

RECIPROCAL EQUATIVES*

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Abstract

A sentence like *John and Mary are equally heavy* conveys that John and Mary are as heavy as each other and can be characterized as a *reciprocal equative*. This paper discusses reciprocal equatives and inequatives in German. It explores the construction as novel source of evidence concerning the scopal properties of degree quantification. Specifically, reciprocal equatives are argued to provide evidence for the view that degree operators can take inverse scope over modal operators and can take scope outside DPs containing them at the surface (Heim 1999, 2001).

1 Introduction

The German morpheme *gleich* ‘equally’ can be prefixed to a gradable adjective such as *schwer* ‘heavy’ to form an adjectival predicate such as *gleich schwer* ‘equally heavy’. This adjective phrase can function as the main predicate of a sentence, as in (1), or it can function as an adnominal modifier, as in (2).

- (1) Hans und Maria sind [**gleich** schwer].
Hans und Maria are equally heavy
‘Hans and Maria are equally heavy.’
- (2) Hans und Maria tragen [[**gleich** schwere] Rucksäcke].
Hans und Maria carry equally heavy backpacks
‘Hans and Maria carry equally heavy backpacks.’

The interpretation of an adjectival predicate introduced by *gleich* can be characterized as both *equative* and *reciprocal*. Sentence (1), for example, conveys that Hans and Maria are as heavy as each other. I will accordingly refer to such adjective phrases and the sentences containing them as *reciprocal equatives*.

Reciprocal equatives, which do not seem to have been described or analyzed in previous literature, raise interesting questions about degree quantification and covert reciprocity. In this paper, I will focus on the scopal behavior of reciprocal equative operators. Specifically, I will show that reciprocal equatives provide novel evidence for the view that degree operators are scopally mobile, and in particular that they are able to scope out of DPs (Heim 1999, 2001).

2 Some preliminaries

Before delving into the analysis of reciprocal equatives, I will establish some basic additional facts. To begin, in addition to *gleich*, German features the reciprocal degree morpheme *unterschiedlich* ‘differently, unequally’, which can introduce adjective phrases such as *unterschiedlich schwer* ‘unequally heavy, of different weight’. As (3) and (4) illustrate, such

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adjective phrases too can occur either predicatively or adnominally. They may be characterized as *reciprocal inequatives*. Sentence (3), for example, expresses that Hans and Maria are not as heavy as each other.¹

(3) Hans und Maria sind [**unterschiedlich** schwer].
Hans und Maria are unequally heavy

(4) Hans und Maria tragen [[**unterschiedlich** schwere] Rucksäcke].
Hans und Maria carry unequally heavy backpacks

Reciprocal inequatives do not seem to exist in English. This is one reason for exploring the phenomenon of reciprocal degree quantification in German, as this offers more opportunity for experimentation.

Another reason for focusing on German data is that equative *equally* in English has a non-reciprocal use as well. In particular, *equally* allows for a discourse anaphoric interpretation in which the so-called standard of comparison is recovered from context. The second sentence in (5)a, for example, can be read as entailing that both John and Mary weigh 80kg. In contrast, the German counterpart in (5)b cannot be so understood.²

(5) a. Bill weighs 80 kg. Hans and Maria are [**equally** heavy].
 b. Bill wiegt 80 kg. Hans und Maria sind [**gleich** schwer].
Bill weighs 80 kg Hans und Maria are equally heavy

As one might expect, a predicate introduced by *equally* in its non-reciprocal, discourse anaphoric interpretation need not combine with a plural argument. Example (6)a illustrates this. In contrast, the German example in (6)b is unacceptable, indicating that predicates introduced by *gleich* do require plural arguments.³

(6) a. (Bill weighs 80 kg.) Maria is [**equally** heavy].
 b. (Bill wiegt 80 kg.) *Maria ist [**gleich** schwer].
Bill weighs 80 kg Maria is equally heavy

It appears that in (6)a, *equally* can be replaced with the more familiar equative operator (*just*) *as* without a change in interpretation. The second sentence in (7)a conveys that Maria also weighs 80 kg.

(7) a. (Bill weighs 80 kg.) Maria is **just as** heavy.
 b. Maria is (**just**) **as** heavy [as Hans].

Sentence (7)b illustrates that the standard of comparison associated with equative (*just*) *as* need not be determined anaphorically, but may be provided explicitly by an *as*-phrase. As shown in (8)a, the same is true for equative *equally*. In contrast, as (8)b illustrates, German *gleich* cannot be accompanied by a *wie*-clause.

(8) a. Maria is [**equally** heavy] [as Hans].
 b. *Maria ist [**gleich** schwer] [wie Hans].
Maria is equally heavy as Hans

The observations reported above suggest that English *equally* is ambiguous between a reciprocal equative operator and an ordinary equative operator with much the same syntax

¹ *Gleich* and *unterschiedlich* can also be used as adjectives, as in *viele gleiche/unterschiedliche Antworten* ‘many identical/different answers’. I will not discuss this use.

² Actually, there appears to be a dialect split. For some German speakers, *gleich* seems to have much the same interpretive options as *equally* does in English. The judgments reported in the text are from my own dialect.

³ This is not quite accurate. Reciprocal equatives with universal subjects, such as *Jeder Junge war gleich schnell* ‘Every boy was equally fast’, appear significantly better than (6)b. I will not discuss such cases.

and semantics as (*just*) *as*. In studying English reciprocal equatives, therefore, care must be taken to exclude potentially interfering discourse anaphoric readings from consideration. No such complications arise in German, where equative *gleich* is unambiguously reciprocal. This is another advantage of studying the reciprocal equative phenomenon in German.⁴

3 A semantics for reciprocal (in)equatives

Following much of the literature on degree constructions, I will assume that a gradable adjective denotes a relation from the set of degrees D_d to the set of individuals D_e .⁵ More specifically, I will assume that a gradable adjective relates a degree d to an individual x just in case x has the property expressed by the adjective to at least degree d (e.g. Bierwisch 1989, Gawron 1995, Heim 1999, 2000). Thus I take *schwer* ‘heavy’ to have the denotation in (9), where HEAVY is a measure function mapping every individual in its domain to its weight.

$$(9) \quad [[\text{schwer}]] = \lambda d. \lambda x. \text{HEAVY}(x) \geq d$$

Turning to the semantics of reciprocal degree operators, I take the denotations of *gleich* and *unterschiedlich* to relate gradable adjective denotations to plural individuals. The lexical entries in (10) are designed to assign the intended truth conditions to simple examples like (1) and (3).

$$(10) \quad \begin{array}{l} \text{a.} \quad [[\text{gleich}]](R)(Z) = \text{True iff} \\ \quad \forall x,y[x,y \leq Z \ \& \ x,y \in C \rightarrow \{d: R(d)(x)\} = \{d: R(d)(y)\}] \\ \text{b.} \quad [[\text{unterschiedlich}]](R)(Z) = \text{True iff} \\ \quad \forall x,y[x,y \leq Z \ \& \ x \neq y \ \& \ x,y \in C \rightarrow \{d: R(d)(x)\} \neq \{d: R(d)(y)\}] \end{array}$$

In these entries, R ranges over relations from D_d to D_e (type $d(et)$); Z ranges over plural individuals (type e); x and y range over individuals, singular or plural (type e); C is to be thought of as a contextually determined set of individuals, an implicit domain restrictor for plural quantification of the sort proposed in Schwarzschild (1996); and \leq is the “part of” relation among individuals. Assuming $C = \{\text{Hans, Maria}\}$, (11) shows how the lexical entries in (10) apply to the examples in (1) and (3).

$$(11) \quad \begin{array}{l} \text{a.} \quad [[[\text{Hans und Maria}] \text{ sind } [\text{gleich schwer}]]] = \text{True iff} \\ \quad \forall x,y[x,y \leq h+m \ \& \ x,y \in C \rightarrow \{d: \text{HEAVY}(x) \geq d\} = \{d: \text{HEAVY}(y) \geq d\}] \text{ iff} \\ \quad \{d: \text{HEAVY}(h) \geq d\} = \{d: \text{HEAVY}(m) \geq d\} \\ \text{b.} \quad [[[\text{Hans und Maria}] \text{ sind } [\text{unterschiedlich schwer}]]] = \text{True iff} \\ \quad \forall x,y[x,y \leq h+m \ \& \ x \neq y \ \& \ x,y \in C \rightarrow \{d: \text{HEAVY}(x) \geq d\} \neq \{d: \text{HEAVY}(y) \geq d\}] \text{ iff} \\ \quad \{d: \text{HEAVY}(h) \geq d\} \neq \{d: \text{HEAVY}(m) \geq d\} \end{array}$$

The sets of degrees $\{d: \text{HEAVY}(h) \geq d\}$ and $\{d: \text{HEAVY}(m) \geq d\}$ are initial intervals on the weight scale, namely the intervals $(0, \text{HEAVY}(h)]$ and $(0, \text{HEAVY}(m)]$, respectively. We therefore have the equivalence in (12), and so (10) indeed derives the intended truth conditions for (1) and (3).

$$(12) \quad \{d: \text{HEAVY}(h) \geq d\} = \{d: \text{HEAVY}(m) \geq d\} \text{ iff} \\ \text{HEAVY}(h) = \text{HEAVY}(m)$$

Following Schwarzschild (1996), I assume that C is a set of singular individuals by default, but that it may also contain plural individuals made salient by the linguistic or non-linguistic

⁴ The contrast between English *equally* and German *gleich* is very much reminiscent of the contrast between English *different* and German *verscheiden* ‘different’ noted in Moltmann (1992) and Beck (2000).

⁵ See Kennedy (1997), Bale (2006), and references cited there for alternative views on the semantics of gradable adjectives.

context. For example, the linguistic form of the subject coordination in (13) may suggest that $C = \{\text{the apples, the plums}\}$. Assuming that *die Äpfel und die Pflaumen* denotes the sum of all the relevant apples and plums, sentence (13) is then assigned the truth conditions in (14).

(13) [Die Äpfel und die Pflaumen] sind [gleich schwer].
the apples and the plums are equally heavy

(14) $\{d: \text{HEAVY}(\text{the apples}) \geq d\} = \{d: \text{HEAVY}(\text{the plums}) \geq d\}$

These are the correct truth conditions for a collective reading of (13), a reading according to which the total weight of the apples is the same as the total weight of the plums. The sentence can also have a fully distributive interpretation according to which all the individual apples and plums have the same weight. This reading is derived if $C = \{x: \text{atom}(x) \ \& \ x \leq \text{the apples+the plums}\}$, that is, if C is the set of all the individual apples and plums that are parts of the subject denotation.⁶

4 Scopal mobility of reciprocal degree operators

In this section, I will demonstrate that reciprocal degree operators are not always semantically interpreted in the position where they are pronounced. In doing so, I will confirm a conclusion reached in Heim (1999, 2001), who analyzes the scope taking properties of more familiar degree expressions. Particularly relevant is the superlative operator *-est*, which Heim assigns a denotation like (15).

(15) $[[\text{-est}]](R)(x) = \text{True}$ iff
 $\exists d[R(d)(x) \ \& \ \forall y[R(d)(y) \ \& \ y \in C \rightarrow x = y]]$

According to this lexical entry, the superlative operator relates gradable adjective denotations to individuals, just like reciprocal degree operators do according to (10). Heim's investigation of the scopal properties of *-est* therefore provides a useful guide to the study of reciprocal operator scope. Sections 4.1 and 4.2 below present variants of data points and their analyses presented in Heim (1999) and Heim (2001), respectively.

4.1 Relational adjectives

A reciprocal equative operator associated with a relational adjective such as *böse* 'angry at', can either distribute over a plurality denoted by the subject or over a plurality denoted by the object. For example, the sentences (16)a and (16)b are perceived to have the truth conditions expressed by (17)a and (17)b, respectively.

(16) a. [Hans und Maria] sind mir [gleich böse].
Hans and Maria are me.DAT equally angry
 'Hans and Maria are equally angry at me.'

b. Ich bin [Hans und Maria] [gleich böse].
I am Hans and Maria equally angry
 'I am equally angry at Hans and Maria.'

(17) a. $\{d: \text{ANGRY}(I)(h) \geq d\} = \{d: \text{ANGRY}(I)(m) \geq d\}$
 b. $\{d: \text{ANGRY}(h)(I) \geq d\} = \{d: \text{ANGRY}(m)(I) \geq d\}$

⁶ Schwarzschild (1996) assumes that C is always a cover of the entire domain of singular individuals. This is consistent with the arguments made here, but for ease of exposition I will assume instead that C is a cover of the set of singular individuals that are parts of the denotation of the individual argument of the reciprocal operator. See Schwarzschild (1994, 1996), Laserson (1995), and Brisson (2003) for discussion.

The word order attested in these examples suggests that a relational gradable adjective in German combines with its degree argument before combining with its object DP argument, hence that the lexical entry for *böse* is as shown in (18).

$$(18) \quad [[\text{böse}]] = \lambda d. \lambda y. \lambda x. \text{ANGRY}(y)(x) \geq d$$

Given this lexical entry, however, the structures in (16) come out uninterpretable. According to (10) the function denoted by *gleich* only has denotations type $d(et)$ in its domain, whereas according to (18), the sister of *gleich* in (16) has a denotation of type $d(e(et))$.

Adopting the T-model of Chomsky and Lasnik (1977), this type mismatch can be repaired under the assumption that a reciprocal degree operator can move covertly at Logical Form, leaving behind a degree variable and introducing abstraction over this variable at the landing site. The truth conditions of the sentences in (16) given in (17) can then be credited to the Logical Forms shown in (19). The examples in (16), then, are a first argument for scopal mobility of reciprocal degree operators.⁷

- (19) a. [Hans und Maria] gleich λd [mir [d böse]]
 b. [Hans und Maria] gleich $\lambda d \lambda x$ [ich x [d böse]]

4.2 Inverse scope over modals

The second piece of evidence for covert movement of reciprocal degree operators is the observation that they can participate in so-called scope ambiguity. To illustrate, sentence (20), where the reciprocal predicate occurs under the modal verb *müssen* ‘must’, can be interpreted in two rather different ways.

- (20) [Hans und Maria] müssen [gleich schnell] sein.
Hans und Maria must equally fast be

In one reading, the sentence expresses the requirement that Hans and Maria move at the same speed. Imagine, for example, that Hans and Maria are required to arrive in Montreal at the same time, although there is no requirement as to their absolute time of arrival, and that both are currently the same distance from Montreal. This scenario guarantees the truth of (20) in the reading under consideration. The relevant truth conditions are expressed by (21)a, where *Acc* is the set of accessible possible worlds. These truth conditions can be credited to the Logical Form in (21)b, where *müssen* and *gleich* have surface scope.

- (21) a. $\forall w \in \text{Acc}: \{d: \text{FAST}_w(h) \geq d\} = \{d: \text{FAST}_w(m) \geq d\}$
 b. müssen [[Hans und Maria] [gleich schnell]]

The reading just described concerns the relative speeds of Hans and Maria and does not entail that Hans and Maria must move at a particular minimal speed. But sentence (20) also has a reading with the reverse properties, conveying information concerning absolute but not relative speeds. Imagine it is currently 3pm and both Hans and Maria need to get to Montreal by 4pm. Suppose it so happens that each of them still has 100km to go. Note that in this scenario there is no requirement on the relative speeds of Hans and Maria. The requirements described could be met if both went at a speed of 100km/h, but given that there is nothing wrong with arriving in Montreal before 4pm, it would also be acceptable, for example, if Hans moved at 100km/h and Maria at 120km/h. Yet sentence (20) can be used to describe the

⁷ Note that in (19)b, covertly moved *gleich* and the lambda binder λd it introduces separate the covertly moved DP *Hans und Maria* from the lambda binder λx it introduces. In the resulting structure, the scope of *gleich* denotes a two-place relation of the appropriate type. That the lambda binder introduced by movement need not appear in the immediate scope of the moved phrase has been argued in different contexts in Nissenbaum (1998) and Sauerland (1998). Heim (1999) proposes a Logical Forms much like (19)b for superlative sentences such as *John is angriest at Mary*.

scenario in question. This suggests that (20) has the interpretation in (22)a, which conveys that the minimal speed at which Hans is permitted to move is the same as the minimal speed at which Maria is permitted to move.

- (22) a. $\{d: \forall w \in \text{Acc}: \text{FAST}_w(h) \geq d\} = \{d: \forall w \in \text{Acc}: \text{FAST}_w(m) \geq d\}$
 b. [Hans und Maria] gleich $\lambda d \lambda x [\text{müssen} [x [d \text{ schnell}]]]$

This reading can be credited to the Logical Form in (22)b, where *gleich* takes inverse scope over *müssen*. The availability of this reading is another indication that *gleich* can reach the position in which it is interpreted by way of covert movement at Logical Form. Analogous observations lead to the same conclusion regarding the reciprocal inequative *unterschiedlich*.

5 Adnominal reciprocal degree operators

I have established that reciprocal degree operators are not always interpreted *in situ*. I have suggested, in particular, that *gleich* is able to take inverse scope over a modal operator such as *müssen* ‘must’. Like similar examples with other degree operators discussed in Heim (2001), such cases present counterexamples to Kennedy’s (1997) claim that degree operators never participate in scope ambiguities and effectively are restricted to surface scope.

In this section, I will identify another kind of exception to Kennedy’s hypothesis. I will argue that it is possible for reciprocal degree operators in adnominal adjective phrases to be interpreted in a position external to the containing DP. In doing so, I am again inspired by existing work on superlatives. Szabolcsi (1987) and Heim (1999) have proposed that superlative *–est* is able to covertly extract from DP. However, this proposal remains controversial (Farkas and Kiss 2000, Sharvit and Stateva 2002), and so the examination of reciprocal degree operator scope below may actually help settle a debate.

5.1 Two accounts

I have so far confined attention to cases where an adjective phrase introduced by a reciprocal degree operator occurs in predicative position. I will now attend to sentences like (2), repeated as (23) below.

- (23) Hans und Maria tragen [[gleich schwere] Rucksäcke].
Hans und Maria carry equally heavy backpacks

In the reading that is of interest here, the sentence implies that there is some backpack carried by Hans which has the same weight as some backpack carried by Maria. This reading might receive two different conceivable analyses, called *internal* and *external* below, which differ as to the logical scope of *gleich* that they posit.

5.1.1 The internal analysis

Sentence (23) might have the Logical Form in (24), where *gleich* remains in its surface position. In (24), Δ is to be read as a silent existential determiner, and * and ** are to be understood as forming predicates that are cumulative in the sense of Krifka (1992), with * applying to one-place predicates and ** to two-place predicates.⁸

- (24) [Hans und Maria] **tragen [Δ [gleich schwere] *Rucksack]

⁸ In (24), *Rucksack* is the singular form of plural *Rucksäcke*. For the purposes at hand, the one-place cumulation operator in **Rucksack* can be thought of as the semantic contribution of plural morphology (although this might ultimately be problematic, see Sauerland 2003). The two-place cumulation operator in ***tragen* does not have a morphological reflex. It is conceivable, in fact, that verbs like *tragen* are cumulative from the outset (Krifka 1992), in which case ** could be omitted. However, I will retain the ** operator for perspicuity.

Assuming that [*gleich schwere*] and **Rucksack* compose conjunctively, (24) has the truth conditions in (25), which states that there is a sum of backpacks that Hans and Maria carry such that all of its parts that are elements of *C* have the same weight. Note that according to (25), sentence (23) compares backpacks, rather than those carrying such backpacks.

$$(25) \quad \exists Z[*\text{backpack}(Z) \ \& \ **\text{carry}(h+m,Z) \ \& \ \forall x,y[x,y \leq Z \ \& \ x,y \in C \rightarrow \{d: \text{HEAVY}(x) \geq d\} = \{d: \text{HEAVY}(y) \geq d\}]]$$

The truth conditions in (25) account for some basic judgments concerning the meaning of (23). For one, (25) accounts for the intuition that (23) entails (26), as (25) cannot be true unless Hans and Mary each carry a backpack.

$$(26) \quad \text{Hans und Maria tragen Rucksäcke.} \\ \text{Hans und Maria carry backpacks}$$

Moreover, if we make the (natural) assumption that Hans and Maria each carry just one backpack, there is a choice of *C*, namely $C = \{\text{the backpack Hans carries, the backpack Maria carries}\}$, relative to which (25) correctly entails that the two backpacks in question have the same weight. It appears, then, that the Logical Form (23) has at least some promise.⁹

5.1.2 The external analysis

While in (24) the degree operator stays *in situ*, there is an alternative Logical Form, shown in (27), which differs minimally from (24) in that *gleich* extracts from the object DP to a position right below the subject DP. This Logical Form has the truth conditions in (28). Note that according to (28), in contrast to (25), sentence (23) compares people, rather than comparing backpacks carried by those people.

$$(27) \quad [\text{Hans und Maria}] \text{ gleich } \lambda d[**\text{tragen} [\Delta [d \text{ schwere}] *Rucksack]]$$

$$(28) \quad \forall x,y[x,y \leq h+m \ \& \ x,y \in C \rightarrow \{d: \exists z[*\text{backpack}(z) \ \& \ **\text{carry}(x,z) \ \& \ \text{HEAVY}(z) \geq d\} = \{d: \exists z[*\text{backpack}(z) \ \& \ **\text{carry}(y,z) \ \& \ \text{HEAVY}(z) \geq d\}]$$

Does the formula in (28) express the intended interpretation? Suppose that $C = \{\text{Hans, Maria}\}$, and suppose moreover that Hans and Maria each carry exactly one backpack. Then (28) is true just in case the weight such that Hans carries a backpack of that weight is the same as the weight such that Maria carries a backpack of that weight. As desired, therefore, the formula is true just in case the two backpacks in question have the same weight.

This is encouraging, but as it stands, (28) misses an important aspect of the meaning of sentence (23). Note that the formula does not account for the fact that (23) entails (26). If neither Hans nor Maria carries a backpack, then of course there is no the weight such that either of them carries a backpack of that weight, and hence each of the two sets of degrees described in (28) is empty and (28) incorrectly comes out as true.

However, this problem does not prove the Logical Form in (27) to be inadequate. Instead, the problem can be taken to indicate that the lexical entries for reciprocal degree operators in (10) need to be amended. Suppose a reciprocal degree operator triggers the presupposition that its first argument relates every part of its second argument that is an element of *C* to some degree. Encoding presuppositions through truth value gaps, this amounts to the proposal that *gleich* and *unterschiedlich* introduce the definedness condition in (29), which requires that the lexical entries in (10) be revised as in (30).

⁹ The internal analysis of cases like (23) is similar to Beck's (2000) analysis of sentences such as *Hans and Maria live in different cities*.

- (29) $[[\text{gleich/unterschiedlich}]](R)(Z)$ is defined only if
 $\forall z[z \leq Z \ \& \ z \in C \rightarrow \{d: R(d)(z)\} \neq \emptyset]$
- (30) a. If defined, $[[\text{gleich}]](R)(Z) = \text{True}$ iff
 $\forall x,y[x,y \leq Z \ \& \ x,y \in C \rightarrow \{d: R(d)(x)\} = \{d: R(d)(y)\}]$
- b. If defined, $[[\text{unterschiedlich}]](R)(Z) = \text{True}$ iff
 $\forall x,y[x,y \leq Z \ \& \ x \neq y \ \& \ x,y \in C \rightarrow \{d: R(d)(x)\} \neq \{d: R(d)(y)\}]$

The definedness condition in (29) ensures that (27), just like (24), cannot be true unless both Hans and Maria carry a backpack. So adopting (29)/(30), the two Logical Forms in (24) and (27) become rather close in meaning. Assuming that Hans and Maria each carry no more than one backpack, each of these Logical Forms is true just in case each of them carries a backpack and these two backpacks have the same weight.¹⁰

This is not to say, of course, that the two Logical Forms are semantically equivalent. The next subsection examines differences in prediction concerning the meaning of sentence (23).

5.2 Differences in predictions

Both the internal and the external analysis predict (23) to imply that both Hans and Maria carry a backpack. The obvious difference between the two accounts, however, is that the internal analysis takes this existential implication to be truth conditionally entailed, while according to the external analysis it is presupposed. These predictions are in principle testable. For example, since presuppositions, but not truth conditional entailments, are expected to project from polar questions, the external account but not the internal account predicts sentence (31) to suggest that Hans and Maria carry backpacks.

- (31) Tragen Hans und Maria $[[\text{gleich schwere}]]$ Rucksäcke?
carry Hans und Maria equally heavy backpacks
 ‘Do Hans and Maria carry equally heavy backpacks?’

Unfortunately, however, I find it hard to say whether or not sentence (31) carries the existential presupposition in question. While I would tend to interpret a speaker uttering (31) as presupposing that Hans and Maria carry backpacks, a reply like (32) would not seem infelicitous, and does not obviously deny such a presupposition. Thus intuitions on the nature of the existential implication carried by (23) are *prima facie* consistent with either analysis

- (32) Nein, nur Hans trägt einen Rucksäck.
 no, only *Hans carries a backpack*
 ‘No, only Hans carries a backpack.’

Another difference in predictions between the two analyses under consideration concerns situations where more than two backpacks are carried. For example, consider the scenario described in (33).

- (33) Hans carries two backpacks, weighing 10kg and 5kg, respectively.
 Maria carries two backpacks, weighing 10kg and 15kg, respectively.

Assuming that C contains all the relevant individual backpacks, the internal analysis can make (23) true in this scenario, as there are two backpacks of the same weight, the two 10kg backpacks, that Hans and Maria carry. In contrast, assuming again that C contains both Hans and Maria, the external analysis predicts the sentence to be false. This is because Maria but

¹⁰ The switch from (10) to (29)/(30) has no negative consequences for the analyses of the examples considered so far. The presupposition that physical objects such as Hans, Maria, apples, plums, or backpacks have weights is unproblematic.

not Hans carries a sum of backpacks with a total weight of 25kg, so that the two sets of degrees described in (28) will be distinct. So here we have a clear difference in predicted truth conditions. However, it seems to me that (23) can be judged either true or false in scenario (33), and so intuitions again appear consistent with either analysis.

In sum, intuitions on the meaning of (23) alone do not clearly favor one of the two analyses under consideration over the other and seem compatible with either. In fact, for all we have seen, it may well be that both analyses are available. Below I will discuss a wider range of data supporting this conclusion.

5.3 Where an internal analysis is needed

From a syntactic perspective, it is hard to see why an internal analysis of adnominal reciprocal equatives should be unavailable. After all, why should it not be possible for the reciprocal degree operator to remain *in situ* at Logical Form? A more direct argument for the internal analysis comes from cases like (34).

- (34) Waldi hat [[unterschiedlich lange] Ohren].
Waldi has unequally long ears

For obvious semantic reasons, the external analysis does not apply correctly to this example. Given that *Waldi* denotes a singular individual, rather than a plurality, the Logical Form in (35)a, where the degree operator has extracted from DP, is uninterpretable. In contrast, the Logical Form in (35)b, where the degree operator remains *in situ*, is interpretable and has the intended interpretation, conveying that Waldi has ears that have different lengths.

- (35) a. Waldi unterschiedlich λd [**hat [Δ [d lange] *Ohr]]
 b. Waldi **hat [Δ [unterschiedlich lange] *Ohr]

There are also cases where the Logical Form posited by the external analysis, although interpretable, does not express the interpretation that is intended. Sentence (36) is just like (23), except that the reciprocal equative is preceded by the numeral *zwei* ‘two’.

- (36) [Hans und Maria] tragen [zwei [gleich schwere] Rucksäcke].
Hans und Maria carry two equally heavy backpacks

Sentence (36) has an interpretation in which it is close to synonymous to sentence (23) in the reading under discussion. In this interpretation, (36) entails that each of Hans and Maria carries a backpack. While the sentence may be consistent with Hans or Maria carrying more than one backpack, it does not entail that either of them does. With this in mind, consider the two Logical Forms in (37).

- (37) a. [Hans und Maria] gleich λd [**tragen [Δ zwei [d schwere] *Rucksack]]
 b. [Hans und Maria] **tragen [Δ zwei [gleich schwere] *Rucksack]

Each of these Logical Form is interpretable, but the two interpretations they express differ dramatically. Since the external analysis is committed to the assumption that *gleich* triggers the existential presupposition encoded in (29), (37)a implies, for $C = \{\text{Hans, Maria}\}$, that Hans and Maria each carry at least two backpacks. As noted, the relevant reading of (36) has no such implication. In contrast, the Logical Form (37)b has the intended semantics, conveying that there are two backpacks that Hans and Maria carry and that have the same weight. Sentence (36), then, is another case for which an internal analysis is without competition.

Yet none of the observations presented here establishes that there could not also be cases for which an external analysis is adequate. In fact, the next section presents examples that do seem to fit this profile.

5.4 Where an external analysis is needed

This section discusses two types of cases that seem to call for an external analyses. Section 5.4.1 presents examples where the reciprocal degree operator is prefixed to *viele* ‘many’, and section 5.4.2 discusses cases where the DP hosting the reciprocal degree operator appears in the scope of a modal verb.

5.4.1 Amount equatives

Sentence (38) is parallel in form to cases like (23) above, but *gleich* combines with the amount expression *viele* ‘many’, rather than with an ordinary gradable adjective such as *schwer* ‘heavy’.

(38) [Hans und Maria] haben [[gleich viele] **Katzen**].
Hans und Maria have equally many cats

In one possible analysis, *viele* is a gradable adjective as well, denoting a relation between individuals and degrees. Specifically, *viele* might be taken to relate an individual to the number of singularities that it has as parts. Thus *viele* might be given the lexical entry in (39), where $/x/$ is the cardinality of $\{y: \text{atom}(y) \ \& \ y \leq x\}$, hence d ranges over natural numbers.

(39) $[[\text{viele}]] = \lambda d. \lambda x. /x/ \geq d$

Assuming this adjectival analysis of *viele*, the internal analysis assigns (38) the Logical Form in (40), which has the interpretation in (41)a. For a suitable value of C , this formula may seem to capture the meaning of sentence (38). To be sure, for $C = \{\text{the cats Hans has, the cats Maria has}\}$, (41)a is true if Hans has exactly the same number of cats as Maria does.

(40) [Hans und Maria] **haben [Δ [gleich viele] *Katze]

(41) a. $\exists Z[\text{*cat}(Z) \ \& \ \text{**has}(h+m,Z) \ \& \ \forall x,y[x,y \leq Z \ \& \ x,y \in C \rightarrow \{d: /x/ \geq d\} = \{d: /y/ \geq d\}]$
 b. $\exists Z[\text{*pet}(Z) \ \& \ \text{**has}(h+m,Z) \ \& \ \forall x,y[x,y \leq Z \ \& \ x,y \in C \rightarrow \{d: /x/ \geq d\} = \{d: /y/ \geq d\}]$

However, the internal analysis is not in fact adequate in this case. One way of showing this builds on the observation that for any fixed value of C , (41)b is true whenever (41)a is true. Since cats are pets, the existence of a sum of cats with a certain property, guarantees the existence with a sum of pets with that property. In other words, the internal analysis predicts sentence (38) to be upward entailing in the position of the common noun. This prediction is clearly incorrect, as the inference from (38) to (42) is judged to be invalid. If Hans has two cats and a dog, while Maria only has two cats, for example, then (38) is true while (42) is false.¹¹

(42) [Hans und Maria] haben [[gleich viele] **Haustiere**].
Hans und Maria have equally many pets

The external analysis, in contrast, does not suffer from the same shortcoming. The Logical Form in (43) has the interpretation in (44)a, which for $C = \{\text{Hans, Maria}\}$ conveys that Hans and Maria have exactly the same number of cats. It is apparent that (44)a does not entail (44)b, hence the external analysis correctly blocks the inference from (38) to (42).

(43) [Hans und Maria] gleich $\lambda d[\text{**haben} [\Delta [d \text{ viele}] *Katze]]$

¹¹ Blocking the inference from (38) to (42) in the internal analysis would require the assumption that (42) cannot be interpreted relative $C = \{\text{the cats Hans has, the cats Maria has}\}$, but must instead be interpreted relative to $\{\text{the pets Hans has, the pets Maria has}\}$. It seems unlikely that this assumption can be derived on principled grounds.

- (44) a. $\forall x,y[x,y \leq h+m \ \& \ x,y \in C \rightarrow \{d: \exists z[*cat(z) \ \& \ **has(x,z) \ \& \ /z/ \geq d\} = \{d: \exists z[*cat(z) \ \& \ **has(y,z) \ \& \ /z/ \geq d\}]$
 b. $\forall x,y[x,y \leq h+m \ \& \ x,y \in C \rightarrow \{d: \exists z[*pet(z) \ \& \ **has(x,z) \ \& \ /z/ \geq d\} = \{d: \exists z[*pet(z) \ \& \ **has(y,z) \ \& \ /z/ \geq d\}]$

Apart from not deriving correct truth conditions for adnominal reciprocal equatives with *viele*, the internal analysis also makes incorrect predictions on acceptability. If *viele* were taken to be interpreted *in situ* in (38) or (42), the plurality of the subject DP should not be essential for semantic well-formedness. Thus, at least in some contexts, a sentence like (45) should be no less acceptable than (38) and (42) are. For example, in a context where $C = \{\text{the cats Hans has, the dogs Hans has}\}$, (45) should convey that Hans has exactly as many cats as he has dogs.

- (45) *Hans hat [[gleich viele] Haustiere].
Hans has equally many pets

However, this prediction is incorrect.¹² Sentence (45) is unacceptable irrespective of the context in which it may appear. In particular, (45) does not improve when preceded by a text like (46), which should presumably be sufficient to make the domain restriction $C = \{\text{the cats Hans has, the dogs Hans has}\}$ available.

- (46) Sowohl Hans als auch Maria haben Hunde und Katzen.
both Hans and Maria have dogs and cats
 Maria hat zwei Hunde und drei Katzen.
Maria has two dogs and three cats

Again, the external analysis has the intended effect, for irrespective of context, it does not assign (45) any denotation. This suggests strongly that in adnominal reciprocal equatives with *viele*, the degree operator must extract from its DP at Logical Form.¹³

The obvious remaining question is what it is that prevents *viele* from being interpreted *in situ*. The answer that I would like to suggest is that *viele* is not an adjective after all, but a determiner. Suppose with Hackl (2000) that *viele* has a lexical entry like (47), hence denotes a function of type $d((et)(et))$, a function from the set of degrees to a relation between sets of individuals.

- (47) $[[\text{viele}]] = \lambda d. \lambda f. \lambda g. \exists x[/x/ \geq d \ \& \ f(x) \ \& \ g(x)]$

Under this revised analysis *viele* is a determiner with existential quantificational force. Accordingly, the revised analysis has no need, and in fact no room, for the silent existential determiner Δ posited in the Logical Forms in (40) and (43). So these Logical Forms are to be replaced with those in (48).

- (48) a. [Hans und Maria] **haben [[gleich viele] *Katze]
 b. [Hans und Maria] gleich λd [**haben [[d viele] *Katze]]

Note now that (48)a is uninterpretable under the assumptions made here. According to (29), and (30), *gleich* denotes a function of type $(d(et))(et)$, a function looking for an input of type $d(et)$. Since (47) assigns *viele* a denotation of type $d((et)(et))$, *gleich viele* in (48)a has no interpretation. In contrast, the Logical Form (48)b is interpretable and under the lexical entry

¹² As the contrast in (6) above would lead one to expect, the English counterpart of sentence (45), *John has equally many pets*, is grammatical.

¹³ Observations reported in Szabolcsi (1986) and Gawron (1995) suggest that in amount superlatives such as *John has the most dogs*, the degree operator also must scope out of its DP. The account proposed in Gawron (1995) derives these observations in a way similar to the treatment of amount equatives proposed here.

(47), it has the very same interpretation that (43) has under the lexical entry (39). So by forcing covert extraction of a reciprocal degree operator from its DP, the determiner analysis of *viele* makes the correct predictions for the cases considered here.

I conclude that an external analysis is available at least for adnominal reciprocal equatives with *viele*. To be sure, this does not mean that an external analysis is possible in all cases. It is conceivable that a reciprocal degree operator can covertly extract from DP when it combines with a determiner, but not when it combines with an adjective. However, data presented in the next subsection suggest that the external analysis is more generally available.

5.4.2 Inverse scope over modals again

Section 4.2 reported that it seems possible for the degree operator in a predicative reciprocal equative to take inverse scope over a modal verb such as *müssen* ‘must’. The natural question arises whether the same option is available for the degree operator in adnominal cases. Consider then the sentence in (49).

- (49) Hans und Maria müssen [[gleich schwere] Rucksäcke] tragen.
Hans und Maria must equally heavy backpacks carry

This sentence has two interpretations that will need to be set aside, as they do not make the point I am after here. One interpretation is an ordinary *de dicto* reading, according to which there is a requirement that Hans and Maria carry backpacks of the same weight. There also is a *de re* reading, according to which there are equally heavy backpacks that Hans and Maria are required to carry. These two readings might well be credited to the two Logical Forms in (50), which differ as to the relative scope of the object DP and the modal, but which are alike in that the degree operator itself remains *in situ*. While the readings in question might also be captured by an external analysis, they do not provide new evidence for the availability of such an analysis.

- (50) a. müssen [[Hans und Maria] [[gleich schwere] *Rucksack] **tragen]
 b. [[gleich schwere] *Rucksack] λx [müssen [[Hans und Maria] x **tragen]]

But now suppose Hans and Maria take part in a contest that requires all participants to carry backpacks weighing at least 20kg. The rules of the contest are consistent with Hans and Maria carrying a 20kg backpack and a 25kg backpack, respectively, so the ordinary *de dicto* reading expressed by (50)a is false. Also, since the regulations do not call for participants to carry any particular backpacks, the *de re* reading expressed by (50)b is false as well. And yet (49) can be used as a true description of the scenario at hand. This suggests that the sentence has a third reading with the interpretation in (51), according to which the minimal backpack weight permitted for Hans is also the minimal backpack weight permitted for Maria.

- (51) $\{d: \forall w \in \text{Acc}: \exists z [* \text{backpack}_w(z) \ \& \ ** \text{carry}_w(h,z) \ \& \ \text{HEAVY}_w(z) \geq d] \}$ =
 $\{d: \forall w \in \text{Acc}: \exists z [* \text{backpack}_w(z) \ \& \ ** \text{carry}_w(m,z) \ \& \ \text{HEAVY}_w(z) \geq d] \}$

Note that this interpretation can be credited to the Logical Form in (52), where *gleich* has extracted from its DP, taking inverse scope over the modal, while the indefinite object evacuated by *gleich* remains in the scope of the modal.

- (52) [Hans und Maria] gleich $\lambda d \lambda x$ [müssen [[x [d schwere] *Rucksack] **tragen]]

If no alternative explanation for the relevant reading can be found, then it can be concluded that reciprocal degree operators in adnominal equatives are generally able to extract from their DP. Thus the existence of the relevant reading of (49) suggest that the external analysis is not restricted to amount equatives.

At this point, a word of caution is in order. Heim (1999) discusses superlative examples analogous to (49) and reports them to permit readings which seem to call for Logical Forms much like (52). However, responding to Heim (1999), Sharvit and Stateva (2002) argue that the relevant readings are consistent with an internal analysis of the superlative operator after all. Therefore, a complete argument for an external analysis should make sure that the account of superlatives given in Sharvit and Stateva (2002) does not correctly extend to reciprocal equatives. While I believe that such an argument can be made, I do not have enough space here to address the issue and must leave it for another occasion. For the time being, though, I tentatively conclude that cases like (49) prove the external analysis to be generally available.

6 Some open questions

To summarize, the range of interpretations available for reciprocal (in)equatives supports the conclusion, reached in studies on more familiar degree constructions, that degree operators are scopally mobile (Heim 1999, 2001). In particular, the data presented here suggest that at least in some cases, reciprocal degree operators in adnominal equative phrases can extract from DP at Logical Form.

In concluding, I will point to three questions that arise from the discussion above and which will need to be answered in future work. The first question concerns the unacceptability of sentences like (53).

- (53) *Hans und Maria tragen [einen [gleich schweren] Rucksack].
Hans und Maria carry a equally heavy backpack

Note that (53) differs from (23) above merely in that the indefinite object DP shows singular morphology. Nothing I have said would lead one to expect that this difference in number morphology correlates with a contrast in acceptability. While the Logical Form in (54)a is expected to be uninterpretable, (54)b is interpretable and should permit (53) to have much the same meaning as (23). The ungrammaticality of (53) therefore remains to be explained.

- (54) a. [Hans und Maria] [**tragen [einen [gleich schweren] Rucksack]]
 b. [Hans und Maria] gleich λd [**tragen [einen [d schweren] Rucksack]]

The second question concerns the acceptability contrast between (45) above and sentence (55) below. In the account proposed above, the Logical Form in (56)a is uninterpretable because the phrase *gleich viele* has no denotation. But if this is correct, then irrespective of the semantics of conjunction, the Logical Form in (56)b should be uninterpretable as well. The question that remains, therefore, is how (55) comes to be semantically well-formed, conveying that Hans has exactly as many dogs as he has cats.

- (55) Hans hat [[gleich viele] [Hunde und Katzen]].
Hans has equally many dogs and cats

- (56) a. Hans **hat [[gleich viele] *Katze]
 b. Hans **hat [[gleich viele] [*Hund und *Katze]]

The third question concerns examples like (13) above, repeated below as (57). As I noted in section 3, the sentence can be read either as saying that the total weight of the apples is the same as the total weight of the plums, or as saying that all of the individual pieces of fruit have the same weight. I suggested that, assuming the lexical entries in (10), the two readings are due to two different choices of C, namely $C = \{\text{the apples, the plums}\}$ and $C = \{x: \text{atom}(x) \ \& \ x \leq \text{the apples} + \text{the plums}\}$, respectively.

- (57) [Die Äpfel und die Pflaumen] sind [gleich schwer].
the apples and the plums are equally heavy

Now consider the variant of (57) in (58) below, where *gleich* is replaced by *unterschiedlich*.¹⁴ In analogy to (57), sentence (58) can be read as saying that the total weight of the apples is different from the total weight of the plums, or as saying that each individual piece of fruit has a different weight than each of the other pieces. Assuming (10) or (29)/(30), these two readings can be derived under the same two choices of C given above.

(58) [Die Äpfel und die Pflaumen] sind [unterschiedlich schwer].
the apples and the plums are unequally heavy

But now consider a scenario with two apples weighing 150g each and three plums weighing 100g each. Since the total weight of the apples is the same as the total weight of the plums, and since some pieces of fruit have the same weight, neither of the two readings described above is true in the scenario at hand. And yet sentence (58) can be used to describe it. Apparently the sentence can be read as conveying that each of the apples has a different weight than each of the plums.

It is not obvious how this reading might be derived under the assumptions I have been making. In fact, it seems to me that it simply cannot be derived under the semantics of reciprocal degree operators given in (10) or (29)/(30). I will not prove this here, but I will show that one particular attempt that may initially seem promising is unsuccessful. This attempt employs a distributive operator ^D of the sort posited in e.g. Roberts (1987). As shown in the Logical Form in (59), after covert movement of both the reciprocal operator and the subject DP, ^D can be applied to the derived predicate of individuals within the scope of *unterschiedlich*. Assuming again that C = {the apples, the plums}, this Logical Form has the truth conditions in (60), where universal quantification over individual pieces of fruit is due to the semantic contribution of ^D.

(59) [die Äpfel und die Pflaumen] unterschiedlich $\lambda d^D \lambda x [x [d \text{ schwer}]]$

(60) {d: $\forall x[\text{atom}(x) \ \& \ x \leq \text{the apples} \rightarrow \text{HEAVY}(x) \geq d]$ } \neq
 {d: $\forall x[\text{atom}(x) \ \& \ x \leq \text{the plums} \rightarrow \text{HEAVY}(x) \geq d]$ }

Unfortunately, however, the formula in (60) does not express the interpretation that is of interest here. It does not convey that each of the apples has a different weight than each of the plums. Instead, it merely conveys that the lightest of the apples has a different weight than the lightest of the plums. Therefore, whether or not (60) is a possible interpretation of sentence (58), the reading of interest here remains to be accounted for.

I suspect that this problem indicates that building reciprocity into the semantics of reciprocal degree operators in the way the lexical entries in (10) or (29)/(30) do is ultimately incorrect. But I must leave the task of explicating this suspicion and exploring alternative analyses for another occasion.

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¹⁴ Thanks to Ivano Caponigro for helping me see that the argument made below needs to be based on cases with *unterschiedlich*.

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