The ‘Associative Reading’ of DPs and the Quantity vs. Quality Distinction
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This paper investigates an unnoticed difference in Mandarin between the Q-adjectives and the gradable adjectives of quality and shows that this observation follows straightforwardly from a theory that differentiates gradable predication of quantity and that of quality (e.g., Rett 2008; Lin 2014; Solt 2015; a.o.).

I. Mandarin Q-adjectives and the ‘Association’ Effect

I.I. The unnoticed reading and the quantity vs. quality distinction

The Mandarin Q-adjectives dùo ‘many/much’ and shǎo ‘few/little’ may appear in predicative position in various degree constructions (see (1))1, 2; in all these examples, the Q-adjectives are predicates of the nominal phrases (indicated by the underlining) that refer to the students that Zhangsan taught and those that Lisi taught respectively.

(1) a. Zhāngsān jiāo-gùo dě xùēshéng hěn dùō/shǎo
Zhangsan teach-EXP REL student very many/few
‘The students Zhangsan taught are many/few.’

b. Zhāngsān jiāo-gùo dě xùēshéng bǐ Lǐsì jiāo-gùo dě xūēshéng
Zhāngsān teach-EXP REL student COMP Līsì teach-EXP REL student
dùō/shǎo many/few (comparative)
‘The students Zhangsan taught are more/fewer than the students Lisi taught.’

c. Zhāngsān jiāo-gùo dě xùēshéng hàn Lǐsì jiāo-gùo dě xūēshéng
Zhāngsān teach-EXP REL student and Līsì teach-EXP REL student
yīyàng dùō/shǎo the-same many/few (equative)
‘The students Zhangsan taught are as many/few as the students that Lisi taught.’

d. Zhāngsān jiāo-gùo dě xūēshéng zǔi dùō/shǎo
Zhāngsān taught-EXP REL student SUPL many/few (superlative)
‘The students that Zhangsan taught are the most/fewest.’

Something that has gone unnoticed in the literature, however, is the fact that the predicative Q-adjectives may give rise to an ‘association effect’ on the nominal phrases they are predicates of: in the various degree constructions in (2), while on the surface it looks as if the Q-adjectives are predicates of the proper names Zhāngsān and Lǐsì, these

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1 There is no morphological many/few vs. much/little distinction in Mandarin, and there is no obligatory plural marking (like English -s) in Mandarin, either.
2 The abbreviations used in glosses are listed below:
COP: copular CL: classifier EXP: experiential marker
GEN: genitive case MOD: modification marker NOM: nominative case
PERF: perfective marker POSS: possessive marker REL: relativizer
SUPL: superlative TOP: topic marker

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Q-adjectives, with the sentential adverbial *speaking of the students that one taught*, are in fact predicates of the students that Zhangsan taught and those that Lisi taught, as indicated by the bold-facing in the translation.

(2) shuòdào jiāo-gùo dé xuéshēng, speaking-of teach-EXP REL student
‘speaking of the students that one taught’

a. Zhāngsān hěn duō/shǎo
Zhangsan very many/few
‘The students that Zhangsan taught are many/few.’

b. Zhāngsān bǐ Lǐsì duō/shǎo
Zhangsan COMP Lisi many/few
‘The students Zhangsan taught are more/fewer than the students Lisi taught.’

c. Zhāngsān hàn Lǐsì yíyàng duō/shǎo
Zhangsan and Lisi the-same many/few
‘The students Zhangsan taught are as many/few as the students Lisi taught.’

d. Zhāngsān zúì duō/shǎo
Zhangsan SUPL many/few
‘The students that Zhangsan taught are the most/fewest.’

Examples (3) and (4) show that it is possible in a comparative sentence for the association effect to target only the nominal after the comparative morpheme *bǐ* (i.e., the post-*bǐ* nominal); in these two examples, while the post-*bǐ* nominal appears to be simply the proper name *Lǐsì*, semantically the standards of comparison in (3) and (4) are the students that Lisi taught and the students of Lisi, respectively.

(3) Zhāngsān jiāo-gùo dé xuéshēng bǐ Lǐsì duō/shǎo
Zhangsan teach-EXP REL student COMP Lisi many/few
‘The students that Zhangsan taught are more/fewer than the students that Lisi taught.’

(4) Zhāngsān-dé xuéshēng bǐ Lǐsì duō/shǎo
Zhangsan-POSS student COMP Lisi many/few
‘Zhangsan’s students are more/fewer than Lisi’s students.’

Examples (5)-(6) further show that it is possible for the association effect to target only the subject of the comparative; while the subject in these two examples appears to be

\[ A \text{ Mandarin } bǐ\text{-comparative has the schema in (i), where } \text{GP is the gradable predicate and DIFF the differential phrase.} \]

(i) \textbf{target } bǐ \textbf{standard GP (DIFF)}

For simplicity we will treat *bǐ* as carrying the function of expressing the meaning of comparison, though this choice has no effect on the discussion below. For more discussion on this matter, see Lin (2009), Liu (2011) and the references cited therein.
the proper name Zhāngsān, semantically the targets of comparison are the students that Zhangsan taught and the students of Zhangsan, respectively.

(5) Zhāngsān bì Lìsì jiao-gùo dè xúshēng dǐu/shào
Zhāngsān COMP Lìsì teach-EXP REL student many/few
‘The students that Zhangsan taught are more/fewer than the students that Lisi taught.’

(6) Zhāngsān bì Lìsì-dè xúshēng dǐu/shào
Zhāngsān COMP Lìsì-POSS student many/few
‘Zhangsan’s students are more than Lisi’s students.’

The data in (2)-(6) are particularly interesting for the following two reasons. First, this way of mapping from form to meaning is far from common in Mandarin. As shown in (7a)-(7b), while it is possible to omit the head noun in a possessive or a complex nominal phrase, a proper name by itself is never interpreted the way it is in (2)-(6), even with a proper antecedent.

(7) a. Wángwú jiaoxùn-lè Zhāngsān-dè xuúshēng, yěi
Wangwu teach.a.lesson-PERF Zhangsan-POSS student also
jiaoxùn-lè Lìsì-dè/ *Līsì
teach.a.lesson-PERF Līsī-POSS/ Līsī
Intended: ‘Wangwu taught Zhangsan’s students a lesson, and he also taught Līsī’s students a lesson.’

b. Wángwú jiaoxùn-lè Zhāngsān jiao-gùo dè xúshēng, yěi
Wangwu teach.a.lesson-PERF Zhangsan teach-EXP REL student also
jiaoxùn-lè Līsī jiao-gùo dè/ *Līsī
teach.a.lesson-PERF Līsī teach-EXP REL/ Līsī
Intended: ‘Wangwu taught a lesson to the students that Zhangsan taught, and he also taught a lesson to the students that Līsī taught.’

Second, the ‘association’ effect observed above is only seen with the Q-adjectives; no such effect on the nominal phrase is observed with a gradable adjective of quality. The various degree constructions in (8), if they are well-formed at all with the sentential adverbial speaking of the students that one taught, only have a reading in which the intelligence of the individual the proper name Zhāngsān refers to and that of the individual that the proper name Līsī refers to are in comparison. In none of these examples is the reading available in which the intelligence of the student(s) Zhangsan taught and/or that of the student(s) Līsī taught are being discussed.

(8) shuòdào jiao-gùo dè xúshēng,
speaking.of teach-EXP REL students
lit. ‘Speaking of students that one taught,’

a. ?/ok Zhāngsān hěn cōngmíng
Zhangsan very smart
✓‘Zhangsan is smart.’
✗‘The student(s) that Zhangsan taught is/are smart.’
b. */okZhāngsān bǐ Līsī cóngmíng (comparative)
   Zhangsan COMP Lisi smart
   ✓ ‘Zhangsan is smarter than Lisi.’
   ❌ ‘The student/s that Zhangsan taught is/are smarter than that/those that Lisi taught.’

c. */okZhāngsān hàn Līsī yīyàng cóngmíng (equative)
   Zhangsan and Lisi the same smart
   ✓ ‘Zhangsan is as smart as Lisi.’
   ❌ ‘The student/s that Zhangsan taught is/are as smart as that/those Lisi taught.’

d. */okZhāngsān zúi cóngmíng (superlative)
   Zhangsan SUPL smart
   ✓ ‘Zhangsan is the smartest.’
   ❌ ‘The student/s that Zhangsan taught is/are the smartest.’

The lack of the association effect with the gradable adjectives of quality is further evidenced by (9) and (10); the fact that the comparative in (9) can only be judged false in the scenario (10) indicates that unlike (3), (9) only has a reading in which the intelligence of Lisi himself, rather than that of the student(s) that he taught, is being compared.

(9) Zhāngsān jiāo-gùo dě xuéshēng bǐ Līsī cóngmíng
   Zhangsan teach-EXP REL student COMP Lisi smart
   ✓ ‘the student(s) taught by Zhangsan is/are smarter than Lisi.’
   ❌ ‘the student(s) that Zhangsan taught is/are smarter than the student/s that Lisi taught.’

(10) Scenario: the IQ of the students that Zhangsan taught is 115-119; the IQ of the students that Lisi taught is 106-109; Lisi’s IQ is 125.

The contrast between (11a)-(11b) provides another piece of evidence for the lack of an association effect with gradable adjectives of quality: while continuing (2a) with the Mandarin counterpart of just pick one to be your assistant is fine (see (11a)), continuing (8a) with the same sentence results in oddity (see (11b)). The cause of this oddity seems intuitively straightforward: given that in (11b) Zhāngsān can only be interpreted as a unique individual, rather than a plurality associated with someone named Zhangsan, there is no appropriate antecedent for the indefinite cardinal determinative one. On the other hand in (11a), the first sentence may carry a meaning in which it is the students that Zhangsan taught, rather than Zhangsan himself, who are under discussion, even though the subject nominal appears to be simply the proper name Zhāngsān. The indefinite cardinal one thus has an appropriate antecedent.

(11) shuōdào jiāo-gùo dě xuéshēng,
   speaking.of teach-EXP REL students
   lit. ‘speaking of students that one taught,’

   a. Zhāngsān hěn dūo/shǎo, nǐ jǐnguǎn zhǎo yī-gè dāng nǐ-dé zhùlì
      Zhangsan very many/few you just 1-CL to.be you-POSS assistant
      ‘Zhangsan’s students are many; you just pick one to be your assistant.’
b. #Zhāngsān hěn cōngmíng, nǐ jīnguǎn zhǎo yī-gè dāng nǐ-de zhùlǐ
   Zhangsan very smart you just/simply find 1-CL to.be you-POSS assistant
   ‘Zhangsan is smart; just pick one to be your assistant.’

It is worth noting that the association effect observed above and the contrast between the Q-adjectives and the gradable adjectives of quality are not unique to Mandarin; they are observed in Japanese as well.\(^4\) Japanese ooi ‘many’ may occur in predicate position.\(^5\) In the various degree constructions in (12), ooi appears to be predicated of the proper names Taro and Hanako; nevertheless, with the sentential adverbial speaking of the students that one taught, it is predicated of the students that Taro taught and those that Hanako taught respectively.

(12) Osieta gakusee niuite in to taught student about talk when ‘Speaking of students one taught,

a. Taro-ga ooi
   Taro-NOM many
   ‘The students that Taro taught are many.’

b. Taro-ga Hanako yori-mo ooi
   Taro-NOM Hanako than-more many
   ‘The students that Taro taught are more than the students that Hanako taught.’

c. Taro to Hanako-ga onaji yooni ooi
   Taro and Hanako-NOM same way many
   ‘The students that Taro taught are as many as the students that Hanako taught.’

Example (13) shows that the association effect observed in (12) is not available with adjectives of quality; with the gradable adjective kasikoi ‘smart’, all the degree constructions in (13) only permit the reading in which the intelligence of Taro and that of Hanoko are under discussion.

(13) Osieta gakusee niuite in to taught student about talk when ‘Speaking of students (people) taught,’

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\(^4\) We thank Toshiko Oda for sharing with us the Japanese data. All errors, of course, are ours.

\(^5\) There are two lexical items in Japanese, ooi and takusan, that translate as ‘many’. Unlike ooi, the predicate position is a less hospitable environment for takusan.

(i) */John-no tomodati-ga takusan-da
    John-GEN friend-NOM many-COP
    ‘John’s friends are many.’
Example (14) shows that it is possible for the association effect to target the complement of -yori alone; in this example, it is the students that John taught and Mary taught who are being compared, despite the fact that the complement of -yori appears to be simply the proper name Mary. This association effect, again, disappears with the gradable adjective of quality smart, as shown in (15).

(14) John-ga osieta gakusee-wa Mary-yori-mo ookatta
John-NOM taught student-TOP Mary-than-more many
‘The students that John taught were more than the students that Mary taught.’

(15) John-ga osieta gakusee-wa Mary-yori-mo atamagaii
John-NOM taught student-TOP Mary-than-more smart
✓ ‘The student(s) John taught is(are) smarter than Mary.’
✗ ‘The students John taught are smarter than the students Mary taught.’

I.II. Some alternatives that do not seem to work

One quick response to the association effect observed in Mandarin (as well as Japanese) is to say that in the relevant examples, the Q-adjectives are predicated not of the proper names Zhāngsān and Lìsì but rather of a nominal phrase that contains a phonetically null head, which may result from PF-deletion or a base-generated empty category e. Along these lines, (2a) may be assigned the structure (16a) or (16b).

(16) a. [ Zhāngsān teach EXP de student ] very dūō/shāō
b. [ Zhāngsān e ] very dūō/shāō

Nevertheless, analyses along with these lines not only lack empirical support, as already shown in (7), but also leave unexplained the contrast between the Q-adjectives and the gradable adjectives of quality.

Another possible response is that the association effect results from coercion. It is assumed that the Q-adjectives carry a plurality requirement and hence do not combine with nominal phrases that are interpreted as atomic individuals (see, e.g., Hackl (2000)). The proper names Zhāngsān and Lìsì denote atomic individuals and hence cannot be combined directly with the Q-adjectives. In order to guarantee interpretability, a coercion operation along the lines of de Swart (1998) and Sawada and Grano (2011) might have applied in the examples above, when the association effect is observed.
If coercion is a ‘last resort’ operation (de Swart 1998; Sawada and Grano 2011; a.o.), an analysis along these lines predicts that the association effect should not arise once the plurality requirement of the Q-adjectives has been satisfied. This prediction is not borne out, however. With the sentential adverbial speaking of one’s books, (17) does carry the meaning in which the cardinality of the books possessed by the group of students that the nominal phrase these students refers to, rather than the cardinality of this group of students itself, is being compared, even though on the surface the Q-adjective appears to combine with the nominal phrase those students.

(17) shūodào shū, zhè-xūe xuēshēng hěn dūo
    speaking.of book these-clqg student very many
    ‘speaking of books, the books of these students are many.’

A coercion-based analysis also leads us to expect that the same effect should be seen with a gradable adjective of quality that also poses a plurality requirement (e.g., diverse). Contrary to our expectation, this prediction is not borne out, as evidenced by the ungrammaticality of (18a) (in contrast to (18b)).

(18) a. *shūodào xuēshēng-dé bèijìng, Zhāngsān hěn dūoyúan
    speaking.of student-poss background Zhangsan very diverse
    intended: ‘speaking of the backgrounds of the students, the backgrounds of
    Zhangsan’s students are diverse.’

       b. Zhāngsān-dé xuēshēng(-dé) bèijìng hěn dūoyúan
    Zhangsan-poss student-poss background very diverse
    ‘The backgrounds of Zhangsan’s students are diverse.’

As we suggest below, an adequate account of the association effect should lie in the combination of the syntax of comparison of quantity and the semantics of the Q-adjectives.

II. The Association Effect and the Syntax and Semantics of Q-adjectives

II.I. The semantics of Q-adjectives and measurement

Constructions involving Q-adjectives have been treated on a par with those involving gradable adjectives of quality and analyzed using degree semantics (Bresnan 1973; Hackl 2000, 2009; Nakanishi 2004; Wellwood et al. 2012; a.o). While some treat the Q-adjectives as comparable to the gradable adjectives of quality (Nakanishi 2004; Wellwood et al. 2012; a.o), others suggest that there is a fundamental difference between the two in their syntax and semantics (Rett 2008; Solt 2015; Lin 2014; a.o.). In the latter approach, a gradable adjective of quality like smart is taken to encode in its lexical meaning a measure function μ that maps individuals to (sets of) degrees (see (19); Creswell 1976; von Stechow 1984; a.o.), whereas the semantic contribution of the Q-adjectives is considered to be rather trivial. Solt (2015) suggests the semantics in (20a)-(20b), according to which the Q-adjectives are semantically bleached.

(19) \[
    \text{[smart]} = \lambda d. \lambda x.e. \mu_{\text{intelligence}}(x) \geq d
\]

(20) a. \[
    \text{[many/dūo]} = \lambda d. \lambda I_{<d, t>}. I(d)
\]

b. \[
    \text{[few/shāo]} = \lambda d. \lambda I_{<d, t>}. \neg I(d)
\]

We thank Stefan Kaufmann and Jon Gajewski for pointing this out.
In the following we will work with this approach, given that it provides a straightforward way to locate the source of the association effect and to account for the contrast between the Q-adjectives and the gradable adjectives of quality. We assume the semantics in (20a)-(20b) for the Mandarin Q-adjectives duō ‘many/much’ and shǎo ‘few/little’, and the measurement of cardinality is introduced by the functional head meas. 7 Syntactically, meas heads the projection MP and takes as its complement an AP headed by the Q-adjective; the specifier of AP may be occupied by a degree variable, which may be bound by a degree operator in a higher position.

(21)  
\[ \text{MP} \]
\[ \text{meas} \]
\[ \text{AP} \]
\[ d \]
\[ A \]
\[ duō/shǎo \]

As we suggest below, the source of the association effect is located in meas. The lexical entry of this functional head is given in (22); it encodes a variable R, whose value is largely determined by the linguistic context.

(22)  
\[ [\text{MEAS}] = \lambda D_{<d, t>, <t>, e}. \lambda x_e. \ D(\lambda d. \mu_{\text{card}}(R(x)) \leq d), \]
where R is a function from individuals to individuals

This flexibility in the lexical meaning of meas enables us to derive the association effect observed above. Provided that the plurality requirement of the measure function \( \mu_{\text{card}} \) is not violated, R may be an identity function and map some individual x to x itself.

II.II. Accounting for the association effect

First consider the positives (1a) and (2a) (with the Q-adjective duō ‘many’). In (1a), the Q-adjective appears to be predicated of the nominal phrase the students that Zhangsan taught. Uttered out of the blue, this example carries a meaning in which the cardinality of the students that Zhangsan taught is what is being discussed. With the lexical meanings of duō in (20a), meas in (22), and the positive morpheme in (23) (von Stechow 2005; Heim 2006; and others), this meaning of (1a) (see the LF (24a)) may be modeled through the truth conditions in (24b); the value of the variable R, in this case, is an identity function, and hence \( \mu_{\text{card}} \) applies to the unique group itself of students that Zhangsan taught.

(1)  
a. Zhāngsān jiāo-gùo dé xuēshēng hěn duō/shǎo
   ‘The students Zhangsan taught are many/few.’

(23)  
\[ [\text{POS}] = \lambda P_{<d, \ <e, \ t>, 
\lambda x_e. \ \forall d \in \text{MIDDLE-GROUND} \rightarrow \text{P}(d)(x)] \]

(24)  
a. \[ [\text{the-students-that-Zhangsan-taught }] \ [\text{MP} \text{ POS } [1 \ \text{MP} \text{ MEAS } [\text{AP} \ d_1 \ duō ]]]] \]

7 The syntax and semantics we assume for meas differs from Solt’s 2015 proposal in several aspects. As far as we can see, nothing hinges on this. Nevertheless, see section IV.I for the empirical support for this move.
b. \[ (1a) \] = 1 \text{ iff } \forall d[d \in \text{MIDDLE-GROUND}_C \rightarrow \\
\mu_{\text{card}}(R(\text{the students that Zhangsan taught})) \geq d],
\]
where \( R = [\lambda x. x] \)

In (2a) on the other hand, while the subject appears to be the proper name Zhāngsān, it is actually the cardinality of the students that Zhangsan taught that is being compared. With the LF (25a), the truth conditions of (2a) are presented as in (25b). The content of the variable \( R \) is made explicit by the sentential adverbial *speaking of the students that one taught*, just as would be the conversational background of a modal statement such as *John must pay a fine*, which can be made explicit by a sentential modifier like *in view of the law* (Kratzer 2012; a.o.). In this case, the value of \( R \) is a function that maps an individual \( x \) to the unique group of students that \( x \) taught.

(2) a. shūódào jiāo-gùo dē xuéshēng, Zhāngsān hěn dūo

‘Speaking of the students that one taught, the students that Zhangsan taught are many.’

(25) a. \[ [\text{Zhangsan} [\text{MP POS } 1 [\text{MP MEAS } [\text{AP } d_1 \text{ dūo }]]]] \]

b. \[ (2a) \] = 1 \text{ iff } \forall d[d \in \text{MIDDLE-GROUND}_C \rightarrow \mu_{\text{card}}(R(\text{Zhangsan})) \leq d],
\]
where \( R = [\lambda x. y[y \text{ are students that } x \text{ taught}]] \)

Note that the variable \( R \) in (2a)/(25a) cannot be an identity relation; otherwise the non-atomicity requirement of MEAS would be violated.

In a comparative, the association effect can target the post-*bǐ* nominal (see (3)-(4)) or the subject of the comparative (see (5)-(6)), or both (see (2b)). At this point we simply assume the Reduction Analysis of the Mandarin comparative (Liu 1996; Hsieh 2015; a.o.) and make the following assumptions, although as far as we can see nothing crucial is hinging on them\(^8\): we assume that there is an occurrence of the gradable predicate in the *bǐ*-constituent that is elided at the surface, and the *bǐ*-constituent adjoins to \( vP \) (see (27a)). For convenience, we also assume that both the subject of the comparative and the post-*bǐ* nominal are interpreted MP-internally. In (2b), both proper names Zhāngsān and Lǐsī, with the sentential adverbial *speaking of the students one taught*, are associated with a contextually bound variable whose value is a function that maps an individual \( x \) to the unique group of students that \( x \) taught. With the lexical meaning of the comparative morpheme *bǐ* in (26) and the LF in (27a), the truth conditions of (2b) are as presented in (27c).\(^9\)

(2) b. shūódào jiāo-gùo dē xuéshēng, Zhāngsān bǐ Lǐsī dūo

‘speaking of the students one taught, the students that Zhangsan taught are more/fewer than the students that Lisi taught.’

(26) \[ [bǐ] = \lambda D_{<d, t>} . \lambda D'_{<d, t>} . \text{MAX}(D') > \text{MAX}(D) \]

(for any \( D_{<d, t>} , \text{MAX}(D) = \text{d}[D(d)] \) and \( \forall d'[D(d') \rightarrow d \geq d'] \)

\(^8\)The implications of the association effect for the structure of the Mandarin comparative are discussed in detail in Section III.

\(^9\)This lexical meaning of *bǐ* needs to be revised in order to derive the correct truth conditions for comparatives of negative gradable adjectives, including *shǎo* ‘few’. The required revision, however, does not affect the point made here. Due to space limitations, we simply refer the reader to Beck (2012) and Solt (2015) for possible solutions.
(27) a. Surface syntax of (2b):

\[
\begin{align*}
&[\text{TP} \text{ Zhangsan}_2 \ldots [\text{v} \ [\text{bǐ} \ [\text{Lisi}_3 \ [\text{AP} \ d_1 \ dūo] \ [\text{MEAS} \ [\text{AP} \ d_2 \ dūo]] \ [\text{MP} \ t_2 \ dūo] \ [\text{MEAS} \ [\text{AP} \ t_2 \ dūo]]]}
\end{align*}
\]

b. LF of (2b):

\[
\begin{align*}
&[[ \text{bǐ} \ [1 \ [\text{MP} \ Lisi \ [\text{AP} \ d_1 \ dūo]] \ [2 \ [\text{MP} \ Zhangsan \ [\text{MEAS} \ [\text{AP} \ d_2 \ dūo]]]]]
\end{align*}
\]

c. \[J(2b) = 1 \text{ iff } \max(\lambda d_d \ \mu_{\text{card}}(R(\text{Zhangsan}) \geq d)) > \max(\lambda d_d \ \mu_{\text{card}}(R(\text{Lisi}) \geq d)),
\]

where \(R = [\lambda x_e. \ iy \ [y \text{ are students that } x \text{ taught}]]\)

In (3) (with \(dūo \text{ ‘many’}\)), where the association effect targets only the post-\(bǐ\) nominal, the \(R’\) associated with the nominal phrase the students that Zhangsan taught is a nominal function, whereas the \(R\) associated with the proper name \(Lisi\) is a function that maps an individual \(x\) to the unique group of students that \(x\) taught (see (28a)-(28b)).

(3) Zhāngsān jiāo-gùo dé xùéshēng bǐ Lǐsì dūo
Zhangsan teach-EXP REL student COMP Lisi many
‘The students that Zhangsan taught are more/fewer than the students that Lisi taught.’

(28) a. \[[ \text{bǐ} \ [1 \ [\text{MP} \ Lisi \ [\text{MEAS} \ [\text{AP} \ d_1 \ dūo]]] \ [2 \ [\text{MP} \ the-students-Zhangsan-taught \ [\text{MEAS} \ [\text{AP} \ d_2 \ dūo]]]]
\]

b. \[J(3) = 1 \text{ iff } \max(\lambda d_d \ \mu_{\text{card}}(R(\text{Zhangsan}) \geq d)) > \max(\lambda d_d \ \mu_{\text{card}}(R(\text{Lisi}) \geq d)),
\]

where \(R = [\lambda x_e. \ iy \ [y \text{ are students that } x \text{ taught}]]\)

Example (5) can be analyzed in the same fashion (see (29)); the variable \(R’\) associated with the subject Zhāngsān maps Zhangsan to the unique group of students that Zhangsan taught; the variable \(R\) associated with the post-\(bǐ\) nominal the students that Lisi taught, on the other hand, is an identity function.

(29) a. \[[ \text{bǐ} \ [1 \ [\text{MP} \ the-student-that-Lisi-taught \ [\text{MEAS} \ [\text{AP} \ d_1 \ dūo]]] \ [2 \ [\text{MP} \ Zhangsan \ [\text{MEAS} \ [\text{AP} \ d_2 \ dūo]]]]
\]

b. \[J(5) = 1 \text{ iff } \max(\lambda d_d \ \mu_{\text{card}}(R’(\text{Zhangsan}) \geq d)) > \max(\lambda d_d \ \mu_{\text{card}}(R(\text{the students that Lisi taught}) \geq d)),
\]

where \(R = [\lambda x_e. \ x] \) and \(R’ = [\lambda x_e. \ iy \ [y \text{ are students that } x \text{ taught}]]\)

Note that the suggested analysis predicts that a comparative like (3) is ambiguous; in addition to the meaning expressed by the translation, (3) can have a meaning in which the quantity of something related to the students that Zhangsan taught and the quantity of the same type of object associated with Lisi are being compared. This reading can be made more salient by adding the sentential adverbial speaking of... , as shown in (30).

(30) shùódào jiāo-gūo dē nǚpéngyóu, Zhāngsān jiāo-gūo dē xùéshēng speaking.of make-EXP REL girl-friend Zhangsan teach-EXP REL student bǐ Lǐsì dūo
COMP Lisi many
‘speaking of the girlfriends that one had, the girlfriends that the student(s) that Zhangsan taught had are more than the girlfriends that Lisi did.’
Likewise, the positive in (1), with the adverbial *speaking of...*, can have a meaning that exhibits the association effect, as shown in (31). This is also expected under our analysis.

\[(31)\]  
shūòdào shū, Zhāngsān-dè xùēshēng hěn dūo  
'speaking of books, the books of Zhangsan’s student(s) are many.'

The contrast between the Q-adjectives and the gradable adjectives of quality, as indicated above, simply follows from the fundamental difference between these two types of gradable predication in the syntactic structure. In the gradable predication of quantity, the functional head *meas*, whose interpretation is contextually dependent, gives rise to the observed association effect. In contrast, the structure of gradable predication of quality lacks such a functional head; therefore, the association effect is not available in gradable predication of quality.

II.III. Remarks on the relation analysis of *many*

In another approach (Nakanishi 2004, 2007; Wellwood et al. 2012; a.o.), the Q-adjectives are treated on a par with gradable adjectives of quality; the lexical meaning of these words is taken to be a relation between degrees and individuals (i.e. a function of type \(<d, <e, t>>\) and is taken to encode the measure function \(\mu_{\text{card}}\). Along these lines, the lexical meanings in (32a) are proposed for the Mandarin Q-adjectives *dūo* and *shǎo*; the source of the association effect, just as in the analysis suggested above, is located in the variable R that is incorporated in these lexical meanings. Its value is a contextually determined function that maps an individual x to the unique group of objects associated with x in some way.

\[(32)\]

\[\begin{align*}
&\text{a. } [dūo] = \lambda d. \lambda x. \mu_{\text{card}}(R(x)) \geq d \\
&[shǎo] = \lambda d. \lambda x. \mu_{\text{card}}(R(x)) < d
\end{align*}\]

\[\text{b. } \text{LF of (2a): } [\text{Zhāngsān } [\text{AP } \text{POS } dūo/shǎo ]]\]

It seems to us that this line of analysis leads to much the same predictions for the data under discussion. For conceptual reasons however, we consider this approach less desirable. Given that within this approach gradable predication of quantity and of quality are executed through the same structure, the only way we can see to cash out the distinction in the availability of the association effect is to stipulate that in Mandarin and other languages where this contrast is observed, the lexical meaning of a gradable adjective of quality like *smart* does not incorporate a contextually bound variable; in other words, it does not have a lexical meaning like (33).

\[(33)\]  
\[\begin{align*}
&[\text{smart}] = \lambda d. \lambda x. \mu_{\text{intelligence}}(R(x)) \geq d
\end{align*}\]

This may lead one to wonder whether there are languages in which a gradable adjective of quality can give rise to the association effect and hence might have a lexical meaning of the same sort. In our limited survey however, we have not encountered any language of this kind. If indeed there exists no such language, it is unclear how to capture the fact under this approach.

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III. More on the Association effect and the Mandarin Comparative

In this section, we will discuss further the association effect in a comparative and its implications for the syntax and semantics of this construction.

III.1. Isomorphism and the association effect

III.1.1. The confinement of the association effect

In the analysis above, we suggest that the association effect arises from the contextually bound variable R incorporated in the lexical meaning of the functional head MEAS. Nevertheless, the following examples show that the rise of the association effect in a comparative seems to be subject to some other constraints.

The association effect, as shown above, may target the subject of the comparative, the post- bí nominal, or both. Hence, we expect to see (34)/(35) carry both readings (34a)/(35a) and (34b)/(35b). In fact, only the readings (34b) and (35b) are available.

(34a) shūódào jīao-gùo dé nǚpúngyǒu, Zhāngsān jīao-gùo dé xúshēng speaking.of make-EXP REL girlfriend Zhangsan teach-EXP REL student bí Lí Sì many
a.ʼSpeaking of the girlfriends one had, the student(s) that Zhangsan taught are more than the girlfriends that Lisi had.’

(34b) shūódào jīao-gùo dé nǚpúngyǒu, Zhāngsān bí Lí Sì jīao-gùo dé speaking-of make-EXP REL girlfriend Zhangsan COMP Lisi teach-EXP REL xúshēng duō student many
a.ʼSpeaking of the girlfriends one had, the students that Zhangsan taught are more than the students that Lisi had.’

(35a) shūódào jīao-gùo dé nǚpúngyǒu, Zhāngsān bí Lí Sì jīao-gùo dé speaking-of make-EXP REL girlfriend Zhangsan teach-EXP REL nǚpúngyǒu, girlfriend Lǐ Sì make-EXP REL student duō many
a.ʼSpeaking of the girlfriends one had, the girls that Zhangsan had are more than the students that Lisi taught.’

(35b) shūódào jīao-gùo dé nǚpúngyǒu, Zhāngsān bí Lí Sì jīao-gùo dé speaking-of make-EXP REL girlfriend Zhangsan COMP Lisi teach-EXP REL nǚpúngyǒu, girlfriend Lǐ Sì make-EXP REL student duō many
a.ʼSpeaking of the friends that Zhangsan had are more than the girls that Lisi taught.’

Note that the meanings (34a) and (35a) are sensible, as evidenced by the well-formedness of the comparatives in (36). This suggests that whatever factor causes the lack of these readings (34a)-(35a) should be structural.

(36a) Zhāngsān jīao-gùo dé xúshēng bí Lí Sì jīao-gùo dé nǚpúngyǒu Zhangsan teach-EXP REL student COMP Lisi make-EXP REL girlfriend duō many ‘The students that Zhangsan taught are more than the girlfriends that Lisi had.’

(36b) Zhāngsān jīao-gùo dé nǚpúngyǒu bí Lí Sì jīao-gùo dé xúshēng Zhangsan make-EXP REL girlfriend COMP Lisi teach-EXP REL student duō many
'The girlfriends that Zhangsan had are more than the students that Lisi taught.'

(34)-(35), together with (3)-(6), suggest that some form of isomorphism between the target and the standard of comparison is required when the association effect arises: in (3), the proper names Lisi and Zhangsan are in contrast, and what is under comparison is the students that Zhangsan taught and the students that Lisi taught; on the other hand, in (34) (with the reading (34b)), the things under comparison are the students that Zhangsan taught and the girlfriends that Lisi had. Below we show that this follows straightforwardly from the Reduction Analysis of the bi-comparative and the constraint of semantic isomorphism on ellipsis (e.g., Rooth 1992; Schwarzschild 1999; Merchant 2001; a.o.).

III.I.II. e-givenness and the association effect

It is widely accepted that there is semantic isomorphism (of some form) between an elided VP and its antecedent, and several proposals have been made to capture this. In the following, we work with Merchant’s (2001) e-givenness condition on ellipsis (37), according to which an expression α may be deleted at the surface only if α is e-given.

(37) a. e-givenness:
   An expression E counts as e-given iff E has a salient antecedent A and modulo ∃-type shifting,
   (i) A entails F-clo(E), and
   (ii) E entails F-clo(A)

b. F-clo(α), the F-closure of α, is the result of replacing the F-marked parts of α with ∃-bound variables.

c. an expression α can be deleted only if α is e-given.

Along with the Reduction Analysis, we assume that there is an AP/MP inside the bǐ-constituent that is elided at the surface. With the e-givenness condition (37), it then follows that the elided constituent is e-given, and hence the conditions (37a-i)-(37a-ii) are met. To see how this works, consider the comparative (3) and its LF (28b) with some slight modification (see (38)): we assume that the nominals that are in contrast, in this case Zhāngsān and Lǐsì (as well as their MP-internal copies), are F-marked (cf. Liu 2011).

(38) \[
  [ [ bǐ [ 1 [\text{MP}_E \text{ Lisi}_F \text{ MEAS } [\text{AP} \text{ d}_1 \text{ dǔo } ]] ] [ 2 [\text{MP}_A \text{ the-students-that-Zhangsan}_F-\text{taught MEAS } [\text{AP} \text{ d}_2 \text{ dǔo } ]] ]
\]

In (38), the antecedent MP (i.e. MP_A) contains an open degree variable; modulo ∃-type shifting, MP_A is assigned the truth conditions (39a). The focus-closure of the elided MP (i.e. F-clo(MP_E)) inside the bǐ-constituent, modulo ∃-type shifting operation on the open degree variable, is assigned the truth conditions (39b). With the given specification of the variables R and R', (39a) entails (39b) and hence (37a-i) is met.

10 As Merchant (2001, p. 26, footnote 9) points out, in general and perhaps on principled grounds, a deleted constituent will not contain any F-marked material. Here we just follow Merchant (2001) and assume that traces of constituents moved out of the ellipsis site will be ∃-bound for purposes of satisfaction of the various Focus conditions.
In the same fashion, MP_E and the F-clo(MP_A), modulo 3-type shifting on the open degree variable, are assigned the truth conditions (40a)-(40b) respectively. Given that (40a) entails (40b), (37a-ii) is met. Therefore, the e-givenness condition on MP_E is satisfied.

(40)  a. \( \exists d [\mu_{\text{card}}(R(\text{the students that Zhangsan taught})) \geq d] \)
    b. \( \exists x \exists d [\mu_{\text{card}}(R'(\text{x})) \geq d] \)
      
      (where \( R = [\lambda x_{e.} \ y[y \text{ are students that x taught}]] \), and \( R' = [\lambda x_{e.} \ x] \))

The e-givenness condition is satisfied in the same fashion in the cases where the association effect targets both the subject and the post-bi nominal (e.g., (2b)) and where it targets only the subject (e.g., (5)-(6)). In (2b) (see the modified LF (41)) the subject and the post-bi nominal are in contrast. In order to satisfy the e-givenness condition, the value for the variables introduced by MEAS is required to be the same.

(41)  [ [ bˇi [ 1 [MP_E Lisi MEAS [AP d_1 dˇuo]]]] [ 2 [MP_A Zhangsan MEAS [AP d_2 dˇuo]]] ]

In (5), the subject is in contrast with part of the post-bi nominal (see the modified LF (42)). With the values in (29b) for the function variables \( R \) and \( R' \), the e-givenness condition is satisfied. Due to space limitations, we leave the details for the reader.

(42)  [ [ bˇi [ 1 [MP_E the-students-that-Lisi-taught MEAS [AP d_1 dˇuo]]]] [ 2 [MP_A Zhangsan MEAS [AP d_2 dˇuo]]] ]

It is then obvious why (34) and (35) lack the reading (34a) and (35a). Take (34) for instance. The comparative in (34) has the very same LF in (42). With the given specification of the function variables for the intended reading and modulo 3-type shifting, MP_A (see (43a)) does not entail F-clo(MP_E) (see (43b)).

(43)  a. \( \exists d [\mu_{\text{card}}(R'(\text{the students that Zhangsan taught})) \geq d], \text{ where } R' = [\lambda x_{e.} \ x] \)
    b. \( \exists x \exists d [\mu_{\text{card}}(R(\text{x})) \geq d], \text{ where } R = [\lambda x_{e.} \ y[y \text{ are girlfriends that x had}]] \)

Likewise, the truth conditions of MP_E (see (44a)) do not entail those of F-clo(MP_A) (see (44b)), either. Hence, the reading (34a) is not available.

(44)  a. \( \exists d [\mu_{\text{card}}(R(\text{Lisi})) \geq d], \text{ where } R = [\lambda x_{e.} \ y[y \text{ are girlfriends that x had}]] \)
    b. \( \exists x \exists d [\mu_{\text{card}}(R'(\text{x})) \geq d], \text{ where } R' = [\lambda x_{e.} \ x] \)

In sum, in our analysis of the association effect, while the value assignment of the function variable incorporated in the lexical meaning of MEAS, as suggested above, is largely contextually determined, it has to comply with other structural constraints at the syntax and syntax-semantics interface.

III.II. The Direct Analysis and the association effect

To the extent that our proposal is on the right track, the association effect from the Q-adjective provides an additional piece of evidence in favor of the Reduction Analysis and against the Direct Analysis. While details vary, all the variants of the Direct Analysis
suggested for the Mandarin comparative (Xiang 2003, 2005; Erlewine 2007; Lin 2009; a.o.)
assume that the size of the post-*bǐ* constituent is exactly what it looks like at the surface,
and no elliptical operation is involved in the derivation. Given that the subject and the post-*bǐ* nominals share one gradable predicate, the syntactic location and the lexical entry of MEAS need to be reconsidered in order to locate the source of the association effect and at the same time keep the flexibility for this effect to target either of the subject or the post-*bǐ* nominal. One possibility is that the subject of the comparative and the post-*bǐ* nominal form a constituent respectively with MEAS, the according lexical entry of which is given in (45).\(^{11}\)

\[
\text{[[meas]]} = \lambda x_e \cdot \lambda d_d \cdot \mu_{\text{card}}(R(x)) \geq d \quad \text{(to be coupled with the Direct Analysis)}
\]

These assumptions, together with Lin’s (2009) syntax and his lexical entry for *bǐ* (46b), give us the LF in (46a) for (3) and the truth conditions (46c).\(^{12}\) With the given specification for the values of the function variables R and R\(^{\prime}\), the intended reading of (3) is derived.

(46) a.  

```
                      MP
                      / \                      
                     /   \                    
                    MEAS the-students-that-     DegP
duó                      Zhangsan-taught
                      / \                      
                     /   \                    
                    MP                  MEAS Lisi
```

b.  

\[
\text{[[bǐ]]} = \lambda \overrightarrow{a}. \lambda P_{<d, <\overrightarrow{a}, t>} \cdot \lambda \overrightarrow{a}. \cdot \lambda_{<d}. \mu_{\text{card}}(R(Lisi)) > \lambda_{<d}. \mu_{\text{card}}(P(d)(\overrightarrow{a})),
\]

where \(\overrightarrow{a} \geq 1\)

c.  

\[
\text{[[(3)/(46a)]]} = \text{[[bǐ]][[[meas](Lisi)][[[duó]]]][[[meas]](the students that Zhangsan taught)] = [[bǐ]](\lambda \overrightarrow{a}. \lambda P_{<d, <\overrightarrow{a}, t>}. \lambda \overrightarrow{a}. \cdot \lambda_{<d}. \mu_{\text{card}}(R(Lisi)) > \lambda_{<d}. \mu_{\text{card}}(P(d)(\overrightarrow{a}))),
\]

\(\text{iff } \lambda_{max}\mu_{\text{card}}(R'(the students that ZS taught)) = 1\)

\(\lambda_{max}\mu_{\text{card}}(R'(the students that Zhangsan taught) \geq d) >\)

\(\lambda_{max}\mu_{\text{card}}(R'(Lisi)) \geq d),\)

where \(R=\lambda x_e \cdot \iota y[y \text{ are students that } x \text{ taught}],\) and \(R'=\lambda x_e \cdot x\]

It is unclear to us however in what way other than stipulation such an analysis may predict the lack of, for instance, the reading (34a). With the structure and semantics in (46), it is possible that the value for the variable R' is an identity function and that for R is the function \(\lambda x_e \cdot \iota y[y \text{ is a girlfriend that } x \text{ had}]); hence the intended reading (34a) is expected to be available. As we have already seen however, this prediction is not borne out.

As already pointed out in various research (Xiang 2003, 2005; a.o.), the lack of sub-comparatives follows straightforwardly from the Direct Analysis but poses a challenge for the Reduction Analysis. Given that the Reduction Analysis has greater advantage

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\(^{11}\)This is the lexical meaning of **meas** suggested by Solt (2015).

\(^{12}\)We do not see a simple way to extend other variants of the Direct Analysis to the data in question; therefore, we will not discuss them.
than the Direct Analysis in accounting for the association effect in a $b\xi$-comparative, an attempt to implement the Reduction Analysis to account for the lack of the subcomparatives in Mandarin is then desirable.\textsuperscript{13} This is however beyond the scope of this paper and should be left for another occasion.

IV. Concluding Remarks and Further Issues

In the discussion above, we investigated the association effect observed with the Q-adjectives in Mandarin and suggested that the solution lies in the syntax of the gradable predication of quantity and the lexical meaning of the functional head involved. Our observation suggests that a theory that differentiates gradable predication of quantity and that of quality is preferable. In the end of the discussion we have two remarks; one concerns the pre-nominal occurrence of the Q-adjectives, and the other the cross-linguistic variation regarding the availability of the association effect.

IV.I. The pre-nominal Q-adjectives

Just like English many and few, the Mandarin Q-adjectives $d\xiu$ and $sh\xio$ may occur in a prenominal position. Nevertheless, unlike those in predicate position, the prenominal Q-adjectives do not give rise to the association effect; the object nominal in (47) merely refers to a group of students the quantity of which is large/small; it cannot refer to a group of students that are associated with some entities or objects the quantity of which is large/small.

(47) Zh\xiang\xian z\xiuo\xiot\xian j\xiian-l\xiee h\xien $d\xiu$/sh\xiao-d\xiee x\xiux\xiesh\xieng
   'Zhangsan yesterday met very many/few students.'

In keep with a unified semantics of the Q-adjectives, what is to blame for the lack of the association effect in this case then is the functional head involved in the prenominal modification of quantity; crucially, this functional head, unlike the one in predicate position (see (22)), does not carry a contextually bound variable that is responsible for the rise of the association effect. This also suggests that an adequate theory of degree syntax and semantics, in addition to the quality $vs.$ quantity contrast in predication, should differentiate the case of predication and that of prenominal modification in comparison of quantity. It is also worth noting that the lack of the association effect in the case of prenominal modification suggests that prenominal modification with Q-adjectives should not involve relativization (Sproat and Shih 1988; Cinque 2010, a.o.), though this conclusion then leads to the question why relativization is not allowed with the predicative use of Q-adjectives, which has to be left for future investigation.

IV.II. A note on cross-linguistic variation

To our knowledge so far, Mandarin and Japanese are the only languages that show the association effect. For instance, (48a), the English counterpart of (2a), is simply ungrammatical.

\textsuperscript{13}See Hsieh (2015) for discussion that the lack of subcomparatives is not necessarily decisive evidence against the Reduction Analysis in a given language.
a. *Speaking of the students that one/he taught, John is/are many.

b. The students that John taught are many.

Our analysis can be easily extended to English and other languages that do not show the association effect. One possibility is that in those languages, the functional head in gradable predication of quantity MEAS does not involve a contextually bound functional variable, and the measure function \( \mu_{\text{card}} \) applies to the individual argument of MEAS directly. Alternatively, we could give MEAS in English and other languages without the association effect the same lexical meaning as it has in those with this effect (see (22)), but with an additional lexical restriction that the functional variable involved must always be an identity function. Under either of these possibilities, this difference can be reduced to one simple lexical variation.

It is desirable to see how this lexical property may be linked to other components of the grammar so that we may form a hypothesis that predicts in which language we may expect to see the association effect. Given that only limited cross-linguistic data of sufficient depth are available for consideration, this will have to be left for future investigation.

References


