than a plane can fly.

(113') context as an 'exactly' meaning for the *than*-clause:

a. $[[\text{than a plane can fly}]] = \lambda d. \exists w[wR@ \& \exists x[\text{plane}_w(x) \& \text{Alt}_w(x) = d]]]$

b. $m\text{-inf}([[\text{than a plane can fly}]]) = [50\text{m}, 10000\text{m}]$

c. $[m\text{-inf} [\text{than a plane can fly}]] [*[1[[-er t1] [2[\text{the heli was t2 high}]]]]]$

d. $\forall d \in m\text{-inf}([[\text{than a plane can fly}]])$: the heli was higher than d
MAX

(113'') context as domain restriction:

a. $[[\text{than a plane can fly}]] = \lambda d: 50 \leq d \leq 10000. \exists w[wR@ \& \exists x[\text{plane}_w(x) \& \text{Alt}_w(x) \geq d]]]$

b. $m\text{-inf}([[\text{than a plane can fly}]]) = 10000\text{m}$

c. $[-er m\text{-inf}([[\text{a plane can fly } \textit{high}]])] [2[\text{the helicopter was flying t2 high}]]]$

d. $[[[-er]] (10000\text{m}) ([[[2[\text{the helicopter was flying t2 high}]]]])] = \text{the helicopter was above } 10000\text{m, the maximal height a plane can reach.}$
MAX

In (114), I summarize the analysis of underlyingly downward scalar predicates and its predictions.

(114) underlyingly downward scalar predicates in Lucinda examples:
ambiguous with LESS: context as non-scalarity =>
plural pred. and MIN
context as domain restriction
=> m-inf and MAX

unambiguous with MORE: context as non-scalarity => plural pred. and MAX
 context as domain restriction => m-inf and MAX

4.4 Upward scalar predicates

To complete the picture, we consider ambiguous examples involving underlyingly upward scalar degree predicates. They are the mirror image of downward scalar predicates in terms of which readings arise in Lucinda contexts:

- (115) underlyingly upward scalar predicates in Lucinda examples:
 ambiguous with MORE: context as non-scalarity => plural pred. and MAX
 context as domain restriction => m-inf and MIN
 unambiguous with LESS: context as non-scalarity => plural pred. and MIN
 context as domain restriction => m-inf and MIN

Let me demonstrate that this is so. The interesting example is the MORE-comparative in (116) which the studies reported in section 3 showed to be ambiguous.

- (116) Lisa has more points than are sufficient (for Africa's agricultural development).

A simpler example is analysed in (117). (117a) can be paraphrased as (117b) or (117c). I find (117c) easiest to understand for present purposes. The degree predicate is upward scalar. See Beck & Rullmann (1999) for a first proposal on the semantics of *sufficient*, and literature on sufficiency modal constructions for further relevant discussion (e.g. von Stechow & Iatridou 2005, Krasikova forthcoming and references therein).

- (117) a. 10 points are sufficient. = It is sufficient for Lisa to have 10 points.
 \approx It is not necessary for Lisa to have more than 10 points.
 b. $\neg \forall w[wR@ \rightarrow \max(\lambda n. \text{Lisa has}_w n\text{-many points}) > 10]$
 'Not all worlds in which Lisa reaches her goals are such that she has more than 10 points.'

- c. $\exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq 10]$
 ‘There are worlds in which Lisa reaches her goals in which the number of points she has is no more than 10.’

- (118) a. it is sufficient to have 10 points \Rightarrow it is sufficient to have 11 points
 b. $\exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq 10] \Rightarrow \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq 11]$

This would lead us to the following upward scalar meaning for the *than*-clause:

- (116') a. *than* [it is sufficient [Lisa have _ many points]]
 b. $\lambda d. \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq d]$

Just like in the case of underlyingly downward scalar predicates, the context provided for the example interferes with this happy scalarity. The context makes it clear that Lisa’s goals can only be reached if the number of points she has are within a particular interval, [50,60]. The domain restriction strategy to incorporate contextual meaning into the *than*-clause interpretation will lead to the MORE MIN interpretation:

- (119) a. $\lambda d: 50 \leq d \leq 60. \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq d]$
 b. $m\text{-inf}(\lambda d: 50 \leq d \leq 60. \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq d]) = 50$ MIN!

Alternatively, suppose that we ‘exactlyfy’ the meaning of the *than*-clause, again just like in the case of underlyingly downward scalar predicates. This meaning has a plurality of maximally informative elements.

- (120) a. $\lambda d. \exists w[wR@ \ \& \ EXH_C [\max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq d]]$
 $C = \{ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) \leq d \mid d \in \mathbb{N} \}$
 b. $\lambda d. \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) = d]$
 c. $m\text{-inf}(\lambda d. \exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) = d]) = [50,60]$

- (121) $\exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) = 10] \neq \Rightarrow$

$\exists w[wR@ \ \& \ \max(\lambda n.Lisa \text{ has}_w \ n\text{-many points}) = 11]$
 (a world in which Lisa reaches her goals and has exactly 10 points is not a world in which Lisa reaches her goals and has exactly 11 points.)

- (122) a. Lisa has more points than are sufficient.
 b. $m\text{-inf}(\llbracket\text{than are sufficient}\rrbracket)$ $[*1\llbracket\text{-er } t1\rrbracket$ $2\llbracket\text{Lisa has } t2 \text{ many points}\rrbracket]$
 c. $\forall d \in m\text{-inf}(\llbracket\text{than are sufficient}\rrbracket)$: Lisa has more points than d MAX!

The ambiguity of MORE comparatives with upward scalar degree predicates is thus derived. To wrap up the discussion of the empirical coverage of this analysis, note that in the case of LESS comparatives, these predicates yield LESS MIN readings via the domain restriction strategy (since the maximally informative element is the minimum) and the same LESS MIN readings via the plural predication strategy (since less than all the elements in the *than*-clause entails less than the minimum). The example below should therefore be fairly bad on the maximum reading, and I think that that is correct.

- (123) Lisa had fewer points than sufficient to acquire ‘Africas agricultural development’,
 a. # so she could get it.
 b. so she couldn’t get it.

4.5 Summary predictions

The table below summarizes the predictions that are made by the proposals in this section.

	non-scal. predicate	downw. scal. predicate	upward scal. predicate
MORE	fairly unamb.: more-than-max (pl. pred.)	fairly unamb.: more-than-max (pl. pred. or dom. res.)	ambiguous : more-than-max (pl. pred.) more-than-min (dom. res.)
LESS	fairly unamb.: less-than-min (pl. pred.)	ambiguous : less-than-min (pl. pred.) less-than-max (dom. res.)	fairly unamb.: less-than-min (pl. pred. or dom. res.)

5 SUMMARY AND CONCLUSIONS

5.1 Summary

This paper has offered a closer empirical study of ambiguous comparatives with *less*, the Lucinda examples. It has been shown that not all LESS-comparatives constructed after the Lucinda pattern are ambiguous, and that there are ambiguous MORE-comparatives. The ambiguity hinges on the scalarity properties of the *than*-clause degree predicate. MORE-comparatives are ambiguous with upward scalar degree predicates, LESS-comparatives are ambiguous with downward scalar degree predicates. These generalizations are blurred by the fact that even 'unambiguous' Lucinda examples can be coerced, to some extent, into a second interpretation.

I have offered an analysis of these findings that relies on the interpretation of the *than*-clause and especially on the way the *than*-clause is combined with the comparative operator. The first important point is the replacement of standard maximality by maximal informativity, m-inf. This move allows for different outcomes depending on the semantic nature of the degree predicate provided by the *than*-clause. The second important point concerns what happens when m-inf does not return a single degree. Plural predication, concretely the semantics of distributivity, is the independently motivated mechanism of choice then. I have shown that the interpretations that plural predication derives for such *than*-clauses match the interpretations of their obviously plural counterparts, plural degree DPs.

On this basis, I have given a semantic explanation for the ambiguity that some Lucinda examples show. An ambiguity arises only when an underlyingly scalar predicate is combined with a context that interferes with its inferential properties. There are two ways to include contextual information in the semantics: the first is to see the context as establishing that scalar inferences do not go through. This creates a non-scalar predicate and a distributive interpretation. The second is to see context as providing the range to which scalar inferences are limited. This creates a scalar predicate and an interpretation derived with m-inf. An example is ambiguous when the two ways to integrate context yield different results, that is when maximal informativity goes against the direction of distributive inferences. For MORE-comparatives, this is the case when m-inf gives us the minimum, yielding a more-than-minimum interpretation, while distributivity entails more-than-maximum. This happens with upward scalar predicates. For LESS-comparatives, the two interpretations diverge when m-inf gives us the maximum,

yielding a less-than-maximum interpretation, while distributivity entails less-than-minimum. Downward scalar predicates create this situation.

In order to make the desired predictions, I made a couple of further assumptions. One is to distinguish two different kinds of adjectives. Another concerns the role of *less*. Both will be examined below, after I have commented on earlier theories of Lucinda examples in the light of the data elicited for this paper.

5.2 Comparing theories of Lucinda examples

Compared to earlier theories of the Lucinda ambiguity, an important change is that scalarity of the degree predicate in the *than*-clause is recognized as a factor for the availability of two readings. The modal theory (Meier 2002) agrees with my analysis that contextual information has to be added to compositional semantics in order to account for the Lucinda data. The way in which this is done, however, is different and hence as far as I can see, the modal analysis over-generates. A context sensitive modal is not all that is required to get an ambiguous Lucinda example. Most MORE examples (i.e. the ones with non-scalar and downward scalar predicates) and many LESS examples (i.e. the ones with non-scalar and upward scalar predicates) are fairly unambiguous.

My analysis is not a scope analysis, in the sense of one and the same element showing up in two different scopal positions to create the two readings. Such an operator is pivotal to Heim's analysis, for instance, and it is the degree negation operator *little*. The strongest reason I can bring forth against such an analysis is the fact that the ambiguity exists with MORE-comparatives, when the example is chosen right. I do not see what operator could be held responsible for a scope ambiguity in such examples, and I went for an analysis that makes crucial use of the semantics/pragmatics interface instead.

A worry one might have about the *little* theory, given the data presented in section 3, is that a completely systematic analysis as scope ambiguity would overgenerate: many examples to which we could apply a scope analysis are not ambiguous. Two such examples are repeated below.

- (124) They were fewer people than can play this game.
 a. so they couldn't play. MIN
 b. # so they could play. # MAX

(125) The tone that the whistle produces is less high than a human can hear.

- a. so it is not audible. MIN
 b. # so it is audible. # MAX

It is easy to present two LFs that differ in terms of the scope of *little*. However, one needs to make several important decisions in order to associate those LFs with an interpretation. If those decisions are the ones I have made below (i.e. I have simply treated the two examples in a parallel fashion to the original Lucinda sentence), then the analysis overgenerates.

- (124') a. than [little [can [_ many people play this game]]]
 \approx than [not [can [_ many people play this game]]]
 $= \lambda d. \neg \exists w[wR@ \ \& \ \exists X[\text{card}(X) \geq d \ \& \ X \text{ play}_w \text{ this game}]]$
 b. than [can [_ little many people play this game]]
 \approx than [can [d-few people play this game]]
 $= \lambda d. \exists w[wR@ \ \& \ \exists X[\text{card}(X) < d \ \& \ X \text{ play}_w \text{ this game}]]$

- (124'') Suppose that 3,4 and 5 people can play this game. Then:
 a. $\lambda d. \neg \exists w[wR@ \ \& \ \exists X[\text{card}(X) \geq d \ \& \ X \text{ play}_w \text{ this game}]]$
 $= \lambda d. d > 5$
 b. $\lambda d. \exists w[wR@ \ \& \ \exists X[\text{card}(X) < d \ \& \ X \text{ play}_w \text{ this game}]]$
 $= \lambda d. d > 3$

- (125') a. than [little [can [a human hear a _ high tone]]]
 \approx than [not [can [a human hear a _ high tone]]]
 $= \lambda d. \neg \exists w[wR@ \ \& \ \exists x[\text{human}(x) \ \& \ \exists y[\text{tone}(x) \ \& \ \text{Freq}(y) \geq d \ \& \ x \text{ hear}_w y]]]$
 $= \lambda d. d > 19\text{kHz}$
 b. than [can [a human hear a _ little high tone]]
 \approx than [can [a human hear a _ low tone]]
 $= \lambda d. \exists w[wR@ \ \& \ \exists x[\text{human}(x) \ \& \ \exists y[\text{tone}(x) \ \& \ \text{Freq}(y) < d \ \& \ x \text{ hear}_w y]]]$
 $= \lambda d. d > 16\text{Hz}$

But of course the *little* theory does not have to make those choices. It could incorporate the idea that non-dimensional adjectives have a non-monotonic semantics, for example and derive (126).

- (126) than [little [can [a human hear a _ high tone]]]
 \approx than [not [can [a human hear a _ high tone]
 $= \lambda d. \neg \exists w[wR@ \& \exists x[\text{human}(x) \& \exists y[\text{tone}(x) \& \text{Freq}(y)$
 $= d \& x \text{hear}_w y]]$
 $= \lambda d. d < 16\text{Hz} \text{ or } d > 19\text{kHz}$

It is not clear to me though how such a meaning for the *than*-clause would combine with the comparative operator. It is therefore hard for me to make a definitive statement about the predictions of the *little* theory regarding such data.

My analysis does not identify a possibility modal as a crucial ingredient for an ambiguous Lucinda example. A ‘span’ interpretation might come about by other means. This is already clear from the data with *sufficient*. Another possibly relevant example type is (127). This example does not contain a modal verb. But in the right context, it could be seen as providing a span on the degree scale. Thus, it might differentiate between a scope theory and the analysis from section 4: I expect it to be ambiguous.

- (127) In their 4x100m relay teams,
 Jamaica has a less fast athlete than the US do.
 a. Jamaica has an athlete who is less fast than the fastest US athlete. MAX
 b. Jamaica has an athlete who is less fast than the slowest US athlete. MIN
- (128) Let $C = \{s:s \text{ is the speed reached by an athlete on the US } 4 \times 100\text{m relay team}\}$
 a. Jamaica has an athlete less fast than the maximally informative speed $s: s \in C$. MAX
 b. For all speeds $s, s \in C$: Jamaica has an athlete less fast than s . MIN

Thus, there could be more data amenable to the two interpretation strategies developed for the Lucinda examples, which may not encourage a scope view. But this is for future research.

5.3 *Two kinds of adjectives*

In section 4, I proposed to distinguish two classes of adjectives w.r.t. their behaviour in Lucinda sentences. Alluding to Bierwisch’s (1987) work I called them dimensional v. non-dimensional adjectives. Their

lexical entries are supposed to differ in terms of monotonicity, hence scalarity, to create the respective Lucinda effects:

- (129) a. high (altitude): $[[\text{high}_{\text{Alt}}]] = [\lambda d. \lambda x. \text{Alt}(x) \geq d]$
 b. high (frequency): $[[\text{high}_{\text{Freq}}]] = [\lambda d. \lambda x. \text{Freq}(x) = d]$

How does this relate to Bierwisch's original motivation for the distinction? I think it is fair to say that the distinction is not always easy to make. There are, however, two empirical criteria he mentions that I think differentiate fairly clearly: Evaluativity (in his terms: norm relatedness) of the equative with a positive antonym adjective and compatibility of a differential with an equative with a negative antonym adjective. I illustrate below with the dimensional adjectives *tall/short* and the non-dimensional adjectives *pretty/ugly*.

- (130) a. Molly is short. She is as tall as Sarah is. [dimensional adjective]
 b. * Molly is three times as short as Sarah.
- (131) a ?? The painting is ugly. It is as pretty as the
 sculpture. [non-dim. adjective]
 b. The painting is three times as ugly as the sculpture.

When we apply Bierwisch's criteria to the adjectives from the Lucinda study, we get a pretty good match with the adjective classes identified there. I give some examples below (I give English examples for simplicity, except in those cases in which I think the choice of English v. German might make a difference; we are, of course, directly concerned with German, for which the studies were run). The examples for which my intuitions are not so clear, interestingly, are also borderline cases as far as Lucinda is concerned. It furthermore deserves mention that Bierwisch, like me, argues that non-dimensional adjectives are the ones without a canonical zero point to their scale structures.

- (132) Dimensional adjectives:
 a. Beate's talk is short. It is as long as Sarah's. [length of time]
 * Beate's talk is three times as short as Sarah's.
 b. The helicopter was flying low. It was flying as high as the
 plane. [altitude]
 * The helicopter was flying three times as low as the plane.

- c. Das Seil ist billig. Es ist genau so teuer wie Fabians
altes. [price]
the rope is cheap. it is just as expensive as Fabian's old
The rope is cheap. It costs just as much as Fabian's old rope.
* Das Seil ist dreimal so billig wie das alte.
the rope is three times as cheap as the old
The rope is three times as cheap as the old one.

(133) Non-dimensional adjectives:

- a. ?? Tone A is low. It is as high as tone B. [frequency]
Tone A is three times as low as tone B.
b. ?? The mug is cold. It is as warm as the plate. [temperature]
The mug is three times as cold as the plate.

(134) Unclear cases:

- a. ? Sarah was slow. She was driving as fast as Katrin. [speed]
? Sarah was driving three times as slowly as Katrin.
b. ? The chocolate cream is thin. It is as thick as the vanilla
cream. [viscosity]
? The chocolate cream is three times as thin as the vanilla
cream.

Note that here is another point (in addition to the vaguaries of plural predication) at which variability of judgments might arise. The distinction between dimensional and non-dimensional adjectives does not seem to be completely clear cut, leaving room for between-speaker variation and even uncertainty within one speaker. According to my suggestions, the variation concerns whether a speaker has a monotonic (129a) or a non-monotonic (129b) semantics for a particular use of an adjective in mind. But that choice is crucial for scalarity and hence for the range of readings in Lucinda examples. I had this point in mind in particular in section 3.4 above, where I stated that the analysis would not offer a clear and stable division into ambiguous and unambiguous examples. Note that the examples with collective predicates, where no such uncertainty arises, were judged more clearly unambiguous than the lexically non-scalar predicates.

Schwarzschild (2010), following Bierwisch, also distinguishes dimensional from non-dimensional adjectives. His purpose is to analyse two classes of adjectives in Navajo and in Hebrew, which behave differently w.r.t. how the standard of comparison (the *than*-constituent) can be realized. Since the relevant effects are language

specific, his work has no direct empirical impact on my proposals. Also, both Bierwisch's and Schwarzschild's concrete analyses of their data sets are not what I proposed above (Schwarzschild suggests that a non-dimensional adjective does not make available a degree argument slot for composition; I cannot see how to apply this suggestion to a non-dimensional adjective in a *than*-clause, to derive a suitable meaning for the *than*-clause. Bierwisch's semantics for non-dimensional adjectives in the context of a *than*-clause would, as far as I can see, not derive a difference to a dimensional adjective in a *than*-clause).

However, we can draw support from their works for the idea that gradable adjectives are not all the same. There are reasons to postulate systematic lexical differences, which create two groups of gradable adjectives in terms of their empirical properties. Moreover, the set of dimensional adjectives (the ones most often studied in comparative semantics) comprises those adjectives that rely on the most canonical scale structures, and they include—this much is probably crosslinguistically stable—at least the adjectives concerned with physical dimension such as *high*, *wide* and *long*. The proposals made in section 4 may be seen as contributing towards understanding the semantic distinctions between the two sets and the empirical effects that those differences create. We have seen in particular that the two adjective classes lead to a different *than*-clause semantics.

There is an interesting prediction made by a non-monotonic semantics for non-dimensional adjectives. The strongest argument in favour of monotonic adjective meanings that I am aware of concerns data like (135). The sentence permits a reading according to which 15 pp specifies the minimum requirement length of the paper. This is the length that the paper reaches in all worlds compatible with the rules. Suppose that the rules specify that the paper needs to be between 15 and 20 pp long. Then there is no unique length that the paper has in all worlds compatible with the requirements. A non-monotonic semantics (136b) for the adjective would be unable to derive reading (135b). A monotonic semantics (136a) makes the desired predictions.

- (135) a. The paper has to be exactly 15pp long.
 b. $\max(\lambda d. \forall w [wAcc@ \rightarrow Length_w(\text{the_paper}) \geq d]) = 15pp$
 15pp is the minimum requirement length for the paper.

- (136) a. $[[\text{long}]] = \lambda w. \lambda d. \lambda x. Length_w(x) \geq d$
 b. $[[\text{long}]] = \lambda w. \lambda d. \lambda x. Length_w(x) = d$

Let us compare the dimensional adjective *high* with its non-dimensional tone frequency counterpart in this respect. My intuition is that while (137a) can specify a minimum altitude required, it is extremely difficult to read (137b) in such a way; similarly for (137c). Perhaps this can be seen as an argument for a non-monotonic semantics.

- (137) a. The plane has to fly exactly 2000m high,
and it's ok if it flies higher.
b. The tone has to be exactly 2500 Hz high,
?? and it's ok if it is higher.
c. Die Pflanze muss genau 8 Grad warm stehen,
the plant has to exactly 8 degrees warm stand
?? und wärmer ist auch gut.
and warmer is also good

5.4 Semantics of comparison

I assumed above that *less* is simply the reverse operator to *-er* (see also Beck in preparation) and of type $\langle d, \langle \langle d, t \rangle, t \rangle \rangle$. The operator *less* is the semantic difference between LESS-comparatives and ordinary MORE-comparatives. This is different in Heim's scope analysis. For her, there is no meaningful element *less*. Comparatives uniformly contain *-er*, and comparatives with *less* differ from ordinary MORE-comparatives in that both main and subordinate clause contain an occurrence of *little*. Scope interaction in the *than*-clause of a LESS-comparative like (138) is seen as parallel to other instances of scope interaction, including scope in non-comparative clauses like (139). Thus, her theory has a wider range of applications.¹¹

- (138) Lucinda was driving less fast than allowed.
a. than [allowed [Lu drive little fast]]
MIN: allowed >> little
b. than [little [allowed [Lu drive fast]]]
MAX: little >> allowed

¹¹ In this connection, an anonymous reviewer enquires after variants of Lucinda sentences with negative polar adjectives, like (i).

(i) The helicopter was flying lower than a plane can fly.
Since Heim decomposes *lower* into *-er* + *little* + *high*, the same components as *less high*, we may expect similar ambiguities (and also, combining the proposals in this paper with the analysis of negative antonyms in Beck in preparation predicts that we find the same range of readings). It is an open question how similar the data really are (Heim 2007; Büring 2007). Studies I–IV did not include examples with negative antonym adjectives, and I have nothing to contribute there.

- (139) (Es ist schade, dass) Lucinda so wenig schnell fahren darf.
 (it is a pity that) Lucinda so little fast drive may
 a. allowed [Lu drive so little fast] allowed >> little
 Lucinda is allowed to drive so slowly.
 b. little [allowed [Lu drive so fast]] little >> allowed
 Lucinda is not allowed to drive faster (must drive so slowly).

Let me refer to (139) as an instance of a positive *little* construction (POS *little*, for short). My analysis loses us the connection between *little* and *less* that is so transparent in Heim's analysis. I have to assume that *less* is a comparative operator and *little* is simply some other operator. At the same time, I am not sure that POS *little* data should be seen as parallel to the *than*-clause in a LESS-comparative. Study IV contained five examples of POS *little*, which were tested on the reading corresponding to the (139b) LF, that is the LF matching the one for the dispreferred MAX reading in the Lucinda example according to the *little* theory. The data were uniformly judged acceptable on that reading (average acceptance rate: 88%). There was a contrast in particular between the pair of examples below.

- (140) Die Creme ist weniger dick, als sie sein darf.
 the creme is less thick than it be may
 The crème is less thick than it is allowed to be.

LESS; CP; MAX: 9/20 = 45%

- (141) Es ist problematisch, wie wenig dick die Creme
 it is problematic how little thick the creme
 sein darf.
 be may

It is problematic how liquid the creme may be/has to be.

little >> allowed: 15/20 = 75%

Thus, there is not a very good match between the acceptability of the two example types. Note that one example type concerns the interpretation of the *than*-clause, while the other concerns the interpretation of a main clause comparison. My plot has been to remove negation (in particular *little*) from the *than*-clause, in order to be able to have type <d> *than*-clauses. So they are not predicted to be parallel. In Beck (in preparation), POS *little* data like (141) and (139) are analysed as scope interaction similar to Heim's *little* theory (quite in contrast to the application of Heim's *little* theory in *than*-clauses of *less*-comparatives, which I have argued against). A scope analysis seems a good match with the acceptance rates found in study IV for POS

little. In short, while I argue that we ought to remove Lucinda *than*-clauses from the realm of Heim's scopal *little* theory, the argument does not extend to other types of data covered by that theory.

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