The Scope of Reciprocal Degree Operators and Degree Pluralities

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(1) (from German) and (2) (from Mandarin) both convey that John and Mary are as heavy as each other and are dubbed ‘Reciprocal Equatives’ by Schwarz (2007). This talk gives a proper treatment of the Mandarin RE. The proposal shows how degree pluralities may interact with individual pluralities (Dotišlíc and Nouwen 2016).

(1) *Hans und Maria sind gleich schwer.*
Hans and Maria are equally heavy

(2) *Yùehán hê Mǎlǐ yìyǎng zhòng.*
John and Mary the same heavy

Previous wisdom: Schwarz (2007) assigns the lexical meaning (3) to German *gleich*: COV is a ‘cover’ à la Schwarzschild (1996): \( x \subseteq Z \) iff \( x \) is part of \( Z \), and \( x \land y \) is the sum of \( x \) and \( y \).

(3) \([\text{gleich}](R_{<d, <e, t>})(Z_o)= 1\) iff \( \forall x, y, x, y \in Cov \rightarrow \{d: R(d)(x) = \{d: R(d)(y)\}\}\)

(4) \([H & M [\text{gleich heavy}]] = 1\) iff \( \forall x, y, x, y \in (H \cup M) \rightarrow \{d: \mu_{weight}(x) \geq d \} = \{d: \mu_{weight}(y) \geq d \}\)

In an adnominal RE (5), *gleich* may be interpreted outside (see (6a)) or inside (see (6b)) a DP where it is base-generated; each LF leads to different truth conditions. The * and ** are defined as in (7); see Link (1983), Sternfeld (1998), Beck (2001); a.o..

(5) *Hans und Maria tragen \( \text{gleich schwer} \) Rucksäcke*
Hans and Maria carry equally heavy backpacks

(6a) \([H & M \text{[gleich[1 **carry][\exists [heavy-d\_1 * backpack]]]]]} = 1\) iff \( \exists Z[\{\mu(Z) & **\text{carry}(Z)(H) \& \mu_{weight}(Z) \geq d\}] = \{d: \exists Z[\{\mu(Z) & **\text{carry}(Z)(M) \& \mu_{weight}(Z) \geq d\}]\}

(6b) \([H & M \text{[**carry][\exists [[\text{gleich heavy} * backpack]]]}]\) = 1 iff \( \exists Z[\{\mu(Z) \& **\text{carry}(Z)(H \cup M) \& \forall x, y, x, y \in Cov \rightarrow \{d: \mu_{weight}(x) \geq d\} = \{d: \mu_{weight}(y) \geq d\}]\]

(7) \([*_{<e, t>}, [x_o] = 1\) if i) \( f(x) \), or ii) \( \exists \forall, v = u, \forall f \in [\exists f[v]][1 \{\exists \forall <e, t> \}[x_o][y_o] = 1\) if i) \( R(x, y) \), or ii) \( \exists x, y \forall x, y \exists ! x = 1 \land y = 1 \land y = 2 \land y = 2 \land [**\text{R}(x)[y_1 \land y_2] \& [**\text{R}(x)[y_2]]\]

(6a), with \( \{H, M\} \subseteq Cov \), predicts that (5) is false in the scenario (8), where the sum of H’s backpacks differ from that of M’s. (6b), with \( \{a, b, c, d\} \subseteq Cov \), predicts that (5) is true in (8), where only one of H’s backpacks (namely, b) weighs the same as one of M’s (namely, d). The prediction from both analyses are compatible with the intuition, according to which (5) may be true or false in (8).

(8) H carries: \( \text{a-10kg and 5-5kg} \); M carries: \( \text{c-7kg and 5-5kg} \)

Schwarz (2007) notes that having *gleich* interpreted DP-internally is required for examples like (9a), where the subject denotes a singular individual and hence cannot serve as the 2nd argument of *gleich*.

(9a) *Hans hat \( \text{gleich lange Ohren} \).*
Hans has equally long ears

b. LF: \( \sqrt{H \text{[**has[\exists [[\text{gleich long} * ear]]]}\}

The in situ analysis of *gleich* also captures the fact that (10a) may be true in (8), where there are two backpacks that weight the same and carried by H&M respectively.

(10) a. *Hans und Maria tragen \( \text{zwei gleich schwere Rucksäcke} \).*
Hans and Maria carry two equally heavy backpacks

b. LF: \( [H & M \text{[**carry][\exists [two [[\text{gleich heavy} * backpack]]]]]}\)

Scope Paradox: With very few exceptions, the Mandarin speakers we consulted simply consider (11) false in (8). They however all accept (12) and consider (13) true in (8).

(11) *Yùehán hê Mǎlǐ běi-lê yìyǎng zhòng-dé běibāo* \( \text{(Mandarin)} \)
John and Mary carry- PERF the same heavy-MOD backpack

(12) *Yùehán yòu liáng-zhī yìyǎng zhòng-dé érduāo* \( \text{(Mandarin)} \)
John have two-CL the same long-MOD ear

(13) *Yùehán hê Mǎlǐ běi-lê liáng-dù yìyǎng zhòng-dé běibāo* \( \text{(Mandarin)} \)
John and Mary carry-PERF two-CL the same heavy-MOD backpack

Extending Schwarz’s (2007) analysis to Mandarin then runs into a paradox: (11) being judged false in (8) indicates that *yìyǎng* must be interpreted DP-externally; the acceptability of (12) and the truth of (13) in (8) however suggest that it can be interpreted DP-internally.

*V*-quantifiers: Mandarin *yìyǎng* may occur with a *V*-quantifier without the presence of any plural-denoting nominals (14); this is not captured by Schwarz’s analysis, according to which the reciprocal degree operator takes only plural individuals as its argument. This problem extends to *gleich*; as
noted by Schwarz, ∀-quantifiers are significantly better with gleich (15) than singular nominals.

(14) mēi-gé xüeshèng dào pào-dé yìyáng kuài (15) Jeder Junge war gleich schnell
every-CL student all run-PART the same fast every boy was equally fast

**Proposal:** Our analysis is built on the theory of plural predication according to which * and ** are sensitive to covers, which are uniformly restricted to salient subgroups (Beck 2001; a.o.). Instead of taking a gradable adjective to be a relation between a d_{PL} and an x, we assume that it relates a degree plurality and an x s.t. the relevant degree of x is part of d ((16); Dotlačil and Nouwen 2016). The operator MIN (see (16b-c)) picks out the smallest one from a set of d-plurals.

(16) a. [[heavy]] =d_{PL}, λx. μ_{weight}(x) ⪯ d_{PL} MIN(D_{<d_{PL}, t>})=d_{PL}(D) & ¬ ∃ [D(d')] & d' ⪯ d
    b. if μ_{weight}(H)=75kg, then {75kg, 75kg, 85kg, 75kg, 105kg} ⪯ {d': [[heavy]](d')(H)} and
       MIN(λd'. [[heavy]](d')(H))=μ_{weight}(H) = 75kg

We suggest that the Mandarin reciprocal d-operator yìyáng is a quantifier over d-plurals (17); like ordinary GQs, it QRs (see (18) for (2)). (2) then is true iff all the subparts of the minimal d-plurality containing John’s and Mary’s weight are the same, which is the case iff μ_{weight}(J)=μ_{weight}(M).

(17) [[yìyáng]] = D̂_{<d_{PL}, t>}, ∀d∀d'[d \subseteq MIN(D) & d' \subseteq MIN(D) → d = d']

(18) [[yìyáng [1.J&M] [ [[d₁ heavy]]]]] = 1 iff ∀d∀d'[d', d' ⪯ MIN(λd. (μ_{weight}(J)∪μ_{weight}(M)) \subseteq d) → d' = d']

∀-QP: the ∀-RE (14) then may be treated on par with, along with Dotlačil and Nouwen’s (2016), the than-clause containing a ∀-standard and analyzed as in (19); it is true iff all the subparts of the minimal d-plurality containing every student’s running speed are equivalent to each other.

(19) [[yìyáng [1 every student run [ d₁ Fast ]]]] = 1 iff ∀d∀d''[d', d'' ⪯ MIN(λd. ∀x[x is a student → (the speed of x running) ⪯ d) → d' = d'']]

**Numeric Plurals:** (12), which along with Schwarz (2007) requires yìyáng to stay in situ at LF, is analyzed as (20). With the assumption that numeric numerals are interpreted with choice functions (Winter 1997) (see (20)), the derived truth conditions say that the minimal d-plurality containing the length of each student’s ears has equivalent subparts to each other.

(20) [[∃ [yìyáng [1 John ** have [ f two [ * long-d₁ ear ] ] ] ]]] = 1 iff there is some f such that: f picks two ears x and y such that \{x, y\} ⪯ COV and John has both x and y and
    ∀d∀d'[d', d' ⪯ MIN(λd. (μ_{length}(x)∪μ_{length}(y)) \subseteq d) → d' = d']

(13) (with the reading for it to be true in (8) is analyzed along with the same lines (see (21)); assuming that in (8) \{a, b, c, d\} ⪯ COV, these truth conditions say that the minimal d-plurality containing the weight of b and that of d has all subparts equivalent each other.

(21) [[∃ [yìyáng [1 J&M ** carry [ f two [ * ] [d₁ heavy bp ] ] ] ]]] = 1 iff there is some f s.t.: f picks some Z s.t. Z are composed of two backpacks x and y s.t. \{x, y\} ⪯ COV and J&M carry x and y respectively and ∀d∀d''[d', d'' ⪯ MIN(λd. (μ_{weight}(x)∪μ_{weight}(y)) \subseteq d) → d' = d'']

In neither case is the reciprocal degree operator yìyáng required to stay in situ at LF.

**Adnominal REs:** (11) may be analyzed as in (22), which says that the minimal d-plurality containing the weight of J’s and M’s backpacks have mutually equivalent parts. In the scenario (8), there are two salient possibilities for COV: COV = \{a, b, c, d\} or COV = \{a\} \cup \{b, c\} \cup \{d\}. Neither of the possibilities however may render the truth conditions satisfied in (22). The falsity of (11) in this scenario hence is predicted.

(22) [[[yìyáng [7 [∃ [[* [d₁ heavy] * backpack]] [1 [J&M ** carry t₁ ] ] ] ]]]] = 1 iff ∀d∀d''[d', d'' ⪯ MIN(D) → d' = d''], where D = λd. there is some group of backpacks X such that i) for all x ε X and x ∈ COV, μ_{weight}(x) ⪯ d, ii) J and M each carry some x ∈ X such that x ∈ COV, and iii) for all x ∈ X and x ∈ COV, either J or M carries x.

The very small number of exceptions we have found among our consultants w.r.t the truth of (11) in (8) may be explained by the possibility that COV = \{b, d, a\} \cup \{x\}. Given that in the given scenario this possibility cannot be a salient way of subgrouping (Beck 2001), compared to the other two mentioned above, it is expected that most speakers have difficulty accessing this possibility and hence consider (12) false in this scenario.
References


