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Mandarin Has Degree Abstraction After All

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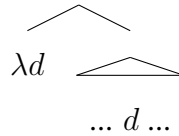
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Abstract

Mandarin, along with Japanese, Yorùbá, Mòoré, and Samoan, has been argued to lack so-called ‘degree abstraction’, a configuration at LF involving lambda abstraction over a degree variable. These languages are claimed to have a negative setting for a hypothesized ‘Degree Abstraction Parameter’. Recent work, however, has argued for degree abstraction in Japanese and Yorùbá, and degree abstraction has been detected in a number of additional languages. Could it in fact be universal? Here, we focus on the case of Mandarin, and argue that Mandarin has degree abstraction too. We offer three arguments in favor of degree abstraction in Mandarin, based on attributive comparatives, comparatives with embedding standards, and scope interactions with modals. We also rebut prior arguments for the lack of degree abstraction in Mandarin, considering degree questions, measure phrases, subcomparatives, and negative island effects. Taken together, these results show that degree abstraction is not a parameter along which Mandarin and English vary, and cast further doubt on the existence of the proposed ‘Degree Abstraction Parameter’.

1 Introduction

Despite claims in the literature that have been made to the contrary, we argue that Mandarin does have so-called ‘degree abstraction’ in this paper. By ‘degree abstraction’ we mean a configuration like the following:



where there is a trace of type d that is bound by a lambda abstraction operator. Mandarin is among a whole class of languages that have been claimed to lack this type of construction, having a negative setting for the so-called ‘Degree Abstraction Parameter’ (DAP) (Beck et al., 2004, 2009).

The (purported) absence of degree abstraction is particularly interesting in the case of languages that have degree semantics as part of their grammar—those that have a positive setting for the so-called ‘Degree Semantics Parameter’ (DSP). In [+DSP] languages, gradable predicates express relationships between individuals and degrees, along the lines proposed by Cresswell (1977).¹ Beck et al. (2009) subdivide the [+DSP] languages into those that allow abstraction over degree variables, the [+DAP] languages, and those that do not allow this, the [−DAP] languages. Beck et al. (2009), building on Beck et al. (2004), as well as Oda (2008) and Krasikova (2008), categorize Mandarin, Yorùbá, Mòoré, and Samoan as [+DSP] and [−DAP], in addition to Japanese, using similar diagnostics.

This typology is inspired by Beck et al.’s (2004) work on Japanese, in which they argue that Japanese should be categorized as [−DAP]. They base this on the following evidence: a) Japanese disallows subcomparatives; b) Japanese fails to show scope interactions between comparatives and modals; c) Japanese comparatives do not display so-called ‘negative island effects’; d) Japanese does not have ‘genuine’ degree questions; and e) Japanese disallows measure phrases directly combining with gradable predicates. To explain these patterns, Beck et al. (2004) suggest that Japanese “probably lacks abstraction over degree variables in the syntax altogether” (p. 289).

Nevertheless, subsequent work has argued *for* the existence of degree abstraction in both Japanese (Kennedy, 2009; Shimoyama, 2012; Sudo, 2015) and Yorùbá (Howell, 2013). These findings raise the question of whether other supposed [−DAP] languages would actually turn out to have degree abstraction upon closer inspection. Here we focus on the case of Mandarin.

¹Purported examples of [−DSP] languages include Motu (Beck et al., 2009) and Washo (Bochnak, 2015); in these languages, it is argued that gradable predicates are ordinary predicates of individuals.

Recent work on Mandarin has actually supported the claim that it lacks degree abstraction (Erlewine, 2018). Although Erlewine takes issue with some of the argumentation in Krasikova's (2008) and Beck et al.'s (2009) paper, he provides two other arguments for the [-DAP] status of Mandarin, one from attributive comparatives and one from comparatives with embedding. But contrary to Krasikova (2008), Beck et al. (2009) and Erlewine (2018), this paper argues that Mandarin in fact allows degree abstraction, adding to the doubt surrounding the Degree Abstraction Parameter in general.

After some background information about comparatives (§2), section (§3) presents three arguments that degree abstraction is a process that is available in Mandarin grammar. After that (§4), we rebut previous arguments that degree abstraction is lacking, and argue that all of the available evidence is consistent with the existence of degree abstraction. By the end, we hope to have convinced the reader that degree abstraction is not a parameter along with Mandarin and English vary, and to have increased the doubt in the reader's mind as to whether this is a parameter along which any languages vary.

2 Background

Below lists the empirical evidence that has been brought to bear against the existence of degree abstraction in Mandarin. The arguments are based on the following empirical claims:

- (1) Mandarin lacks...
 - a. ...degree questions
 - b. ...direct measure phrases
 - c. ...subcomparatives
 - d. ...scope interactions between comparatives and modals
 - e. ...negative island effects
 - f. ...attributive comparatives

g. ...comparatives with matching embedded standard and associate

The first five are diagnostics that Beck et al. (2009) use in their cross-linguistic investigation on degree semantics. The last two are discussed specifically for Mandarin by Erlewine (2018). As most of the diagnostics are relevant to comparative constructions, let us first introduce some background on Mandarin comparatives and the significance of degree abstraction in comparative constructions.

The Mandarin *bi*-comparative construction, as exemplified in (2), involves four essential components: the associate DP, the standard DP, the morpheme *bi*, and the gradable predicate.

- (2) John *bi* Bill *gao*.
John BI Bill tall
'John is taller than Bill (is).'

With a seemingly phrasal standard at the surface, it is controversial whether *bi*-comparatives are underlyingly phrasal or clausal.

Various flavors of phrasal analysis have been given for *bi*-comparatives in the literature (see Xiang 2003; Erlewine 2007; Lin 2009 among others). Under a 'direct analysis' (Heim, 1985), the comparative operator *-er* denotes a three-place predicate as defined (3)²:

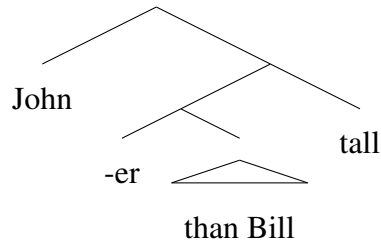
$$(3) \quad -er \rightsquigarrow \lambda y . \lambda P_{\langle d, \langle e, t \rangle \rangle} . \lambda x . \max(\lambda d_1 . P(d_1)(x)) > \max(\lambda d_2 . P(d_2)(y))$$

Comparatives like (4) can be analyzed as involving 'parasitic scope' (see Heim 1985, Beck & Sauerland 2000; Kennedy & Stanley 2009 among others) where the DegP [*-er* than Bill] moves to a position created by the the movement of the associate *John*.

- (4) John is taller than Bill.

²We assume that \max is defined as the unique greatest degree among a set of degrees, so $\max(D)$ is equivalent to $\iota d . D(d) \wedge \forall d' [D(d) \rightarrow d' \leq d]$.

(5)



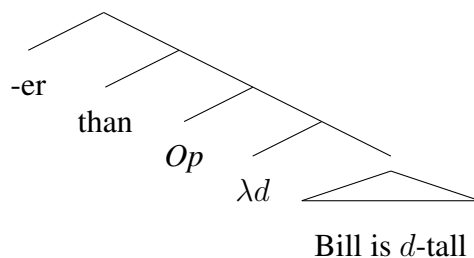
The comparative operator *-er* combines with the two individual arguments and the gradable predicate directly, deriving the truth conditions for (4) without degree abstraction.

On the other hand, Erlewine (2018), following Liu (1996), argues for a clausal analysis of *bi*-comparatives. Clausal comparatives in general are thought to involve degree abstraction; an example is given in (6).

(6) John is taller than [Bill is tall].

The clausal standard in (6) denotes a set of degrees, namely the set of degrees to which Bill is tall (i.e., λd . Bill is *d*-tall). That set of degrees is thought to be obtained through Quantifier Raising (QR) of a covert operator with a meaning like *what* from a base position beside the gradable predicate to the edge of the *than* clause, where it contributes abstraction over the degree variable (Chomsky, 1977; Bresnan, 1973).

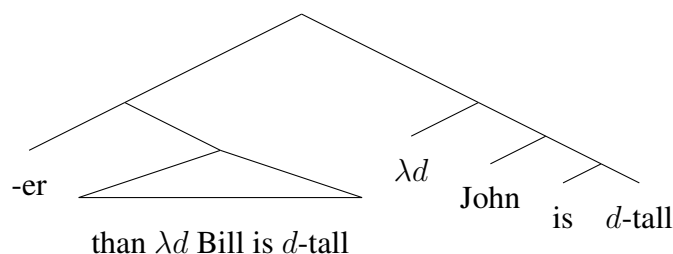
(7)



This set of degrees is compared to the set of degrees to which John is tall (i.e., λd . John is *d*-tall). The latter is obtained through covert QR of the DegP headed by *-er* from its base position beside the gradable predicate in the matrix clause (the instance of *tall* that is pronounced) to the edge of the clause, where it binds the trace it left behind – another case of degree abstraction. The standard

clause is late-merged to *-er* at its scope position (Bhatt & Pancheva, 2004).

(8)



The two-place predicate *-er*, as defined in (9a), takes two complex degree arguments of type $\langle d, t \rangle$ and returns true if the maximal degree of set Q exceeds the maximal degree of set P . The truth conditions for (6) are represented in (9b).

- (9) a. $-er \rightsquigarrow \lambda P_{\langle d, t \rangle} . \lambda Q_{\langle d, t \rangle} . \max(Q) > \max(P)$
 b. $\max(\lambda d . \text{John is } d\text{-tall}) > \max(\lambda d . \text{Bill is } d\text{-tall})$

Again, two instances of degree abstraction are thought to be involved in the derivation of these truth conditions.

The situation is not so simple, though. For cases like the ones we have been considering, there is actually a way to form the relevant degree description without degree abstraction. There are two different ways of analyzing gradable predicates. The first is to assume, as is commonly done, that gradable predicates denote relations between individuals and degrees. A gradable adjective like *tall* is treated as an expression of type $\langle d, et \rangle$ with a lexical entry as in (10), in which **tall** is a measure function that takes an entity x and returns the degree d to which x is tall (Kennedy, 2007b).

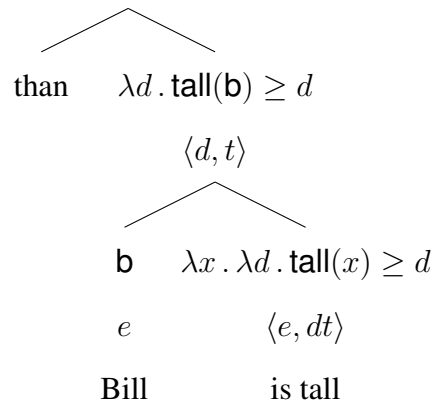
(10) $tall_1 \rightsquigarrow \lambda d . \lambda x . \mathbf{tall}(x) \geq d$

However, Erlewine (2018) analyzes gradable predicates in Mandarin as type $\langle e, dt \rangle$, as exemplified in (11). Following Erlewine, we refer to this as a ‘degree-last’ analysis.

(11) $tall_2 \rightsquigarrow \lambda x . \lambda d . \mathbf{tall}(x) \geq d$

The degree-last analysis makes it possible to construct the needed degree descriptions of type $\langle d, t \rangle$ purely through functional application, without degree abstraction. For example, consider a comparative like *John is taller than Bill is*:

(12) Deriving type $\langle d, t \rangle$ under a degree-last analysis:



The relevant degree-description is formed here simply by applying the gradable adjective to a type e subject argument. This means that under the degree-last analysis of gradable predicates, degree abstraction is not essential in order for *than*-clauses to denote sets of degrees.

As degree abstraction interacts with comparatives in such a sensitive way, to test whether degree abstraction is really at work in Mandarin, it is necessary to consider all the possible analyses of comparatives. Among the seven diagnostics listed at the beginning of this section, we identify three constructions that require degree abstraction regardless of which analysis is given to comparatives. They are attributive comparatives, comparatives with embedding, and scope interactions between comparatives and modals. In the next section, we present our arguments for degree abstraction in Mandarin, addressing each of these constructions one by one.

3 Positive arguments for degree abstraction in Mandarin

3.1 Attributive comparatives

Attributive comparatives are ones in which a comparative attributively modifies a nominal. (13) is an example of attributive quantity comparative, whereas example (14) is an attributive degree comparative.

(13) J bought more books than B.

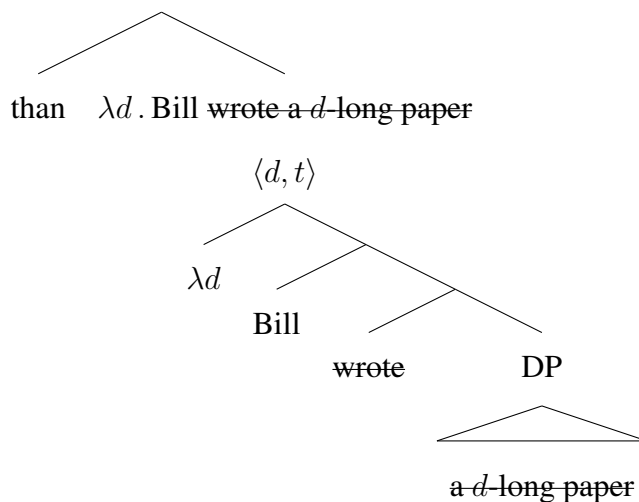
$$\max(\lambda d . J \text{ bought } d\text{-many books}) > \max(\lambda d . B \text{ bought } d\text{-many books})$$

(14) J wrote a longer paper than B.

$$\max(\lambda d . J \text{ wrote a } d\text{-long paper}) > \max(\lambda d . B \text{ wrote a } d\text{-long paper})$$

In these cases, two degree descriptions are compared; for instance, in (14), ‘ $\lambda d . J$ wrote a d -long paper’ is compared to ‘ $\lambda d . B$ wrote a d -long paper’. Forming these degree descriptions requires degree abstraction, even under a degree-last approach: In attributive position, the degree argument is trapped inside the DP and only via degree abstraction can it be interpreted at the clause-level in order to produce a degree-description of type $\langle d, t \rangle$.

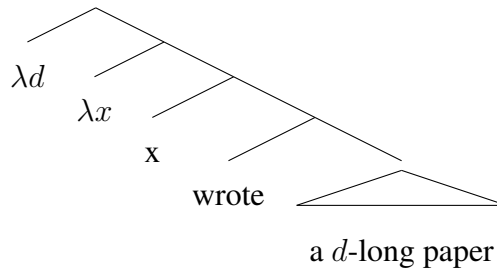
(15) ...than Bill wrote a d -long paper.



This $\langle d, t \rangle$ degree description can be fed as an argument to a two-place *-er* that compares two degree descriptions.

Degree abstraction would also be required under a direct analysis, under which a three-place *-er* compares two individuals with respect to a gradable predicate. The gradable predicate embodying the dimension along which the two individuals are compared is complex, involving content from both the verb and the DP ($\lambda d . \lambda x . x$ wrote a *d*-long paper), so it cannot be formed purely through function application.

(16) $\lambda d . \lambda x . x$ wrote a *d*-long paper



Hence, regardless of whether one uses a standard two-place analysis of *-er* or a ‘direct’ three-place analysis, degree abstraction is a must for attributive comparatives. We therefore take attributive comparatives to be a reliable diagnostic for degree abstraction (at least in the positive direction; finding them implies that the language allows for degree abstraction).

Erlewine (2018) argues that attributive comparatives are impossible in Mandarin based on the following example.

(17) *John bi Bill xie le {duo, chang} de lunwen.
 John than Bill write ASP {many, long} DE paper
 ‘John wrote more papers/a longer paper than Bill.’

We do not dispute the acceptability judgments for (17), but we doubt that this observation can be explained by the lack of degree abstraction. (17) can be rescued by an additional degree adverb *geng* ‘more’ as in (18).

- (18) a. John bi Bill xie le (yi pian) **geng** chang de lunwen.
 John than Bill write ASP (one CL) GENG long DE paper
 ‘John wrote a longer paper than Bill.’
- b. John bi Bill xie le **geng** duo de lunwen.
 John than Bill write ASP GENG many DE paper
 ‘John wrote more papers than Bill.’

Granted, it is not clear that the examples in (18) are equivalent to their English counterparts. According to the native speaker intuitions of the first author, (18a) implies that both John and Bill wrote a long paper, and (18b) implies that both John and Bill wrote many papers. So the question arises whether *geng* is truly a marker of comparison, or something else, such as an intensifier.

We argue that *geng* is truly a marker of comparison on several grounds. First, it contrasts with the degree adverb *hen* (which functions either as an intensifier or a neutral, “bleached” marker of the positive form; Paul 2015) in its ability to co-occur with *bi*-phrases. In (19), while *geng* is obligatory with the *bi*-phrase, *hen* is incompatible with it.

- (19) John bi Bill xie le yi pian {geng, *hen} chang de lunwen.
 John than Bill write ASP one CL {GENG, HEN} long DE paper
 ‘John wrote a longer paper than Bill.’

In other comparative constructions, as in (20) *geng* is optional with *bi*-phrases, while *hen* is ungrammatical:

- (20) John de lunwen bi Bill de lunwen {(geng), *hen} chang.
 John DE paper than Bill DE paper {GENG, HEN} long
 ‘John’s paper is longer than Bill’s.’

These patterns can be explained under the assumption *geng* is licensed by a comparative operator that licenses both *geng* and a *bi*-phrase. Alternatively, *geng* might be the overt realization of a comparative operator that licenses a *bi*-phrase and can be covert in some environments. In either case, this data supports the view that attributive comparatives with *geng* are true comparatives.

Mandarin does make use of *hen* to construct comparatives, as shown in (21).

- (21) a. *biqi* Bill de lunwen, John de lunwen *hen chang*.
 compare Bill DE paper John DE paper HEN long
 ‘Compared to Bill’s paper, John’s paper is long.’
- b. *biqi* Bill, John *xie le yi pian* *hen chang de lunwen*.
 compare Bill John write ASP one CL HEN long DE paper
 ‘Compared to Bill, John wrote a long paper.’

But if we apply Kennedy’s (2007a) tests for explicit vs. implicit comparison, we see that these examples involve implicit comparison. Here we adopt two of Kennedy’s (2007a) tests for explicit and implicit comparisons, and the results support this claim.³

First, the examples in (21) are infelicitous in the crisp judgment contexts like the following.

- (22) Context: Bill has written a 200-page paper, whereas John has written a 201-page paper.

In contrast, the attributive *geng*-comparative in (20) is felicitous in context (22), in support of the view that attributive *geng*-comparatives involve explicit comparison. The analogous observations hold with quantity attributive *bi*-comparatives.

- (23) Context: Bill has written 100 papers; John has written 101 papers.
- a. John de lunwen *bi* Bill de lunwen {(*geng*), **hen*} duo.
 John DE paper than Bill DE paper GENG HEN many
 ‘John’s papers are more than Bill’s.’
- b. John *bi* Bill *xie le* {*geng*, **hen*} duo (de) lunwen.
 John than Bill write ASP GENG HEN many DE paper
 ‘John wrote more papers than Bill.’
- c. #*biqi* Bill, John *xie le* *hen duo* (de) lunwen.
 compare Bill John write ASP HEN many DE paper
 ‘Compared to Bill, John wrote many papers.’

Attributive quantity comparatives with *bi*-phrases are ungrammatical with *hen* and grammatical with *geng*; *geng* is either obligatory or optional with a *bi*-phrase, and the *hen* comparative without

³The third test Kennedy proposes involves differential measure phrases combining directly with the comparative operator. We exclude this test only because it is technically inapplicable to attributive comparatives.

a *bi*-phrase is infelicitous in the crisp judgment context, showing that it involves implicit rather than explicit comparison.

The second piece of evidence that attributive *bi*-comparatives are explicit comparatives is based on the fact that they can co-occur with absolute gradable predicates. Absolute gradable predicates such as *bent*, *wet*, etc. are context-insensitive; they can be used in explicit comparison but not in implicit comparison since only the latter is context-sensitive in nature (cf. (24a) and (24b)).⁴ As shown in (24c), attributive *bi*-comparatives have no problem with absolute gradable predicates, suggesting that they are explicit comparatives.

Context: Line A:  Line B: 

- (24) a. xiantiao B bi xiantiao A wan.
line B than line A bent.
'Line B is more bent than line A.'
- b. #biqi xiantiao A, xiantiao B shi wan de.
compare line A line B is bent de.
'Compared to line A, line B is bent.'
- c. Bill bi Ann hua le yi tiao geng wan de xian.
Bill than Ann draw ASP one CL more bent de line
'Bill drew a more bent line than Ann.'

In sum, if attributive constructions like (17) are ruled out by the lack of degree abstraction, we should not have constructions like (18). Although attributive *bi*-comparatives are more restricted than the non-attributive ones, both degree and quantity attributive comparatives are possible in Mandarin. This provides positive evidence that degree abstraction is present in Mandarin, as the compositional analysis of attributive *bi*-comparatives would require binding of degree variables in syntax. (See Appendix A for discussion of why *geng* might be required in attributive comparatives.)

That being said, there is still room for doubt about the quantity examples with *duo* 'many'.

⁴Instead of using the simple predicative positive form *line B hen bent*, we present the example using the *shi...de* cleft construction. This is only because *hen* in this case would realize an intensifier use, which will cause this test to be unsuccessful.

One reviewer observes that the relative clause marker *de* seems to be optional with *duo* ‘many’ but obligatory with *chang* ‘long’. This might suggest that these cases might not be truly attributive. But although *de* is indeed optional with *duo*, it is obligatory with another quantity predicate, namely *shao* ‘little (amount)’. As shown below, the negative quantity predicate *shao* patterns with degree predicates instead of its positive antonym *duo*:

- (25) a. John you hen duo (de) shu.
 John have very many DE book
 ‘John has many books.’
- b. John you hen hou *(de) shu.
 John have very thick DE book
 ‘John has (some) thick books.’
- c. John you hen shao ??(de) shu.
 John have very few DE book
 ‘John has few books.’

Appendix B gives statistical evidence that Mandarin speakers prefer the variant with *de*.⁵ Thus, it seems that quantity words can function attributively.

The second concern pertains to the syntactic role of *geng* in attributive *bi*-comparatives. While we take *geng* as modifying the object NP, it is possible in principle that *geng* modifies the whole VP. Under the latter view, the comparative reading can be obtained without degree abstraction. Take the following sentence as an example, which is repeated from (18) :

- (26) John bi Bill xie le **geng** duo de lunwen.
 John than Bill write ASP **geng** many DE paper
 ‘John wrote more papers than Bill.’

This example could in principle be understood as comparing the magnitude of the paper writing event (i.e., *John wrote papers more than Bill did*) as opposed to the magnitude of papers (i.e., *John wrote more papers than Bill*). (26) is a case where the ad-verbal use of *geng* is difficult to

⁵There has also been observed that *de* is optional when the prenominal measure function is monotonic (Jiang, 2009), by which the optionality of *de* with *duo* can be explained.

disentangle from the ad-nominal use truth-conditionally. But in cases where these two readings come apart, as in (27), it is clear that the ad-verbal analysis of *geng* is not available.

- (27) Lisa bi Mary tou le yi ge geng nianqing de houxuanren.
 Lisa BI Mary vote ASP one CL GENG young DE candidate
 Ad-nominal *geng*: ‘Lisa voted for a younger candidate than Mary.’
 Ad-verbal *geng*: #‘Lisa voted for a young candidate more than Mary did.’

The fact that (27) does not have a reading where Lisa voted for a young candidate more times than Mary supports the view that *geng* is ad-nominal in these attributive comparatives.

3.2 Comparatives with matching embedded standard and associate

In English, a clausal standard in a comparative construction can itself embed another clause, as exemplified in (28) and (29).

- (28) Mary is taller than Bill thinks she is.
 $\max(\lambda d . \text{Mary is } d\text{-tall}) > \max(\lambda d . \text{Bill thinks Mary is } d\text{-tall})$
- (29) John thinks Mary is taller than Bill thinks she is.
 $\max(\lambda d . \text{John thinks Mary is } d\text{-tall}) > \max(\lambda d . \text{Bill thinks Mary is } d\text{-tall})$

Such examples involve a description of a degree that crosses a clause boundary, necessitating degree abstraction.

Erlewine (2018) argues on the basis of the absence of similar constructions in Mandarin that Mandarin lacks degree abstraction. His argument is based on the assumption that *bi*-comparatives are clausal, and that the predicate in the antecedent clause, which he calls the target clause, is deleted:

- (30) [_{TP1} Mary gao] bi [_{TP2} John gao].
 Mary tall than John tall
 ‘Mary is taller than John.’

If this analysis is correct, and Mandarin allows the standard clause to contain an embedding predicate as in (28) and (29), then without further constraints, we would expect the following structures to be licit, contrary to fact:

- (31) *_{[TP1 Mary_i gao] bi} _[TP2 John juede ta_i gao].
 Mary tall than John think she tall
 ‘Mary is taller than John thinks she is.’
- (32) *_{[TP1 John juede Mary gao] bi} _[TP2 Bill juede Mary gao].
 John think Mary tall than Bill think Mary tall
 ‘John thinks Mary is taller than Bill thinks she is.’

The ungrammaticality of (31) can be explained by the comparative deletion requirement suggested by Erlewine (2018):

(33) **Comparative Deletion Requirement** (Erlewine, 2018)

In a *bi*-comparative, elide a local predicate of the target TP under identity with a local predicate of the standard TP. If the target TP has no elidable local predicate, the derivation is illicit.

Locality of a predicate is defined as follows.

- (34) α is a local predicate of β iff
- (a) α is a VP or a predicative AP;
 - (b) β dominates α ;
 - (c) there is no TP that is dominated by β and dominates α .

(Erlewine, 2018)

In (31), the local predicate of the target clause (i.e., *tall*) is not identical to the local predicate of the standard clause (i.e., *think*); therefore, the deletion is illicit.

However, in (32), the deletion requirement is satisfied but the sentence is still ungrammatical-

cal. Erlewine (2018) himself points out that the VP [think Mary tall] is both local to the target TP and identical to a local predicate of the standard TP. He proposes that the reason for the ungrammaticality of (32) is that Mandarin lacks degree abstraction: In (32), it is impossible to derive the complex degree descriptions without degree abstraction when the standard and target clause involves embedding.

A ban on degree abstraction would rule out too much, though. There are other embedding verbs that do allow comparative ellipsis. Examples with *ling* ‘make’ (and its alternatives such as *shi* and *rang*) and *bang* ‘help’ are more acceptable than those with *juede* ‘think’, as shown in (35).

- (35) a. John hui bi Bill ling Mary geng touteng.
 John will BI Bill make Mary GENG headachy
 ‘John will make Mary more headachy than Bill will make Mary headachy.’
- b. John hui bi Bill ling Mary geng qiong.
 John will BI Bill make Mary GENG poor
 ‘John will make Mary more poor than Bill will make Mary poor.’
- c. John bi Bill ling Mary shu le geng duo qian.
 John BI Bill make Mary lose ASP GENG many money
 ‘John made Mary lose more money than Bill did.’
- d. John bi Bill bang Mary mai le geng gui de liwu.
 John BI Bill help Mary buy ASP GENG expensive DE gift
 ‘John helped Mary buy more expensive gifts than Bill did.’

Notice that in (35c) and (35d), an aspect marker *le* occurs within the embedded clause, showing that it is a full clause that is embedded by the matrix verb.⁶ In all three examples, John and Bill are being compared along a dimension that involves a matrix predicate (‘make’ or ‘help’) as well as an embedded gradable predicate. Degree abstraction is a mechanism that would provide that.

⁶It is controversial whether Mandarin ‘make’ verbs select small clauses as complements (Yang, 2003) or full clauses (Paul, 2021). Paul (2021) argues that these constructions should be analyzed as object control constructions, as illustrated in (36), where the ‘make’ verbs, unlike ECM verbs, select a DP and a *clausal* complement. The argument is based on the fact that the complement introduced by ‘make’ allows adverbs, negation, and aspect.

- (36) na jian shi ling Mary_i [PRO_i congci bu zai kuaile le].
 that CL thing make Mary_i [PRO_i since.then NEG again happy ASP].
 ‘That thing has made Mary no longer happy.’

Is there any other mechanism that could provide that? One possibility to consider is that *geng* is actually being interpreted as a modifier of the whole VP. In some cases, the overt degree morpheme *geng* may occur to the left of the matrix verb *ling* ‘make’, giving rise to an interpretation where what is being compared is a gradable property that includes the embedding predicate, as instantiated in (37).

- (37) a. John hui bi Bill **geng** ling Mary touteng.
 John will BI Bill GENG make Mary headachy
 ‘John will make Mary headachy more than Bill does.’
- b. Tiaowu bi changge **geng** ling wo kuaile.
 dance BI sing GENG make me happy
 ‘Dancing makes me happy more than singing does.’
- c. Zhe ge gushi bi na ge gushi **geng** rang ren xiang ku.
 this CL story BI that CL story GENG make person want cry
 ‘This story makes a person want to cry more (is more heartrending) than that story.’

In these examples, it is reasonable to assume that *geng* is actually modifying the whole *make*-phrase, making it possible to render a comparison without degree abstraction: Instead of the degree of *headachiness*, it is certain dimension of *making one headachy* that is being compared. On this view, the matrix *geng* is base-generated in a predicate-adjacent position.

There is a subtle meaning difference between (35a) and (37a). But setting this aside, it could possibly be maintained that these two examples are identical at LF, with *geng* in a VP-modifying position in both cases, even though *geng* surfaces lower in the structure. (Somehow the movement from its surface position to the VP-adjacent position in (35a) would have to avoid leaving a trace; otherwise degree abstraction would be necessary to interpret this structure.) In that case, their meanings would both be derived without degree abstraction.

However, a similar non-degree-abstraction analysis is not viable for (35b), (35c) or (35d). For such an analysis predicts the corresponding matrix-*geng* examples to be grammatical, contrary to fact. Versions of (35b), (35c) and (35d) where *geng* appears before the matrix verb are ungrammatical:

- (38) a. *John hui bi Bill **geng** ling Mary qiong.
 John will BI Bill GENG make Mary poor
- b. *John bi Bill **geng** ling Mary shu le (hen duo) qian.
 John BI Bill GENG make Mary lose ASP very much money
- c. *John bi Bill **geng** bang Mary mai le (hen gui de) liwu.
 John BI Bill GENG help Mary buy ASP very expensive DE gift

Furthermore, to the extent that they can be interpreted, they differ in meaning from their corresponding embedded versions. This can be seen most clearly with the verb *help*: Whereas (38c) would be translated ‘John helps Mary buy expensive gifts more than Bill does’, the embedded version (35d) would be translated ‘John helps Mary buy more expensive gifts than Bill does’. One compares degree of helpfulness; the other compares degree of expensiveness. With uncontroversial VP-comparatives constructed with mental state verbs, the matrix *geng* gives rise to an intensity reading, whereas the low *geng* gives rise to a reading where the embedded gradable predicate is being compared:

- (39) a. John bi Bill **geng** xiang ying qian.
 John BI Bill GENG want win money
 ‘John wants to win money more than Bill wants.’
- b. John bi Bill xiang ying **geng** duo qian.
 John BI Bill want win GENG much money.
 ‘John wants to win more money than Bill wants.’

Sentence (39a) is true in a scenario where John and Bill want to win the same amount of money, but John is more eager to win—a scenario where (39b) is false.

If the low *geng* is underlyingly the matrix *geng*, it is predicted that i) whenever the low *geng* is allowed, the matrix *geng* should also be allowed and ii) both versions should have the same meaning. As we have shown, both predictions are violated: There are cases where only the low *geng* is allowed and cases where the two versions have truth-conditional differences. So the embedded versions cannot be understood as underlyingly non-embedded. With a VP-comparison analysis ruled out, we conclude that degree abstraction must be involved in embedded cases like (35). Therefore,

we argue that comparatives with embedding do not provide evidence against degree abstraction; on the contrary, they provide evidence for degree abstraction.

While it is not crucial for our argument, we can offer a speculation as to what makes the matrix-*geng* ungrammatical in some cases. The relevant fact is that whether the matrix *geng* is allowed depends on whether or not the VP is gradable along an intensity dimension. Comparatives with *make*-phrases like “make one headachy/happy/want to cry etc. ” which involve causing a change of the mental state can be associated with an intensity-measuring meaning. Those are the cases where the matrix-*geng* are found to be acceptable. On the other hand, *make*-phrase like “make one poor/lose money etc. ” cannot be understood as measuring an intensity dimension, and the matrix-*geng* is disallowed in those cases. This distinction between intensity-measuring and non-intensity-measuring predicates is also relevant to VP-comparatives in general, as Pasternak (2019) observes.

3.3 Scope interactions between comparatives and modals

Another place to look for degree abstraction is in scope interactions between degree quantifiers and modals. Heim (2000) investigates the question of whether there are quantifiers over degrees – *-er than 6 feet* being a candidate – which, like quantifiers over individuals, undergo QR, leaving a trace in their original position, and triggering lambda abstraction in their scope. The structural analogy is illustrated in Figure 1.

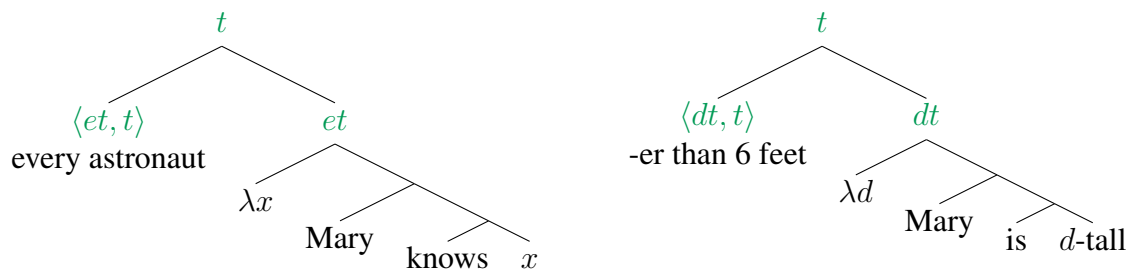


Figure 1: Quantifiers over individuals and degrees undergoing QR

How would we know whether there are such things? Scope ambiguity with other operators would be an indication that there are. Such scope ambiguities are often missing, as Kennedy (1997)

pointed out; moreover, often the two scope readings collapse, giving rise to the same truth conditions (Heim, 2000). However, multiple scope readings can be truth-conditionally distinguished in certain cases, and although degree quantifiers do not appear to interact scopally with quantifiers over individuals (‘Kennedy’s generalization’), they do seem to interact scopally with some modals. Examples claimed to exhibit scopal ambiguity include *less*-comparatives as in (40) and examples involving comparative ellipsis as in (43).

(40) Mary drives 80mph. John needs to drive less fast than that.

a. *need* > *less*

[need [[less than that] [λ_1 [John drive t_1 fast]]]]

$\rightsquigarrow \square[\max(\lambda d . \text{speed}(j) \geq d) < 80\text{mph}]$

b. *less* > *need*

[less than that] [λ_1 [need [John drive t_1 fast]]]

$\rightsquigarrow \max(\lambda d . \square \text{speed}(j) \geq d) < 80\text{mph}$

The two readings of (40) are represented by the LFs in (40a) and (40b). Heim assumes that *less* takes the degree denoted by the pronoun *that* in the standard phrase and says that the maximum degree described by the main clause is smaller than that degree. She assumes further that ‘John drives *d*-fast’ means that John’s driving speed is greater than or equal to *d*: $\text{speed}(j) \geq d$. We use $\text{speed}(j)$ as a notational shorthand for ‘the (maximal) speed at which John drives’. The maximum degree *d* to which John drives *d* fast, then, would be John’s actual speed: $\text{speed}(j)$ is equivalent to $\max(\lambda d . \text{speed}(j) \geq d)$. Given these assumptions, (40a) says it is disallowed for John to drive faster than 80mph.

A degree *d* such that John *needs* to drive *d* fast is a degree such that John’s speed reaches or exceeds *d* in all worlds. Such a degree would be a lower bound on acceptable speeds. The maximum such degree is the greatest lower bound on acceptable speeds. Hence (40b) says the minimum speed required for John is less than 80mph. The first reading is derived with the intensional verb *need* taking scope over the comparative operator, while the second reading is derived when the

comparative operator takes scope over *need*. Crucially, the truth conditions differ depending on scope.⁷

Degree abstraction being essential for comparative operators to take wide scope over modals, it follows that in languages without degree abstraction, there should be no scopal ambiguity in such sentences. Indeed, this is one of the diagnostics used by Beck et al. (2004) in order to support the idea that some language lack degree abstraction. However, this argument must always be made carefully, with the specific lexical resources of the language taken into consideration. For instance, Howell (2013) argues that the lack of scope ambiguity in certain Yorùbá sentences is compatible with degree abstraction simply because Yorùbá lacks *less*-comparatives. A similar point can be made here.

Arguing that Mandarin lacks degree abstraction, Krasikova (2008) and Beck et al. (2009) give the following example (based on a similar one given for Japanese in Beck et al. 2004):

- (41) John xuyao bi Bill shao mai yixie lazhu.
John must than Bill little buy some candles
'John must buy fewer candles than Bill.'

Not: 'John's minimally required amount is below Bill's.'

They use the absence of the second reading as evidence for the lack of degree abstraction in Mandarin. This argument comes with the caveat that the construction here belongs to "differential verbal comparatives" which are argued to involve set comparison rather than degree constructions by Li (2009). To avoid this potential controversy, we construct an example using attributive comparatives as below.

- (42) John xuyao bi Bill fan geng shao de cuowu.
John must than Bill make GENG few DE mistake
'John must make fewer mistakes than Bill.'

This example is not perfectly analogous to ones like (40), because the standard is not a given

⁷We acknowledge that there are other approaches to this type of ambiguity. Beck (2012), for example, makes use of alternative semantics and Krifka's (1995) scalar assertion operator; see also Krasikova (2010).

degree ('that'), but rather 'than Op_d Bill (needs to) make d -few mistakes', given a clausal analysis of *bi*-comparatives (Erlewine, 2018). To understand its significance, then, let us first dig into comparative ellipsis a bit.

For the comparative ellipsis sentence in (43), there are two possible scope positions of the comparative.

(43) Mary needs to drive faster than John.

a. *need* > *-er*:

need [*-er* than λd John ~~drive d -fast~~] λd Mary to drive d -fast

$\Box \max(\lambda d . \text{speed}(j) \geq d) < \max(\lambda d . \text{speed}(m) \geq d)$

'It is required that Mary's speed exceed John's'

b. *-er* > *need*

[*-er* than λd ~~need~~ John ~~drive d -fast~~] λd need Mary drive d -fast

$\max(\lambda d . \Box[\text{speed}(j) \geq d]) < \max(\lambda d . \Box[\text{speed}(m) \geq d])$

'Mary's minimum required speed is above John's minimum required speed'.

The surface-scope configuration is the one in (43a), where the modal *need* takes scope over the comparative. The truth conditions for this configuration can be paraphrased, 'It is required that the degree to which Mary drives fast exceeds the degree to which John does,' i.e., 'It is required that Mary drives faster than John drives.'

The interesting scope configuration is where the comparative takes scope over *need*, as in (43b). With that configuration, the truth conditions are 'The (greatest) degree to which Mary needs to drive fast exceeds the (greatest) degree to which John needs to drive fast'. The greatest degree to which X needs to drive fast is the greatest lower bound on acceptable speeds for X. Another way of paraphrasing the truth conditions, then, is: 'Mary's minimum required speed is above John's minimum required speed.'⁸ Heim designs a context in which this *-er* > *need* reading is true, and

⁸(43) involves ambiguity of antecedent-size: whether the antecedent is the VP [drive d -fast], or the one including the modal verb [need to drive d -fast]. In the latter case, we get the minimum-required reading when the DegP scopes over the modal verb *need*. (Heim, 2000)

the *need* > *-er* reading is false:

(44) **East coast driving scenario** (Heim, 2000)

John and Mary both need to get to Boston by eight o'clock; Mary is far away, in New Haven, and John is closer by, in Providence.

In this scenario, *Mary needs to drive faster than John* in order to get to Boston on time, but it is acceptable for John to drive faster than Mary; it's just that Mary's *minimum required* speed is above John's.

With this background on comparative ellipsis covered, let us also give a bit more background on cases involving negative antonyms, because Krasikova's example (41) as well as our example (42) also involved a negative antonym. With the negative antonyms *less fast* and *slower*, Heim (2006) noticed that there's actually a difference in meaning between (45a) and (45b).

(45) a. John needs to drive less fast than Mary.
b. John needs to drive slower than Mary. (Heim, 2006)

Example (45a) is true in Heim's east coast driving scenario, whereas (45b) does not seem to be. What we would like to point out is that there are actually two readings where the comparative scopes over the modal, depending on whether the negative component of the negative antonym comes with the comparative or not. *Less* expresses both the comparative part and the negative part. If both take scope over *need*, then the resulting reading is as in (46a). This reading is true in the east coast driving scenario. But if only the comparative component scopes over *need*, and the negative component remains underneath it, the reading in (46b) is obtained.

(46) a. *less* > *need*:
[less than λd needs Mary ~~drive d fast~~] λd needs John drive d -fast
 $\max(\lambda d . \Box[\text{speed}(j) \geq d]) < \max(\lambda d . \Box[\text{speed}(m) \geq d])$
'John's minimum required speed is below Mary's.'

b. *-er > need > slow*:

[*-er* than λd needs Mary ~~drive *d* slow~~] λd needs John drive *d*-slow

$\min(\lambda d . \Box[\text{speed}(j) < d]) < \min(\lambda d . \Box[\text{speed}(m) < d])$

‘The degree to which John needs to drive *slowly* exceeds the degree to which Mary needs to drive slowly.’

hence ‘John’s maximum allowed speed is below Mary’s.’

These two readings are very different, although they both involve high scope for the comparative over the modal. The reading in (46b), although it involves a min operator, is actually a comparison-of-maxima reading, where John’s maximum allowed speed is below Mary’s maximum allowed speed. More directly, what it says is that John’s required slowness exceeds Mary’s required slowness. John’s required slowness is the set of degrees to which John does *not* drive fast. This is an interval that stretches from right above his speed indefinitely upwards – the sort of thing that serves as a ‘negative degree’ for Kennedy (2001). The set of degrees such that in no possible world John drives that fast is the set of impossible speeds for John. Because the interval of impossible speeds stretches down lower from infinity for John than for Mary, its minimum is below the one for Mary. Where the impossible speeds end, the acceptable speeds begin. Hence the greatest *acceptable* speed for John (the speed right below the lower tip of that interval) is lower than the greatest acceptable speed for Mary.

Let us now return to example (42), repeated here:

(47) John xuyao bi Bill fan geng shao de cuwu.
 John must than Bill make GENG few DE mistake
 ‘John needs to make fewer mistakes than Bill.’

This sentence does have a reading where *must* scopes over *little* + *-er*:

(48) *must > little* + *-er*

$\Box[\max(\lambda d . \text{mistakes}(j) \geq d) < \max(\lambda d . \text{mistakes}(b) \geq d)]$

‘It is required that John make fewer mistakes than Bill.’

It also has a comparison-of-maxima reading which Krasikova does not discuss: The comparative element alone scopes over the modal, which in turn scopes over the negative antonym.

(49) *-er > must > little*

$$\min(\lambda d . \Box[\text{mistakes}(j) < d]) < \min(\lambda d . \Box[\text{mistakes}(b) < d])$$

‘John’s maximal amount allowed is below Bill’s.’

Consider a scenario where players in a competition will be disqualified if they make 10 mistakes. John has made eight mistakes already; Bill has made five mistakes. The above sentence would have a comparison-of-maxima reading in such a context: The max amount of mistakes John is allowed to make, namely two, is below the max amount of mistakes Bill is allowed to make, namely five.⁹

We argue that the sentence also has the reading where *little + -er* (the comparative and the negative component together) scope over the modal—the one that is reported as missing in Mandarin in previous literature: ‘John’s minimally required amount is below Bill’s’.

(50) *little + -er > must*

$$\max(\lambda d . \Box[\text{mistakes}(j) \geq d]) < \max(\lambda d . \Box[\text{mistakes}(b) \geq d])$$

‘John’s minimally required amount is below Bill’s.’

Admittedly, this reading is harder to get in Mandarin than in English. To determine whether the narrow scope reading of the modal verb is truly available in Mandarin, we carried out a survey measuring acceptability in context, in which four different modal verbs were tested, including two necessity modal verbs and two possibility modal verbs, described in Appendix C. We found

⁹Heim (2006) also recognizes this reading (*-er > modal > little*-phrase) but suggests that it does not have any truth-conditional difference with the wide scope reading of the modal verb. We find that in the provided context, the wide scope reading of *xuyao* ‘need’, as in (48), is likely to be false because the sentence is true even if John ended up with making more new mistakes than Bill. However, one reviewer points out that the wide scope reading of *xuyao* can also convey a reading similar to the comparison-of-maxima reading with certain generic quantification: It can be paraphrased as ‘In general, to avoid being disqualified, John is required to make fewer mistakes than Bill’. We agree with this reviewer and believe this is a pending question that requires future study.

that that a narrow scope reading of the modal verb is indeed possible in Mandarin. Below is another example with the possibility modal verb *neng* ‘can’, where the *little + -er > can* reading is available. (See Appendix C for the statistics supporting the empirical claim.)

- (51) a. hong xiangzi neng bi lan xiangzi zhuang geng shao de dongxi.
 red box can BI blue box pack GENG few DE stuff
 ‘The red box can pack less stuff than the blue box.’
- b. *little + -er > can*:
 $\max(\lambda d. \diamond[\text{stuff}(\text{redbox}) \geq d]) < \max(\lambda d. \diamond[\text{stuff}(\text{bluebox}) \geq d])$
 ‘The max possible amount of stuff to which the red box pack is smaller than the max possible amount of stuff to which the blue box pack.’
hence ‘The maximum capacity of the red box is smaller than the maximum capacity of the blue box.’

As *neng* ‘can’ surfaces in a higher position than the comparative in (51a), the narrow scope reading of *neng* requires degree abstraction to enable the comparative operator to take scope over *neng*.

4 Rebutting arguments against degree abstraction

So far we have presented three positive arguments for degree abstraction in Mandarin. What about the other empirical evidence that was used to argue against degree abstraction? In this section, we show that the relevant empirical facts are all compatible with the presence of degree abstraction in Mandarin, upon closer inspection.

4.1 Degree questions

Degree questions can be analyzed as involving quantification over degrees (Heim, 2000). A degree question like (52) involves movement of the *wh*-phrase *how*, which leaves a trace at the degree slot next to the degree predicate *tall*. Movement of *how* triggers lambda abstraction, giving us a degree abstraction configuration.

(52) How tall is John?

[Q [λ_1 [John is t_1 tall]]]

It follows from this quantificational analysis that if a language lacks degree abstraction, then it should not allow English-style degree questions. The absence of such constructions can then be taken as supporting evidence that the language does not have degree abstraction. Japanese, for example, employs degree nouns such as *kurai* ‘degree’ in constructing degree questions (Beck et al., 2004).

(53) John wa {*ikura, dore-kurai} kasikoi no?
John TOP how-much, which-degree smart Q
‘How smart is John?’

Beck et al. (2004) suggest that the use of *kurai* ‘degree’ indicates that Japanese degree questions involve quantification over individuals instead of degrees. However, as argued by Sudo (2015), it is also possible to have an analysis in which *kurai* ‘degree’ has a degree-based denotation, and does participate in a degree abstraction configuration as in (54).

(54) which degree [λd . John is d -smart].

So while Japanese does lack English-style degree questions, this does not constitute evidence against degree abstraction in Japanese.

According to Beck et al. (2009), Mandarin lacks English-like degree questions, just like Japanese. However, unlike in Japanese, degree questions in Mandarin do not make use of degree nouns. Instead, they are constructed with the degree *wh*-expression *duo* as exemplified in (55).

(55) John (you) duo gao?
John COP how tall
‘How tall is John?’

The example provided by Beck et al. (2009) uses *shi* as the copula and is reported to be ungram-

matical¹⁰:

- (56) (*)John shi duo gao?
John COP how tall
'How tall is John?'

But *shi* is often analyzed as the focus marker or the emphasis marker in Mandarin (Huang 1982; Paul 2021 among others). We note that (56) is acceptable in the right context, for example, as a clarification/echo-question: Imagine that someone just told you John's height but you didn't hear that clearly, or that you used to know John's height but now you forgot it. In such scenarios, (56) is totally fine. But regardless of whether the example with *shi* can be counted as a genuine degree question, example (55) above clearly is. So the relevant phenomenon does exist in Mandarin.

That said, the significance of degree questions for degree abstraction is highly analysis-dependent: Only if a language has attested *wh*-movement, either overt or covert, in degree questions, can degree questions be used as a diagnostic for degree abstraction. As Erlewine (2018) points out, degree questions do not really provide conclusive evidence in Mandarin since it is a *wh*-in-situ language, and its degree questions have been argued to not involve movement (Tsai, 1994; Liao, 2013). In other words, degree abstraction should not be expected in Mandarin degree questions in the first place because there is no proof of *wh*-movement. Hence, we argue that Mandarin degree questions do *not* provide any argument against or for degree abstraction, *contra* Krasikova (2008) and Beck et al. (2009).

Nevertheless, in this connection, we want to point to one *potential* positive argument for degree abstraction that involves the degree *wh*-word *duo*. Sentences like (57) consist of two full clauses, each of which contains a degree *wh*-phrase *duo* 'how'. Such constructions are often referred to as "bare-conditionals" or "wh-correlatives" in the literature.

- (57) chuanzi duo long, wo jiu hui mai duo long de chuanglian.
window how long, I then will buy how long DE curtain

¹⁰We use asterisk in parentheses to indicate that the judgment is attributed to Beck et al. (2009), with which we disagree.

‘I will buy a curtain as long as the window is long.’

There are multiple views on how to analyze cases like (57), and depending on a given analysis, arguments in favor of degree abstraction might come along. For example, under a *wh*-correlative or free relative analysis (Crain & Luo, 2011; Huang, 2010; Chen, 2020), the antecedent clause would be a definite description of a degree (Dayal, 1996) (here a type *d*-argument) and serve as the argument to the consequent clause. Degree abstraction is needed to form the type $\langle d, t \rangle$ predicate out of the consequent clause:

(58) [λd . I will buy a *d*-long curtain](*t*d (window is *d*-tall))

Other approaches to such constructions include the unselective-binding account (Cheng & Huang, 1996; Chierchia, 2000) and the question-based analysis (Liu, 2016; Xiang, 2021; Li, 2021). In the former, these constructions are as analyzed as conditionals with two matching *wh*-pronouns being bound by a covert universal operator, whereas in the latter, they are viewed as interrogative conditionals consisting of two embedded questions. Although such analyses do not rely on degree abstraction, they also do not oppose it. In fact, most scholars advocating for a question-based analysis also assume covert *wh*-movement, which, in the case of the degree *wh*-phrase, is an instance of degree abstraction.

While it is a pending issue what analysis we should give to this type of construction, the assumption that Mandarin lacks degree abstraction certainly constitutes an inconvenience for analytical approaches that have made use of it. We leave it an open question whether *wh*-movement is involved in such constructions—if it is, it would then provide positive evidence for degree abstraction.

4.2 Quantificational direct measure phrases

Like degree questions, a quantificational analysis has been proposed for direct measure phrase constructions in English (Heim, 2000).

- (59) John is exactly six feet tall. (Direct measure phrase)
 [exactly six feet] [λ_1 [John is t_1 tall]]

A similar argument based on Mandarin direct measure phrase constructions has been given by Beck et al. (2009): Mandarin lacks English-like measure phrase constructions as measure phrases *cannot* combine directly with the degree adjective as in (60a).

- (60) a. (*)John shi 2 mi gao.
 John COP 2 meter tall
 'John is 2 meters tall.'
- b. John you 2 mi gao.
 John COP 2 meter tall
 'John is 2 meters tall.'

Again, we argue that direct measure phrase constructions are possible in Mandarin with both *shi* and *you*. (60a) is good when it is used as an affirmation that John is truly 2 meters tall, whereas (60b) expresses that John is *at least* 2 meters tall. These two meanings can be teased apart under negation: in a context where John is higher than 2 meters, (61b) is false whereas (61a) is true.

- (61) a. John bu shi 2 mi gao.
 John NEG COP 2 meter tall
 'John is not 2 meters tall.'
- b. John mei you 2 mi gao.
 John NEG COP 2 meter tall
 'John is less than 2 meters tall.'

While Mandarin does have direct measure phrase constructions like those in (60), Krasikova (2008) takes issue with Mandarin measure phrases themselves: Unlike English measure phrases which are optional in simple positive forms, measure phrases are required in simple positive forms in Mandarin (cf. (62a) and (62b)).

- (62) a. John is (2 meters) tall.

- b. John *(2 mi) gao.
 John 2 meter tall
 ‘John is tall./John is 2 meters tall.’

She argues that the contrast between (62a) and (62b) indicates that Mandarin measure phrases do not function as quantifiers, and hence Mandarin direct measure phrase constructions do not count as the kind of measure phrase constructions that would give evidence for degree abstraction. As for *you*-sentences like (60b), Krasikova (2008) suggests that they can be analyzed as resultative constructions: Roughly, (60b) can be treated as stating the resulting state in height such that John has reached. Hence, no degree abstraction is required.

While Krasikova’s analysis for *you*-sentences is indeed plausible and can potentially be extended to *shi*-sentences, the motivation for such a degree-less analysis is questionable, as the ungrammaticality of (62b) could be explained independently of measure phrases. For example, the obligatory presence of the measure phrase in (62b) can follow directly from a syntactic constraint proposed by Grano (2012), called the T+[V] constraint:

(63) **T+[V] constraint** (Grano, 2012)

In Mandarin, the direct complement to T(ense) must either be (an extended projection of) a verb or functional morpheme that can in principle combine with a verb.

Since APs cannot be the direct complement of T, a degree morpheme such as a measure phrase is hence required to project a functional phrase (e.g. DegP) to satisfy T+[V] constraint.¹¹ Therefore, the difference in measure phrase constructions that Krasikova observes can be a consequence of an independent syntactic constraint in Mandarin, unrelated to degree abstraction. Thus, we argue, Mandarin measure phrases do not provide evidence in favor of a degree-less analysis.

On the other hand, overt quantificational measure phrases modified by *zhenghao* ‘exactly’ are acceptable in Mandarin, as shown below.

¹¹For this property of Mandarin gradable adjectives, see discussions in Grano (2012).

- (64) a. zhe gen shengzi **zhenghao** 5 mi chang.
 this CL rope exactly 5 meter long
 ‘This rope is exactly 5 meters long.’
- b. zhe gen shengzi bu shi **zhenghao** 5 mi chang.
 this CL rope NEG COP exactly 5 meter long
 ‘This rope is not exactly 5 meters long.’

English-like *exactly*-differentials where scope interactions between the comparative operator and modal verbs are attested (Heim, 2000) can be constructed with *zhenghao* and differential adjectival comparatives (Li, 2009)—differentials that are argued to involve degree-denoting measure phrases, as illustrated in (65a).¹² Suppose you have written a draft of 10 pages, and you wonder if that meets the requirement for the term paper.

- (65) a. qimo lunwen zhenghao xuyao [bi na] chang 2 ye.
 term-final paper exactly need [than that] long 2 page
 ‘The term paper needs to be exactly 2 more pages longer than that.’
- b. require [exactly 2pp -er than that] [λ_1 [the paper be t_1 long]]
 $\leadsto \Box \max(\lambda d . \text{length}(\text{the-paper}) \geq d) = 10\text{pp} + 2\text{pp}$
 ‘It is required that the term paper is exactly 2 pages longer than that.’
- c. [exactly 2pp -er than that] [λ_1 [require the paper be t_1 long]]
 $\leadsto \max(\lambda d . \Box \text{length}(\text{the-paper}) \geq d) = 10\text{pp} + 2\text{pp}$
 ‘The minimum requirement is exactly two pages greater than that.’

Sentence (65a) can be judged true in a scenario where the requirement is exactly 12 pages—not more not less—and also true in a scenario where the minimal requirement is 12 pages, but you are allowed to write more than that. Hence both the reading in (65b) and in (65c) are available.

The narrow scope reading of *xuyao* ‘need’ in (65c) not only provides additional evidence that comparative operators can take scope over modal verbs in Mandarin but also shows that Mandarin measure phrases do move like a quantifier and trigger degree abstraction. We conclude,

¹²Beck et al. (2009) used examples like the following (although did not report the translation into Mandarin for the “exactly” case): The minimal requirement for the length of the paper is 25 pages. The draft is 20 pages long. *Your paper must be exactly 5 pages longer than that.*

therefore, that the empirical evidence suggests that Mandarin measure phrases should receive a quantification-over-degree analysis and hence provide evidence for degree abstraction.

4.3 Subcomparatives

We turn now to subcomparatives, another one of Beck et al.'s (2009) diagnostics. In subcomparatives, two commensurable adjectives are used for comparison, as exemplified in (66).

- (66) a. The door is wider than the table is long.
b. $\max(\lambda d . \text{the door is } d\text{-wide}) > \max(\lambda d . \text{the table is } d\text{-long})$

Subcomparatives are unambiguously clausal. The associate clause and the standard clause each characterize a different degree d by way of a condition that it could meet: ‘the door is d wide’ and ‘the table is d long’. Hence degree abstraction would seem to be an essential component of any analysis of this phenomenon. Inability to form subcomparatives might then be taken as an indication that a language lacks degree abstraction.

Subcomparatives are disallowed in Mandarin (Fu, 1978; Xiang, 2005; Krasikova, 2008), as shown in (68). An ordinary comparative is given in (67) for comparison.

- (67) men [bi zhuozi] kuan.
door [than table] wide
‘The door is wider than the table.’
- (68) *men kuan [bi zhuozi chang].
door wide [than table long]
‘The door is wider than the table is long.’

The following alternative word order is also out (cf. Erlewine 2018, fn. 3):

- (69) *men [bi zhuozi chang] kuan.
door [than table long] wide
‘The door is wider than the table is long.’

Depending on how *bi*-comparatives are analyzed, either (68) or (69) would be the relevant structure to consider when assessing whether subcomparatives are possible. In any case, neither option works. Beck et al. (2009) and Krasikova (2008) suggest that the lack of subcomparatives in Mandarin is caused by absence of degree abstraction in the language.

Erlewine (2018) adopts a clausal analysis of *bi*-comparatives and a degree-last analysis of gradable predicates. Given these assumptions, there is no reason for subcomparatives to be ruled out, even if degree abstraction is absent in the language. He is therefore forced to offer an alternative explanation for the ban on subcomparatives. Like others who advocate a clausal analysis of *bi*-comparatives such as Liu (1996), Erlewine (2018) stipulates a deletion requirement in comparatives: One of the two gradable predicates must be deleted, as illustrated in (70).¹³

- (70) [[TP men [VP ~~kuan~~]] [bi [TP zhuozi [VP kuan]]]].
 door wide than table wide
 ‘The door is wider than the table.’

The deletion operation is subject to the following requirement:

- (71) Comparative Deletion Requirement (CDR):

In a *bi* comparative, elide a local predicate of the target TP under identity with a local predicate of the standard TP. If the target TP has no elidable local predicate, the derivation is illicit. (Erlewine, 2018, 454)

A *local predicate* of a given TP is a VP or AP dominated by that TP and not dominated by any intervening TP. It follows from this deletion requirement that any sentence with two gradable predicates that are not identical (e.g. *wide* and *long* in (68), repeated below) will be ruled out in the syntax.

- (72) * [[TP men [VP ~~kuan~~]] [bi [TP zhuozi [VP chang]]]].
 door wide than table long

¹³Analyses vary with respect to the deletion site: Liu (1996) suggests that the predicate in the standard clause is elided, while Erlewine (2018) suggests the predicate in antecedent clause, which he names as “the target clause”.

‘The door is wider than the table is long.’

If this deletion requirement is in force, then subcomparatives are ruled out independently of whether degree abstraction exists in the language. The lack of subcomparatives therefore does not provide a convincing argument against degree abstraction.

4.4 Negative island effects

Another key DAP test suggested by Beck et al. (2004) involves so-called ‘negative island effects’. Negation in the standard clause results in anomaly in constructions like (73).

- (73) a. #Mary bought a more expensive book than no boy did.
b. #Mary bought a more expensive book than John didn’t.

An explanation for the anomaly is that the set of degrees denoted by the *than*-clause containing negation does not have a maximal degree (von Stechow, 1984; Rullmann, 1995). For example, the *than*-clause in (73b) has a denotation as follows:

- (74) λd . John didn’t buy a *d*-expensive book

Suppose the price of the most expensive book John has bought is p . So for any price p' that is greater than p , it is always true that John did not buy a p' -expensive book. As p' can increase without bound, there is no maximum, so the maximum operator is undefined.

Beck et al. (2009) suggest that degree abstraction is closely related to negative island effects: only if the *than*-clause denotes a set of degrees will there be a need to define the maximal degree. Hence, according to Beck et al. (2009), if a language does not display such negative island effects, it is likely that *than*-clauses in the language do not denote sets of degrees.

We take issue both with the empirical claim that Mandarin lacks negative island effects and with the logic of the argument. Example (75) is presented by Beck et al. (2009) to show that Mandarin displays no island effects.

- (75) [DP_[RC]John mai de shu]] bi [DP_[RC]Bill mei mai de]] gui.
 John buy DE book BI Bill NEG buy DE expensive
 ‘John bought a more expensive book than the one Bill didn’t buy.’

Literally: ‘The book John bought is more expensive than the book Bill didn’t buy.’

Example (75) is quite different from English examples in (73), and not just in that it has an acceptable reading. As one can tell from the added literal translation, (75) makes a comparison between a book which John bought and *the book which Bill didn’t buy*. Although Mandarin does not have (in)definite articles equivalent to English *the*, the sentence clearly involves reference to a particular book, the book Bill didn’t buy. This reference to a particular book is overtly, and obligatorily, expressed in cases like (76) where *meiren* ‘nobody’, unlike *Bill*, is unable to provide a definite interpretation for the standard clause.

- (76) John mai de shu bi mei ren mai de *(na ben) gui.
 John buy DE book BI NEG person buy DE that CL expensive
 ‘The book John bought is more expensive than the book nobody bought.’

Thus, under a clausal analysis, the denotation of the *than*-clause in (75) should be along the lines of the following:

- (77) λd . the book which Bill didn’t buy is *d*-expensive

Because of the fact that the *than*-clause denotes a set of degrees to which a particular book is expensive, we indeed can define the maximal degree. No anomaly should be expected. Thus, (75) does not show Mandarin lacks negative island effects. In general, if a language allows an interpretation of a string similar to *John bought a more expensive book than Bill didn’t* involving definite reference to a particular non-bought book, this does not provide evidence that the language *lacks* degree abstraction; it just shows that the syntax of the language *permits* such a parse.

Now consider examples (78) and (79). The negation in (78) gives rise to a sentential negation interpretation, whereas the negation in the standard clause makes (79) unacceptable.

(78) John **mei/bu** [bi Bill pao de kuai].
John NEG [BI Bill run DE fast]
'It is not the case that John runs faster than Bill.'

(79) #John [bi Bill **mei/bu** pao de kuai].
John [BI Bill NEG run DE fast]
#'John runs faster than Bill doesn't.'

The anomaly of (79) can be explained under the same set of assumptions that explain the anomaly of its English counterpart (80), i.e., there is no maximum of the set of degrees such that Bill doesn't run *d*-fast.

(80) #John runs faster than Bill doesn't.
 λd . Bill doesn't run *d*-fast

Thus Mandarin actually patterns with English, displaying negative island effects. Far from providing an argument *against* degree abstraction, the evidence in this arena is just what is expected if Mandarin comparatives involve sets of degrees, just like their English counterparts.

Other types of data that could be considered include scope interactions with negative quantity words like *little* and superlatives. Unfortunately, both of these diagnostics turn out to be inconclusive, but they are included in Appendix D as they may be of methodological interest for future researchers.

5 Conclusion

In this paper we have investigated Mandarin degree constructions with respect to the Degree Abstraction Parameter (DAP). We have examined the arguments that Mandarin lacks degree abstraction from Krasikova (2008), Beck et al. (2009) and Erlewine (2018). As many proposed diagnostics for degree abstraction are analysis-sensitive, we have taken into account the different analyses of *bi*-comparatives as well as the Degree Last assumption for gradable predicates and how the potential variations might affect the overall argument.

We have recognized three diagnostics for degree abstraction that are capable of deciding the issue independently of which analysis we assume, and we have shown that they provide positive arguments for degree abstraction in Mandarin:

- We provided new empirical data involving attributive *bi*-comparatives. We illustrated in detail that Mandarin does have explicit attributive comparatives, contrary to previous claims. This is strong evidence for degree abstraction, regardless of what analysis is given to *bi*-comparatives.
- We showed that with certain types of embedding verbs—the ‘make’ verbs—it is possible to have embedding in a standard clause of a comparative ellipsis construction. This data provides further evidence for degree abstraction.
- We have given new evidence for degree abstraction from scope interactions with modals. We showed that comparatives can take scope over modals and gives rise to a comparison-of-maxima reading as well as a reading where the modal verb takes narrow scope. Such scopal interactions require degree abstraction no matter what analysis is assumed for *bi*-comparatives in general.

Aside from the above positive arguments for degree abstraction, we have argued that the following putative negative arguments are unconvincing as they are based on empirical facts that are compatible with the presence of degree abstraction.

- We have shown that Mandarin does have degree questions. This fact cannot straightforwardly be used as evidence for degree abstraction because Mandarin is a *wh*-in-situ language. However, depending on how bare conditionals are analyzed, if *wh*-movement is required, then bare conditionals likely provide positive arguments for degree abstraction too.
- Meanwhile, Mandarin direct measure phrase constructions are just like English ones, where a quantification-over-degree analysis is quite possible. Using evidence from scope interac-

tion in *exactly*-differentials, we argue that Mandarin direct measure phrases can receive a quantificational analysis, which requires degree abstraction.

- We showed that negative island effects do exist in Mandarin, but we argue that this test does not provide any evidence with respect to degree abstraction.

Taken together, these results strongly support the view that degree abstraction is not a parameter along which Mandarin and English vary.

One consequence of this conclusion is that Mandarin is not, as is often claimed, a surface-only scope language. For instance, Tsai et al. (2014) give evidence that quantifiers like *some* and *every* cannot take inverse scope in multiply quantified sentences. Regardless of whether a ban on inverse scope holds for quantifiers over individuals, our conclusion implies that there is no parallel constraint in the degree domain.

Furthermore, our conclusion, along with those made for Japanese by Shimoyama (2012); Sudo (2015) and Yorùbá by Howell (2013), casts further doubt on the existence of the Degree Abstraction Parameter. As more and more languages are argued to have degree abstraction in recent studies—including P’urhepecha (Zyman, 2015), Twesap (Clem, 2019), and two Salish languages (Davis & Mellesmoen, 2019)—our findings add to the growing evidence that degree abstraction may in fact be universal among languages with degree predicates.

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A On the obligatoriness of *geng* in attributive comparatives

Let us take a moment to speculate as to what might account for the unacceptability of (17), repeated here:

- (81) *John bi Bill xie le {duo, chang} de lunwen.
 John than Bill write ASP {many, long} DE paper
 ‘John wrote more papers/a longer paper than Bill.’

and the obligatoriness of the variant with *geng*, illustrated in (18), repeated here:

- (82) John bi Bill xie le **geng** {duo, chang} de lunwen.
 John than Bill write ASP **more** {many, long} DE paper
 ‘John wrote more papers/a longer paper than Bill.’

We would like to raise the possibility that the obligatoriness of *geng* here is related to the obligatoriness of *hen* ‘very’ in positive form adjectives. In particular, we suggest that Grano’s (2012) T+[V] constraint lies behind both of these phenomena.

There is a debate over how to analyze prenominal modifiers in Mandarin: are they actually relative clauses, or are they just simple attributive modifiers (see discussions in Sproat & Shih (1988) and Paul (2005))? It is also possible that there is widespread ambiguity, and that the answer differs depending on the class of modifier. We cannot resolve this issue here, but if we can assume that comparative modifiers are actually relative clauses, then we can take advantage of Grano’s (2012) a T+[V] constraint in order to explain the obligatoriness of *geng* in this construction.

Prenominal comparative modifiers pattern with uncontroversial relative clauses insofar they can appear to the left of the numeral+classifier sequence.

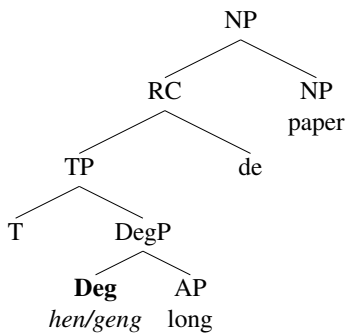
- (83) a. yi ge [RC jiao yufa de] laoshi
 one CL teach grammar DE teacher
 ‘a teacher who teaches grammar’
 b. [RC jiao yufa de] yi ge laoshi
 teach grammar DE one CL teacher
 ‘a teacher who teaches grammar’
- (84) a. yi pian [geng chang DE] wenzhang
 one CL more long DE article
 ‘a longer paper’
 b. [geng chang de] yi pian wenzhang
 more long DE one CL article
 ‘a longer paper’

This evidence supports the idea that the prenominal modifier in attributive comparatives is parsed as a relative clause, though we acknowledge that far more would have to be done in order to establish this claim carefully.

Recall the T+[V] constraint as given in (63): the direct complement to T(ense) must either be (an extended projection of) verb or functional morpheme that can in principle combine with a verb (Grano, 2012). DegP is one such projection while AP is not:

- (85) a. John [TP [DegP hen [AP gao]]]
 John very tall
 ‘John is tall.’
 b. *John [TP [AP gao]]
 John tall
 ‘John is tall.’

Following Grano (2012), since relative clauses contain projections of T, if a prenominal modifier is parsed as relative clause, it must project a DegP instead of an AP. A structure for prenominal modifiers as relative clauses is sketched below:



In this configuration, according to Grano, the Deg head needs to be filled by a morpheme such *hen* since it is the direct complement of T. We suggest tentatively that *geng* is a suppletive form of *hen* in comparatives (not necessarily the only one), and it is required in those attributive comparatives involving a prenominal structure like above.

It has been observed that simple positive forms like *John gao* ‘John is tall’ in Mandarin can receive a comparative reading with a contextual standard (Grano, 2012). This seems to be good evidence for a null comparative operator in this language. Evidence from Mandarin transitive comparatives (Grano & Kennedy, 2012) also suggests that Mandarin has a null comparative \emptyset_{COMP} in syntax (see also Liu 2018). If our analysis is on the right track, something must be said with respect to \emptyset_{COMP} : Why can’t the null operator save those Mandarin attributive comparatives?¹⁴

It is, however, an empirical fact that the null comparative operator is not at work in attributive phrases:

- (86) a. Who is the smarter boy? John or Bill?
 b. #John shi ge \emptyset_{COMP} congming de nanhai.
 John is CL \emptyset_{COMP} smart de boy
 Intended: John is the smarter boy.

We suggest that the null comparative operator fails in attributive configurations for compositional reasons. Notice that in order to be interpreted in attributive position, it would have to move. We suggest that \emptyset_{COMP} is scopally immobile unless it is given some phonological content, e.g. in the form of *geng*. In other words, *geng* but not \emptyset_{COMP} can be extracted from a NP boundary, giving the right truth conditions for Mandarin attributive comparatives. We leave a fuller investigation of this issue to future work.¹⁵

¹⁴In fact, this objection is not only possible, but actual; it was raised to us via personal communication by [NAME OMITTED].

¹⁵Given that there are environments where *hen* is not required for a positive interpretation, we might expect *geng* to be optional in the same environments if indeed *geng* alternates with *hen* the manner we propose. But the environments in which *hen* is not required for a positive interpretation are yes/no question contexts, where Grano (2012) posits an affirmative operator. These are not environments where we would expect a comparative to be felicitous.

B Experiment 1: Acceptability of attributive comparatives

In Section 3.1 we argued that Mandarin has attributive comparatives, and in Section 3.3 we made use of attributive comparatives in which *shao* ‘few’ is the gradable predicate, like (42), repeated below.

- (87) John xuyao bi Bill fan geng shao de cuowu.
John must than Bill make more little DE mistake
‘John must make fewer mistakes than Bill.’

Unlike with quality predicates like *xiao* ‘small’, the particle *de* is optional with the quantity predicate *shao* ‘few’. Given this, and the well-established fact that quantity predicates can differ grammatically from quality predicates, it is reasonable to wonder whether *shao* ‘few’ is genuinely capable of serving as an attributive modifier of a noun.

The particle *de* is commonly assumed to be a way of introducing attributive modifiers. If *shao* ‘few’ is not capable of serving as an attributive modifier of a noun, then we would expect it not to be compatible with *de*, or at least that it would have reduced acceptability when *de* is included. On the other hand, if it can be attributive, then we would expect examples with *shao* ‘few’ to be at least as acceptable with *de* as without, and at least as acceptable with *de* as comparable examples with quality predicates. We tested these predictions in Experiment 1.

Another empirical question that Experiment 1 addresses has to do with the lexical semantics of the governing verb. In informal discussions regarding these examples, the intuition has been expressed that the acceptability of these attributive-seeming examples with *shao* ‘few’ might be limited to the object position of a certain class of verbs, and that in particular, they may be more acceptable with verbs of creation. Experiment 1 tests this prediction.

Design. We carried out an acceptability judgment study involving sentences with 4 different verbs, each presented in three different attributive comparative structures (two quantity, one quality). The quality comparative always had *de* linking the gradable predicate and the noun, and the quantity comparatives were shown in two versions: one with *de* and the other without. Thus all told there were $4 \times 3 = 12$ different sentences. Each participant was shown all 12 sentences.

Materials. Mandarin sentences containing adnominal quality and quantity comparatives were constructed along with short contexts. Here we present English translations of the contexts and the Mandarin sentences. (Add clarification about orthography.) In the following examples, the (a) sentences involve quantity comparatives, and the (b) sentences involve quality comparatives. The quantity comparatives were presented both with and without *de* between the gradable predicate and the noun.

- (88) *chi* ‘eat’
a. Context: Assume A ate 2 apples; B ate 4 apples.
A bi B chi le geng shao (de) pingguo. (quantity)
‘A ate fewer apples than B’

- b. Context: Assume a normal sized apple is around 40g. A ate a 20g apple; B ate a 30g apple.
A bi B chi le yi ge geng xiao de pingguo. (degree)
 ‘A ate a smaller apple than B.’

(89) *xie* ‘write’

- a. Context: Assume A wrote 3 papers; B wrote 5 papers.
A bi B xie le geng shao (de) lunwen.
 ‘A wrote fewer papers than B.’
- b. Context: Assume a normal-length paper is around 10 pages. A wrote a 2-page paper; B wrote a 4-page paper.
A bi B xie le yi pian geng duan de lunwen.
 ‘A wrote a shorter paper than B.’

(90) *da* ‘hit’

- a. Context: Assume in one battle, C hit 20 monsters; B hit 3 monsters; A only hit 1 monster.
A bi B da le geng shao (de) yaoguai.
 ‘A hit fewer monsters than B’
- b. Context: Assume in one battle, C hit a very strong monster; B hit a weak monster; A hit a even weaker monster.
A bi B da le yi ge geng ruo de yaoguai.
 ‘A hit a weaker monster than B’

(91) *tou* ‘vote for’

- a. Context: Assume 20 people are competing for the manager position. The company decides to vote. Everyone can vote for one or more people. Most people voted for people.
A bi B tou le geng shao (de) ren.
 ‘A voted for fewer people than B.’
- b. Context: Assume normally managers are in their 40s. The candidate B voted for is 25 years old; the candidate A voted for is 20.
A bi B tou le yi ge geng nianqing de houxuanren.
 ‘A voted for a younger candidate than B.’

Attention check items. We constructed three sentences to serve as attention checks. We endeavored to ensure that these examples carried the same degree of complexity as the other sentences being tested, to ensure that participants are giving the amount of attention necessary to process sentences of that complexity. Each attention check item is associated with an expected range of responses.

(92) Context: Assume a normal family use car is 100k. A wants to buy a 400k car; B wants to buy a 500k car.

‘The car B wants to buy is even more expensive than the car A wants to buy.’
Expected response: high acceptance (above 3)

- (93) Context: Assume the school is hosting an event. All grade 1-5 students must come, and 6th graders can choose to come or not.
‘Every student cannot come to the event.’
Expected response: low acceptance (below 3)
- (94) Context: Assume that the school is having a tug-of-war game. All students who are attending the game are required to come to the playground; the other students would have their free time.
‘Not every student needs to come to the playground.’
Expected response: high acceptance (above 3)

Procedure. Participants were presented with each of the 12 sentences in the given context, along with the attention check sentences, and asked to judge whether or not the sentence was a ‘correct expression’ in Mandarin on a 1-5 scale for each (5 = correct/natural, 1 = incorrect/unacceptable). The sentences were presented in a fixed order, and Experiment 1 items were presented in the same survey as Experiment 2 items (discussed below), with Experiment 1 items preceding Experiment 2 items. One attention check question was interspersed with the Experiment 1 items, and the other two were interspersed with Experiment 2 items.

Participants. 53 participants were recruited through Prolific, and selected according to self-reported native language (“Mandarin” or “Chinese”) and nationality (“China”). 5 participants were excluded on the grounds that they gave unexpected responses to one or more attention check items, yielding a dataset of 48 participants.

Results. The results are shown in Figure 2, which plots the acceptability ratings we obtained for each of the 4×3 sentence-types. Visually, this graph shows the same pattern with all of the verbs, and statistics (reported below) confirm this. So the hypothesis that these verbs would differ was not supported. With each verb, we found high acceptability ratings for quality predicates (with mean ratings between 4 and 5) and comparable acceptability ratings for quantity predicates with *de*. Regardless of verb, removing *de* from prenominal quantity comparatives yields moderately but reliably lower acceptability ratings, with a mean near 3.

An ANOVA calculated over a linear regression model of the acceptability judgments including verb, type of gradable predicate, and their interaction yields an estimated probability of 0.84 for the null hypothesis that there is no main effect of verb, and of 0.56 for the null hypothesis that there is no interaction between verb and type of gradable predicate. On the other hand, a highly significant effect of gradable predicate was detected ($p < 0.0001$), such that quantity comparatives without *de* received lower ratings than those with *de* and lower ratings than comparable quality comparatives.

Discussion. These results support our assumption that quantity comparatives participate in genuinely attributive structures (just as degree comparatives do), and we found no evidence that the

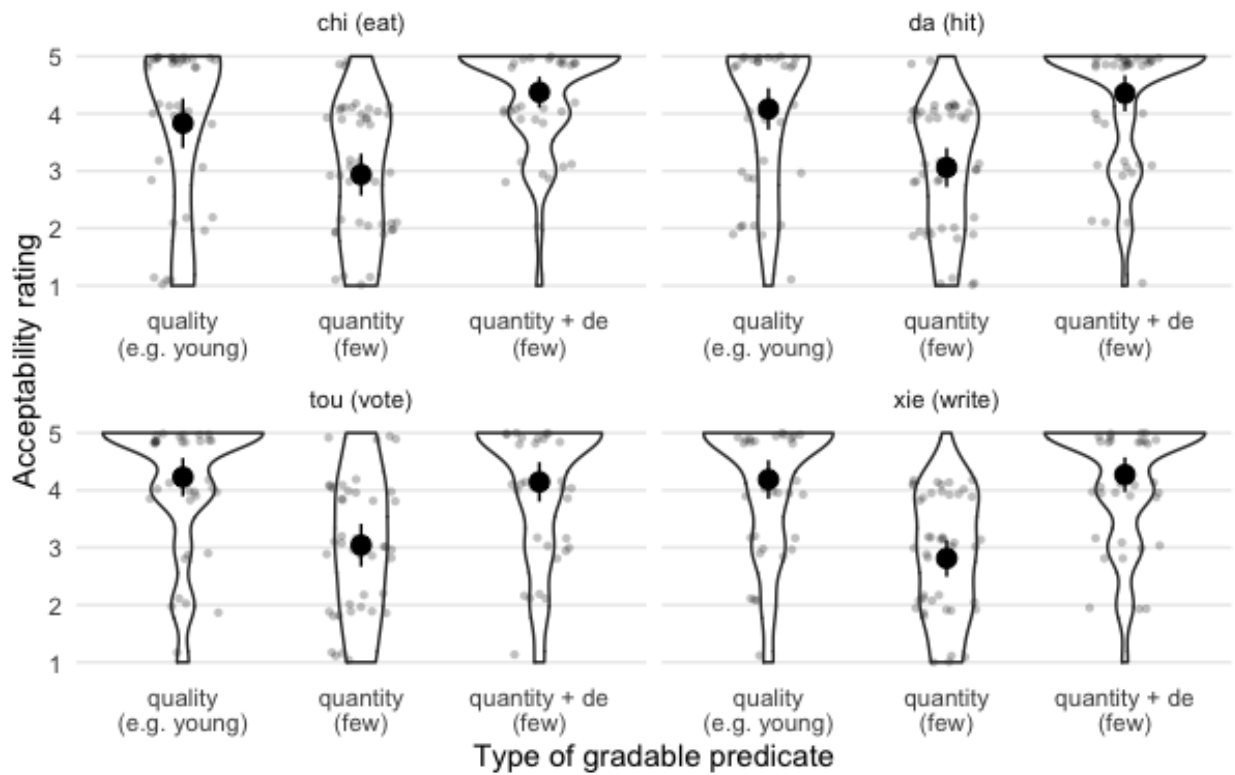


Figure 2: Violin plot of judgments obtained in acceptability study on attributive comparatives. The large dot represents the mean, and is surrounded by a 95% confidence interval.

semantic class of the governing verb impacts the acceptability of adnominal quantity comparatives.

C Experiment 2: Scope preferences

Purpose. We claimed in Section 3.3 that in sentences with modals and *bi*-comparatives, the comparative is capable of taking scope over the modal. This experiment is designed to assess whether such readings exist, whether there is any preference among the possible scope readings, and whether any such preference is modulated by the particular choice of modal verb. This experiment also tests whether there is any sensitivity to the word order, specifically between the verbs and the comparative *bi*-phrase.

Design. The dependent measure was the degree of fit between a given sentence and the context. All target sentences contained a modal and a comparative. These sentences were embedded in two kinds of contexts: ones supporting a reading where the comparative scopes over the modal, and one supporting a reading where the modal scopes over the comparative. We tested two necessity modals (*bixu* and *xuyao*) and two possibility modals (*keyi* and *neng*). Sentences also varied in the choice of main verb and object noun ('lexicalization'); we used three lexicalizations for the possibility modals, and three different lexicalizations for the necessity modals. With four modal verbs and three lexicalizations per modal verb, we had 12 basic sentences. Three word order variations on these 12 basic sentences were tested, making for a total of 36 sentences. These 36 sentences could be presented in one of two types of contexts, making for 72 conditions.

Participants did not view all 72 conditions; rather they were assigned one of six lists. Each list contained 12 sentences, two per lexicalization, in a latin square-like design. The lists were designed so that although each lexicalization would appear twice, no two sentences within a list constituted a minimal pair, differing along only one dimension. The purpose of avoiding minimal pairs was to limit the chances that participants would become consciously aware of the factors being manipulated. Across the 6 lists of 12 sentences, all 72 conditions were represented.

Materials. The three lexicalizations for the possibility modals are shown below. Each was associated with two contexts, and the target sentence varied ever so slightly across contexts. The modal verb is highlighted in bold.

(95) *seating at a table*

- a. Context 1: Assume there is a square table where a maximum of four people can sit and there is a round table where a maximum of six people can sit.
*zhege fangzhuo **neng/keyi** bi nage yuanzhuo zuo geng shao de ren* 'This square table **can** seat fewer people than that round table.'
- b. Context 2: Assume there is a glass table and a wooden table. Now 5 people come. John doesn't know how to sit people on these two tables. You tell him:
*boli zhuo **neng/keyi** bi muzhuo zuo geng shao de ren (huozhe geng duo, suibian ni)* 'This glass table **can** seat fewer people than that wooden table (or more, it's up to you).'

(96) *loading a truck*

- a. Context 1: Assume there is a small truck with 4-package load limit and a big truck with 6-package load limit.
xiao kache neng/keyi bi da kache zhuangzai geng shao de huowu.
'The small truck **can** load fewer cargo packages than the big truck.'
- b. Context 2: Assume there is a red truck and blue truck. There are 5 packages of cargo and the porter doesn't know which car should be loaded with how many packages. You tell him:
hong kache neng/keyi bi lan kache zhuangzai geng shao de huowu (huozhe geng duo, suibian ni).
'The red truck **can** load fewer cargo packages than the blue truck (or more, it's up to you).'

(97) *packing a suitcase*

- a. Context 1: Assume there is a small suitcase which packs a maximum of 2 winter coats, and a big one which packs a maximum of 4 winter coats.
xiao xinglixiang neng/keyi bi da xinglixiang zhuang geng shao de hou waitao.
'The small suitcase **can** pack fewer winter coats than the big suitcase.'
- b. Context 2: Assume John has a yellow suitcase and a blue suitcase. He wants to bring 5 winter coats with these two suitcases but doesn't know which suitcase should be packed with how many coats. You tell him:
huangse xinglixiang neng/keyi bi lanse xinglixiang zhuangse geng shao de hou waitao (huozhe geng duo, suibian ni).
'The yellow suitcase **can** pack fewer winter coats than the blue suitcase (or more, it's up to you).'

The three lexicalizations for the necessity modals are shown below.

(98) *adding water to a water boiler*

- a. Context 1: Context 1: Electric water boilers won't start work if the water you add is below its minimum water level. Assume now there is a small electric water boiler with a 500ml minimum water level, and a big electric water boiler with a 1000ml minimum water level. John wants to boil some hot water with these two boilers, and you tell him:
xiao reshuihu xuyao/bixu bi da reshuihu jia geng shao de shui
'The small water boiler **needs** to be added with less water than the big water boiler.'
- b. Context 2: Assume there is a glass water boiler and an iron water boiler. It is required that the water added to the glass water boiler is less than the water added to the iron boiler. John is adding the water to these two boilers, and you tell him:
boli reshuihu xuyao/bixu bi tie reshuihu jia geng shao de shui.
'The glass water boiler **needs** to be added with less water than the iron water boiler.'

(99) *having security guards on duty*

- a. Context 1: Assume is a 3-level building that requires at least 3 security guards and a 5-level building that requires at least 5 security guards. John is the security captain, and you tell him:
san ceng gaode lou xuyao/bixu bi wu ceng gao de lou anpai geng shao de baoan.
 ‘The 3-story building **needs** to have fewer security guards on duty than the 5-story building.’
- b. Context 2: Assume there is an old building and a new building. Because the old building has fewer rooms, it is required fewer security guards are arranged to the new building than the old building. John is the security captain, and you tell him:
xinlou xuyao/bixu bi laolou anpai geng shao de baoan.
 ‘The new building **needs** to have fewer security guards on duty than the old building.’

(100) *putting pillows in hotel rooms*

- a. Context 1: Assume there is a double room and a quad. It is required that the double room has at least 2 pillows, and the quad has at least 4 pillows. Bill is putting pillows in these two rooms, and you tell him:
shuangrenjian xuyao/bixu bi sirenjian fang geng shao de zhengtou.
 ‘The double-room **needs** to have fewer pillows than the quad.’
- b. Context 2: Assume there is a standard room and a luxury suite. It is required that the standard room has fewer pillows than the suite. Bill is putting pillows in these two rooms, and you tell him:
biaozhun jian xuyao/bixu bi zongtong taofang fang geng shao de zhengtou.
 ‘The standard room **needs** to have fewer pillows than the suite.’

Each of these sentences could appear either in the order just presented, with the modal preceding the comparative *bi*-phrase, which in turn precedes the main verb, or with the *bi*-phrase preceding the modal, or with the *bi*-phrase occurring after the modal.

Procedure. After completing Experiment 1, the survey continued to Experiment 2, during which participants rated the 12 target items on their list and 2 attention checks interspersed with them. In this portion of the survey, participants were instructed to judge whether the sentence would be suitable (*shiyong*) or unsuitable (*bushiyong*) in the given context (1 = unsuitable, 5 = suitable). *Shiyong* ‘suitable’ was characterized as: ‘the meaning expressed by the sentence and the context are compatible’; *bushiyong* ‘unsuitable’ was characterized as: ‘the meaning expressed by the sentence and the context are incompatible’. The judgment was thus meant to be about fit between the sentence and the context rather than grammatical correctness.

Participants. The same 48 participants who did Experiment 1 participated in this study. The same attention checks were used to filter out participants.

Results. The results are plotted in Figure 3. Since we found no effect of word order, the results are collapsed across all word order variation. With necessity modals, we found a clear preference for contexts supporting an interpretation where the modal takes scope over the comparative, as opposed to the opposite scoping order. This preference was starkest with the necessity modal

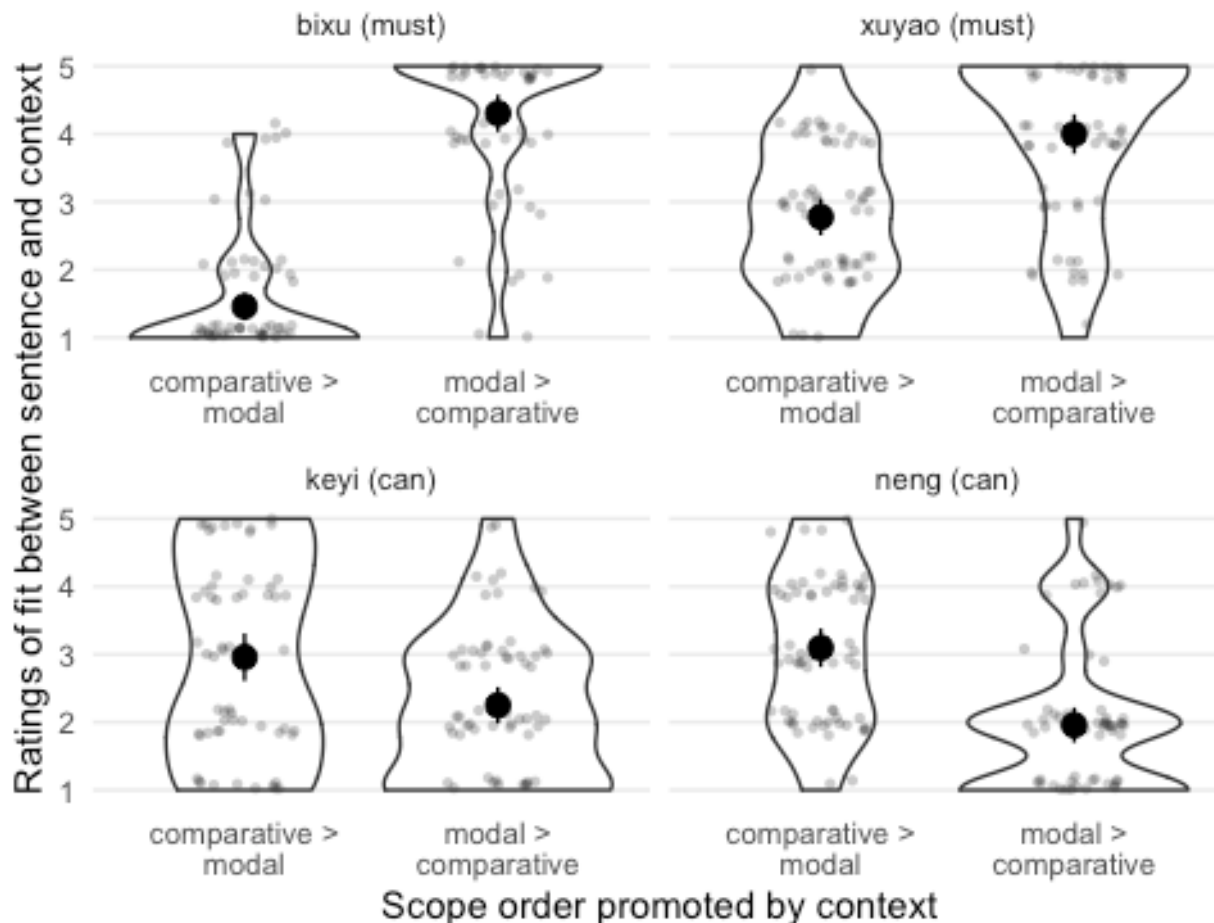


Figure 3: Violin plot of judgments obtained in Experiment 2, overlaid on raw data (jittered). The large dot represents the mean, and is surrounded by a 95% confidence interval.

bixu, and clear but less pronounced with *xuyao*. ANOVA tests based on a linear regression model confirms these impressions: Within the dataset for necessity modals, we found a significant main effect of context, a significant main effect of verb, and a significant interaction between context and verb, all with $p < 0.001$.

With possibility modals, the preference appears to go in the opposite direction, so that the reading where the comparative scopes over the modal is preferred. Within the dataset for the possibility modals, the effect of context was significant below the 0.001 level, and no other effects were found to be significant, using ANOVA tests of a linear regression model including main effects of context and verb and their interaction.

For the comparative > modal reading especially, there was quite a wide distribution in judgments, with a good number of participants giving ratings of four and five, though a roughly equal number gave quite low ratings. The least common rating for these cases was a 3, so the distribution is mildly bimodal here. Even with *xuyao* ‘must’, there was a sizable group of participants who rated the comparative > modal reading at a 4, although very few gave a 5.

Discussion. Based on the wide range of judgments and the bimodal distribution for the comparative $>$ modal reading with weak modals, we conclude that for some speakers, comparatives can scope over the possibility modals *keyi* and *neng*. The results are also consistent with the possibility that some speakers allow comparatives to scope over the necessity modal *xuyao*. The necessity modal *bixu*, however, appears to be subject to a categorical restriction disallowing modals to scope over it.

D Additional diagnostics

In section 4, we provided rebuttals for all arguments that we know to have been made against degree abstraction in Mandarin. In some cases, our rebuttals spoke to the contrary, giving positive evidence in *favor* of it. Here, we consider two additional diagnostics. Unfortunately, the results are somewhat inconclusive, but we hope that our discussion will be of methodological value to future researchers working on degree abstraction in the languages of the world.

D.1 Scope interaction in *little*-sentences

As discussed by Heim (2006), degree constructions like (101) below involve scope interactions between degree operators and intensional verbs. We refer to such constructions as *little*-sentences.

(101) The school lets the students write so little!

There are two readings available in (101): a) There is no penalty from the school for the students if they write very little; b) There is penalty if the students write too much. The ambiguity is analyzed as a scopal ambiguity in Heim (2006). When *let* takes scope over *little*, we have the reading (a), which is true when it is allowed for the students to write very little; whereas when *little* takes scope over *let*, we have reading (b): the students are not allowed to write more than very little. This interaction between the quantifier and the degree argument provides evidence for degree abstraction in English. More specifically, the wide scope reading (b) requires a degree operator to take scope over the modal, suggesting that the operator undergoes QR.

The closest correlate to (101) in Mandarin is the following:

(102) John keyi chi yi-dian-dian.
 John can eat one-dot-dot
 ‘John can eat a little.’

This sentence can be used to express that eating very little is a possible choice for John (which corresponds to the $\diamond >$ *little*) reading. It can also be used to express that eating more than a little is not allowed, for example in a context where the question is *How much can John eat?* But before we conclude that these interpretive possibilities are due to a scope ambiguity, we must determine whether *yi-dian-dian* is a scope-taking degree operator like *little* or a minimizer-like indefinite like *a little* or *a tiny bit*. Both options are compatible in principle with this observation. If *yi-dian-dian* is an indefinite like *a little*, then the fact that (102) can be used to express that eating more is not

allowed could be explained via scalar implicature, so ‘John can eat a little’ is interpreted as ‘John can only eat a little’.

An environment where *little* and *a little* come apart is embedding under emotive factive verbs like *happy* and *sad*. As Beaver & Clark (2008) discuss, emotive factive verbs are a way of getting at the at-issue content. Notice the contrast between *very little* and *a little* in the following context:

- (103) a. I’m sad because we can grow {very little/#a little} in our garden.
 b. I’m happy because we can grow {#very little/a little} in our garden.

These judgments are based on the assumption that it is always better to be able to grow more in one’s garden, so the impossibility of growing more is something to be sad about; the possibility of growing some is something to be happy about. Hence, this contrast shows that with *very little*, the at-issue content can be the impossibility of growing more (*little* > \diamond), whereas with *a little*, the at-issue content can only be the possibility of growing a little bit.

If the at-issue content of (102) can be the impossibility of eating more, then we expect that it should be embeddable under *sad* in the same way.

- (104) wo hen { #shangxin, kaixin } yinwei women keyi zhong yi-dian-dian zai women de
 I very sad happy because we can plant one-dot-dot in we DE
 yuanzi li.
 garden inside
 ‘I’m {#sad, happy} because we can plant a little in our garden.’

From this evidence, we conclude that *yi-dian-dian* is a minimizing indefinite rather than a scope-taking degree operator like English *little*. Hence, unfortunately, we do not get positive evidence for degree abstraction from (102).

D.2 Superlatives

A second additional diagnostic for degree abstraction comes from superlative constructions. It is generally accepted that superlatives are ambiguous between an absolute reading (with a contextual comparison class) and a relative reading (with a focus-driven comparison class), as exemplified in (105).

- (105) John received the most beautiful gift.
 Absolute reading: John received a more beautiful gift than all other gifts in the world.
 Relative reading: John received a more beautiful gift than all other people.

Under a scope analysis, the absolute reading has the *-est* part being interpreted inside the NP, whereas the relative reading involves LF-movement of the *-est* part: it is moved to a position taking scope over the proposition (Szabolcsi, 1986; Heim, 1985). The representations are roughly as follows.

- (106) a. John received [-est [λd [*d*-good present]]] (absolute)

b. John_F [-est [λd [λx [x received d -good present]]]] (relative)

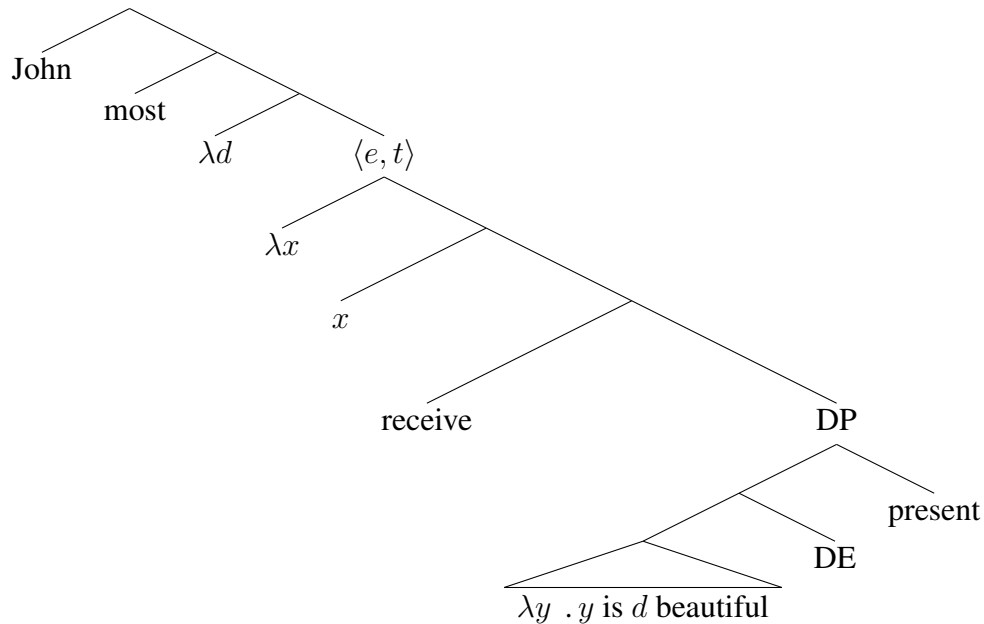
Superlatives can therefore be used as a probe for degree abstraction. With respect to Japanese, for instance, Sudo (2015) points out that the relative readings of *ichiban* ‘#1; -est’ observed and analyzed by Aihara (2009) constitute evidence for degree abstracting in Japanese.

Superlatives in Mandarin are constructed with the degree adverb *zui* ‘most’ as in (107).

(107) John shoudao le zui piaoliang de liwu.
 John receive ASP most beautiful DE present
 ‘John received the most beautiful present.’

Both an absolute reading and a relative reading are available for Mandarin superlatives. If we adopt the scope analysis, in which abstraction is used to derive the relative reading, we expect λ -abstraction over degree variables for the relative reading, i.e., degree abstraction. The derivation of (107) under a relative reading is given in (108).

(108)



If superlatives undergo covert movement at LF to a position near the focussed constituent, leaving a degree-type trace, then degree abstraction is involved in the generation of relative readings of superlatives. Of course, the force of this argument ultimately depends on what the right analysis of relative readings for superlatives is. The most recent analysis of relative readings of superlatives, given by Bumford (2017, 2018), does involve scope-taking but it actually does not involve degree abstraction. If that theory is right, then relative readings of superlatives do not provide evidence for degree abstraction.