On reciprocal degree constructions

A view from Mandarin

I-Ta Chris Hsieh
National Tsing Hua University

A degree sentence such as *John and Mary are equally tall* conveys both reciprocity and equivalence and hence are termed "Reciprocal Equatives" (RE). Building on Schwarz's (2007) pioneer study, I suggest an account for this degree construction that covers a wider range of data. To the extent that the proposal is on the right track, it provides new support for building in plurality in the domain of degrees, an idea that has been put forward by Beck (2010; 2014) and Dotlačil & Nouwen (2016).

Keywords: reciprocal (in)equative, degree plurality, plural predication, tolerance of exceptions

1. Introduction

The notion of **plurality** has been extended to degrees in many research (e.g. Fitzgibbons et al. 2008; Beck 2010, 2013, 2014; Dotlačil & Nouwen 2016). As Dotlačil & Nouwen (2016) point out, it is not surprising that semantic mechanisms governing plurality formation and plural predication may be extended to degrees, given that degrees and entities behave very much alike. For instance, (1a) carries a cumulative interpretation (e.g. John is 20 years old, Peter is 22, and Mary 26) in the way that (1b) possibly could (e.g. John likes Bill, Peter likes Chris, and Mary likes Sue).

(1) a. John, Peter and Mary are 20, 22 and 26 years old.
b. John, Peter and Mary like Bill, Chris and Sue.

Most proposals relying on the idea of **degree plurality** of some form (Beck 2010, 2014; Dotlačil & Nouwen 2016) aim to account for comparatives with quantifiers in the *than*- clause, an example of which is given in (2).[1] Intuitively, (2) is true only

1. For detailed discussion on this topic, see Beck (2010; 2014), Alrenga & Kennedy (2014), Dotlačil & Nouwen (2016) and references cited therein.

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if John is taller than the tallest girl. While details vary, the research along these lines all suggest that this intuition may be captured if the *than*-clause is interpreted as a collection of degrees that represents all the girls' heights and the comparison relation targets the height of John and that of the tallest girl.

(2) John is taller than every girl is.

This paper intends to widen the scope of investigation along these lines by seeking another phenomenon that could possibly provide support for the idea of incorporating plurality in degree semantics. The discussion centers on what Schwarz (2007) calls "Reciprocal Equatives" (henceforth, RE), a degree construction that receives much less attention in the literature. Examples of this degree construction are given in (3)–(4).[2]

(3) *Hans und Maria sind* ***gleich*** *schwer.* (German)
Hans and Maria are equally heavy
'John and Mary are equally heavy.'

(4) *Yūehàn hé Mǎlì* ***yíyàng*** *zhòng.* (Mandarin)
John AND Mary equally heavy
'John and Mary are equally heavy.'

Both examples express that John's weight and Mary's are equivalent. This degree construction, as noted by Schwarz (2007), may be characterized as both "reciprocal" and "equivalent", and these meaning components are carried out by the RE morpheme *gleich*/*yíyàng*. This is also where this construction differs from English *as*-equatives; English *as*-equatives, as shown in (5), do not express "mutual equivalence" among the objects in comparison.

(5) John is as tall as Mary, and even taller.
(Matushansky 2008, attributed possibly to Chris Kennedy)

(6) *Hans und Maria sind gleich groß.*
Hans and Maria are equally tall
#*Hans ist sogar größer als Maria.*
Hans is even taller than Maria
Lit: 'Hans and Maria are equally tall. Hans is even taller than Maria.'

2. Throughout this paper, I gloss the Mandarin nominal coordinator *hé/gēn* as AND, despite the fact they might have the same semantic contribution as English *and* in nominal coordination. As pointed out in some research (Chao 1968; Paris 2008; et al.), the coordinators may be ambiguous between a nominal conjunct coordinator or a comitative marker; in the latter case, *hé/gēn* and the nominal it precedes for a comitative adjunct. See also Footnote 9 for some relevant discussion.

(7) #*Yuēhàn*$_1$ *hé Mǎlì yíyàng gāo; tā*$_1$ *shènzhi bǐ Mǎlì gāo.*
John AND Mary equally tall; he even COMP Mary tall
Lit. 'John and Mary are equally tall; he is even taller than Mary.'

More syntactic and semantic properties of REs are reviewed below. The discussion throughout this paper is mainly based on data from Mandarin; some German data however are mentioned when they bear relevance to the discussion. As to the reason why English may not be appropriate for this topic, I refer the reader to Schwarz (2007) (and also Footnotes 3 and 4 below). Nonetheless, I expect the proposal to be extended to English and any other language where this degree construction is found.

1.1 Types of reciprocal equatives

In addition to predicative REs like (3)–(4), there are adnominal ones; see (8)–(9).

(8) *Yuēhàn yǒu-zhė yíyàng cháng-dė ěrduo.* (Mandarin)
John have-PROG equally long-MOD ear
'John has equally long ears.'

(9) *Yuēhàn hé Mǎlí bēi-lė yíyàng zhòng-dė bēibāo.* (Mandarin)
John AND Mary carry-PERF equally heavy-MOD backpack
'John and Mary carry/carried equally heavy backpacks.'

Degree comparison in a RE may be along the dimension of quantity, as shown in (10)–(11).

(10) *Yuēhàn hé Mǎlí yǎng-lė yíyàng dūo-dė māo.* (Mandarin)
John AND Mary keep-PERF equally many-MOD cat
'John and Mary have equally many cats.'

(11) *Yuēhàn yǎng-lė yíyàng duō-dė gǒu gēn māo.* (Mandarin)
John keep-PERF equally many-MOD dog and cat
'John has equally many dogs and cats.'

The need to distinguish an amount RE from those like (8)–(9) comes from their contrast with (12b): in German, for instance, a simple plural noun modified by the Q-adjective *viele* 'many' does not suffice to license the RE morpheme *gleich*, though the RE morpheme, in both (12a) and (12b), occur in pre-nominal position.[3]

3. The Mandarin counterpart of (12b) (see below), in some contexts, may carry an "anaphoric" interpretation; see Footnote 4. This interpretation is irrelevant to the discussion here.

(12) a. *Hans hat gleich longe Ohren.* (German)
Hans has equally long ears
'Hans has equally long ears.'
b. **Hans hat gleich viele Haustiere.* (German)
Hans has equally many pets

The RE morpheme, in most cases, needs to be accompanied by a plural nominal; as shown in (13), a singular nominal in subject position of a predicative RE leads to ungrammaticality.[4]

(13) a. **Maria ist gleich schwer.* (German)
Maria is equally heavy
b. **Mălí yíyàng zhòng.* (Mandarin)
Mary equally heavy
'Mary is equally heavy.'

At least in Mandarin however, the presence of a universal quantifier suffices to license the RE morpheme, as shown in (14)–(15): in (14), all the students in the discourse context are compared based on their speed; in (15), they are compared based on the length of the rope they are given by Zhangsan.

(14) *měi-gė xuéshēng dōu pǎo-dė yíyàng kuài.*
every-CLF student all run-PTCP equally fast
'Every student runs/ran equally fast.'

(15) *Zhāngsān gěi-lė měi-gė xuéshēng yī-tiáo yíyàng cháng-dė shéngzi.*
Zhangsan give-PERF every-CLF student one-CLF equally long-MOD rope
'Zhangsan gave every student an equally long rope.'

(i) *Zhāngsān yǎng-lė yíyàng duō-dė chǒngwù.*
Zhangsan keep-PERF equally many-MOD pet

4. English *Maria is equally heavy* is grammatical on a reciprocal, discourse anaphoric interpretation, which is not in the concern of this paper. As Schwarz (2007) notes, such an interpretation, in some dialects of German, is not possible for *gleich*. To my ear, such an interpretation is possible for Mandarin *yíyàng* only if it is accompanied by the additive particle *yěi* 'also'.

(i) *Yuēhàn bēi-le yí-gė wǔshi gōngjīn zhòng-dė bēibāo; Mǎlì */?? (yěi) bēi-lė*
John carry-PERF one-CLF 50 kg heavy-MOD backpack; Mary also carry
yí-gė yíyàng zhòng-dė bēibāo.
one-CLF equally heavy-MOD backpack
Intended: 'John carried a backpack that weighs 50kgs; Mary carried an equally heavy backpack.'
≅ John and Mary each carry one backpack weighing 50kgs.

Schwarz (2007) also notes that in spite of the fact that a universal quantifier headed by German *jeder* is morphologically singular, a predicative RE with a universal subject like (16) sounds significantly better than (13a).

(16) *Jeder Junge war gleich schnell.*
'Every boy was equally fast.'

1.2 Vagueness and context sensitivity

The adnominal RE (9) may be easily judged true in the scenario in (17), where John and Mary each carry just one backpack.

(17) John carries one backpack weighing 10kgs; Mary carries one weighing 10kgs.

Intuitions however are not always this clear, especially when objects in comparison are in a relatively large group. In a scenario like (18), where John and Mary each carry more than one backpack, and only one backpack John carries weighs the same as one Mary carries, judgment making seems less easy.

(18) John carries two backpacks a and b; <u>a weighs 10kgs</u> and b 15kgs.
Mary carries two backpacks c and d; <u>c weighs 10kgs</u> and d 5kgs.

Schwarz (2007) reports that intuitively the German counterpart of (9) may be true or false in such a scenario.[5] To my ears as well as those of the speakers I have consulted, the Mandarin Example (9) is difficult to judge in this scenario and might hardly be considered true. Nevertheless, such difficulty in judgment making seems to be ameliorated with extra contextual information; for instance, with the additional information in (19), it becomes much easier to consider (9) true in (18).

(19) All the students randomly pick two backpacks to carry on the hiking trip. After the hiking trip, let's weigh the backpacks they choose and see whether there are any two students who get at least two backpacks that have the same weight. It then happens that…
a. *Yuēhàn hé Mǎlì bēi-lė yíyàng zhòng-dė bēibāo.* (Mandarin)
John AND Mary carry-PERF equally heavy-MOD backpack
'John and Mary carried/carry equally heavy backpacks.'

The difficulty in judgment making also varies with the choice of verb; changing the verb in (9) to *pick* (see (20a)) makes it much easier to consider this example true in a scenario very similar to (18) (see (20b)).

5. See § 7 for further discussion on this.

(20) a. *Yuēhàn hé Mǎlì tīao-lė yíyàng zhòng-dė bēibāo.* (Mandarin)
John and Mary pick-PERF equally heavy-MOD backpack
'John and Mary picked equally heavy backpacks.'
b. John picks two backpacks, one weighs 10kgs and one 15kgs;
Mary picks two backpacks, one weighs 10kgs and one 5kgs.

All these observations suggest that intuitions around an adnominal RE may be vague about the contribution of each individual in comparison and may be sensitive to the context of utterance and the property attributed. This is reminiscent of vagueness observed in plural predication, where the contribution of each individual may be vague and is highly influenced by the linguistic and discourse contexts (Schwarzschild 1996; et al.).

1.3 Roadmap

An adequate analysis of REs should not only cover the data discussed in § 1.1 but also provides an explanation for the vagueness and contextual sensitivity shown in § 1.2; this paper aims to achieve this goal. The analysis I would like to propose relies on the assumption that a reciprocal degree morpheme, such as German *gleich* and Mandarin *yíyàng*, obligatorily takes scope at LF. Crucially, some form of "degree plurality" along the lines of Beck (2014) and Dotlačil & Nouwen (2016) need to be built in in degree semantics. On these grounds, the context sensitivity and vagueness found in an adnominal RE may be cashed out with a covered-based theory of plural predication (Schwarzschild 1996; Brisson 1998, 2003; et al.). In § 2 the theoretical tools needed in my proposal are reviewed. In § 3 I lay out my analysis of the RE morpheme. § 4 centers on adnominal REs; the discussion reveals how delicately plurality in the domain of individuals interact with that in the domain of degrees. § 6 briefly discusses reciprocal inequatives. In § 7 I discuss the alternative analysis. Some concluding remarks are in § 8.

2. Plural predication and degree plurality

The analysis I would like to suggest dwells on: (i) the theory of plural predication that makes use of the operators * and ** (Link 1983; Sternefeld 1998; Beck 2000, 2001) constrained by covers, a salient way objects in the universe of discourse are grouped (Schwarzschild 1996; Brisson 1998, 2003); and (ii) Dotlačil & Nouwen's (2016) idea of degree plurality.[6]

6. As noted in § 8, the proposal presented below may be easily adapted to other variants of the approach along with this idea.

2.1 Plural predication and covers

Following Link (1983), Sternefeld (1998), Beck (2000; 2001) and many others, I assume the pluralization operations * and **, which are introduced via the operators * and ** prefixed to the constituent whose denotation undergoes pluralization. The application of these operators, I assume, may combine freely with QR and variable binding (Beck 2000; 2001, et seq.).[7] Along the lines of Schwarzschild (1996), Brisson (1998; 2003), Beck (2001) and many others, I further assume that quantification introduced by these pluralization operators are constrained by **covers**, a salient way of grouping the objects in the universe of discourse; see the definition in (21), which is adopted from Schwarzschild (1996) with slight modification. Throughout the discussion below, $\sqcup$ is the summation operation; $x\sqcup y$ is the sum of two individuals x and y.

(21) C is a cover of a set P iff:
C is a subset of the smallest set X such that: (i) $P\subseteq X$, and (ii) for any x, y such that $x\in X$ and $y\in X$, $(x\sqcup y)\in X$; and every member of P is part of some member in C.

The way a cover C groups objects in the context of utterance is context-sensitive. Following Schwarzschild (1996), I assume that: (i) a cover C is introduced through a free pronoun *C* at LF; and (ii) if there is no cue about how objects in the universe of discourse should be grouped, then they are grouped with the default option, the one in which each atomic individual forms a group on its own.

The operator * pluralizes a one-place predicate and gives rise to the so called "distributive reading" of, e.g. *John and Mary left*, according to which John left and Mary, too, did. In the definition given in (22), $\sqsubseteq$ is a part-whole relation; $x\sqsubseteq y$ iff x is part of y.

(22) a. $[\![\, * \,]\!]\,(C)(P_{<e,\,t>}) = \lambda X_e.\ \forall x\sqsubseteq X[x\in C\rightarrow [{*}P](x)]$
b. *Distribution:*
* is that function: $D_{<e,\,t>}\rightarrow D_{<e,\,t>}$ such that for any $f\in D_{<e,\,t>}$ and any x in D_e, $[{*}f](x)=1$ iff $f(x)=1$ or $\exists u\exists v[x=(u\sqcup v)$ and $[{*}f](u)$ and $[{*}f](v)]$
c. $[\![\,[$*John and Mary* $[$*-*C left*$]]\,]\!] =1$ iff $\forall x\sqsubseteq(J\sqcup M)[x\in C\rightarrow{*}\mathrm{left}(x)]$, where $C\supseteq\{J, M\}$

** is prefixed to a 2-place predicate and gives rise to the so called "cumulative reading" of, e.g. *John and Mary love Bill and Sue*, according to which each of John and

7. It would be more appropriate to use different symbols to distinguish the semantic pluralization operators and the syntactic objects at LF that introduce them. Nevertheless, in order not to create confusion and be consistent with most literature cited here, I will use * and ** to refer to the relevant semantic operations as well as the syntactic operators that introduce them.

Mary loves one of Bill and Sue, and each of Bill and Sue is loved by one of John and Mary.

(23) a. $[\![**]\!] (C)(P_{<e, <e, t>>}) = \lambda X_e. \lambda Y_e.$
$\forall x \sqsubseteq X[x \in C \rightarrow \exists y \sqsubseteq Y[y \in C$ and $[**P](x)(y)]]$ and
$\forall y \sqsubseteq Y[y \in C \rightarrow \exists x \sqsubseteq X[x \in C$ and $[**P](x)(y)]]$

b. *Cumulation:*
** is that function: $D_{<e, <e, t>>} \rightarrow D_{<e, <e, t>>}$ such that for any $R \in D_{<e, <e, t>>}$ and any x, y such that $x \in D_e$ and $y \in D_e$, $[**R](x)(y)=1$ iff $R(x)(y)$, or $\exists x_1 \exists x_2 \exists y_1 \exists y_2[x=(x_1 \sqcup x_2)$ and $y=(y_1 \sqcup y_2)$ and $[**R](x_1)(y_1)$ and $[**R](x_2)(y_2)]$

c. $[\![$ [*John and Mary* [[**-*C*]-*love Bill and Sue*] $]\!]$ =1 iff
$\forall x \sqsubseteq (J \sqcup M)[x \in C \rightarrow \exists y[y \sqsubseteq (B \sqcup S)$ and $y \in C$ and $**love(y)(x)]]$ and
$\forall y \sqsubseteq (B \sqcup S)[y \in C \rightarrow \exists x[x \sqsubseteq (J \sqcup M)$ and $x \in C$ and $**love(y)(x)]]$, where $C \supseteq \{J, M, B, S\}$

2.2 Plurality in the domain of degrees

Dotlačil & Nouwen (2016) suggest that in the doman of degrees, a sum of degrees may be formed via the same summation operation a sum of individuals is: for any two degrees d and d′, d⊔d′ is the sum of d and d′. A gradable adjective such as *tall*, in their proposal, relates a degree d, be it plural or atomic, and an individual x in the way that the height of x (i.e. $\mu_{height}(x)$) is part of d.

(24) $[\![$ tall $]\!] = \lambda d_d. \lambda x_e. \mu_{height}(x) \sqsubseteq d$

An operator MIN is postulated to pick out the unique member d′ from a set D of sums of degrees such that d′ does not contain any other members in D as its proper subparts. Applying MIN to the set of degrees that contain, e.g. John's height, gives us John's height.

(25) For any $D' \in D_{<d, t>}$, $\textsc{min}(D') = \iota d[D'(d)$ and $\neg \exists d'[D'(d')$ and $d' \sqsubset d]]$; undefined otherwise.

(26) If $\mu_{height}(J) = 180cm$, $\{d: [\![tall]\!] (d)(J)\} = \{d: \mu_{height}(J) \sqsubseteq d\} = \{d: 180cm \sqsubseteq d\}$;
$\textsc{min}(\lambda d. \mu_{height}(J) \sqsubseteq d) = \mu_{height}(J) = 180cm$

As noted above, Dotlačil & Nouwen's (2016) main goal is to account for comparatives with a universal quantifier inside the *than*-clause. Intuitively, *John is taller than every girl is* is true iff John is taller than the tallest girl. Dotlačil & Nouwen suggest that this intuition may be captured in the following way. Suppose that in the context there are three girls a, b, and c. The *than*-clause then denotes the set of degrees such that d contains as its subpart every girl's height (i.e. $(\mu_{\text{height}}(a) \sqcup \mu_{\text{height}}(b) \sqcup \mu_{\text{height}}(c)) \sqsubseteq d$; see (27)).

(27) $[\![$*than every girl is ~~tall~~*$]\!] = \lambda d_d.\ \forall x[x \text{ is a girl} \rightarrow \mu_{\text{height}}(x) \sqsubseteq d]$

MIN then picks out the unique sum from this set that does not have any other members as its subparts, and that is $(\mu_{\text{height}}(a) \sqcup \mu_{\text{height}}(b) \sqcup \mu_{\text{height}}(c))$. With the application of the cumulation operation **, the truth conditions (28) are derived, which amounts to saying that $\mu_{\text{height}}(J)$ is greater than all of $\mu_{\text{height}}(a)$, $\mu_{\text{height}}(b)$ and $\mu_{\text{height}}(c)$. This then correctly predicts that *John is taller than every girl is* is true iff John is taller than the tallest girl.

(28) $\mu_{\text{height}}(J)[{**}{>}]\ \text{MIN}\ (\lambda d.\ \forall x[x \text{ is a girl} \rightarrow \mu_{\text{height}}(x) \sqsubseteq d])$

3. The semantics of REs

Below I lay out my proposal for reciprocal equatives. The lexical meaning of the Mandarin RE morpheme *yíyàng* I would like to suggest is given in (29).

(29) $[\![$*yíyàng*$]\!] = \lambda D'_{\langle d,t \rangle}.\ \forall d', d''[d', d'' \sqsubseteq \text{MIN}\ (D') \rightarrow d' = d'']$

According to (29), the RE morpheme operates on a set of degrees and asserts that all the subparts of the member picked out by the operator MIN from this set are mutually equivalent. Together with the definition of MIN in (25), it then follows from (29) that the set of sums of degrees an RE morpheme operates on is not empty; this, I suggest, may be seen as a presupposition carried by an RE morpheme.

I assume that at the surface an RE morpheme is located at the specifier of AP (see (30)). Along with the assumption that a gradable adjective like *tall* relates degrees to individuals in the way we have seen in (24) and denotes a function of type <d, <e, t>>, the type mismatch between the RE morpheme and the gradable adjective is resolved by having the RE morpheme undergo LF-movement; a degree variable then is left in its base-generation position and bound by a λ-abstractor 7 (see Heim & Kratzer (1998); see (30)).

(30) $[_{AP}$ *yíyàng* $[_{A'}$ *tall*$]] \Rightarrow [$*yíyàng* $[7\ [\ldots[_{AP}\ d_7\ [_{A'}$ *tall*$]]]]]$

3.1 Universal and predicative REs

Along with the proposal laid out above, an RE with a universal quantifier, such as (14)–(15) and the Mandarin Example (31), may be accounted for in a way very similar to that in which a comparative with a universal quantifier in the *than*-clause is in Dotlačil & Nouwen's (2016) analysis.

(31) *měi-yī-kùai níupái dōu yíyàng hòu.* (Mandarin)
every-one-CLF steak all equally thick
'Every steak is equally thick.'

Take (31) for instance; at LF the RE morpheme moves out of its base-generation position; the truth conditions in (32) then are derived.[8]

(32) ⟦ [*yíyàng* [7 [*every steak* [d_7 *thick*]]]] ⟧
= ⟦ *yíyàng* ⟧ (λd_d. $\forall x$[x is a steak→$\mu_{\text{thickness}}$ (x)⊑d])
=1 iff $\forall$d′,d″[d′,d″⊑MIN(λd_d. $\forall x$[x is a steak→$\mu_{\text{thickness}}$(x)⊑d])→d′=d″]
'All the subparts of the unique sum d of degrees that contains the thickness of each of the steaks are equivalent to each other.'

These truth conditions say that all the subparts of the degree picked out by MIN, namely the one that contains all and only the thickness of all the steaks in comparison, are mutually equivalent. Suppose that the steaks in comparison are a, b, and c; the set of degrees *yíyàng* operates on contains all and only those that have $\mu_{\text{thickness}}(a)\sqcup\mu_{\text{thickness}}(b)\sqcup\mu_{\text{thickness}}(c)$ as one of their subparts; MIN then picks out $\mu_{\text{thickness}}(a)\sqcup\mu_{\text{thickness}}(b)\sqcup\mu_{\text{thickness}}(c)$, the unique one that contains all and only the thickness of the steaks in comparison. By saying that all the subparts of $\mu_{\text{thickness}}(a)\sqcup\mu_{\text{thickness}}(b)\sqcup\mu_{\text{thickness}}(c)$ are mutually equivalent, the derived truth conditions amount to saying that $\mu_{\text{thickness}}(a)=\mu_{\text{thickness}}(b)=\mu_{\text{thickness}}(c)$; i.e. that all the steaks in comparison have the same thickness.

In a predicative RE like (3)–(4), the pluralization operator * is prefixed to AP and introduces universal quantification in plural predication; at LF, the RE morpheme undergoes movement at LF. The truth conditions in (33b) then are derived. With the natural assumption that the cover C contains the individuals J and M, the derived truth conditions assert that $\mu_{\text{weight}}(J)\sqcup\mu_{\text{weight}}(M)$ have sub-

8. Here I take the combination of *měi*-NUM-CLF-N and *dōu* to be the counterpart of *every*; this is surely for convenience only. While there exist tremendous proposals for the semantic contribution of the particle *dōu* in Mandarin (e.g. Lee 1986; Cheng 1995; Huang 1996; Lin 1998; Chen 2005, 2008; et al.), the analysis I have proposed for REs is independent of these proposals and hence is compatible with any of them; given that in my analysis, the RE morpheme needs to move outside the scope of the elements that bring up the universal quantificational force and as shown in § 3.2, independent principles serve to cash out the plurality requirement, it has nothing to do with the proposed analysis for the RE morpheme *per se* how the semantics contribution of *dōu* may be characterized.

parts mutually equivalent, which amounts to saying that John's weight and Mary's weight are the same.[9]

(33) a. [*yíyàng/gleich* [7 [*J and M* [*-*C* [$_{AP}$ d_7 *heavy*]]]]]
b. ⟦ (33a) ⟧ = ⟦ *yíyàng/gleich* ⟧ (λd. $\forall x \sqsubseteq (J \sqcup M)[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d]$)=1 iff $\forall d',d''[d',d'' \sqsubseteq$ MIN$(\lambda d. \forall x \sqsubseteq (J \sqcup M)[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d]) \rightarrow d'=d'']$
'All the subparts of the unique degree that contains the weight of John and that of Mary are equivalent.'

3.2 The plurality requirement of REs

According to the lexical meaning suggested in (29), the RE morpheme, instead of sets of individuals, operates on sets of degrees. This begs for the question how the ungrammaticality of (13a)–(13b) may be accounted for; in both cases, a singular nominal in subject position results in ungrammaticality.

(13) a. **Maria ist gleich schwer.* (German)
Maria is equally heavy
b. **Mǎlì yíyàng zhòng.* (Mandarin)
Mary equally heavy

Consider (35a), the LF representation of the examples in (13). If we relativize the lexical meaning of a gradable adjective to possible worlds (see (35a)), the examples in (13) then denote the proposition in (35b). This proposition, if defined, obviously is tautological, for the degree picked out by MIN, namely $\mu_{weight}(w)(M)$, the weight of Mary in the world of evaluation w, is atomic (i.e. has no subparts other than itself) across worlds and hence always has subparts mutually equivalent.

(34) ⟦ *heavy* ⟧$^w = \lambda d_d. \lambda x_e. \mu_{weight}(w)(x) \sqsubseteq d$, where $\mu_{weight}(w)(x)$ is the weight of x in w

9. An anonymous reviewer, following Chao (1968), points out that a Mandarin predicative RE like (4) is syntactically ambiguous and may be parsed in two ways (see also Footnote 2). In one, *hé* is a nominal conjunction coordination and hence *Yuēhàn hé Mǎlì* is a nominal conjunction; in the other, *hé* is a comitative marker and together with *Mǎlì* forms a comitative adjunct that excludes *Yuēhàn*. The analysis I suggest for REs is not affected by such an ambiguity in any way, given that in my analysis, (i) the RE morpheme, e.g. in (4), scopes over *Yuēhàn hé Mǎlì* at LF, (ii) the RE morpheme operates on degrees rather than individuals. Hence the internal structure of the nominal coordination has no effect on how the RE morpheme makes its semantic contribution. Since such an syntactic ambiguity has no effect in semantic composition, there is no need to postulate two different lexical entries for the RE morpheme just because of this ambiguity.

(35) a. [*yíyàng* [7 [*Mary* d_7-*tall*]]]
b. $\lambda w.\ \forall d',d''[d',d'' \sqsubseteq \textsc{min}\ (\lambda d.\ \mu_{weight}(w)(M) \sqsubseteq d) \rightarrow d'=d'']$

It has been suggested in much research that some sentences are ungrammatical because the propositions they express are tautological (Barwise & Cooper 1981; Gajewski 2002; et al.); for instance, Barwise & Cooper (1981) suggest that a strong quantifier is ungrammatical in a *there*-sentence (e.g. **There was every student in the room*) because it leads to tautological truth conditions. Along these lines, I suggest that the ungrammaticality of the examples in (13) may be captured in the same way: in these cases, MIN picks out an atomic degree in all words where they are defined; the propositions they express are trivially true and hence are tautological, which consequently results in ungrammaticality.[10]

4. Covers, grouping and the interpretation of adnominal REs

4.1 The syntax and semantics of adnominal REs

As already noted in § 1.2, intuitions around an adnominal RE like (9) are vague, and judgments on these examples are highly influenced by other information in the context of utterance.

(9) *Yuēhàn hé Mǎlì bēi-lė yíyàng zhòng-dė bēibāo.* (Mandarin)
John AND Mary carry-PERF equally heavy-MOD backpack
'John and Mary carry/carried equally heavy backpacks.'

10. An anonymous reviewer points out that (13b) becomes grammatical once a quantificational temporal adverb such as *always/every year* is added in.

(i) *Mǎlì yīzhí/měi.nián dōu yíyàng zhòng.*
Mary always/every.year all equally heavy

To account for this example, one only needs to further relativize the lexical meaning of a gradable adjective to times, as shown in (ii.a). With the LF in (ii.b), the operator MIN then operates on the set of degree that contain as their subparts Mary's weight at various time points. In other words, (i) may be treated on a par with a universal RE and hence denotes the proposition in (ii.c)

(ii) a. $[\![\text{heavy}]\!]^{w,t} = \lambda d_d.\ \lambda x_e.\ \mu_{weight}(w)(t)(x) \sqsubseteq d$, where $\mu_{weight}(w)(x)$ is the weight of x at t in w
b. LF: [*yíyàng* [7 [*always/every year* [*Mary* d_7-*tall*]]]]
c. $\lambda w.\ \lambda t.\ \forall d', d''[d', d'' \sqsubseteq \textsc{min}\ (\lambda d.\ \forall t' \subseteq t[\mu_{weight}(w)(t')(M) \sqsubseteq d]) \rightarrow d'=d'']$

Given that the degree MIN is not necessarily atomic, this proposition is not trivial. (i), unlike (13b), hence is grammatical.

Along with the assumptions laid out above, an adnominal RE like (9) may be assigned the LF (36). Here I assume that the object nominal in (9) denotes an existential plural quantifier and undergoes QR; some crucial steps of the derivation and the derived truth conditions are in (37).[11] [12]

(36) Surface Structure: [*J&M* [**-*C*]-*carry* $[_{DP}$ ∃ [[*-*C*]-[*yíyàng heavy*]] *backpacks*$]_{DP}$]
LF: [*yíyàng* $[_{①}$ 7 $[[_{DP}$ ∃[[*-*C*]-[d_7 *heavy*]] *backpacks*$]]_{DP}$ 1 [*J&M* [**-*C*]-*carry* t_1]]]]

(37) $[\![DP]\!] = \lambda P_{<e,t>}. \exists X[{}^*backpack(X) \text{ and } \forall x \sqsubseteq X[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d] \text{ and } P(X)]$
$[\![①]\!] = \lambda d. \exists X[{}^*backpack(X) \text{ and } \forall x \sqsubseteq X[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d] \text{ and } \forall y \sqsubseteq (J \sqcup M)[y \in C \rightarrow \exists x \sqsubseteq X[x \in C \text{ and } {}^{**}carry(x)(y)]] \text{ and } \forall x \sqsubseteq [x \in C \rightarrow \exists y \sqsubseteq (J \sqcup M)[y \in C \text{ and } {}^{**}carry(x)(y)]]]$
$[\![(36)]\!] = [\![\text{yíyàng}]\!] ([\![1]\!]) = 1$ iff:

$$\forall d', d''[d', d'' \sqsubseteq MIN \begin{pmatrix} \lambda d. \quad \exists X[{}^*backpack(X) \quad \text{and} \\ \forall x \sqsubseteq X[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d] \text{ and} \\ \forall y \sqsubseteq (J \sqcup M)[y \in C \rightarrow \exists x \sqsubseteq X[x \in C \quad \text{and} \\ {}^{**}carry(x)(y)]] \text{ and} \\ \forall x \sqsubseteq X[x \in C \rightarrow \exists y \sqsubseteq (J \sqcup M)[y \in C \quad \text{and} \\ {}^{**}carry(x)(y)]]] \end{pmatrix} \rightarrow d' = d'']$$

Consider a scenario in which John and Mary each carry only one backpack (e.g. (26)). Intuitively, (9) is true in such a scenario iff the backpack carried by John and that by Mary weigh the same. With the natural assumption that the cover C in (37) contains J, M, the backpack J carries, and the backpack M carries, the derived truth conditions say that the degree that contains only the weight of the backpack J carries and that of the backpack M carries has subparts mutually equivalent.

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11. (9) also carries an interpretation that may render it true in a scenario in which, for instance, John carries two backpacks each of which weighs 10kgs and Mary carries two each of which weighs 5kgs. Such a "double distributive" interpretation may be derived with two applications of * and a cover C containing J, M and each individual backpack carried by J or M (see the LF in (i)).

(i) [*J&M* [[*-*C*] [1 [*yíyàng/gleich* [7 $[[_{DP}$ ∃ [[*-*C*]-[d_7 *heavy*] *backpacks*]] [[*-*C*] [2 [t_1 *carry* t_2]]]]]]]]]

12. For convenience and simplicity, I assume that the common noun *bēibāo* here is property-denoting. With the view that Mandarin common nouns are kind-denoting, one only has to assume the type-shifting rules suggested in Chierchia (1998a; b) and Dayal (2004) for my analysis to work.

This amounts to saying that the backpack J carries weighs the same as the one M carries.

4.2 Context sensitivity and covers

Intuitions to an adnominal RE, as already noted, become not so clear once objects in comparison are in large groups. It is worth to note that although most speakers consulted have find it difficult to judge (9) against the scenario (18), enrichment of contextual information or the change of verb, as already shown in (19) and (20), might make this task easier.

(18) John carries two backpacks a and b; <u>a weighs 10kgs</u> and b 15kgs.
Mary carries two backpacks c and d; <u>c weighs 10kgs</u> and d 5kgs.

Through the discussion above, we have seen that a cover, a salient way how objects in the universe of discourse may be divided into groups, plays a crucial role in determining how the truth conditions derived may be satisfied in a given context of utterance. Covers are context-sensitive; it depends on the context of utterance and the nature of the property expressed by the predicate how a cover C divides objects in the universe of discourse into groups (Schwarzschild 1996). Given its context dependency, the source of vagueness and context sensitivity observed in an adnominal RE, I suggest, should be located in the cover the RE is interpreted against.

Consider first the default option for C, according to which C contains J, M and each individual backpack carried by J or M (i.e. {J, M, a, b, c, d}⊆C). The set of sums of degrees MIN operates on, in this case, contains those that have as their subparts the weight of some backpack(s) John carries and that of some backpack(s) Mary carries. Given the settings in (18), all the members in this set include as their subparts one of those in (38).

(38) **15kg⊔5kg**, 15kg⊔10kg, 10kg⊔5kg, **10kg**

In this set, **10kg** (i.e. $\mu_{\text{weight}}(\text{b})\sqcup\mu_{\text{weight}}(\text{c})$) does not have any other member as its sub-parts; nevertheless, neither does **15kg⊔5kg** (i.e. $\mu_{\text{weight}}(\text{a})\sqcup\mu_{\text{weight}}(\text{d})$). Applying MIN then is undefined, given that it fails to pick out the unique degree from this set that contains no other members as its subparts. Consequently, the truth conditions derived in (37) cannot be satisfied in the scenario (18), and therefore (9), with this option for C, cannot be true.

It seems that the only possibility for C that may render (9) true against (18) is to let it be, along the lines of Brisson (1998; 2003), an **ill-fitting cover** for the backpacks in this scenario. Being such a cover, C may contain the individual backpacks a and c but group b and d together with some random objects in the universe of discourse. With the theory of plural predication my proposal relies on, this way of grouping renders the backpacks b and d escape from quantification introduced in plural predication and consequently only the weight of a and that of c may be seen in degree comparison. Suppose that $\{J, M, a, c, (b \sqcup d) \sqcup e\} \subseteq C$, where e is some random object in the universe of discourse. The truth conditions derived in (37), along these lines, may be satisfied in (18) in the following way: MIN operates on the set in (39) and picks out **10kg**, which is the sum of the weight of a and that of c (i.e. $\mu_{\text{weight}}(a) \sqcup \mu_{\text{weight}}(c)$).

(39) $\{d: \mathbf{10kg} \sqsubseteq d\}$

The truth conditions in (37) then amount to saying that a and c have the same weight. On the other hand, given that the backpacks b and d escape from quantification, their weights (i.e. $\mu_{\text{weight}}(b)$ and $\mu_{\text{weight}}(d)$) are ignored.

Along with the idea presented above, the fact that (9) can be true in face of (18), like the non-maximality effect on a definite plural, is just an instance of tolerance of exceptions. Brisson (1998; 2003), who first suggests the idea of **ill-fitting** covers, attributes the non-maximality effect observed on a definite plural to the way objects in the universe of discourse are grouped. Consider (40); while (40a) may be true in a situation in which one of the students in the group did not participate in any raft building, (40b), for it to be true, requires all the members in the group to be involved in a raft-building activity.

(40) a. The students built a raft.
b. The students all built a raft.

This contrast, as noted by Brisson (1998; 2003), is observed no matter whether the intended reading is collective or distributive.[13] Brisson employs the idea of **good-fitting** vs. **ill-fitting** covers to account for this contrast. Along with the ontology employed above, good-fitting and ill-fitting covers may be defined as below.

(41) Let P be a set, and $\sqcup P$ be the sum that contains all elements in P as its subparts, and C be a cover for P,
a. C is a good-fitting cover for P if $\sqcup(\{x: x \in C \text{ and } x \sqsubseteq (\sqcup P)\}) = (\sqcup P)$;
b. C is an ill-fitting cover for P if $\sqcup(\{x: x \in C \text{ and } x \sqsubseteq (\sqcup P)\}) \sqsubset (\sqcup P)$.

Suppose that the extension of *the students* contains four individuals John, Bill, Tom, and Mary, and the universe of discourse additionally includes some non-student individual e. The cover in (42a), with the definition in (41), is a good-fitting cover for the atomic individuals contained in the extension of *the students*: all the members in this cover that are also part of the sum of all the students

13. For other analyses of this kind of contrast, see Lasersohn (1999), Križ (2016), and references cited therein.

exhaust the extension of *the students*. On the other hand, the cover in (42b) is an ill-fitting cover, given that Bill and Tom are grouped with the non-student individual e.

(42) a. {J, B⊔M, T, e}
b. {J, M, B⊔T⊔e}

The presence of *all*, in Brisson's (1998; 2003) words, poses a requirement that the sentence where it occurs be interpreted with a good-fitting cover. Hence, maximality is forced in (40b). In contrast, without the presence of *all*, as in (40a), the cover involved may be an **ill-fitting** one; in this possibility, it could be the case that one student is grouped with some random non-student objects present in the universe of discourse (i.e. what Brisson (1998) called a *junkpile*, a term she attributes to Roger Schwarzschild), just like what we have seen in (42b), and hence escapes from universal quantification introduced via plural predication. Brisson identifies various factors that affect tolerance of exceptions; I refer the reader to her work for further discussion on this issue.

Back to the vagueness and context-sensitivity of the adnominal REs (9) observed in the scenario in (18). Compared to the default option, the possibility of C being ill-fitting for the backpacks is far from salient in an out-of-the-blue context. This provides an explanation why judgments on (9) in face of the scenario in (18) are often not clear unless the contextual information is enriched. (9) uttered out of the blue, the default value for C, according to which it contains each individual backpack in (18), renders the application of the operator MIN undefined. Therefore, speakers usually have difficulty judging (9) with respect to (18) and often do not consider it true in this scenario. Once enrichment of contextual information or the change of verb has made salient an ill-fitting cover that may render the derived truth conditions satisfied in the context of utterance, these examples then may be easily considered true by the speaker. After all, the saliency of a cover depends on the contextual information as well as the semantic nature of the predicate: in (19) and (20a), enrichment of the contextual information and the lexical meaning of the verb *tīao* 'pick' make salient the backpacks that weigh the same and consequently, in Brisson's (1998) term, render those that do not weigh the same salient enough to be ignored.

The analysis suggested above receives further support from the contrast between (9) and (43). (43) carries a meaning according to which it may be true in (18). Crucially, compared to (9), (43) is more likely to be judged true in face of the scenario in (18).

(43) *Yuēhàn hé Mǎlì bēi-lė liǎng-gė yíyàng zhòng-dė bēibāo.*
John AND Mary carry-PERF two-CLF equally heavy-MOD backpack
'John and Mary carry/carried two equally heavy backpacks.'

Along with the analysis I have suggested, the LF in (44a) may be assigned to (43); following Winter (1997), I assume that numeric indefinites are interpreted *in situ* with a choice function existentially closed at some propositional level (e.g. Reinhart 1997; Winter 1997; et al.). The truth conditions of these examples then are derived as in (44b). With the scenario in (18), the default value for C, which contains each of J, M, and the backpacks a, b, c, and d (i.e. {J, M, a, b, c, d}⊆C), suffices to render the truth conditions in (44b) satisfied: let the choice function f that verifies these truth conditions pick out the sum of the backpacks a⊔c; these truth conditions then amount to saying that there are two backpacks that weigh the same and are carried by J and M respectively.

(44) a. $[\exists_f [$*yíyàng* $[7\ [$*J&M* $[^{**}\text{-}C]$-*carry* $[_{DP} f\ [$*two* $[[[^{*}\text{-}C]\text{-}[d_7$ *heavy*$]$ *back-packs*$]]]]]]]]$

b. $[\![\text{ DP }]\!] = f(\lambda X_e.\ |X|=2 \text{ and } {}^{*}\text{backpacks}(X) \text{ and } \forall x \sqsubseteq X[x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d])$
'the two backpacks selected by the function f each of which is d-heavy'
(abbreviated as: $f(2\text{-}^{*}\text{heavy}_d\text{-}^{*}\text{bp})$)

$[\![\text{ (44a) }]\!] = 1$ iff there is a choice function f such that:

$$\forall d', d''[d', d'' \sqsubseteq \text{MIN} \left(\begin{array}{l} \lambda d_d.\forall y \sqsubseteq (J \sqcup M)[y \in C \rightarrow \\ \qquad \exists x \sqsubseteq f(2\text{-}^{*}\text{heavy}_d\text{-}^{*}\text{bp})[x \in C \\ \qquad \text{and } {}^{**}\text{carry}(x)(y)]] \\ \qquad\qquad\qquad \text{and} \\ \qquad \forall x \sqsubseteq f(2\text{-}^{*}\text{heavy}_d\text{-}^{*}\text{bp})[x \in C \rightarrow \\ \qquad\qquad \exists y \sqsubseteq (J \sqcup M)[y \in C \\ \qquad\qquad \text{and } {}^{**}\text{carry}(x)(y)]] \end{array} \right) \rightarrow d' = d'']$$

'There are two (specific) backpacks X each of which is carried by one of J and M, and each of J and M carries one of X, and the total weight of X has subparts that are mutually equivalent.'

The difference between (43) and (9) in their ease of being judged true in the face of (18) may then be attributed to the possibility of using the default value for C to satisfy their truth conditions: given that judgments for (43) can be made simply by appealing to the default value for C, it is expected that speakers find it easier to judge (43) than (9) in the face of scenario (18).

5. Amount REs

Additional assumptions on the syntax and semantics of Q-adjectives are in order to account for amount REs (10)–(11). It has been pointed out that modification and predication with adjectives of quantity (henceforth, Q-adjectives; e.g. *many* and *few*) have been seen as involving degree semantics and measurement of quantity. In one approach along these lines, measurement of quantity is introduced via a functional head that co-occurs with a Q-adjective, whereas the semantic contribution of a Q-adjective is rather trivial (see, e.g. Rett (2008), Solt (2015), et al.). In the following, I adopt such an approach and shall work with Solt's (2015) analysis; this paper surely is not a suitable occasion for comparison of different analyses of Q-adjectives.

Solt (2015) assigns the lexical meaning (45a) to the Q-adjectives *many/much*. As she notes, once both arguments of *many* are saturated by a degree variable d and a set of degrees I, *many*, after λ-abstraction over d, returns the set of degrees I (see (45b)).[14]

(45) a. $[\![\textit{many/much/duō}]\!] = \lambda d_d.\ \lambda I_{<d,\,t>}.\ I(d)$
b. $[\lambda d.\ [\![\textit{many/much/duō}]\!]\,(d)(I)] = [\lambda d.\ I(d)] = I$

Measurement of quantity, instead, is introduced by a separate functional head; in the discussion below, I present this functional head as Meas. Incorporating Dotlačil & Nouwen's (2016) idea of degree plurality, the lexical meaning of this functional head may be presented as in (46); it maps an individual x to a degree d such that d contains as its subpart the quantity (i.e. cardinality or amount) of x.

(46) $[\![\ \text{Meas}\ ]\!] = \lambda x_e.\ \lambda d_d.\ \mu_{\text{quantity}}(x) \sqsubseteq d$

Following Solt, I employ the compositional rule **D**egree **A**rgument **I**ntroduction to resolve the type-mismatch between Meas and the NP it combines with.

(47) **Degree Argument Introduction:** (from Solt 2015, with slight modification)
For any branching node α, whose daughters are β and γ, if $[\![\ \beta\ ]\!] \in D_{<e,\,t>}$ and $[\![\ \gamma\ ]\!] \in D_{<e,\,<d,\,t>>}$, then $[\![\ \alpha\ ]\!] = [\lambda d_d.\ \lambda x_e.\ [\![\ \beta\ ]\!]\,(x)$ and $[\![\ \gamma\ ]\!]\,(x)(d)]$

Given these assumptions, the amount RE (10) may be assigned the LF (48). The RE morpheme *yíyàng*, just like in other RE constructions, undergoes raising and moves out of its containing DP at LF. The truth conditions of (10), along with the LF (48), are derived as in (49).[15] With the natural assumption that C contains J, M, the sum of the cats J has, and the sum of the cats M has (i.e. C⊇{J, M, the-cats-J-has, the-cats-M-has}), MIN operates on the set of degrees that contain as their

14. See Lin (2014) for analyzing Mandarin *dūo* along the lines of Solt (2015).

15. Following Solt (2015), I assume that *many*, after its degree argument is saturated, undergoes movement at LF out of its base-generation position in order to solve type-mismatch and leave a degree variable (e.g. in (49), d_5).

subparts $\mu_{quantity}$ (the-cats-J-has) $\sqcup\mu_{quantity}$ (the-cats-M-has) and picks out $\mu_{quantity}$ (the-cats-J-has) $\sqcup\mu_{quantity}$ (the-cats-M-has).

(10) *Yuēhàn hé Mǎlì yǎng-lė yíyàng duō-dė māo.*
John AND Mary keep-PERF equally many-MOD cat
'John and Mary have equally many cats.'

(48) Surface Structure: [*J&M* **-*C* -*have* $[_{DP}$ ∃ $[_{D'}$ *-*C* $[_{MeasP}$ [*yíyàng many*] $[_{Meas'}$ Meas *cats*]]]]$_{DP}$]
LF: [*yíyàng* [② 7 [[d_7 *many*] [① 5 [[$_{DP}$ ∃ $[_{D'}$ *-*C* $[_{MeasP}$ d_5 $[_{Meas'}$ Meas *cats*]]]]$_{DP}$ [1 [*J&M* [**-*C* -*have* t_1]]]]]]]]

(49) ⟦ Meas′ ⟧ $=\lambda d_d.\ \lambda x_e.\ \mu_{quantity}(x)\sqsubseteq d$ and $^*cat(x)$ (via DAI in (47))
⟦ MeasP ⟧ $=\lambda x_e.\ \mu_{quantity}(x)\sqsubseteq d$ and $^*cat(x)$
⟦ DP ⟧ $=\lambda P_{<e,t>}.\ \exists X[\forall x\sqsubseteq X[x\in C\rightarrow \mu_{quantity}(x)\sqsubseteq d$ and $^*cat(x)]$ and $P(X)]$
⟦ ② ⟧ $=[\lambda d_d.$ ⟦ *many* ⟧ (d)(⟦ ① ⟧)= ⟦ ① ⟧ $= \lambda d.\ \exists X[\forall x\sqsubseteq X[x\in C\rightarrow \mu_{quantity}(x)\sqsubseteq d$ and $^*cat(x)]$ and $\forall y\sqsubseteq(J\sqcup M)[y\in C\rightarrow \exists x\sqsubseteq X[x\in C$ and $^{**}have(x)(y)]]$ and $\forall x\sqsubseteq X[x\in C\rightarrow \exists y\sqsubseteq(J\sqcup M)[y\in C$ and $^{**}have(x)(y)]]]$
⟦ (10)/(48) ⟧ = ⟦ *yíyàng* ⟧ (⟦ ② ⟧)=1 iff

$$\forall d',d''[d',d''\sqsubseteq \textsc{min}\left(\begin{array}{l}\lambda d.\ \exists X[\forall x\sqsubseteq X[x\in C\rightarrow \mu_{quantity}(x)\sqsubseteq d \text{ and}\\ \quad {}^*cat(x)] \text{ and}\\ \quad \forall y\sqsubseteq(J\sqcup M)[y\in C\rightarrow \exists x\sqsubseteq X[x\in C \text{ and}\\ \quad {}^{**}have\ (x)(y)]] \text{ and}\\ \quad \forall x\sqsubseteq X[x\in C\rightarrow \exists y\sqsubseteq(J\sqcup M)[y\in C \text{ and}\\ \quad {}^{**}have\ (x)(y)]]]\end{array}\right) \rightarrow d'=d'']$$

'There is a group composed of John's and Mary's cats and the unique degree d that contains the quantity of John's cats and that of Mary's have subparts mutually equivalent.'

The truth conditions derived then assert that $\mu_{quantity}$(the-cats-J-has) $\sqcup\mu_{quantity}$(the-cats-Mary-has) has mutually equivalent subparts, which amounts to saying that the number of cats John has is exactly the same as the number of those Mary has.

In an amount RE, objects in comparison may be contributed by a nominal conjunction in object position, as we have seen in (11). Along with the assumptions above, the LF in (50) is assigned to (11).

(11) *Yuēhàn yǎng-lė yíyàng duō-dė gǒu gēn māo.*
John keep-PERF equally many-MOD dog and cat
'John has equally many dogs and cats.'

(50) $[yíyàng\ [_{②}\ 7\ [[_{QP}\ d_7 \text{ many}]\ [_{①}\ 5\ [[_{ConjP}\ [_{DP1}\ \exists\ [{}^{*}\text{-}C]\text{-}[_{MeasP}\ d_5\ [_{Meas'} \text{ Meas } dogs]]]$ $and\ [_{DP2}\ \exists\ [{}^{*}\text{-}C]\text{-}[_{MeasP}\ d_5\ [_{Meas'} \text{ Meas } cats]]]]\ [1\ J\ [{}^{**}\text{-}C]\text{-}have\ t_1]]]]]]$

In this LF, *and* conjoins two existential plural quantifiers each of which contains a functional head Meas, which introduces measurement of quantity. Here I take *and* to be intersective (see (51a); Partee & Rooth 1983, Champollion 2016 and others); the nominal conjunction ConjP in (50) then is interpreted as in (51b). Some crucial steps of the calculation and the derived truth conditions are given in (52).

(51) a. $[\![and]\!] = \lambda P_{<\tau, t>}.\ \lambda Q_{<\tau, t>}.\ \lambda x_{\tau}.\ P(x) \text{ and } Q(x)$ (τ is a semantic type)

b. $[\![\ DP_{1/2}]\!] = \lambda P_{<e, t>}.\ \exists X[\forall x \sqsubseteq X[x \in C \rightarrow {}^{*}dog/{}^{*}cat(x) \text{ and } \mu_{quantity}(x) \sqsubseteq d] \text{ and } P(X)]$

$[\![\ ConjP\ ]\!] = \lambda P_{<e, t>}.\ [\![\ DP_1]\!]\ (P) \text{ and } [\![\ DP_2]\!]\ (P)$

(52) Assuming that {J, the-dogs-J-has, the-cats-J-has}⊆C,

$[\![\ ②\ ]\!] = [\![\ ①\ ]\!] = \lambda d_d.\ \exists X[\forall x[x \in C \rightarrow {}^{*}dog(x) \text{ and } \mu_{quantity}(x) \sqsubseteq d] \text{ and } \exists x \sqsubseteq X[x \in C \text{ and } {}^{**}have(x)(J)] \text{ and } \forall x \sqsubseteq X[x \in C \rightarrow {}^{**}have(x)(J)]] \text{ and } \exists Y[\forall y[y \in C \rightarrow {}^{*}cat(y) \text{ and } \mu_{quantity}(y) \sqsubseteq d] \text{ and } \exists y \sqsubseteq Y[y \in C \text{ and } {}^{**}have(y)(J)] \text{ and } \forall y \sqsubseteq Y[y \in C \rightarrow {}^{**}have(y)(J)]]$

$[\![\ (50)\ ]\!] = [\![yíyàng]\!]\ (\ [\![\ ②\ ]\!]\ ) = 1$ iff:

$$\forall d', d''[d', d'' \sqsubseteq \textsc{min} \left(\begin{array}{c} \lambda d.\exists X[\forall x[x \in C \rightarrow {}^{*}dog(x) \text{ and } \mu_{quantity}(x) \sqsubseteq d] \\ \text{and} \\ \exists x \sqsubseteq X[x \in C \text{ and } {}^{**}have\ (x)(J)] \\ \text{and} \\ \forall x \sqsubseteq X[x \in C \rightarrow {}^{**}have\ (x)(J)]] \\ \text{and} \\ \exists Y[\forall y[y \in C \rightarrow {}^{*}cat(y) \text{ and } \mu_{quantity}(y) \sqsubseteq d] \\ \text{and} \\ \exists y \sqsubseteq Y[y \in C \text{ and } {}^{**}have(y)(J)] \\ \text{and} \\ \forall y \sqsubseteq Y[y \in C \rightarrow {}^{**}have(y)(J)]] \end{array} \right) \rightarrow d = d'']$$

$$\cong \forall d', d''[d', d'' \sqsubseteq \textsc{min}(\lambda d.\ (\mu_{quantity}(\text{the-dogs-J-has}) \sqcup \mu_{quantity}(\text{the-cats-J-has})) \sqsubseteq d) \rightarrow d' = d'']$$

'There is a group composed of the dogs John has and the cats he has, and the unique degree d that contains all and only the number of John's cats and that of his dogs have subparts mutually equivalent.'

In these truth conditions, MIN picks out $\mu_{quantity}$ (the-dogs-J-has) $\sqcup \mu_{quantity}$ (the-cats-J-has). These truth conditions hence amount to saying that the number of dogs John has is the same as the number of cats he has.

6. On reciprocal inequatives

The idea for REs can be extended to reciprocal inequatives. Intuitively, (53) and its German counterpart (54) express that John's height and Mary's are unequal.

(53) *Yuēhàn hé Mǎlì* ***bù-yíyàng*** *zhòng.*
John AND Mary NEG-equally heavy
'John and Mary are unequally heavy.'

(54) *Hans und Maria sind* ***unterschiedlich*** *schwer.*
John and Maria are unequally heavy
'John and Maria are unequally heavy.'

Along with the analysis suggested above, the Mandarin reciprocal inequative morpheme *bù-yíyàng* (and its German counterpart *unterschiedlich*) may be assigned the lexical meaning in (55).

(55) $[\![bù\text{-}yíyàng]\!] = \lambda D'_{<d,t>}. \neg \forall d,d'[d,d' \sqsubseteq \text{MIN}(D') \rightarrow d=d']$

Bù-yíyàng expresses the negation of *yíyàng*; the reciprocal inequative morpheme, just like the RE one, operates on a set of degree pluralities. At LF, it also moves out of its base-generation position. With these assumptions, the truth conditions of (53) are derived as in (56). Let C contain the individuals J and M, the truth conditions derived in (56b) say that not all the subparts of the minimal degree plurality that contains the weight of John and that of Mary are equivalent.

(56) a. LF: [*bù-yíyàng* [7 [*J&M* [[*-*C*] [d_7 *heavy*]]]]]
b. $[\![bù\text{-}yíyàng]\!]$ $(\lambda d. \forall x[x \sqsubseteq (J \sqcup M) \text{ and } x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d])=1$ iff
$\neg \forall d,d'[d,d' \sqsubseteq \text{MIN}(\lambda d. \forall x[x \sqsubseteq (J \sqcup M) \text{ and } x \in C \rightarrow \mu_{weight}(x) \sqsubseteq d]) \rightarrow d=d']$
'Not all the subparts of the unique degree d that contains all and only John's weight and Mary's weight are mutually equivalent.'

These truth conditions amount to saying that μ_{weight} (J) $\neq \mu_{weight}$ (M), that the weight of John and that of Mary are not equivalent.[16]

16. An anonymous reviewer claims that the analysis I have proposed for the Mandarin reciprocal inequative morpheme *bù-yíyàng* suggests that *bù* is a lexical negator and may be inconsistent with Chao's (1968) description that "A and B *bù-yíyàng* Adj" is the negation of "A and B *yíyàng* Adj". Note that my proposal for a predicative reciprocal inequative need not rely on the

Schwarz (2007) presents an interesting example of reciprocal inequative. The German example in (57) can be interpreted in multiple ways. In one (call it Reading 1), it says that the total weight of the apples and that of the plums are different; in another (call it Reading 2), it says that for every piece of fruit x in the pile that is composed of the apples and the plums, x weighs differently from other pieces of fruit in the same pile.

(57) [*Die Äpfel und die Pflaumen*] *sind* [*unsterschiedlich schwer*]
the apples and the plums are unequally heavy
'The apples and the plums are unequally heavy.'

Neither of these readings, however, are of interest here. The reading Schwarz is concerned with (call it Reading 3) may be paraphrased as follows: for each apple x and each plum y, x and y weigh differently, and it is left open whether each piece of fruit weighs differently from all the others. A scenario in which (57) may be true on this reading is given in (58).

(58) There are two apples a and b and three plums c, d, and e. The apples a and b each weigh 150g, and the plums c, d and e each weigh 100g.

In this scenario, (57) cannot be true on either Reading 1 or Reading 2. To my ear, the Mandarin counterpart (59) of (57) may be true in this scenario as well, which suggests that just like its German counterpart, it may be true on Reading 3.

(59) *zhè-xīe pínggŭo hé zhè-xīe lĭzi bù-yíyàng zhòng.*
this-CLF$_{\text{PL}}$ apple AND this-CLF$_{\text{PL}}$ plum NEG-equally heavy
'These apples and these plums are unequally heavy.'

Along with the proposal laid out above, Reading 3 may be delivered via the lexical meaning of the reciprocal inequative morpheme in (55) together with two applications of the Distribution operation *. Consider the LF in (60a) and the truth conditions derived in (60b). Let C_1 be a cover that include all the pairs formed with an apple and a plum and C_2 be a cover that contains each individual piece of fruit (see (61)).

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assumption that *bù* is a lexical negator. The truth conditions in (56b) can still be derived if it is assumed that *bù* is a sentential negator. Nevertheless, assuming that *bù* and the RE morpheme *yíyàng* together form a constituent provides a straightforward way to capture the meaning of an adnominal reciprocal inequative (see (i)) and need not appeal to any additional syntactic assumption. After all, there does not seem to be any motivation for seeing *bù* as a sentential negator in (i).

(i) *Yuēhàn hé Mǎlì bēi-lė bù-yíyàng zhòng-dė bēibāo.*
John AND Mary carry-PERF NEG-equally heavy-MOD backpack
'John and Mary carried/carry unequally heavy backpacks.'

(60) a. [*the-apples-and-the-plums* [*-C_1 [1 [*bù-yíyàng* [7 [t_1 [*-C_2 [d_7 *heavy*]]]]]]]]

b. $\forall x \sqsubseteq (A\text{-}P)[x \in C_1 \rightarrow \neg \forall d', d''[d', d'' \sqsubseteq \textsc{min}(\lambda d.\ \forall y \sqsubseteq x[y \in C_2 \rightarrow \mu_{weight}(y) \sqsubseteq d]) \rightarrow d' = d'']]$

'For all the apple-pear pairs x made from the pile of apples and the pile of pears in question, the subparts of the unique degree d that contains the weight of each piece of fruit in x are not mutually equivalent.'

(61) $C_1 = \{a \sqcup c, a \sqcup d, a \sqcup e, b \sqcup c, b \sqcup d, b \sqcup e\}$;
$C_2 = \{a, b, c, d, e\}$

The derived truth conditions (60b) then say that for all the pairs that contain an apple x and a plum y, x and y weigh differently. This amounts to saying that for every apple x and every plum y, x weighs differently from y. Reading 3 hence is captured.

Reading 2 from (57) and (59) may be derived in the same fashion: with the LF in (60a) and the truth conditions in (60b), keep C_2 as it is in (61) and let C_1 contain any pairs of pieces of fruit (see (62)); the derived truth conditions (60b) then say that for any pairs of fruit x and y, x weighs differently from y.[17]

(62) $C_1 = \{a \sqcup b, a \sqcup c, a \sqcup d, a \sqcup e, b \sqcup c, b \sqcup d, b \sqcup e, c \sqcup d, c \sqcup e, d \sqcup e\}$

This amounts to saying that for every x such that x is a piece of fruit in the relevant pile, x differs from other pieces in the same pile.

7. The alternative analysis

The analysis of REs I have proposed is developed from the idea of **degree plurality**; to see the advantage of incorporating plurality in degree semantics in face of the data discussed above, a comparison of my proposal with one not relying on such an idea might be necessary.

To my knowledge, Schwarz (2007) is the first to provide a detailed investigation and a formal analysis of this degree construction. Building on the assumption that a gradable predicate such as *heavy* relates a degree d and an individual x in the way that x's weight at least reaches d, Schwarz suggests that the German RE morpheme *gleich* relates a gradable property R and a plural individual X and asserts that all the relevant subparts of X have the same degree with respect to R.

17. Reading 1 may be easily derived from the LF and the assumption that the cover C⊇{*the-apples, the-oranges*}.

(i) [*bù-yíyàng* [7 [*the-apples-and-the-plums* [*-*C* [d_7 *heavy*]]]]]

(63) a. $[\![$*schwer/heavy*$]\!] = \lambda d_d.\ \lambda x_e.\ \mu_{weight}(x) \geq d$

b. $[\![$*gleich*$]\!] = \lambda R_{<d, <e, t>>}.\ \lambda X_e: \neg\ \textsc{atom}(X).\ \forall x,y \sqsubseteq X[x \neq y \text{ and } x,y \in C \rightarrow \{d: R(d)(x)\} = \{d: R(d)(y)\}]$

In (63b), C is a contextual restriction that plays a role very similar to Schwarzschild's (1996) **cover**. The truth conditions in (64) then are derived for (4): with the natural assumption that C contains the individuals Hans and Maria, these truth conditions say that the weight of Hans is equivalent to that of Maria.

(64) $[\![$ [*Hans and Maria*] *are* [*gleich heavy*] $]\!] = 1$ iff
$\forall x,y \sqsubseteq (H \sqcup M)[x \neq y \text{ and } x,y \in C \rightarrow \{d: \mu_{weight}(x) \geq d\} = \{d: d: \mu_{weight}(y) \geq d\}]$
'The set of degrees d such that Hans is at least d-heavy is the same as the set of degrees d′ such that Maria is d′-heavy.'

In this analysis, a RE morpheme may but need not undergo LF-movement, though in certain circumstances such movement is obligatory. One such case is the amount RE.[18] Assuming that in (65) C contains the group of the pets Hans has and that of the pets Maria has, the derived truth conditions amount to saying that the number of the pets Hans has is the same as that of those Maria has.

(65) $[\![$ [*H&M* [***gleich*** [1 [***have* [∃ [[d_1 *many*] **cat*]]]]]] $]\!] = 1$ iff
$\forall x,y \sqsubseteq (H \sqcup M)[x \neq y \text{ and } x,y \in C \rightarrow$
$\{d: \exists Z[{}^*pet(Z) \text{ and } |Z| \geq d \text{ and } {}^{**}have(Z)(x)]\} =$
$\{d: \exists Z[{}^*pet(Z) \text{ and } |Z| \geq d \text{ and } {}^{**}have(Z)(y)]\}]$
'The set of degrees d such that Hans has at least d-many pets is the same as the set of degrees d′ such that Maria has at least d′-many pets.'

The vagueness observed in an adnominal RE, in this analysis, is taken to be an instance of scope ambiguity. Given that the movement of *gleich* at LF is optional, the German counterpart of the adnominal RE (9) may be parsed in two different ways: in one, *gleich* stays *in situ*, as shown in (66a); in the other, *gleich* moves out of its containing DP, as shown in (67a).

18. Schwarz's (2007) analysis of amount REs correctly predicts the ungrammaticality of (i).

(i) **Hans hat gleich viele Haustiere.*
Hans has equally many pets

Furthermore, as he notes, having *gleich* interpreted *in situ* in an amount RE, in his analysis, results in the truth conditions that further lead to the wrong prediction that *Hans and Maria have equally many cats* entails *Hans and Maria have equally many pets*. Schwarz suggests that the obligatory movement of the RE morpheme may be explained if it is assumed that *many* is a parameterized determiner and hence is of type <d, <<e, t>, <<e, t>, t>>> (see Hackl (2000)). I refer the reader to Schwarz (2007) for details.

(66) a. LF 1: [*H&M* [***carry* [∃ [[**gleich** *heavy*] **backpacks*]]]]
b. $[\![$ (66a) $]\!]$ =1 iff $\exists Z[{}^*\text{bp}(Z)$ and $^{**}\text{carry}(Z)(\text{H\&M})$ and $\forall x,y \sqsubseteq Z[x,y \in C$ and $x \neq y \rightarrow$ $\{d: \mu_{\text{weight}}(x) \geq d\} = \{d: \mu_{\text{weight}}(y) \geq d\}]]$

(67) a. LF 2: [*H&M* [**gleich** [1 [***carry* [∃ [[d_1 *heavy*] **backpacks*]]]]]]
b. $[\![$ (67a) $]\!]$ =1 iff $\forall x,y \sqsubseteq (\text{H} \sqcup \text{M})[x,y \in C$ and $x \neq y \rightarrow$ $\{d: \exists Z[{}^*\text{bp}(Z)$ and $^{**}\text{carry}(Z)(x)$ and $\mu_{\text{weight}} \geq d]\} =$ $\{d: \exists Z[{}^*\text{bp}(Z)$ and $^{**}\text{carry}(Z)(y)$ and $\mu_{\text{weight}} \geq d]\}]$

As Schwarz (2007) notes, these two LF representations, in a context in which Hans and Maria each carry just one backpack, lead to the same prediction: assuming that C in (66a) contains each of the backpacks Hans or Maria carries respectively and on the other hand that in (67a) contains the individuals Hans and Maria, these two sets of truth conditions both predict that (the German counterpart of) (9) is true iff the backpacks they carry weigh the same.[19] Nevertheless, in face of the scenario in (18), where Hans and Maria each carry two backpacks, these two representations lead to the different predictions: while (66b) predicts that (9) is true against this scenario, (67b) predicts that it is false. Schwarz (2007) reports that the German counterpart of (9) intuitively can be true or false in this scenario and hence concludes that both analyses make the correct predictions.

Promising as it might initially seem to be, Schwarz's (2007) analysis suffers from several problems some of which are already noted by him himself. One of them has to do with universal REs like (14)–(16).[20] As Schwarz notes himself, it is unclear how such cases may be addressed in his analysis. Another challenge comes from examples like (11), where objects in comparison of quantity are contributed by the nominal conjunction in object position. As noted above, in an amount RE, a RE morpheme, in Schwarz's settings, must move out of the containing DP. Nevertheless, having the RE morpheme interpreted DP-externally in these cases wrongly predicts that (11) is unacceptable for the reason why **John has equally many dogs* is, given that in this analysis, *gleich* operates on a singular individual in both cases. Furthermore, to the extent that the observations presented in § 1.2 are accurate, it seems left unexplained how the context of utterance may influence a speaker's intu-

19. Schwarz (2007) notes that the truth conditions in (67b) need to be accompanied with the existence presupposition that John and Mary carry backpacks in order to avoid the prediction that (9) may be true in a situation in which John and Mary do not carry any backpacks.

20. As an anonymous reviewer points out, with Lin's (1998) analysis of *měi*-NUM-CLF+*dūo*, according to which *měi*-NUM-CLF is characterized semantically as a definite plural, Schwarz's (2007) analysis captures the interpretation of a Mandarin universal RE. Nevertheless, given the controversy on the semantic characterization of *dūo*, as noted in Footnote 8, my proposal has an advantage over Schwarz's in that it need not rely on any particular analysis of this particle.

ition around an adnominal RE. To be more specific, it is unclear in this analysis how enrichment of contextual information or the change of verb favors one scope possibility over another so that difficulty in judgment making may be ameliorated in a given context of utterance.

8. Conclusion

In the discussion above, I have offered an account for reciprocal degree constructions; the proposal dwells on the idea of degree plurality, according to which mechanisms governing plural formation and plural predication play a crucial role in degree syntax and semantics; to the extent that the proposal is on the right track, it provides support for this idea from degree constructions other than comparatives with quantifiers in the *than*-clause. Furthermore, in the analysis I have suggested, the vague intuition one might have for an adnominal RE is taken to be the result from the same contextual factors that lead to vagueness observed in plural predication; to the extent that this analysis is on the right track, it then reveals the intricate interaction between plurality in the domains of degrees and that in the domain of individuals.

Dotlačil & Nouwen's (2016) idea of building in plurality in degree semantics makes use of the summation operation ⊔ and the pluralization operators * and **; crucially, they encode the part-of relation ⊑ in the lexical meaning of a gradable predicate and take it to be a relation between degrees d and individuals x such that the degree x possesses is part of d. In another variant along with this approach, the idea of "degree plurality" is cashed out via the interval-based semantics of degrees (Schwarzschild & Wilkinson 2002; Heim 2006; Beck 2010, 2014; et al.), according to which a gradable predicate denotes a relation between sets of degrees and individuals (see e.g. (68)).

(68) $[\![\textit{tall}]\!] = \lambda D_{<d,\,t>}.\ \lambda x_e.\ \mu_{height}(x) \in D$

As far as I can see, the account I have suggested for reciprocal equatives may be easily adapted to this variant. In order to do so, one need only assume the lexical meaning in (69) for the RE morpheme. Ceteris paribus, the truth conditions in (69c) are derived, which also amount to saying that John's height and Mary's are equivalent.

(69) a. $[\![\textit{yíyàng}]\!] = \lambda \mathcal{D}_{<<d,\,t>,\,t>}.\ \forall d,d'[d,d' \in \text{MIN}(\mathcal{D}) \rightarrow d=d']$

b. For any $\mathcal{D}_{<<d,\,t>,\,t>}$, $\text{MIN}(\mathcal{D}) = \iota D[\mathcal{D}(D) \text{ and } \neg\ \exists D'[\mathcal{D}(D') \text{ and } D \subset D']]$; undefined otherwise.

c. ⟦ [*yíyàng* [7 [*J&M* [[* *C*] [$_{AP}$ D_7 *tall*]]]]] ⟧ =1 iff $\forall d,d'[d,d' \in \textsc{min}\ (\lambda D.\ \forall x \sqsubseteq (J \sqcup M)[x \in C \rightarrow \mu_{height}(x) \in D) \rightarrow d=d']]$, where $\{J,M\} \subseteq C$

The comparison between these two variants should lie somewhere else. Further discussion on this issue is outside the scope of this paper; readers interested are referred to Dotlačil & Nouwen (2016) for further discussion.

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Abbreviations

CLF	classifier	PL	plural
COMP	comparative marker	PROG	progressive
MOD	modification marker	PTCP	participle
NEG	negation	RE	Reciprocal Equative
PERF	perfective		

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Author's address

I-Ta Chris Hsieh
Institute of Linguistics
National Tsing Hua University
No. 101, Sec. 2, Kuang-Fu Road
East District, Hsinchu 30013
Taiwan
ita.hsieh@mx.nthu.edu.tw

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