

Is Degree Abstraction a Parameter or a Universal?

Evidence from Mandarin Chinese

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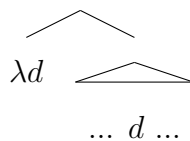
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Abstract

Mandarin Chinese, along with Japanese, Yorùbá, Mòoré, and Samoan, has been argued to lack ‘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 embedded predicates, and scope interactions with modals. We also rebut prior arguments for the lack of degree abstraction in Mandarin, considering degree questions, measure phrases, and negative island effects. Taken together, these results show that degree abstraction is not a parameter along which Mandarin and English vary, and suggest rather that degree abstraction may be universally available.

1 Introduction

Despite claims in the literature that have been made to the contrary, we argue in this paper that Mandarin does have ‘degree abstraction’. 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 a key example used by Beck et al. (2009) to support the idea that languages vary with respect to whether or not they allow this kind of configuration; they argue that it has a negative setting for the purported ‘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 what Beck et al. (2004) call the ‘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, Japanese, Yorùbá, Mòoré, and Samoan as [+DSP] and [−DAP], 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 what they call ‘nega-

¹Purported examples of [−DSP] languages include Motu (Beck et al. 2009), Washo (Bochnak 2015), and Nez Perce (Deal & Hohaus 2019), among others; in these languages, it is argued that gradable predicates are ordinary predicates of individuals.

tive 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).

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.

Recent work on Mandarin has in fact 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) papers, he provides two other arguments for the [–DAP] status of Mandarin, one from attributive comparatives and one from comparatives with embedding.

Contrary to Krasikova (2008), Beck et al. (2009) and Erlewine (2018), this paper argues that Mandarin indeed allows degree abstraction. After some background information about comparatives (Section 2), Section 3 presents three arguments that degree abstraction is a configuration available in Mandarin grammar. In Section 4, we rebut previous arguments that degree abstraction is lacking, and argue that all of the available evidence is consistent with a positive setting for the DAP in Mandarin. In Section 5, we put forth several additional diagnostics that may be of methodological interest for future researchers. By the end, we hope to have convinced the reader that degree abstraction is not a parameter along which Mandarin and English vary, and to have opened up the possibility that degree abstraction is in fact universal.

2 Background

Below we list the types of empirical evidence that have 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. ...scope interactions between comparatives and modals
 - d. ...subcomparatives²
 - e. ...negative island effects
 - f. ...attributive comparatives
 - g. ...comparatives with matching embedded standard and target

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). Many of these diagnostics involve comparative constructions, and whether or not degree abstraction is involved in a given case can depend on one's analysis of comparatives. Let us therefore introduce some background on Mandarin comparatives and the role of degree abstraction in comparative constructions.

There are several ways of forming comparatives in Mandarin, but for simplicity, we will focus on comparatives formed with the morpheme *bi* in this section. Mandarin *bi*-comparatives, as exemplified in (2), involve four essential components: the target (of comparison) (John), the standard (of comparison) (Bill), the morpheme *bi*, and the gradable predicate (*gao* 'tall').

²Erlewine (2018) argues that the lack of subcomparatives does not necessarily provide evidence against degree abstraction, contra Beck et al. (2009). We find this to be a plausible assessment and exclude discussions on this test in this paper.



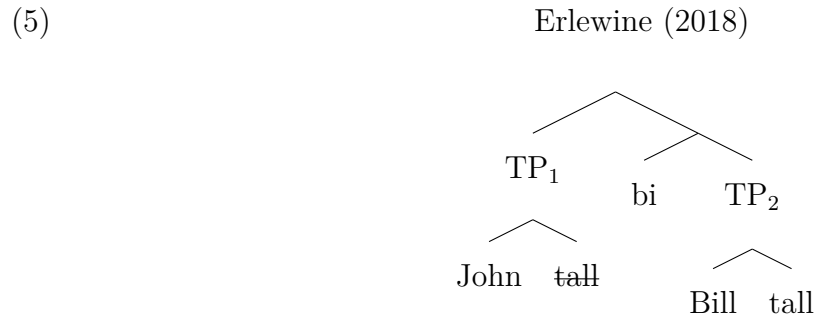
Using the structure in (4)a, truth conditions for comparatives like (2) can be composed with *bi* functioning as a Heim-style operator as in (3a). There is no need for degree abstraction in this structure. We refer to this type of analysis as the ‘3-place *bi* analysis’, capturing its two main features, namely (i) the comparative operator is a three-place operator, expecting an individual-denoting standard (so the analysis is “phrasal” in that sense); and (ii) *bi* functions as the comparative operator.

Xiang (2005), contra her 2003 paper, argues against the view that *bi* forms a constituent with the standard and proposes a structure where a null degree morpheme *exceed* is base-generated lower in the tree. This structure is later adopted by Grano & Kennedy (2012) and Kennedy (2019), among others; the function of the null element varies slightly depending on the exact analysis. Building on Alrenga et al.’s (2012) distinction between predicate-marking and standard-marking items in comparatives, and based on independent evidence from Mandarin bare comparatives for a null comparative operator (Grano 2012), Kennedy (2019) proposes that there is a null predicate-marking comparative element \emptyset_{COMP} in *bi*-comparatives, which functions as the comparative operator rather than *bi*. The null comparative operator \emptyset_{COMP} , which has the denotation in (3b), combines with the gradable predicate first and returns a two-place predicate, seeking two type *e* arguments. With *bi* denoting an identity function, the two-place predicate can combine with the standard and the target straightforwardly.⁴ We refer to this type of analysis as the ‘3-place \emptyset_{COMP} analysis’ as it involves a three-place operator that is phonologically null.

On the other hand, Erlewine (2018), following Liu (1996), argues for a clausal analysis of *bi*-comparatives. His assumed structure is as in (5), where *bi* conjoins two clauses, i.e.,

⁴Whether *bi* contributes to the comparative semantics or not, this predicate-marking analysis is applicable (see the treatment of English *than* and *-er* in Alrenga et al. 2012).

the target clause TP_1 and the standard clause TP_2 .



He adopts a two-place analysis of *bi*, following the clausal analysis of comparatives in English, as defined in (6); *bi* takes two complex degree arguments S and T of type $\langle d, t \rangle$ and returns true if the maximal degree in set T exceeds the maximal degree in set S .

$$(6) \quad \llbracket \text{bi} \rrbracket = \lambda S_{\langle d, t \rangle} . \lambda T_{\langle d, t \rangle} . \max(T) > \max(S)$$

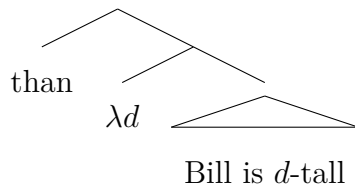
We refer to as the ‘2-place *bi* analysis’.

The extent to which degree abstraction is involved in this sort of analysis is a bit of a layered issue. Clausal comparatives are generally thought to involve degree abstraction. Consider the English example in (7).

$$(7) \quad \text{John is taller than [Bill is } \cancel{\text{tall}} \text{].}$$

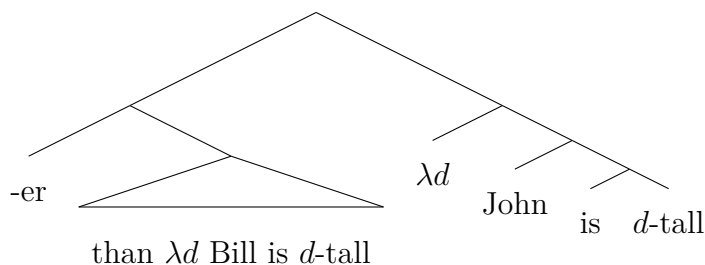
The clausal standard in (7) denotes a set of degrees, namely the set of degrees to which Bill is tall (i.e., $\lambda d . \text{Bill is } d\text{-tall}$). That set of degrees can be obtained through Quantifier Raising (QR) of a covert *wh* operator from a base position beside the gradable predicate to the edge of the *than* clause, where it contributes abstraction over the degree variable (Chomsky 1977, Bresnan 1973, Heim 1985).

(8)



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 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).

(9)



On this relatively standard version of a clausal analysis, two instances of degree abstraction are involved in the derivation.

For Mandarin, however, Erlewine has proposed a way of deriving truth conditions for such cases without degree abstraction. Assuming that gradable predicates denote relations between individuals and degrees, adjectives like tall above were commonly assumed to compose with their degree argument first (type $\langle d, et \rangle$), as shown in (10).

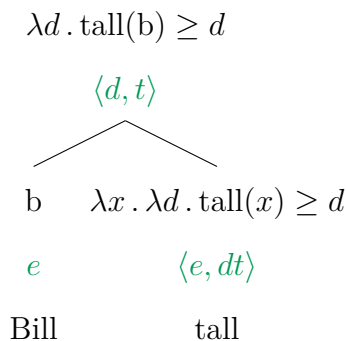
$$(10) \quad \llbracket \text{tall}_1 \rrbracket = \lambda d . \lambda x . \text{tall}(x) \geq d$$

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.

$$(11) \quad \llbracket \text{tall}_2 \rrbracket = \lambda x . \lambda d . \text{tall}(x) \geq d$$

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, as shown below:

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



This means that under the degree-last analysis of gradable predicates, degree abstraction is not essential in order for an (unembedded) clausal target or standard to denote a set of degrees.

As degree abstraction interacts with comparatives in such a sensitive way, to test whether degree abstraction is really at work in Mandarin, we will consider these three types of the possible analyses of bi-comparatives, namely the 3-place bi analysis (Xiang 2003, Lin 2009), the 3-place \emptyset_{COMP} analysis (Xiang 2005, Kennedy 2019) and the 2-place bi analysis (Liu 1996, Erlewine 2018). 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 embedded predicates, 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 those in which a comparative attributively modifies a nominal. The comparative can be one of quantity, as in (13), or degree, as in (14).

(13) John bought more books than Bill. [quantity comparative]
 $\max(\lambda d. J \text{ bought } d\text{-many books}) > \max(\lambda d. B \text{ bought } d\text{-many books})$

(14) John wrote a longer paper than Bill. [degree comparative]
 $\max(\lambda d. J \text{ wrote a } d\text{-long paper}) > \max(\lambda d. B \text{ wrote a } d\text{-long paper})$

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’. In order to construct the degree descriptions to be compared, a degree abstraction operator needs to be present at a clausal level, because the degree descriptions are constrained by information from the clause surrounding the DP containing the comparative on the surface. In other words, as pointed out in Beck et al.’s (2004) original work, attributive comparatives require degree abstraction. We will defend this claim in more detail in the Mandarin context in this section, arguing that Mandarin has attributive comparatives, hence, Mandarin has degree abstraction.

3.1.1 Mandarin has attributive comparatives

Attributive comparatives require overt marking. Comparative predicates are not always marked with comparative morphology in Mandarin. In a predicative bi-comparative, no overt predicate marker is needed, as shown in (15).

(15) John de lunwen bi Bill de lunwen chang. [bi/predicative]
John de paper than Bill de paper long
‘John’s paper is longer than Bill’s paper.’

Even with no overt standard phrase, bare adjectives in Mandarin allow comparative readings in predicative position. For example, sentences with a predicative adjective like (16) can receive a comparative reading with a contextual standard (Grano 2012):

- (16) John de gushi youqu. [simple predicative]
 John de story interesting
 Available: ‘John’s story is more interesting (than some other story).’

In contrast, a bare attributive phrase never receives a comparative interpretation (cf. (16) and (17)).

- (17) John jiang le yi ge youqu de gushi. [simple attributive]
 John tell asp one cl interesting de story
 ‘John told an interesting story.’
Unavailable: ‘John told a more interesting story.’

Erlewine (2018) observes further that even with an overt standard introduced by *bi*, a comparative interpretation of an unmarked gradable predicate is not possible in attributive position.

- (18) *John bi Bill xie guo {duo, chang, youqu} de lunwen.
 John than Bill write asp {many, long, interesting} de paper
 [bi/attributive] Intended: ‘John has written more papers/longer papers/more interesting papers than Bill.’

In fact, Erlewine uses this observation as support for the claim that Mandarin lacks attributive comparatives (and hence as support for the idea that Mandarin lacks degree abstraction).

While it is true that attributive comparatives cannot be constructed with bare gradable predicates, attributive comparatives are possible in the presence of certain degree words. For example, including the degree adverb *geng* (or its alternatives such as *gengjia* and *gengwei*) in an example like (17) produces a comparative reading, as in (19):

- (19) John jiang le yi ge geng youqu de gushi. [simple attributive]
 John tell asp one cl geng interesting de story
 ‘John told a more interesting story.’

A similar observation can be made with comparatives involving an overt bi-phrase. When the adjective is put in attributive position, an overt marker of comparison like *geng* is required.⁵

- (20) John bi Bill xie guo geng {duo, chang, youqu} de lunwen.[bi/attributive]
 John than Bill write asp geng {many, long, interesting} de paper
 ‘John has written more/longer/more interesting papers than Bill.’

Mandarin has other degree adverbs that rescue attributive comparatives, along with *geng*. As Liu (2018) observes, including *bijiao* in an example like (17) also produces a comparative reading, as shown in (21):⁶

- (21) John jiang le ge bijiao youqu de gushi. [simple attributive]
 John tell asp cl bijiao interesting de story
 ‘John told a more interesting story.’

We take these examples, some with an overt bi-phrase and some without, to show that Mandarin has attributive comparatives, albeit with obligatory markers of comparison. If indeed attributive comparatives are a robust diagnostic for degree abstraction, then these cases prove the existence of degree abstraction in Mandarin.

⁵For readers who are interested in the acceptability of these attributive bi-comparatives: More examples can be found in major Chinese corpus lists such as The Lancaster Corpus of Mandarin Chinese (LCMC) and The UCLA Written Chinese Corpus. The following example is adopted from the LCMC:

- (i) Mei yi ge houji de shidai dou neng bi qian yi shidai tigong geng duo, geng jingliang
 every one cl succeeding de era all can bi former one era provide geng many geng fine
 de yiqi he gongju.
 de instrument and tool
 ‘Every succeeding era can provide more and finer instruments and tools than the preceding era.’

As illustrated by the boldfaced adjectives in the example, gradable adjectives, whether degree or quantity, can occur in such attributive constructions.

⁶*Bijiao* cannot replace *geng* in (20) because *bijiao* cannot co-occur with bi-phrases, being subject to the Constraint on Multiple Foci (Liu 2018).

Attributive bi-comparatives are explicit comparatives. Before moving on, let us address a potential concern regarding the obligatoriness of predicate-marking in attributive comparatives. Does this fact threaten the claim that Mandarin has attributive comparatives? Could one argue that examples of the sort we have given in (20) are not ‘genuine’ comparatives in some sense, on these grounds? We argue ‘no’; these are genuine comparatives, in that they express explicit comparison in Kennedy’s (2007) sense.⁷ Erlewine (2007) has already argued that ordinary comparatives involving *bi* express explicit comparison. The same holds for attributive bi-comparatives, as we see if we apply Kennedy’s (2007) tests for explicit vs. implicit comparison.⁸

First, attributive bi-comparatives of both degree and quantity are felicitous in crisp judgment contexts, in support of the view that attributive bi-comparatives are explicit.

(22) Context: Bill has written a 10-page paper, whereas John has written a 11-page paper.

- a. John de lunwen *bi* Bill de lunwen chang. [predicative]
 John de paper than Bill de paper long
 ‘John’s paper is longer than Bill’s.’
- b. John *bi* Bill xie guo geng chang de lunwen. [attributive]
 John than Bill write asp geng long de paper
 ‘John wrote a longer paper than Bill.’



(23) Context: Bill has written 100 papers, whereas John has written 101 papers.

- a. John de lunwen *bi* Bill de lunwen duo. [predicative]
 John de paper than Bill de paper many
 ‘John’s papers are more than Bill’s.’
- b. John *bi* Bill xie guo geng duo de lunwen. [attributive]
 John than Bill write asp geng many de paper
 ‘John wrote more papers than Bill.’

⁷Here we focus on those comparatives with an overt *bi*-phrase. While bi-comparatives have been studied to a considerable extent in the literature, the attributive ones have received scarce attention as far as we are aware. For insights into non-bi-comparatives with *geng* and *bijiao*, see Liu 2018 for more a detailed discussion.

⁸We adopt two of Kennedy’s (2007) tests for explicit and implicit comparisons. The third test Kennedy proposes involves differential measure phrases combing directly with the comparative operator. We exclude this test only because it is inapplicable to attributive comparatives.

Secondly, these attributive bi-comparatives 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. As shown in (24b), 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. [predicative]
 line B than line A bent.
 ‘Line B is more bent than line A.’
- b. Bill bi Ann hua le geng wan de xian. [attributive]
 Bill than Ann draw asp geng bent de line
 ‘Bill drew a more bent line than Ann.’

Moreover, we argue that the standard degrees in these attributive comparatives are compositionally provided, not contextually. Japanese exhibits an acceptability variation in attributive comparatives such that only certain “relevant” combinations of gradable predicates and verb phrases are allowed (Beck et al. 2004, Oda 2008):

- (25) Taroo-wa Hanako-ga katta yori {takusanno, takai, ??nagai} kasa-o
 Taroo-top Hanako-nom bought yori {many, expensive, long} umbrella-cc
 katta.
 bought
 ‘Taroo bought (a) more/more expensive/longer umbrella(s) than Hanako did.’

This fact leads to the proposal of a pragmatic account in which the standard degree is inferred contextually. The variation in acceptability boils down, on this account, to the question of whether the standard degree can be successfully inferred (Beck et al. 2004, Oda 2008): The idea is that the amount and the price of the umbrella are salient in an umbrella-buying event, whereas the length of the umbrella is not. Therefore, the inferential process is easier with takusanno ‘many’ and takai ‘expensive’ than with nagai ‘long’.

However, Mandarin does not show similar variation in the acceptability of those attribu-

tive bi-comparatives. In an apple-eating event, for example, comparisons can be made along not only the amount but also the size and the redness of the apples.

- (26) John bi Bill chi guo geng {duo, da, hong} de pingguo.
John bi Bill eat asp geng {many, big, red} de apple
'John has eaten more/bigger/redder apples than Bill.'

Furthermore, in Appendix A, we provide survey results supporting the acceptability of a variety of attributive comparatives, including ones where the degree is presumably not 'inferrable' in Beck et al.'s (2004) sense, such as the following:

- (27) Context: Assume normally managers are in their 40s. The candidate Bill voted for is 25 years old; the candidate John voted for is 20.

John bi Bill tou le yi ge geng nianqing de houxuanren.
John bi Bill vote asp one cl geng young de candidate
'John voted for a younger candidate than Bill.'

These findings further support the conclusion that Mandarin attributive bi-comparatives are indeed productive and are not subject to Japanese-like pragmatic restrictions. Hence, the standard degrees in these comparatives are not provided contextually as in Japanese, but rather compositionally, as in English.

In sum, although attributive bi-comparatives are more restricted than the non-attributive ones, they are genuine comparatives. So attributive comparatives really do exist in Mandarin.

3.1.2 Attributive comparatives in Mandarin require degree abstraction

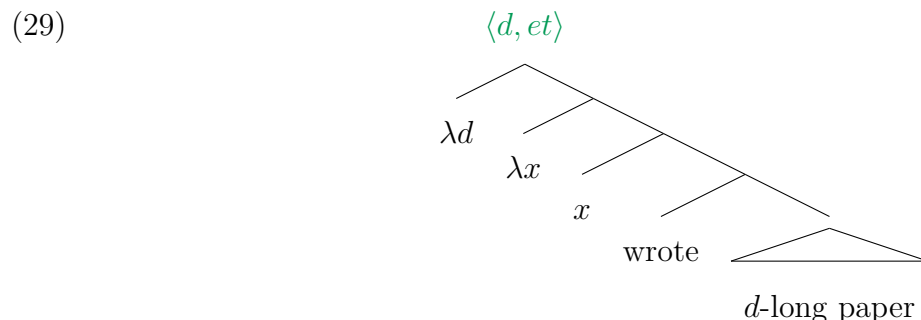
Previous literature (Beck et al. 2004, Liu 2010a, Erlewine 2018, a.o.) has argued that attributive comparatives require degree abstraction, but let us now establish that degree abstraction is required specifically for Mandarin attributive bi-comparatives. We will consider the three analyses of bi-comparatives discussed in Section 2 and show that regardless of the analysis one adopts, degree abstraction is required. There are several different ways of integrating

geng into each analysis, but as far as we can see, adding this overt marker would not obviate the need for degree abstraction under any of the analyses. Hence we will leave geng uninterpreted in our derivations and come back to this question later in Section 3.1.3.

Where exactly degree abstraction enters into the compositional derivation depends on the precise analysis of comparatives that one adopts. Consider the attributive comparative in (28).

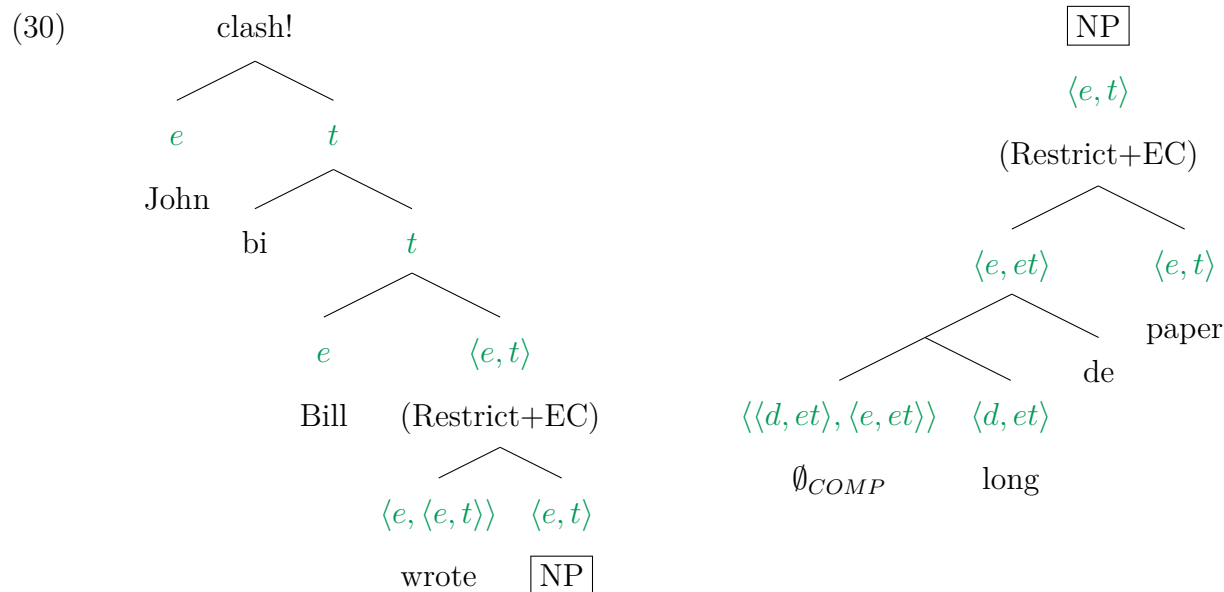
- (28) John bi Bill xie guo geng chang de lunwen.
 John than Bill write asp geng long de paper
 ‘John has written a longer paper than Bill.’

Given a 3-place bi analysis, the comparative operator bi compares two individuals with respect to a gradable predicate like the one shown in (29).



Such a predicate cannot be formed purely through Function Application; the degree abstraction operator must be placed outside the immediate reach of the gradable predicate, as the dimension along which comparison takes place incorporates information from the verb (‘wrote’).

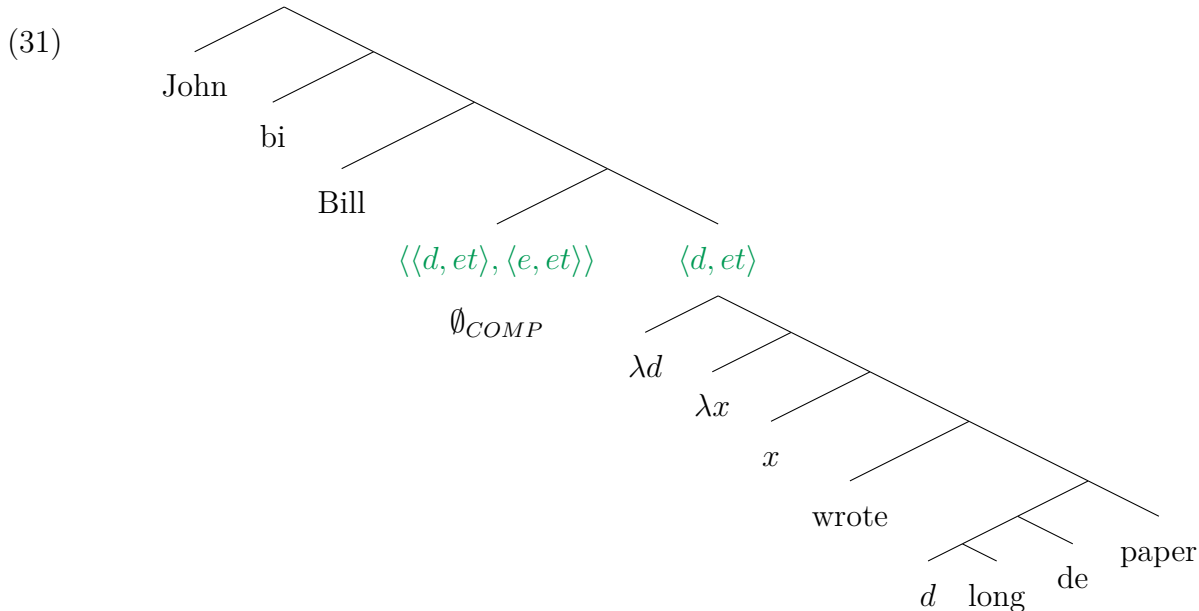
Alternatively, consider the 3-place \emptyset_{COMP} analysis, where a comparative operator is base-generated beside the gradable predicate. As illustrated in (30), the derivation would fail if the comparative operator were interpreted in situ. (The NP nodes with the box around them are to be understood as identical.)



Suppose the comparative operator were to be interpreted beside the adjective ‘long’. A type clash would arise at the NP node: The resulting two-place predicate (type $\langle e, et \rangle$) would need to compose with the nominal ‘paper’ (type $\langle e, t \rangle$). In principle, this clash could be avoided by allowing for Restrict plus a following Existential Closure (Diesing 1992, Chung & Ladusaw 2004). A second instance of Restrict plus Existential Closure could then be used to combine the transitive verb with its NP complement. This will not yield a sensible interpretation for the VP, but more to the point, even if the composition makes it this far, a type clash would still be caused eventually, as a type t argument would be constructed below the target ‘John’.

In order to derive the truth conditions for the sentence, the comparative operator has to undergo movement and be interpreted beside the verbal predicate. This can be done via a movement involving ‘parasitic scope’ (see Heim 1985, Beck & Sauerland 2000, Kennedy & Stanley 2009 among others) where the comparative operator moves to a position created by the movement of the standard Bill, as shown below:⁹

⁹We assume that the direct object ‘ d -long de paper’ combines with the verb via Restrict plus Existential Closure à la Chung & Ladusaw (2004).



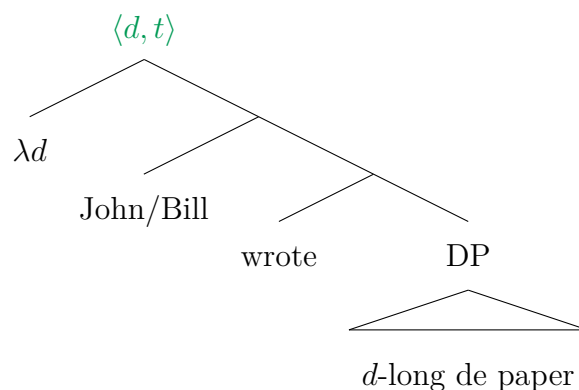
In this derivation, the comparative operator takes scope over the VP, having left a degree trace in its initial position beside the gradable adjective ‘long’. So degree abstraction is involved.¹⁰

Degree abstraction would also be required under a 2-place bi analysis. Following Erlewine (2018), the comparative marker *bi* takes as input two degree descriptions of type $\langle d, t \rangle$ denoted by the target clause ‘John wrote a long paper’ and the standard clause ‘Bill wrote a long paper’. The degree descriptions could be constructed using degree abstraction as follows:

¹⁰Beck et al. (2012), Berezovskaya & Hohaus (2015) point out that a Kennedy (1997)-style 3-place comparative operator that combines first with a gradable predicate and then with the standard DP cannot produce a sensible reading for attributive comparatives in English. The comparative operator would have to undergo movement from its base position in order to produce the right kind of derived gradable predicate, and the standard DP would then have to undergo movement in order to be accessible to the comparative operator. The problem is that there is no movement operation that would place the standard DP in the right position to be fed as the second argument to the comparative operator.

However, there is a crucial difference between the derivation that Beck et al. (2012) point out to be impossible and the one we propose here. Due to the base positions of the target and standard DPs in the structure for Mandarin comparatives that we assume following Xiang (2005), where both are in subject positions at different levels of the same clause, it suffices for the standard DP to undergo a short QR movement, opening up a position for the comparative operator to be inserted parasitically. As shown in our derivation, the arguments are then positioned correctly to combine with the Kennedy (1997)-style operator in Mandarin. Hence, (31) is a viable analysis of attributive bi-comparatives.

(32)



Unlike in predicative constructions (e.g., John’s paper is longer than Bill’s), use of a degree-last analysis of gradable predicates does not obviate the need for degree abstraction here, in attributive constructions. If the gradable predicate ‘long’ is type $\langle e, \langle d, t \rangle \rangle$, then it will not be able to compose via Function Application or Predicate Modification with a sortal noun like ‘paper’, assuming sortal nouns are type $\langle e, t \rangle$. Even if this composition challenge could be overcome so that the DPs are interpretable, degree abstraction would still be needed, because the relevant $\langle d, t \rangle$ descriptions (e.g. λd . John wrote a d -long paper) must incorporate information from the verb.

As we have shown, regardless of whether one uses a clausal analysis of bi-comparatives or a phrasal analysis of either kind, degree abstraction is a must for attributive bi-comparatives. This result aligns with conclusions from previous literature that attributive comparatives can be taken as a sturdy diagnostic for degree abstraction (in the positive direction – finding that attributive comparison is regularly allowed by the grammar of a language implies that the language allows for degree abstraction).

3.1.3 Why is *geng* obligatory?

In this section, we offer a speculation as to why *geng* is required in attributive bi-comparatives. This issue is orthogonal to our main point, as we are not aware of any treatment of *geng* that could save the above derivations from utilizing degree abstraction. But we would like to

put forth a suggestion that may shed light on why it is required in attributive constructions and the role that it plays in them.

The exact account of geng depends on which analysis of bi-comparatives is assumed. Our proposal here builds on the 3-place \emptyset_{COMP} analysis shown in (31).¹¹ We suggest that geng is actually an overt counterpart of the phonologically null 3-place comparative operator, and that the structure of the attributive comparative in (28) is exactly as given in (31), with the exception that the null operator \emptyset_{COMP} is replaced by geng. We suggest that attributive comparatives require geng because \emptyset_{COMP} cannot undergo movement, and movement is required in order to give the right truth conditions for attributive bi-comparatives. (Hence the actual structure with \emptyset_{COMP} being moved in (31) is ruled out.)¹²

¹¹Under a 3-place bi analysis, geng can be viewed as a relative pronoun like which; on this view, it moves to take scope over an expression of type $\langle e, t \rangle$ and triggers Predicate Abstraction, forming the complex gradable predicate of type $\langle d, et \rangle$ (e.g. $\lambda d. \lambda x. x$ wrote a d -long paper). On the other hand, under the 2-place bi analysis, a coherent proposal is that geng functions as a type-shifting operator such that it changes the degree-last gradable predicate of type $\langle e, \langle d, t \rangle \rangle$ to $\langle d, \langle e, t \rangle \rangle$ to allow abstraction over the degree variable in attributive comparatives.

¹²Our treatment of geng aligns with Liu (2010a) in viewing it as a comparative operator. Liu (2010a) suggests that geng has an evaluative presupposition that both the standard and the target are true of the property denoted by the gradable predicate. Example (i), for instance, implies that both John and Bill are tall, in contrast to the form without geng.

- (i) John bi Bill geng gao.
 John bi Bill geng tall
 ‘John is even taller than Bill.’

But there are non-presuppositional uses of geng: In the following scenario, (iib) is a natural continuation of (iia).

- (ii) Context: In a show, the player who loses the game for having fewer votes says the following to the audience:
- a. Wo yijing shouhuo le bi toupiao geng zhongyao de dongxi.
 I already gain asp bi vote geng important de stuff
 ‘I’ve already gained more important things (e.g. friendship) than votes.’
- b. ..., wo bu shi shuo nimen de toupiao bu zhongyao.
 I neg cop say you.pl de vote neg important
 ‘..., I’m not saying that your votes are not important.’

If the use of geng in (iia) presupposes that the standard (i.e., vote) is important, the speaker would not use (iib) to clarify that he were not to say that votes are not important. Quite to the contrary, (iia) seems to imply something in conflict with the purported presupposition. So we are hesitant to adopt the assumption that geng lexically carries such a presupposition. We leave it open how to account for the observation that (i) implies that both John and Bill are tall.

This account of *geng* does not posit that *geng* is the only possible overt counterpart of \emptyset_{COMP} , nor that it is unique in saving attributive comparatives. On the contrary, this proposal is consistent with the attributive data beyond bi-comparatives discussed in section 3.1.1. In particular, it correctly predicts that an overt marker of comparison is required for attributive phrases to have a comparative interpretation, and is consistent with the observation that other overt degree words such as *bijiao*, *gengjia*, and *gengwei*, along with *geng*, surface in structures that require movement of a comparative operator.¹³

3.1.4 Bi-clausal *geng* constructions

The observation that Mandarin has attributive comparison has actually been made before by Liu (2010a): In (33), the quantity of books that Lisi bought is compared to the quantity of books that Zhangsan bought.

- (33) Zhangsan mai le hen duo shu, Lisi mai le geng duo shu.
 Zhangsan buy asp hen many book Lisi buy asp geng many book
 ‘Zhangsan bought many book, but Lisi bought more books.’

The examples on display involve two clauses, so we will refer to them as ‘biclausal *geng* comparatives’.¹⁴ Liu (2010a) argues biclausal *geng* comparatives require binding of degree

¹³There are some other degree morphemes such as *yidian* and *yixie* ‘a bit’ that may function as a signal that a comparative construction is in play. These occur in Mandarin transitive comparatives like *John gao Bill yidian* ‘John is a bit taller than Bill’ (Grano & Kennedy 2012). These morphemes can also be used with attributive adjectives and give rise to comparative readings in some cases:

- (i) John du le pian chang yidian de wenzhang.
 John read asp cl long a.bit de article
 ‘John read a relatively longer article.’

There are many open questions about how to understand the role of these items in comparatives. *Yidian* and *yixie* appear after the adjective, and they can co-occur with the other pre-adjectival items like *bijiao* and *geng*. It is not clear whether they function as degree modifiers or vague measure phrases (Grano & Kennedy 2012) or something else. They also vary puzzlingly in their acceptability across different types of adjectives; replacing ‘long’ with ‘interesting’ in (i) degrades the sentence. Nevertheless, this data point is broadly consistent with our claim that an overt marker of comparison is required in attributive comparatives.

¹⁴Liu refers to them as *geng*-clausal comparatives but we choose ‘biclausal *geng* comparatives’ in order to clarify that we intend it only to apply to multi-clausal constructions, and not mono-clausal constructions that might involve a ‘clausal’ analysis of *geng*.

variables in the syntax (i.e., degree abstraction). His arguments come from the availability of attributive comparison as in (33) and structures like the following, which he analyzes as cases of comparative subdeletion:

- (34) zhe duo hua, hua hen hong, yezi geng lü.
 this cl flower flower hen red leaf geng green
 ‘As for this flower, the leaf is (even) greener than the flower is red.’

However, Liu (2010a) suggests that the binding relation is not of a kind that is generated by movement of a degree operator like in English; rather, the binding is achieved by unselective binding, as shown in (35).¹⁵

- (35) [[Op_i [Z bought hen_i many book]], [L bought geng many book]]

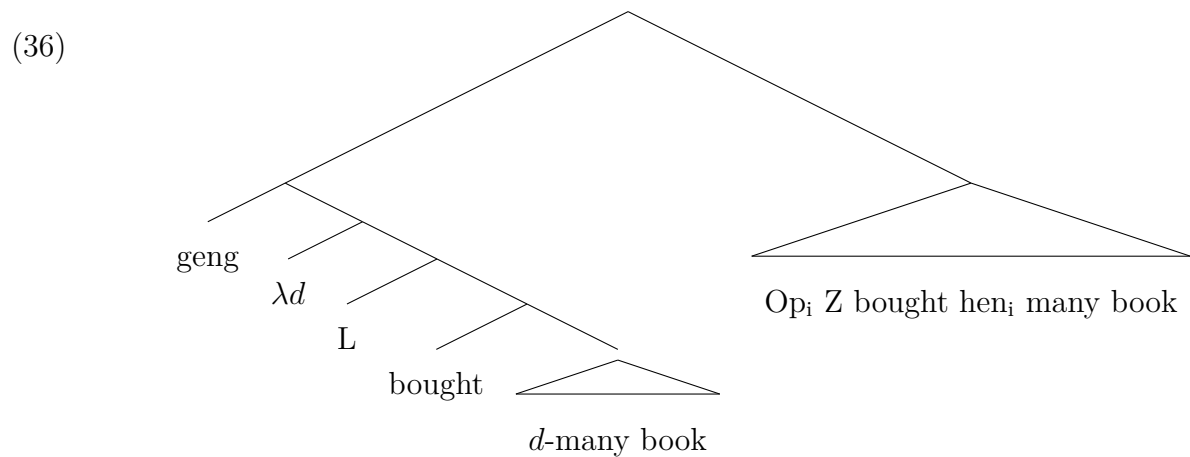
The degree morpheme *geng* functions as the comparative operator and takes two degree arguments, one being the standard of comparison and the other provided by the target clause (‘comparee clause’ in Liu’s terminology). In the standard clause, according to Liu (2010a), the degree operator *Op* is base-generated at Spec-CP and unselectively binds the degree variable, which is spelled out as the adverb *hen* in the standard clause, providing the standard of comparison. Liu suggests that binding of degree variables in the syntax may be limited to cases that do not involve the movement of an operator (non-movement binding). If Liu is right, then there is degree abstraction in Mandarin biclausal *geng* comparatives, but only of a limited, non-movement kind.

It is not clear that unselective binding suffices to account for all cases of degree abstraction in Mandarin; in fact, it’s not clear whether it could be used to construct both of the relevant degree descriptions in biclausal *geng* constructions like (33). Such examples involve two instances of attributive modification, one in the standard clause (‘Z bought hen many book’)

¹⁵Liu (2010a) uses two putative island violations as evidence that the binding relation in biclausal *geng* comparatives does not involve movement. For the scope of this paper, we will not extend our discussion to this issue; but we wonder whether those putative island violations necessarily lead to a conclusion as such.

and one in the target clause ('L bought geng many book'). A binding relation needs to be established for both. Liu does not specify if and whether unselective binding is to apply in the target clause, and no lexical entry for *geng* in these sorts of usages is provided. But Liu also does not make mention of any silent degree-binding operator in the target clause.

We suggest that in biclausal *geng* comparatives like (34), the comparative operator *geng* moves to the left edge of the target clause, leaving a trace of type *d* that is abstracted over by a λ -binder. The degree description denoted by the target clause is thus derived.



It is beyond the scope of this paper to assess empirically whether or not the target clause involves movement or unselective binding. But even if a silent unselective degree-binding operator is present in the target clause, as far as we can see, the comparative operator *geng* still needs to undergo QR in order to combine with its two degree arguments denoted by the two clauses. In other words, assuming that *geng* leaves a trace when it moves, this construction involves degree abstraction produced via movement, even if unselective binding may be involved as well.

3.1.5 Summary

To summarize this section: We have argued that Mandarin has degree abstraction based on the availability of attributive bi-comparative constructions. We showed that they are both attributive and genuine comparatives, expressing explicit comparison. To offer a concrete

argument, we have gone through various existing analyses of bi-comparatives and showed that degree abstraction cannot be avoided in any case. We have also motivated and provided an account for the obligatoriness of *geng* in attributive comparatives. In addition to our new observation on attributive bi-comparatives, we have extended our discussion to the type of biclausal attributive comparatives observed in Liu 2010a. We suggest that a movement-type of degree abstraction is still required even if the given analysis makes use of unselective binding.

3.2 Comparatives with embedded predicates

3.2.1 Prima facie evidence for [-DAP]

In English, a clausal standard in a comparative construction can itself embed another clause, as exemplified in (37) and (38).

(37) Mary is taller than Bill thinks she is.

$$\max(\lambda d. \text{Mary is } d\text{-tall}) > \max(\lambda d. \text{Bill thinks Mary is } d\text{-tall})$$

(38) John thinks Mary is taller than Bill thinks she is.

$$\max(\lambda d. \text{John thinks Mary is } d\text{-tall}) > \max(\lambda d. \text{Bill thinks Mary is } d\text{-tall})$$

In both examples, the standard clause [than Bill thinks she is ~~tall~~] embeds the clause [she is ~~tall~~], which includes a gradable predicate. Such examples involve a configuration where a degree variable is bound across a clause boundary, necessitating degree abstraction, as illustrated in (39).

(39) [than [Op [λd [Bill [thinks [_{TP} she [is *d*-tall]]]]]]]

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

- (40) [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 (37) and (38), then without further constraints, we would expect the following structure to be licit, contrary to fact:

- (41) *[TP₁ Mary_i gao] bi [TP₂ John juede ta_i gao].
 Mary tall than John think she tall
 Intended: ‘Mary is taller than John thinks she is.’

The ungrammaticality of (41) can be explained by the comparative deletion requirement suggested by Erlewine (2018):

- (42) 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.

- (43) 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 (41), the local predicate of the target clause (i.e., gao ‘tall’) is not identical to the local predicate of the standard clause (i.e., juede ta gao ‘think she is tall’); therefore, the deletion is illicit.

However, Erlewine’s analysis also predicts the sentence in (44) to be possible with an underlying structure in (45). Here the deletion requirement is satisfied but the sentence is still ungrammatical.

- (44) *John bi Bill juede Mary gao.
 John bi Bill think Mary tall
 Intended: ‘John thinks Mary is taller than Bill thinks she is.’

- (45) * $[_{TP1}$ John ~~juede Mary gao~~] bi $[_{TP2}$ Bill juede Mary gao].

Erlewine (2018) himself points out that the VP *juede Mary gao* ‘think Mary tall’ is both local to the target TP and identical to a local predicate of the standard TP. As degree abstraction would be required in order to derive the relevant degree descriptions, he proposes that the reason for the ungrammaticality of (44) is that Mandarin lacks degree abstraction.

This potential argument that Mandarin lacks degree abstraction is not specific to Erlewine’s treatment of bi-comparatives. If degree abstraction is allowed, a phrasal analysis also predicts that (44) should be possible with an interpretation where the target John and the standard Bill are compared along a dimension comprising the matrix verb *juede* ‘think’ and the embedded gradable predicate *gao* ‘tall’. One way of ruling this sentence out would be to posit that Mandarin lacks degree abstraction; the complex gradable predicate $(\lambda d . \lambda x . x$ thinks Mary is d -tall) cannot be formed without it.

But we are skeptical that degree abstraction is the culprit. As discussed in the next section, Mandarin allows comparatives involving gradable predicates embedded under verbs like *make* as well. A ban on degree abstraction would therefore rule out too much.

3.2.2 Embedded gradable predicates are possible

There are verbs other than *juede* ‘think’ that do embed gradable predicates. Examples with matrix verbs such as *ling* ‘make’ (and its alternatives *shi* and *rang*) and *bang* ‘help’ are

acceptable, in contrast to those with *juede* ‘think’, as shown in (46) and (47).¹⁶

- (46) a. *shenme bi diu shu geng ling Mary shengqi?*
what bi lose book geng make Mary angry
‘What makes Mary angry more than losing books?’
- b. *gou bi ren geng rang zhenchayuan haipa.*
dog bi human geng make scout terrified
‘Dogs make a scout terrified more than a person does.’
- (47) a. *heise yifu bi baise yifu shi lengjiao geng fenming.*
black cloth bi white cloth make angle geng clear
‘Black cloth makes the body-shape more clear than white cloth does.’
- b. *zheyang hui bi nayang shi qifen geng qingsong.*
this.way will bi that.way make atmosphere geng relaxed.
‘This way will make the atmosphere more relaxed than that way.’
- c. *John bi Bill bang Mary nadao le geng youyi de chengji.*
John bi Bill help Mary get asp geng good de score
‘John helped Mary get a better score than Bill did.’

In all these examples, the target and the standard are being compared along a dimension

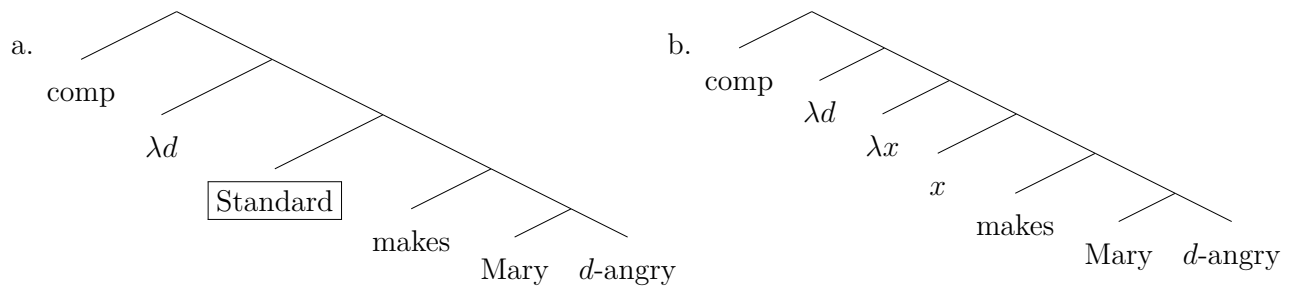
¹⁶All examples here except (47c) are adapted from the corpora. Similar comparative meanings can be expressed in analogous no-bi constructions with *bijiao*, where the standards are understood contextually.

- (i) a. *shenme bijiao ling Mary shengqi?*
what bijiao make Mary angry
‘What makes Mary more angry?’
- b. *gou bijiao rang zhenchayuan haipa.*
dog bijiao make scout terrified
‘Dogs make a scout terrified more.’
- c. *heise yifu shi lengjiao bijiao fenming.*
black cloth make angle bijiao clear
‘Black cloth makes the body-shape more clear.’
- d. *zheyang hui shi qifen bijiao qingsong.*
this.way will make atmosphere bijiao relaxed.
‘This way will make the atmosphere more relaxed.’
- e. *John bang Mary nadao le bijiao youyi de chengji.*
John help Mary get asp bijiao good de score
‘John helped Mary get a better score.’

Since *bijiao* involves explicit comparison (Liu 2018), these data points provide additional evidence for the possibility of embedding gradable predicates in Mandarin. The argumentation made throughout this section also holds with these *bijiao*-comparatives.

that involves a matrix predicate (e.g. ‘make’ and ‘help’) as well as an embedded gradable predicate.¹⁷ Degree abstraction is a mechanism that would provide that. Below, the LF under a 2-place operator (clausal) analysis is given in (48)a, and the LF under a 3-place operator (phrasal) analysis is given in (48)b. (Here we abstract away from the exact place where the 3-place operator merges in the structure.)

(48) Derivations with degree abstraction



But is degree abstraction really needed in order to generate these examples? Is there any other mechanism that could provide a comparison involving the matrix predicate? The examples in (46) where the overt degree morpheme *geng* occurs to the left of the matrix verb might lead to the suspicion that these examples involve VP-comparisons such that *geng* is actually modifying the whole make-phrase.¹⁸ A VP-comparison analysis gives rise to an interpretation where what is being compared is a gradable property that includes the

¹⁷It 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 (i), 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.

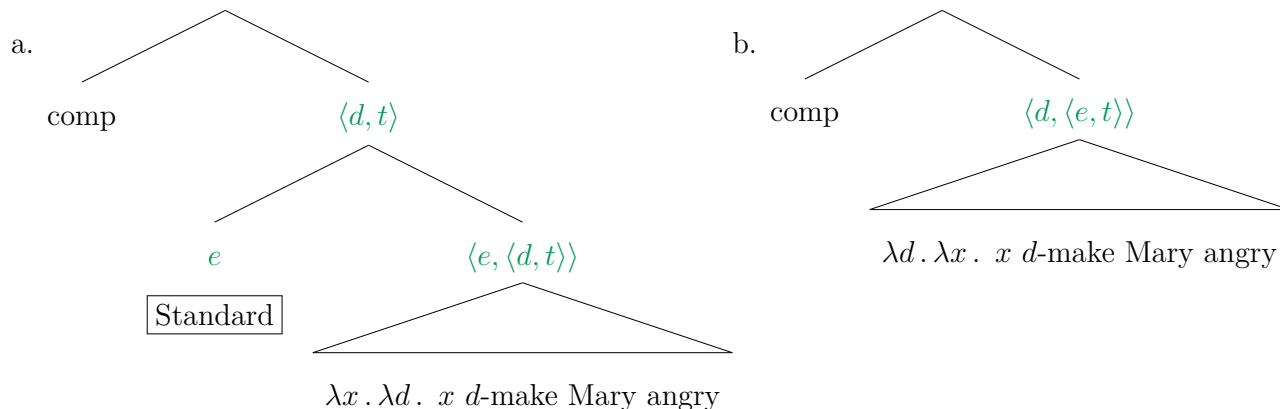
(i) na jian shi ling Mary_i [PRO_i congci bu zai kuaile le].
 that cl thing make Mary_i [PRO_i since.then neg again happy asp]
 ‘That thing has made Mary no longer happy.’

One reviewer points out that *bang* may not belong to the same group as those ‘make’-verbs and wonders if they should be discussed together. As we will soon show, ‘help’-phrases do differ from ‘make’-phrases such that the former does not allow VP-parsing at all. This fact, however, only strengthens our argument that Mandarin has genuine embedded comparative constructions.

¹⁸This question was raised to us by a (non-anonymous) reviewer, Mitcho Erlewine.

embedding predicate: Instead of the degree of being angry/terrified, it is along a dimension of making one angry/terrified that a comparison is being made. On this view, the comparative reading can be derived without degree abstraction, as sketched in (49). The structure for 2-place operator analyses is shown in (49)a, and the structure for 3-place operator analyses is illustrated in (49)b. (Under the 2-place operator analysis, it is necessary to assume degree-last in order to avoid degree abstraction entirely.) Notice that a VP-comparison analysis would require the ‘make’ verb to have a built-in degree argument in its semantics; we return to this point below.

(49) Derivations under a VP-comparison analysis



We agree that a VP-comparison account is plausible a priori for the examples where *geng* surfaces in matrix position. It is harder to assume a similar non-degree-abstraction VP-comparison analysis of the examples in (47), however, as *geng* surfaces lower in the structure in these examples. Under a 3-place \emptyset_{COMP} analysis, to be interpreted as a comparative operator above the VP level, *geng* would need to undergo movement from their surface position to the VP-adjacent position at LF. If this movement leaves a degree trace, then degree abstraction is necessary to interpret this structure.

But suppose *geng* is actually not the comparative operator and the true comparative operator is base-generated in a position above VP, as in the 2-place bi and the 3-place

bi analysis. With analyses like those, could it possibly be maintained that the low *geng* examples in (47) also involve VP-comparison? We argue that the answer is no; a VP-comparison analysis is not viable for these examples.

Against a VP-comparison analysis. In Mandarin, verbal comparatives analogous to English *John runs more (than Bill)* are constructed with the degree morpheme *duo* and the concomitant particle *de*, as shown in (50).

- (50) John bi Bill pao *(de) (geng) *(duo).
John bi Bill run de geng much
'John runs more than Bill.'

While the degree modifier *geng* can occur in a post-verbal position (i.e., not preceding the verb *pao* 'run'), the presence of *duo* and *de* are required in (50). Pasternak (2019) argues that *duo* functions as *much* (Wellwood 2014, 2015) in that it introduces a degree argument and imposes a monotonicity requirement. In other words, without a degree argument built into the semantics of the verb, a degree morpheme like *duo* would be required for constructing verbal comparatives in Mandarin. If the examples in (47) are the type of verbal comparative that is found in (50), then the overt realization of *duo* is expected, contrary to fact.

It is indeed possible to construct verbal comparatives without an overt *duo* in Mandarin; however, such constructions are restricted to intensity-measuring mental state verbs, as in (51):

- (51) ta bi wo (geng) xihuan kan shu.
he bi I geng like read book
'He likes reading books more than I do.'

In (51), a comparison is being made along a dimension involving the matrix verb *xihuan* 'like', namely the intensity of love towards reading books.

Mental state verbs have been argued to be inherently gradable in Mandarin (Pasternak

2019): Not only can they be used in verbal comparatives without *duo*, but also they can be modified by degree adverbs directly. In the above example (51), *geng* may appear to the left of the verb *xihuan* ‘like’. The same can be observed with positive constructions. As shown below, just like gradable adjectives, the mental state verb *xihuan* ‘like’ can be modified by a positive degree modifier occurring to the left of it:

- (52) John *hen/feichang/xiangdang* *xihuan* *kan shu*.
 John very/extremely/quite like read book
 ‘John likes reading books very much.’

If a similar VP-comparison analysis is viable for (47), namely that the verb phrases in these examples are inherently gradable so that they are able to construct a verbal comparative without *duo*, then it is predicted that *geng* should be capable of surfacing in a VP-initial position (i.e., the position preceding the word *shi* ‘make’ and *bang* ‘help’, respectively) rather than an embedded position. However, versions of (47) where *geng* occurs before the matrix verb are significantly degraded (indicated as ??) or ungrammatical:

- (53) a. ??/**heise yifu bi baise yifu geng shi lengjiao fenming*.
 black cloth bi white cloth *geng* make angle clear
 b. ??/**zheyang hui bi nayang geng shi qifen qingsong*.
 this.way will bi that.way *geng* make atmosphere relaxed
 c. **John bi Bill geng bang Mary nadao le youyi de chengji*.
 John bi Bill *geng* help Mary get asp good de score

Similarly, in positive constructions, the VPs in (47) do not accept degree adverbs in the VP-modifying position. Rather, they can only be modified by a positive degree modifier occurring to the left of the embedded predicate (*fenming* ‘clear’, *qingsong* ‘relaxed’, or *youyi* ‘good’):

- (54) a. *heise yifu (??/*feichang) shi lengjiao (feichang) fenming*.
 black cloth extremely make angle extremely clear
 ‘Black cloth makes angles extremely clear.’

- b. zhezhang hui (*feichang) shi qifen (feichang) qingsong.
 this.way will extremely make atmosphere extremely relaxed
 ‘This way will make the atmosphere extremely relaxed.’
- c. John (*feichang) bang Mary nadao le (feichang) youyi de chengji.
 John extremely help Mary get asp extremely good de score
 ‘John helped Mary get an extremely good score.’

To summarize: A non-degree-abstraction VP-comparison analysis relies on the assumption that the VP denotes a gradable predicate as a whole; this can be achieved in either of two ways: (i) by adding *duo*, i.e., Mandarin *much*, to the structure or (ii) by assuming that the verb carries a degree argument inherently. The former predicts the overt realization of *duo* in the sentence, whereas the latter predicts that VP-modifying degree adverbs are allowed. However, as we have shown, both predictions are violated with the low *geng* examples in (47); this provides evidence against a non-degree-abstraction, VP-comparison analysis of them.

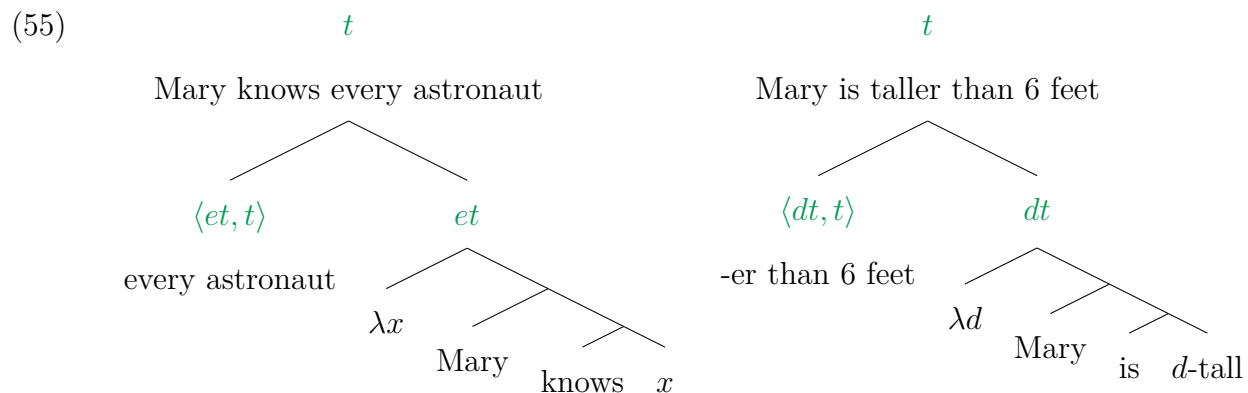
3.2.3 Summary

In this section, we have argued that comparatives constructed with an embedded gradable predicate are possible in Mandarin. While some of the constructions may be analyzed as VP-comparison constructions so that degree abstraction is not needed, we have shown that a VP-comparison analysis is not viable for all such constructions, particularly those that contain a *geng* or other comparative operators in embedded position. With a VP-comparison analysis ruled out for such comparatives, we conclude that degree abstraction must be involved in these cases. In sum, comparatives with embedded gradable predicates do not provide evidence against degree abstraction; on the contrary, they provide evidence for it.

3.3 Scope interactions between degree quantifiers and modals

3.3.1 Degree-modal scope interactions in English

Another place to look for degree abstraction is in scope interactions between degree quantifiers and modals. Heim (2001) 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 below.



How would we know whether there are such things? Scope ambiguity with other operators would provide an indication. Such scope ambiguities are often missing (Kennedy 1997); moreover, often the two scope readings collapse, giving rise to the same truth conditions (Heim 2001). 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’), some degree quantifiers do interact scopally with some modals.

One place where genuine scope ambiguities arise is with negative antonyms. With the negative antonyms less fast and slower, Heim (2006) notices that there is a subtle difference in meaning between (56a) and (56b).

- (56) a. Tom needs to drive less fast than Sue ~~needs to~~.

- b. Tom needs to drive slower than Sue ~~needs to~~.

Example (56a) is true in Heim’s East Coast Driving Scenario, whereas (56b) does not seem to be.

- (57) East Coast Driving Scenario (Heim 2001)
 Tom and Sue both need to get to Boston by eight o’clock; Sue is far away, in New Haven, and Tom is closer by, in Providence.

This difference can be attributed to scope. Let us assume that less fast and slower can be described in terms of three components, the comparative element, a negative component that could be expressed as little, and a gradable predicate (fast). In order to deal with antonymy in the context of comparatives, we follow the proposal of Heim (2006) to treat the comparative operator -er as expressing a subset relation between two sets of degrees.¹⁹

- (58) $-er \rightsquigarrow \lambda S_{dt} . \lambda T_{dt} . S \subset T$

We further adopt the definition of little from Heim (2006); this is an antonymizer that takes the complement of a set of degrees:

- (59) $little \rightsquigarrow \lambda d . \lambda P_{dt} . \neg P(d)$

Both -er and little are scopally mobile.

If the negative component little takes scope over need, and -er takes widest scope, then the resulting reading is as in (60). An LF assuming a clausal analysis of -er is given below the example, along with a translation into the logical representation language.

¹⁹While we assume a maximality-based semantics for the two-place bi in Section 2, we use the subset-based semantics of -er in (58) in this section in order to deal with negative antonyms. The subset-based semantics for the two-place comparative operator would yield the same results as the maximality-based semantics for the purposes of the discussion in Section 2.

(60) -er > little > need

LF: [-er than $\lambda d'$ d' -little λd ~~need~~ Sue ~~drive d -fast~~] $\lambda d'$ d' -little λd need Tom drive d -fast

Translation: $\{d : \neg \Box \text{speed}(s) \geq d\} \subset \{d : \neg \Box \text{speed}(t) \geq d\}$

or equivalently: $\min(\lambda d . \neg \Box \text{speed}(t) \geq d) < \min(\lambda d . \neg \Box \text{speed}(s) \geq d)$

or equivalently: $\max(\lambda d . \Box \text{speed}(t) \geq d) < \max(\lambda d . \Box \text{speed}(s) \geq d)$

‘Tom’s minimum required speed is below Sue’s.’ (comparison-of-minima)

What is the set of degrees d such that it is not the case that in all possible worlds, X drives d fast? It is an interval that stretches from right above the greatest speed that X reaches in all possible worlds indefinitely upwards. Because the two sets of degrees S and T , for the standard and the target, respectively, stretch up from a degree d to infinity, the subset requirement imposed by -er in (58) boils down to the claim that $\min(T) < \min(S)$ (Kennedy 2001, Heim 2006). The interval stretches down lower from infinity for the target than for the standard, hence the lower tip of the target interval is lower than the lower tip of the standard interval. The greatest speed that Tom reaches in all possible worlds is actually the lower limit on how fast Tom is required to drive, or in other words, his minimum required speed. So on the reading we’ve illustrated in (60), the sentence expresses that Tom’s minimum required speed is below Sue’s. This reading is true in the East Coast Driving Scenario, where (56a) (less fast) is true. This type of reading involves degree abstraction.

Example (56b), on the other hand, is judged false in the East Coast Driving Scenario, so evidently the scope configuration where both the comparative and the negative component take scope over the modal is not available in (56b). But there is another scope configuration involving degree abstraction that is available for this sentence.

Consider the possibility that only the comparative component scopes over need, and the negative component takes lowest scope, under the modal. As a shorthand, we will treat slow as a lexical amalgam of little and fast:

(61) $\text{slow} = \text{little+fast} \rightsquigarrow \lambda d . \lambda x . \neg \text{speed}(x) \geq d$
 ‘the set of degrees x ’s speed does NOT reach’

Then the following reading for (62) is obtained when the negative component of slower is interpreted with the gradable predicate.

(62) $-\text{er} > \text{need} > \text{little+fast}$
 LF: [$-\text{er than } \lambda d \text{ needs Sue drive } d \text{ slow}] \lambda d \text{ needs Tom drive } d \text{ slow}$
 Translation: $\{d : \Box \neg \text{speed}(s) \geq d\} \subset \{d : \Box \neg \text{speed}(t) \geq d\}$
 or equivalently: $\min(\lambda d . \Box \neg \text{speed}(t) \geq d) < \min(\lambda d . \Box \neg \text{speed}(s) \geq d)$
 or equivalently: $\max(\lambda d . \Diamond \text{speed}(t) \geq d) < \max(\lambda d . \Diamond \text{speed}(s) \geq d)$
 ‘Tom’s maximum allowed speed is below Sue’s.’ (comparison-of-maxima)

With this scoping, the comparative expresses that the set of degrees Sue’s speed is prohibited from reaching is the subset of Tom’s prohibited speeds. In other words, the lowest impossible speed for Tom is lower than that for Sue. Where the impossible speeds end, the acceptable speeds begin. Hence the greatest acceptable speed for Tom is lower than the greatest acceptable speed for Sue, i.e., Tom’s maximum allowed speed is below Sue’s maxima allowed speed. This reading is very different from the reading in (60), although they both involve high scope for the comparative over the modal.

Furthermore, this comparison-of-maxima reading obtained via the scope order ‘-er > need > little-phrase’ is truth-conditionally distinct from the wide-scope-modal reading (‘It is necessary that Tom drives slower than Sue’). Imagine a scenario where Tom is driving in an area with a 60 mph speed limit, whereas Sue is driving in an area with a 80 mph speed limit, but Tom actually drives faster than Sue. This kind of scenario is prohibited by the wide-scope-modal reading, but allowed in principle by the ‘-er > need > little-phrase’ reading.²⁰

²⁰Granted, this claim is somewhat controversial. Heim (2006) states that these two readings are equivalent (p. 51). A perceived equivalence between these readings could come about through generic quantification, as

In sum, there are potentially two scope configurations of comparatives with negative antonyms where the modal verb takes narrow scope. The first one is the -er > little > modal reading, and the second one is the -er > modal > little reading. With a necessity modal, the first scope reading is the comparison-of-minima reading, and the second the comparison-of-maxima reading. With a possibility modal verb, on the other hand, the first scope reading will be the comparison-of-maxima reading and the second the comparison-of-minima reading. Hence with both necessity and possibility modals, there are two scope readings that could provide evidence for degree abstraction.

3.3.2 Degree-modal scope interactions in Mandarin

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):

- (63) John xuyao bi Bill shao mai yixie lazhu.
 John must than Bill few buy a.bit candles
 Available: ‘It is required that the amount of candles John buys is below Bill’s.’
 Unavailable: ‘John’s minimally required amount is below Bill’s.’

They use the absence of the comparison-of-minima reading (i.e., the -er > little > need reading) as evidence for the lack of degree abstraction in Mandarin. This argument is subject to several caveats. First, the example involves a ‘differential verbal comparative’, whose analysis is controversial: In (63), yixie ‘a bit’ is a vague quantity term that denotes a measure phrase in this case (Grano & Kennedy 2012); a more literal translation of this sentence would be: ‘John must buy a bit fewer candles than Bill’. This type of comparative involves set comparison rather than degree comparison according to Li (2009), although degree-based analyses of these differential verbal comparatives have been proposed (see Luo & Xie 2018). Furthermore, regardless of the issue of set comparison vs. degree comparison, this example involves a differential comparative, and scope readings cannot be disentangled

one reviewer points out. The wide-scope-modal can be paraphrased as ‘In general, to avoid speeding, Tom is required to drive slower than Sue’.

with differential measure phrases unless they involve modifiers like exactly (Heim 2001).

We argue that the two readings where the comparative operator takes scope over the modal verb are available in Mandarin. Consider the following example with the necessity modal verb *xuyao* ‘need’:²¹

- (64) John *xuyao* *bi* Bill *fan* *geng* *shao* *de* *cuowu*.
 John need *bi* Bill make *geng* *few* *de* mistake
 ‘John needs to make fewer mistakes than Bill.’

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

- (65) *must* > *-er* > *little+many*
 $\Box[\min(\lambda d. \neg \text{mistakes}(j) \geq d) < \min(\lambda d. \neg \text{mistakes}(b) \geq d)]$
 or equivalently: $\Box[\max(\lambda d. \text{mistakes}(j) \geq d) < \max(\lambda d. \text{mistakes}(b) \geq d)]$
 ‘It is required that John make fewer mistakes than Bill.’

It also has an *-er* > *need* > *little* (i.e., the comparison-of-maxima reading) where the comparative element alone scopes over the modal, which in turn scopes over the negative antonym.

- (66) *-er* > *must* > *little+many*
 $\min(\lambda d. \Box \neg \text{mistakes}(j) \geq d) < \min(\lambda d. \Box \neg \text{mistakes}(b) \geq d)$
 or equivalently: $\max(\lambda d. \Diamond \text{mistakes}(j) \geq d) < \max(\lambda d. \Diamond \text{mistakes}(b) \geq d)$

²¹Our arguments for scope interactions are based on examples of attributive comparatives. We do find ambiguity in adverbial comparatives analogous to the English example in (56) as shown below:

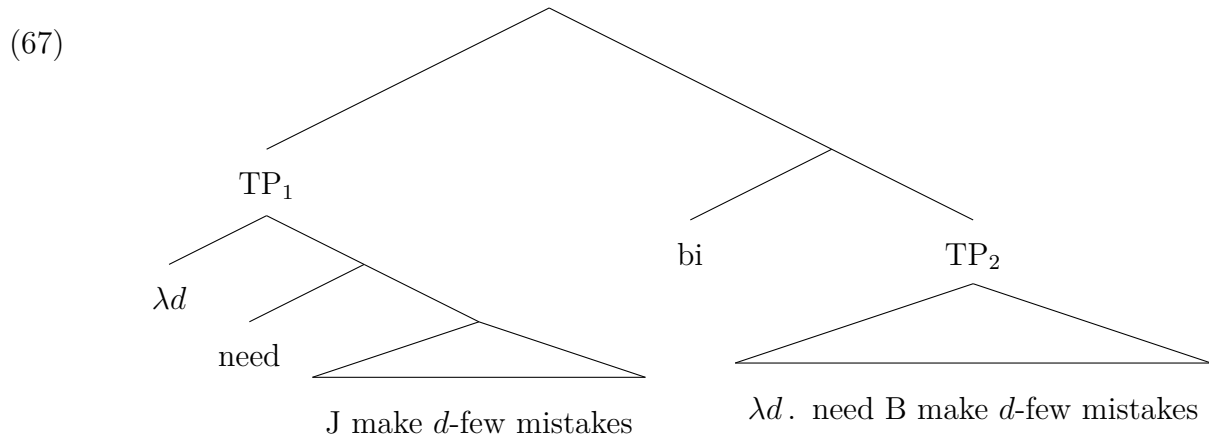
- (i) *motuoche* *zai* I-90 *xuyao* *bi* *zai* I-95 *kai* *de* *man*.
 motorbike on I-90 need *bi* on I-95 drive *de* slow

The sentence has a comparison-of-maxima reading ‘For motorbikes, the maximum allowed speed on I-90 is below the maximum allowed speed on I-95’. The sentence can be judged true in a scenario where the speed limit on I-90 is 60 mph and the speed limit on I-95 is 80 mph, yet one is driving 50 mph on I-90 but 40 mph on I-95. However, it is controversial whether Mandarin post-verbal adverbials are complements of the verb or simply adjuncts (Ernst 2014). Thus, it is not impossible that the ambiguity we found in (i) is in fact an ambiguity related to the structure of post-verbal adverbials in Mandarin, rather than the scope of degree quantifiers.

‘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 is acceptable in such a context in view of its comparison-of-maxima reading: The maximum number of mistakes John is allowed to make, namely two, is below the maximum number of mistakes Bill is allowed to make, namely five.

The scope reading in (66) provides positive evidence for degree abstraction in Mandarin. Following Erlewine’s (2018) 2-place *bi* analysis, the comparative operator *bi* is base-generated in the highest position, conjoining the standard and the target clause. Therefore, QR is not required in order for the comparative to take the widest scope. Degree abstraction is not necessary to interpret the negative antonym either if we assume that *shao* ‘few’ does not decompose to little plus a positive antonym but denotes a gradable predicate with the negative component built in. Nevertheless, degree abstraction over the modal verb *xuyao* ‘need’ is still required to derive the complex degree descriptions in both clauses.²²



It is harder to get the -er > little > modal reading with necessity modal verbs in examples like (64). But an -er > little > modal reading is available with certain Mandarin possibility

²²To avoid redundancy, as well as to provide a fair assessment of the data point regarding scope interactions, we ignore instances of degree abstraction that are associated with attributive modifications in examples in this section.

modal verbs such as neng ‘can’. Such a reading is available in the following example.²³

- (68) xiao xinglixiang neng bi da xinglixiang zhuang geng shao de waitao.
 small suitcase can bi big suitcase pack geng shao de coat
 ‘The small suitcase can pack fewer coats than the big suitcase.’

The sentence is judged true in a scenario where the small suitcase packs two coats with a maximum capacity of two coats, whereas the big one packs only one coat with a maximum capacity of four coats. This shows that (68) has a comparison-of-maxima reading (i.e., -er > little > can reading) where the maximum possible number of coats the small suitcase packs is below the maximum possible number of coats the big suitcase packs.

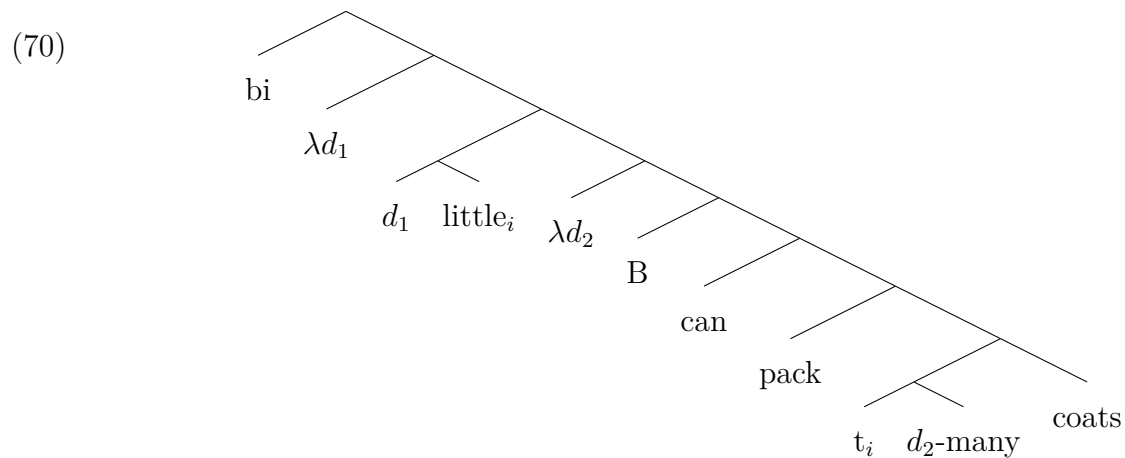
- (69) -er > little > can:

$$\min(\lambda d. \neg \diamond[\text{coats}(s) \geq d]) < \min(\lambda d. \neg \diamond[\text{coats}(b) \geq d])$$

$$\text{or equivalently: } \max(\lambda d. \diamond[\text{coats}(s) \geq d]) < \max(\lambda d. \diamond[\text{coats}(b) \geq d])$$

‘The maximum allowed amount of the small suitcase is below the maximum allowed amount of the big suitcase.’

To derive this scope reading, beside abstracting the degree variable over the modal verb, degree abstraction following the movement of the negative component is also required:



²³The surface order of the modal verb neng ‘can’ relative to bi is not rigid; neng can occur either before bi or to the immediate left of the matrix verb zhuang ‘pack’. See section 3.3.3 for empirical evidence.

This instance of degree abstraction is achieved not by *bi* but by *little*, which surfaces below the modal and undergoes movement to a position above it.²⁴

3.3.3 Experiment: Scope preferences

To provide empirical evidence that the narrow-scope readings of the modal verbs are truly available in Mandarin, we designed an experiment measuring acceptability in context. In addition to assessing whether such readings exist, we are also concerned with two other questions: (i) whether there is any preference among the possible scope readings, and (ii) whether any such preference is modulated by the particular choice of modal verb. This experiment also tests whether there is any sensitivity to word order, specifically between the modal verb 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: one 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.

²⁴A reviewer points out that the felicity of examples like (64) and (68) is quite surprising from the perspective that Mandarin is a scope-rigid language, assuming that it is the modal verb that takes widest scope. Two points are in order regarding this: (i) That a finding is surprising should not prevent us from concluding that it is correct; the data does suggest that a comparison-of-maxima reading is available for these sorts of cases; (ii) There is room for discussion regarding what actually constitutes surface scope in this example. Although the modal verb may occur to precede *bi* linearly, as we illustrate in (67), it may be that the surface structure is as suggested by Erlewine (2018), where the comparative takes widest scope.

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 target sentences were constructed using attributive comparatives with a negative gradable predicate. Each of the three lexicalizations was associated with two contexts, each promoting a particular reading. The target sentence varied ever so slightly across the two contexts. Below gives an example of one lexicalization for the possibility modals and one for the necessity modals. A full list of the lexicalizations can be found in Appendix B, along with attention check items and filler items. The modal verb is highlighted in bold.

(71) packing a suitcase

Context 1 (promotes -er > can): 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.

- a. xiao xinglixiang neng bi da xinglixiang zhuang geng shao de waitao.
 small suitcase can bi big suitcase pack geng few de coat
 ‘The small suitcase can pack fewer coats than the big suitcase.’

Context 2 (promotes can > -er): 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:

- b. huangse xinglixiang neng bi lanse xinglixiang zhuang geng shao de waitao,
 yellow suitcase can bi blue suitcase pack geng few de coat
 (huozhe geng duo, suibian ni).
 or more, it’s up to you
 ‘The yellow suitcase can pack fewer winter coats than the blue suitcase, or more; it’s up to you.’

(72) adding water to a water boiler

Context 1 (promotes -er > need): Electric water boilers won't start work if the water added is below its minimum water level. Assume now there is a small water boiler with a 500ml minimum water level, and a big water boiler with a 1000ml minimum water level. John wants to boil some hot water with these two boilers, and you tell him:

- a. xiao reshuihu xuyao bi da reshuihu jia geng shao de shui
 small water-boiler need bi bi water-boiler add geng few de water
 'The small water boiler needs to be added with less water than the big water boiler.'

Context 2 (promotes need > -er): 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:

- b. boli reshuihu xuyao bi tie reshuihu jia geng shao de shui.
 glass water-boiler need bi iron water-boiler add geng few de water
 'The glass water boiler needs to be added with less water than the iron water boiler.'

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 (e.g. A can bi B pack ...), or with the bi-phrase preceding the modal (e.g. A bi B can pack ...), or with the bi-phrase occurring after the modal and the main verb (e.g. A can pack bi B ...), as shown below. (The modal verb is boldfaced and the main verb is underlined.)

- (73) a. xiao xinglixiang neng bi da xinglixiang zhuang geng shao de waitao.
 b. xiao xinglixiang bi da xinglixiang neng zhuang geng shao de waitao.
 c. xiao xinglixiang neng zhuang bi da xinglixiang geng shao de waitao.

Procedure. Survey respondents participated in this experiment after completing a survey on the acceptability of attributive bi-comparatives. (The results of the acceptability judg-

ment survey are reported in Appendix A.) All materials were presented to the participants in Mandarin only. The participants were asked to rate the 12 target items on their list and 2 attention checks and 6 filler sentences interspersed with them. The 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. 53 participants were recruited through Prolific, and selected according to self-reported native language (“Mandarin” or “Chinese”) and nationality (“China”). Five participants were excluded on the grounds that they gave unexpected responses to one or more attention check items, yielding a dataset of 48 participants. All 48 participants have finished the preliminary survey before participating in this study. Participants were asked to self-rate their Mandarin proficiency from 1 (bad) to 10 (good); the average score is 9.3/10.

Results. The results are plotted in Figure 1. Since we found no effect of word order, the results are collapsed across word order variants. 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 *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, a statistical trend was found in the opposite direction, where more participants accepted the reading where the comparative scopes over the modal, vs. the modal-over-comparative reading. In other words, with possibility modals, if any scope

reading was preferred, it was the reading where the comparative scopes over the modal. 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.

With possibility modals, especially for the comparative > modal reading, there was quite a wide distribution in judgments, with a good number of participants giving ratings of 4 and 5, 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.

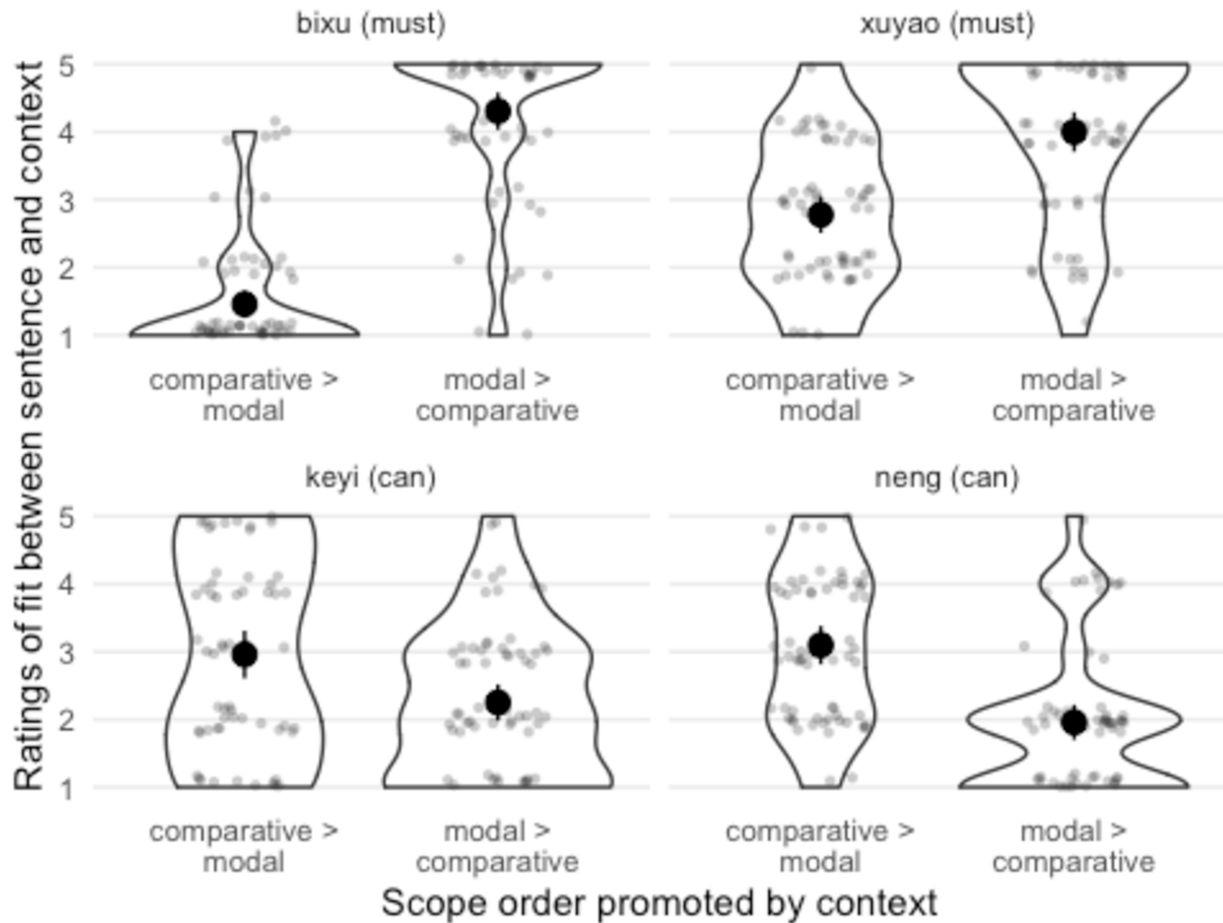


Figure 1: Violin plot of judgments obtained in Experiment 2, overlaid on raw data (jittered). The large dot represents the mean, and is surrounded by a 95% confidence interval.

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 comparative from scoping over it. It is not uncommon for modals to differ in their scope possibilities on a lexical basis; we see this also with English *must* and *need* (cf. John *must* drive less fast than Mary, which is not true in the East Coast Driving Scenario, vs. John *needs* to drive less fast than Mary, which is).

3.3.4 Summary

In this section, we have provided an investigation of the phenomenon of scope interactions between modal verbs and degree quantifiers. We have argued that degree abstraction is involved in comparatives with negative antonyms and strong modal verbs, as well as in examples with weak modals. With the recognition of two readings where the modal verb takes narrow scope in English, we have presented the results of an experiment to show that Mandarin allows such readings where the modal verb is interpreted as taking a narrow scope. In particular, the comparison-of-maxima reading is available with possibility modal verbs, necessitating degree abstraction for interpretation.

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 it? In this section, we show that the relevant empirical facts are all compatible with the idea that degree abstraction is possible in Mandarin, upon closer inspection.

4.1 Degree questions

Degree questions can be analyzed as involving quantification over degrees (Heim 2001). According to some treatments of questions (Groenendijk & Stokhof 1984, Heim & Kratzer 1998), a degree question like (74) 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.

- (74) How tall is John?
[q [λ_1 [John is t_1 tall]]]

If this is how degree questions are formed (and the only way they are formed), then if a language lacks degree abstraction, then it should not allow 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(-like) questions (Beck et al. 2004).

- (75) 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(-like) questions involve quantification over individuals instead of degrees. However, as argued by Sudo (2015), it is also possible that *kurai* ‘degree’ has a degree-based denotation, and does participate in a degree abstraction configuration as in (76).

- (76) 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* ‘how’ as exemplified in (77) (corpus examples adapted from LCMC).²⁵

- (77) a. *nimen diu de dami you duo zhong?*
you.pl lose de grain you how heavy
‘How heavy is the grain that you lost?’
- b. *xianzai cangku liangshi wendu duo gao?*
now storage grain temperature how high
‘How high is the temperature of the grain in the storage now?’

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

- (78) *John shi duo gao?*
John shi how tall
‘How tall is John?’
(ungrammatical according to Beck et al. 2009)

But *shi* is often analyzed as a focus marker or the emphasis marker in Mandarin (Huang 1982, Paul 2021 among others). We note that (78) 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, (78) is perfectly fine. Echo questions may not be considered genuine questions, through (Beck & Reis 2018). But regardless of whether the example with *shi* can be counted as a genuine degree question, example (77) above clearly is. So the relevant phenomenon does exist in Mandarin.

Furthermore, wh items appear to take scope over other scope-bearing elements. In (79), the sentence has a direct question interpretation where the wh-phrase scopes over the matrix verb ‘think’.²⁶

²⁵We leave *you* and *shi* both unglossed because how they should be glossed is unclear.

²⁶We thank an anonymous reviewer for pointing out this set of data to us.

- (79) John juede Bill duo gao?
 John think Bill how tall
 ‘How tall does John think Bill is?’

There are possible analyses of the direct question reading of (79) on which it involves degree abstraction; for example, the degree wh-item duo could take scope over the matrix verb via a covert wh-movement or QR (see Huang 1982 for discussions on this type of scope effects of Mandarin wh-constructions in general).

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 degree abstraction should not be expected in Mandarin degree questions in the first place unless there is 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).

Another potential locus of degree abstraction with wh items is in constructions that are referred to as “bare conditionals” or “wh-correlatives” in the literature (Cheng & Huang 1996, Crain & Luo 2011, Huang 2010, Chen 2020). Consider sentences like (80), which consist of two full clauses, each of which contains the same degree wh-item duo.

- (80) chuangzi duo chang, wo jiu mai duo chang de chuaglian.
 window how long, I then buy how long de curtain
 ‘I will buy a curtain as long as the window is long.’

There are multiple views on how to analyze cases like (80), and depending on the 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:

(81) [λd .I will buy a d -long curtain](ιd (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 analyzed as conditionals with two matching wh-pronouns being bound by a covert universal operator. If the wh pronoun is type d , then the configuration in question involves degree abstraction, if not an instance of it that is derived by movement. Under the question-based analysis, these correlative constructions are viewed as interrogative conditionals consisting of two embedded questions. Scholars advocating for a question-based analysis also assume covert wh-movement, which, in the case of the degree wh-phrase, produces an instance of degree abstraction involving movement.

Just because previous analyses of this construction happen to have made use of degree abstraction doesn't mean that there is no possible analysis that avoids it. Perhaps an analysis without degree abstraction could be constructed. But if previous analyses of this construction are on the right track, then degree abstraction is available in Mandarin.

4.2 Direct measure phrases

An argument against degree abstraction based on Mandarin direct measure phrase constructions (MPCs) is given by Beck et al. (2009): Mandarin lacks English-like MPCs, as measure phrases cannot combine directly with a degree adjective as in (82a). Krasikova (2008) discusses examples like (82b) involving the copula *you*, which on the surface appear to be grammatical MPCs, but Krasikova argues that these are not English-like MPCs, in part on the basis of the observation that the measure phrase cannot be omitted.

(82) a. John shi 2 mi gao.
John shi 2 meter tall
'John is 2 meters tall.'

(marked as ungrammatical by Beck et al. 2009)

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

So there is a consensus in this prior literature that MPCs are ungrammatical in Mandarin.

We find it plausible that Mandarin does in fact allow direct measure phrases with *shi*. While we do not dispute Krasikova's assessment of *you*-constructions, we take issue with the claim that (82a) is ungrammatical; it would be felicitously used as an affirmation that John is truly 2 meters tall. The *shi* construction and the *you* construction have different meanings; (82b) 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, (83b) is false whereas (83a) is true.

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

The contrast between (83a) and (83b) shows that *shi*-MPCs and *you*-MPCs are distinct from each other. While Krasikova's analysis for *you*-MPCs is indeed plausible, there is no reason to assume the same for *shi*-MPCs. An analysis of *shi*-MPCs as genuine MPCs is consistent with the evidence.²⁷

But the point is moot, because degree abstraction is not required to analyze structures

²⁷Another piece of evidence that *shi*-constructions are distinct from *you*-constructions is that *shi* can occur in positive forms without a measure phrase (also see Liu 2010b:fn14):

- (i) John shi gao. Bill ye bu ai.
John shi tall Bill also neg short
'John is tall; Bill is not short either.'

More evidence for the distinct feature of *you*-sentences and *shi*-sentences can be found in Xie (2014).

involving a measure phrase that denotes a degree. Unlike quantificational measure phrases (discussed in §5.1), a degree-denoting expression can saturate a degree argument directly through Function Application.²⁸ The sentences in (82) therefore do not provide evidence either for or against degree abstraction.

4.3 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 (84).

- (84) 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 (84b) has a denotation as follows:

- (85) $\lambda d. \text{John didn't buy a } d\text{-expensive book}$
 $\lambda d. \neg \text{J bought a } d\text{-expensive book}$

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.

²⁸This same is true under Kennedy & McNally’s (2005) view that measure phrases denote functions from gradable adjectives to predicates of individuals.

We take issue both with the empirical claim that Mandarin lacks negative island effects and with the logic of the argument. Example (86) is presented by Beck et al. (2009) to show that Mandarin displays no negative island effects.

- (86) [DP<sub>[RC John mai de] shu] bi [DP<sub>[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.’</sub></sub>

Example (86) is quite different from English examples in (84), and not just in that it has an acceptable reading. As one can tell from the added literal translation, (86) makes a comparison between two nominals—each made of a complex DP including a relative clause. That means, whether under a direct or a clausal analysis, the standard in (86) contains the complex DP [Bill mei mai de ~~shu~~] ‘(book) Bill didn’t buy’ where the negative item mei ‘not’ is included inside the DP. In contrast, the English example (84) has a clausal standard (i.e., than John didn’t buy a *d*-expensive book) where the negative item is interpreted outside the DP [a *d*-expensive book].

The true English counterpart to Beck et al.’s Mandarin example (86) should be something like (87) where the negative item is included inside the nominal standard:

- (87) John bought a more expensive book than [DP a/the book [RC Bill didn’t buy]].

Just like (86), there are no negative island effects to show with sentence (87), and it is acceptable. Because of the fact that the than-clause denotes a set of degrees to which a particular book (the book not bought) is expensive, we indeed can define the maximal degree. No anomaly should be expected. In other words, if the negation takes scope within the definite noun phrase, as in ‘the book Bill didn’t buy’, then the standard clause does not denote a degree interval that lacks a maximum, so we don’t have a situation where the maximum operator looks for a maximum and fails. The same thing can be said to the Mandarin example (86). Thus, (86) does not show Mandarin lacks negative island effects,

as this example does not test for them.

Mandarin actually behaves exactly like English with respect to negative island effects. Consider the examples in (88). The negation in (88a) gives rise to a sentential negation interpretation, whereas the negation under *bi* makes (88b) unacceptable.

- (88) a. 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.’
- b. *John *bi* Bill mei/bu pao de kuai.
 John *bi* Bill neg run de fast

Assume a 2-place *bi* analysis. The LFs of (88a) and (88b) can be given as follows, respectively:

- (89) a. neg [*bi* [λd B runs *d*-fast] [λd J runs *d*-fast]]
 $\neg \max(\lambda d . \text{speed}(j) \geq d) > \max(\lambda d . \text{speed}(b) \geq d)$
- b. *bi* [λd neg B runs *d*-fast] [λd J runs *d*-fast]
 $\max(\lambda d . \text{speed}(j) \geq d) > \max(\lambda d . \neg \text{speed}(b) \geq d)$

The anomaly of (88b), given the LF in (89b), can be explained under the same set of assumptions that explain the anomaly of its English counterpart (90), i.e., there is no maximum of the set of degrees such that Bill doesn’t run *d*-fast; this set of degree stretches from right above Bill’s greatest possible speed to infinity.

- (90) #John runs faster than Bill doesn’t.

Thus Mandarin 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.

5 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 hints in favor of it. Here, we consider several 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.

5.1 Quantificational direct measure phrases

For quantificational measure phrase constructions in English, it has been proposed that degree abstraction is involved (Heim 2001).

- (91) John is exactly six feet tall.
[exactly six feet] [λ_1 [John is t_1 tall]]

Here, the quantifier over degrees exactly six feet cannot combine in situ, so it must undergo QR.

Similar exactly-MPCs can be constructed with *zhenghao/ganghao* ‘exactly, just’ in Mandarin, as shown below.

- (92) 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 ganghao 5 mi chang.
this cl rope neg shi exactly 5 meter long
‘This rope is not exactly 5 meters long.’

Notice, however, that the gradable predicate *chang* ‘long’ may occur before the measure phrase 5 mi ‘5 meters’, forming what is labelled as a ‘transitive comparative’ by Grano &

Kennedy (2012):

- (93) a. zhe gen shengzi zhenghao chang 5 mi.
this cl rope exactly long 5 meter
'This rope is exactly 5 meters long.'
- b. zhe gen shengzi bu shi ganghao chang 5 mi.
this cl rope neg shi exactly long 5 meter
'This rope is not exactly 5 meters long.'

Grano & Kennedy (2012) provide an analysis where the degree-denoting measure phrase merges with the adjective either as its specifier or as its complement, resulting in the two different linear orders (i.e., 5 mi chang in (92) and chang 5 mi in (93)). Under this view, zhenghao/ganghao are modifiers of the whole AP, and degree abstraction is not needed for interpretation. In other words, for the exactly-MPCs in (92) and (93), an analysis where measure phrases are treated as denoting degrees (not requiring degree abstraction) is just as viable as a quantification-over-degree analysis (requiring degree abstraction). Hence, we do not get a solid positive argument for degree abstraction from exactly-MPCs; but, of course, these examples do not provide negative evidence either.

5.2 Exactly-differentials

Exactly-modified measure phrases can also participate in scope interactions with comparative operators and modal verbs, as Heim (2001) points out for English. Suppose you have written a draft of 10 pages, and you wonder if that meets the requirement for the term paper. Then the meaning of (94) could be either as in (95a) or (95b).

(94) The term paper needs to be exactly 2 pages longer than that.

- (95) a. require [exactly 2pp -er than that] [λ_1 [the paper be t_1 long]]
 $\Box \max(\lambda d . \text{length}(\text{the-paper}) \geq d) = 10\text{pp} + 2\text{pp}$
'It is required that the term paper is exactly 2 pages longer than that.'

b. [exactly 2pp -er than that] [λ_1 [require the paper be t_1 long]]

$$\max(\lambda d . \Box \text{length}(\text{the-paper}) \geq d) = 10\text{pp} + 2\text{pp}$$

‘The minimum requirement is exactly two pages greater than that.’

In order to handle the differential argument of the comparative in (94), exactly two pages, Heim assumes that the maximum degree described by the main clause is constrained to be equal to the sum of the degree denoted by the standard and the degree denoted by the differential. (Although exactly two pages might be analyzed compositionally as a quantifier, the resulting semantics is the same as if it picked out a particular quantity, 2 pages itself.) The first reading, (95a), says that it is required that the paper be 12 pages long. The second reading says that the greatest lower bound on acceptable lengths is 12 pages (so the paper has to be at least 12 pages long).²⁹

The same phenomenon can be observed in Mandarin, as illustrated in (96).³⁰

(96) qimo lunwen zhenghao xuyao [bi na] chang 2 ye.
 term-final paper exactly need [than that] long 2 page
 (ambiguous between (95a) and (95b))

Sentence (96) 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 (95a) and in (95b) are available; the narrow scope reading of ‘need’ in (95b) can be understood under a view where Mandarin measure phrases can move like a quantifier and trigger degree abstraction. That being said, we are aware that zhenghao ‘exactly’ appears before the modal verb in (96),

²⁹For what it’s worth, while Beck (2012) suggests that exactly-differentials are probably the only true test for scope interactions, the second author, a native speaker of English, does not get a reading where lengths greater than 12pp are allowed. We believe it would be worth carrying out a judgment study on native English speakers before continuing to use this type of example in semantic fieldwork on degree abstraction.

³⁰Beck 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. The example we provide in (96) makes use of differential adjectival comparatives—unlike the controversial differential verbal comparatives as discussed in 3.3, differential adjectival comparatives are argued to involve degree-denoting measure phrases both by Li (2009) and Luo & Xie (2018).

hence we leave for future research whether this piece of data point can be used as a positive argument for degree abstraction.

5.3 Scope interaction in little-sentences

As discussed by Heim (2006), degree constructions like (97) below involve scope interactions between degree operators and intensional verbs. We refer to such constructions as little-sentences.

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

There are two readings available in (97): 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 (97) in Mandarin is the following:

(98) 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 (98) 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:

- (99) 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 ($\text{little} > \diamond$), whereas with *a little*, the at-issue content can only be the possibility of growing a little bit.

If the at-issue content of (98) can be the impossibility of eating more, then we expect that it should be embeddable under *sad* in the same way.

- (100) wo hen { #shangxin, kaixin } yinwei women keyi zhong yi-dian-dian zai women
 I very sad happy because we can plant one-dot-dot in we
 de yuanzi li.
 de 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 (98).

5.4 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 (101).

(101) 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: The focused constituent (indicated with the subscript F on John in the representation below) undergoes Quantifier Raising, and -est takes scope over the resulting predicate, below the landing site for the focused constituent, in a parasitic scope configuration (Szabolcsi 1986, Heim 1985). The representations are roughly as follows.

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

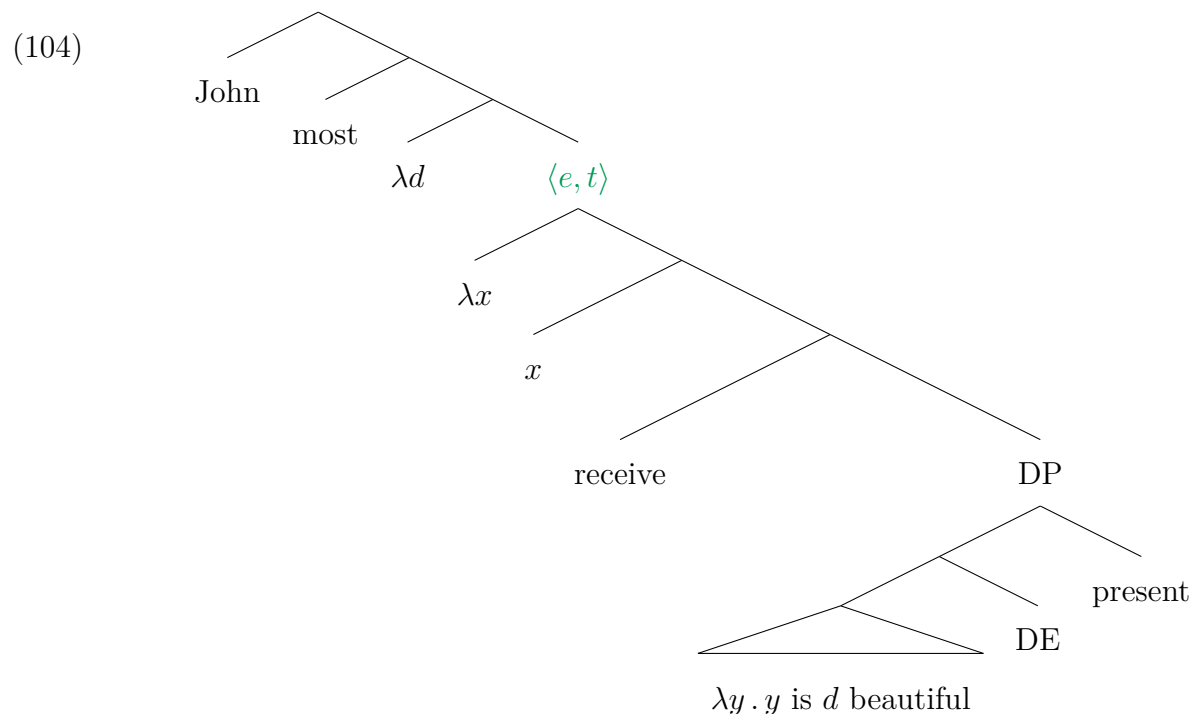
Superlatives can therefore be used as a probe for degree abstraction. With respect to Japanese, for instance, Sudo (2015) points out that the relative readings of *ichiban* ‘#1; -est’ observed and analyzed by Aihara (2009) constitute evidence for degree abstracting in Japanese.

Superlatives in Mandarin are constructed with the degree adverb *zui* ‘most’ as in (103).

- (103) 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 (103) under a relative reading is given in (104).



If superlatives undergo covert movement at LF to a position near the focused 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.

6 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 three 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—e.g. the ‘make’ verbs—it is possible to have comparatives with embedded gradable predicates in Mandarin. This data provides further evidence for degree abstraction.
- We showed that comparatives can take scope over modals and gives rise to a reading that is derived from an -er > little > modal scoping as well as a reading with a -er > modal > little scoping. We provided novel statistical evidence for the existence of such scope interactions in Mandarin, supporting the claim that Mandarin has degree abstraction.

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, we have presented examples with embedded degree questions that are in favor of a degree-abstraction analysis. We have also showed that depending on how Mandarin bare conditionals are analyzed, if wh-movement is required, then bare conditionals likely provide positive arguments for degree abstraction too.
- Meanwhile, we have argued that non-quantificational direct measure phrase constructions, which are used in previous literature as negative evidence against degree abstraction in Mandarin, in fact do not provide any evidence relevant to degree abstraction. Nevertheless, there is an empirical fact that direct measure phrase is allowed in two distinct constructions in Mandarin.
- We have shown that negative island effects do exist in Mandarin, but we argue that this test does not provide any evidence with respect to degree abstraction either. The previously reported lack of negative island effects only represents that the language allows the negative item to not take scope over the standard clause.

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.

(Word count: 17,619)

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A Survey: Acceptability of attributive comparatives

A reviewer observes that the marker *de* seems to be optional with *duo* ‘many’ but obligatory with *chang* ‘long’ in attributive bi-comparatives. This might suggest that the examples with quantity predicates that we have characterized as attributive comparatives might not be truly attributive. To establish firmly that Mandarin has both quantity and quality attributive comparatives, we carried out an acceptability judgement study to determine whether there is any difference in the syntax with respect to particle *de*. Another empirical question that this study addresses has to do with the lexical semantics of the governing verb. In informal discussions regarding attributive comparatives, the intuition has been expressed that there may be pragmatic considerations governing their acceptability. This study probes the productivity of attributive comparatives.

Design. We include sentences with four 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. We tested both quality and quantity attributive structures. We designed four choices of main verb and object noun ('lexicalization'). Each lexicalization is associated with one quality attributive structure and two quantity attributive structures, which differ in the presence of de. The gradable predicate is highlighted in bold. The letters "A" and "B" in the examples stand for a proper name used in the actual experiment.

(105) chi pingguo 'eat apples'

Context 1: Assume A ate 2 apples; B ate 4 apples.

a. A bi B chi le geng shao pingguo.

a'. A bi B chi le geng shao de pingguo.

'A ate fewer apples than B'

Context 2: Assume a normal sized apple is around 40g. A ate a 20g apple; B ate a 30g apple.

b. A bi B chi le yi ge geng xiao de pingguo.

'A ate a smaller apple than B.'

(106) xie lunwen 'write papers'

Context 1: Assume A wrote 3 papers; B wrote 5 papers.

a. A bi B xie le geng shao lunwen.

a'. A bi B xie le geng shao de lunwen.

'A wrote fewer papers than B.'

Context 2: Assume a normal-length paper is around 10 pages. A wrote a 2-page paper; B wrote a 4-page paper.

b. A bi B xie le yi pian geng duan de lunwen.

'A wrote a shorter paper than B.'

(107) da yaoguai 'hit monsters'

Context 1: Assume in one battle, C hit 20 monsters; B hit 3 monsters; A only hit 1 monster.

a. A bi B da le geng shao yaoguai.

a'. A bi B da le geng shao de yaoguai.

'A hit fewer monsters than B'

Context 2: Assume in one battle, C hit a very strong monster; B hit a weak monster; A hit a even weaker monster.

b. A bi B da le yi ge geng ruo de yaoguai.

‘A hit a weaker monster than B’

(108) tou ren/houxuanren ‘vote for people/candidates’

Context 1: 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. A bi B tou le geng shao de ren.

a’. A bi B tou le geng shao de ren.

‘A voted for fewer people than B.’

Context 2: Assume normally managers are in their 40s. The candidate B voted for is 25 years old; the candidate A voted for is 20.

b. A bi B tou le yi ge geng nianqing de houxuanren.

‘A voted for a younger candidate than B.’

The (a) sentences involve a quantity comparative, differing only in the presence of *de* between the gradable predicate and the noun. The (b) sentence involves a quality comparative.

Two attention check sentences were constructed, each associated with an expected range of responses:

(109) Context: Assume a typical-priced car is \$100k. A wants to buy a \$400k car; B wants to buy a \$500k car.

a. B xiang mai de che bi A xiang mai de che geng gui.

B want buy de car bi A want buy de car geng expensive

‘The car B wants to buy is more expensive than the car A wants to buy.’

Expected response: high acceptance (above 3)

b. B bi A xiang mai yi liang gui che.

B bi A want buy one cl expensive car

‘B wants to buy a more expensive car than A wants to buy.’

Expected response: low acceptance (below 3)

Procedure. Participants were presented with each of the 12 sentences in a given context, along with the two attention check sentences interspersed with the items. The participants were 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. Survey respondents participated in this experiment prior to the experiment on scope interactions reported in section 3.3.3.

Participants. Same as in the experiment on scope interactions reported in section 3.3.3.

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

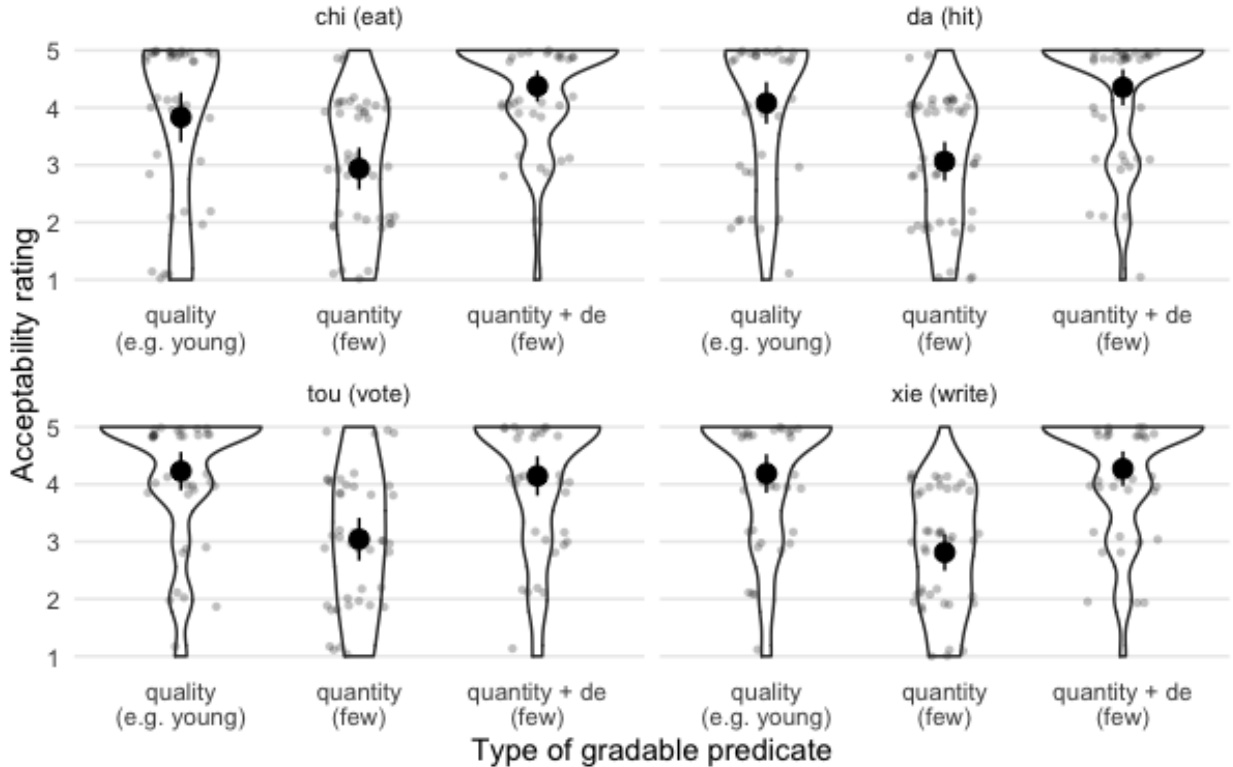


Figure 2: Violin plot of judgments obtained in acceptability study on attributive comparatives. The large dot represents the mean, and is surrounded by a 95% confidence interval.

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 the conclusion that both quality and quantity comparatives are genuinely acceptable in Mandarin. We found no evidence that the semantic class of the governing verb impacts the acceptability of adnominal quality or quantity comparatives.

B Materials for the Experiment on Scope Interaction

The experiment reported in Section 3.3.3 involved sentences containing a modal and a comparative. As mentioned above, we tested two necessity modals (*bixu* and *xuyao*) and two

possibility modals (keyi and neng). The sentences varied in the choice of main verb and object noun ('lexicalization') and word order; we used three lexicalizations for the possibility modals, and three different lexicalizations for the necessity modals.

The three lexicalizations for the possibility modals are shown below. Context 1 supports the comparison-of-maxima reading (e.g., The maximum possible/allowed amount of people seating at the square table is below the maximum possible amount of people seating at the round table); Context 2 supports the wide scope reading of the modal verb (e.g., It is possible/allowed that the amount of people seating at the glass table is below the amount of people seating at the wooden table). The modal verb is highlighted in bold, and the main verb is underlined. Each sentence could appear in one of the three word-orders.

(110) seating at a table

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.

- a. zhege fang zhuo neng/keyi bi nage yuan zhuo zuo geng shao de ren
 - a'. zhege fang zhuo bi nage yuan zhuo neng/keyi zuo geng shao de ren
 - a''. zhege fang zhuo neng/keyi zuo bi nage yuan zhuo geng shao de ren
- 'This square table can seat fewer people than that round table.'

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:

- b. boli zhuo neng/keyi bi mu zhuo zuo geng shao de ren (huozhe geng duo, suibian ni)
 - b'. boli zhuo bi mu zhuo neng/keyi zuo geng shao de ren (huozhe geng duo, suibian ni)
 - b''. boli zhuo neng/keyi zuo bi mu zhuo geng shao de ren (huozhe geng duo, suibian ni)
- 'The glass table can seat fewer people than the wooden table (or more, it's up to you).'

(111) loading a truck

Context 1: Assume there is a small truck with 4-package load limit and a big truck with 6-package load limit.

- a. xiao kache neng/keyi bi da kache zhuangzai geng shao de huowu.
 - a'. xiao kache bi da kache neng/keyi zhuangzai geng shao de huowu.
 - a''. xiao kache neng/keyi zhuangzai bi da kache geng shao de huowu.
- 'The small truck can load fewer cargo packages than the big truck.'

Context 2: Assume there is a red truck and blue truck. There are 5 packages of cargo and the porter doesn't not know which car should be loaded with how many packages. You tell him:

- b. hong kache neng/keyi bi lan kache zhuangzai geng shao de huowu (huozhe geng duo, suibian ni).
- b'. hong kache bi lan kache neng/keyi zhuangzai geng shao de huowu (huozhe geng duo, suibian ni).
- b''. hong kache neng/keyi zhuangzai bi lan kache 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).’

(112) packing a suitcase

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.

a. xiao xinglixiang neng/keyi bi da xinglixiang zhuang geng shao de hou waitao.

a'. xiao xinglixiang bi da xinglixiang neng/keyi zhuang geng shao de hou waitao.

a''. xiao xinglixiang neng/keyi zhuang bi da xinglixiang geng shao de hou waitao.

‘The small suitcase can pack fewer winter coats than the big suitcase.’

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:

b. huangse xinglixiang neng/keyi bi lanse xinglixiang zhuang geng shao de hou waitao (huozhe geng duo, suibian ni).

b'. huangse xinglixiang bi lanse xinglixiang neng/keyi zhuang geng shao de hou waitao (huozhe geng duo, suibian ni).

b''. huangse xinglixiang neng/keyi zhuang bi lanse xinglixiang 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. Context 1 supports the comparison-of-minima reading (e.g., The minimum required amount of water of the small water boiler is below that of the big water boiler.; Context 2 supports the wide scope reading of the modal verb (e.g., It is required that the water added to the glass water boiler is less than the water added to the iron water boiler.).

(113) adding water to a water boiler

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:

a. xiao reshuihu xuyao/bixu bi da reshuihu jia geng shao de shui

a'. xiao reshuihu bi da reshuihu xuyao/bixu jia geng shao de shui

a''. xiao reshuihu xuyao/bixu jia bi da reshuihu geng shao de shui

‘The small water boiler needs to be added with less water than the big water boiler.’

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:

- b. boli reshuihu xuyao/bixu bi tie reshuihu jia geng shao de shui.
- b'. boli reshuihu bi tie reshuihu xuyao/bixu jia geng shao de shui.
- b''. boli reshuihu xuyao/bixu jia bi tie reshuihu geng shao de shui.
'The glass water boiler needs to be added with less water than the iron water boiler.'

(114) having security guards on duty

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:

- a. san ceng gao de lou xuyao/bixu bi wu ceng gao de lou anpai geng shao de baoan.
- a'. san ceng gao de lou bi wu ceng gao de lou xuyao/bixu anpai geng shao de baoan.
- a''. san ceng gao de lou xuyao/bixu anpai bi wu ceng gao de lou geng shao de baoan.
'The 3-story building needs to have fewer security guards on duty than the 5-story building.'

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:

- b. xin lou xuyao/bixu bi lao lou anpai geng shao de baoan.
- b'. xin lou bi lao lou xuyao/bixu anpai geng shao de baoan.
- b''. xin lou xuyao/bixu anpai bi lao lou geng shao de baoan.
'The new building needs to have fewer security guards on duty than the old building.'

(115) putting pillows in hotel rooms

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:

- a. shuangren jian xuyao/bixu bi siren jian fang geng shao de zhentou.
- a'. shuangren jian bi siren jian xuyao/bixu fang geng shao de zhentou.
- a''. shuangren jian xuyao/bixu fang bi siren jian geng shao de zhentou.
'The double room needs to have fewer pillows than the quad.'

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:

- b. biao zhun jian xuyao/bixu bi zongtong taofang fang geng shao de zhentou.
- b'. biao zhun jian bi zongtong taofang xuyao/bixu fang geng shao de zhentou.
- b''. biao zhun jian xuyao/bixu fang bi zongtong taofang geng shao de zhentou.
'The standard room needs to have fewer pillows than the suite.'

Two sentences were constructed 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.

(116) Context: Assume the school is hosting a hiking event. All grade 1-5 students must come, and 6th graders can choose to come or not.

a. mei yi ge xuesheng dou bu neng canjia chunyou.

every one cl student dou neg can attend hiking

‘Every student cannot come to the hiking event.’

Expected response: low acceptance (below 3)

(117) 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.

a. bu shi mei yi ge xuesheng dou xuyao qu caochang jihe

neg shi every one cl student dou need go playground gather

‘Not every student needs to come to the playground.’

Expected response: high acceptance (above 3)

Finally, there were two filler items, each associated with a modal verb and lexicalization. For each filler item, three different word orders were tested, so there were six filler sentences in total. The filler sentences involve modals and positive antonyms, and all six sentences were presented to the participant. The two filler items are give as below. One uses the possibility modal neng ‘can’, and the other uses the necessity modal xuyao ‘need’. All sentences use the same gradable predicate duo ‘many’.

(118) hosting people in ballrooms

Context: There is a small ballroom that can host maximally 50 people, and there is a big ballroom that can host maximally 100 people.

a. da yanhuiting neng bi xiao yanhuiting jiedai geng duo de ren.

b. da yanhuiting bi xiao yanhuiting neng jiedai geng duo de ren.

c. da yanhuiting neng jiedai bi xiao yanhuiting geng duo de ren.

‘The big ballroom can host more people than the small ballroom.’

(119) installing cameras in meeting rooms

Context: There is a round meeting room and a oval meeting room. Now we want to install cameras in both rooms. It is required that the oval meeting room has more camera installed in it than the round meeting room.

a. tuoyuan huiyishi xuyao bi yuanxing huiyishi anzhuang geng duo de shexiangtou.

b. tuoyuan huiyishi bi yuanxing huiyishi xuyao anzhuang geng duo de shexiangtou.

c. tuoyuan huiyishi xuyao anzhuang bi yuanxing huiyishi geng duo de shexiangtou.

'The oval meeting room needs to have more cameras installed in it than the round meeting room.'