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Comparative morphemes are additive particles

English *-er*/*more* vs. Chinese *gèng*

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1 Introduction

Human languages support the expression of **measurement** and **comparison**. The notion of comparison is based on the notion of measurement. Measurement means mapping an entity/individual or event to a value on a relevant **scale** (e.g., a scale of height, weight, temperature, or timeline, see Stevens 1946), and comparison means establishing an ordering relation **between scalar values**.

As illustrated in (1) and (2), intuitively, two entities (here me and my cat) can be compared along different scales. In (1a/2a), comparison is conducted between height values, while in (1b/2b), comparison is between weight values.[1]

(1) a. I am taller than my cat (is). **Comparing heights**

b. I am heavier than my cat (is). **Comparing weights**

(2) **Comparatives in (Mandarin, same below) Chinese**

a. wǒ bǐ wǒ-de māo gāo.
1SG STDD 1SG-POSS cat tall(er)
'I am taller than my cat.' **Comparing heights**

b. wǒ bǐ wǒ-de māo zhòng.
1SG STDD 1SG-POSS cat heavy(er)
'I am heavier than my cat.' **Comparing weights**

1. Special abbreviations used in the gloss: COP=copula, LNK=linker, POSS=possession marker, Q=interrogative marker, RELZ=relativizer, STDD=standard marker.

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Cross-linguistically, **comparatives** are often used to encode the meaning of a comparison that results in **strict inequality** relation (i.e., '>').

As illustrated by (3), an English comparative contains these 5 elements (see e.g., Ultan 1972, Stassen 1985): **(comparison) target** (here *Lucy*), **(comparison) standard** (here *Mary*('s height)), **gradable adjective** (here *tall*), **comparative morpheme** *-er/more*, and **standard marker** *than*. A **numerical differential** (here *2 inches*) is optional.

(3) Lucy (target) is (2 inches) (differential) tall (gradable adjective) -er (comparative morpheme) than (standard marker) Mary (standard) .

Intriguingly, human languages demonstrate great variation in comparatives. One much-discussed variation is whether comparatives require the use of morphemes like English *-er/more* (see e.g., Klein 1980, Bobaljik 2012).

As illustrated in (4–6), in languages like English and French, the morpho-syntax of the **positive** and **comparative** use of gradable adjectives (e.g., *tall*, *many*, French *grand*) is distinguished by whether a comparative morpheme (e.g., *-er/more*, French *plus*) is **obligatorily required**. In the positive use (4a–6a), the presence of a comparative morpheme is forbidden, while in comparatives (4b–6b), omitting this comparative morpheme would lead to ungrammaticality.

(4) a. Lucy is tall. **Positive**: *tall*

b. Lucy is (1 inch) taller than Mary is. **Comparative**: *tall+er*

(5) a. Lucy has many books. **Positive**: *many*

b. Lucy has (three) more books than Mary does. **Comparative**: *many+er*

(6) **French**

a. Jean est grand.
John be.3SG tall
'John is tall.' **Positive**: *grand* 'tall'

b. Jean est (trois centimetres) plus grand que Pierre.
John be.3SG three cm more tall what Peter.
'John is (3 cm) taller than Peter.' **Comparative**: *plus+grand* 'taller'

In contrast, as illustrated in (7) and (8), languages like Chinese and Japanese apparently lack comparative morphemes like English *-er/more*. For a gradable adjective (e.g., Chinese *gāo* 'tall(er)', Japanese *taka-* 'tall(er)'), the same form is adopted for both the positive and comparative use.[2]

(7) **Chinese**

a. Lèlè gāo ma?
Lèlè tall Q
'Is Lèlè tall?' **Positive**: *gāo* 'tall'

b. Lèlè bǐ Mǐmǐ gāo (wǔ límǐ) ma?
Lèlè STDD Mǐmǐ taller five cm Q
'Is Lèlè (5 cm) taller than Mǐmǐ?' **Comparative**: *gāo* 'taller'

(8) **Japanese**

a. Rika-wa (se-ga) taka-i.
Rika-TOP back-NOM tall-PRES
'Rika is tall.' **Positive**: *taka-* 'tall'

b. Rika-wa Makoto-yori (go senti se-ga) taka-i.
Rika-TOP Makoto-STDD five cm back-NOM tall-PRES
'Rika is (5 cm) taller than Makoto.' **Comparative**: *taka-* 'taller'

Starting with this empirical, theory-neutral observation on the morpho-syntax of cross-linguistic comparatives (i.e., whether the presence of *-er/more*-like morphemes is required), this paper provides a novel perspective on the universals and variation underlying comparison. In a nutshell, we propose that:

(9) a. **Comparison is universally conducted by gradable adjectives**, rather than morphemes like *-er/more* (cf. the canonical view in the formal semantics literature on English comparatives, see §2 for details).

b. Languages with vs. without *-er*-like morphemes (e.g., English vs. Chinese) differ with regard to whether the lexical semantics of gradable adjectives encodes **non-strict** vs. **strict inequalities** (i.e., '$\geq$' vs. '$>$').

2. In (7), we use a minimal pair of yes/no questions to illustrate the positive and comparative use of gradable adjective *gāo* 'tall(er)', because in Chinese, a declarative positive use (e.g., *Lucy is tall*) involves additional complication, which is orthogonal to this paper (see e.g., Zhang 2023 (Sections 2.1 and 2.2) and Grano 2012 for discussion).

c. **Morphemes like *-er/more* are additive particles**, and cross-linguistically, different types of seemingly comparative morphemes contribute to achieve different kinds of additivity effects.

In particular, we highlight two kinds of comparative morphemes (or rather additive particles), **English *-er/more*** and **Chinese *gèng***, and argue that

(10) a. **English *-er/more* is similar to *another***, denoting a positive value, **an increase** anaphoric to a contextually salient base item.

b. **Chinese *gèng* is similar to *moreover***, updating a contextual threshold for the positive use of gradable adjectives.

We highlight English *-er*/more and Chinese *gèng* for discussion mainly because, in the existing literature, they are among the morphemes often considered responsible for performing comparison. We dispel these exsiting views and argue that instead of performing comparison, these morphemes contribute additivity effects, in different ways. It is likely that cross-linguistically, there are other morphemes that achieve other kinds of additivity effects in expressions of comparison (e.g., see §5.3 for discussion on Chinese *hái* vs. Chinese *gèng*). The current paper does not aim to be exhaustive, but rather (i) initiate a new perspective on addressing the universals and variation underlying comparatives and (ii) connect comparatives with our existing understanding on additivity-related phenomena. Along the discussion, we try to be theory-neutral and make our analysis not overly technical. Many formal details as well as detailed investigation on more cross-linguistic phenomena will be for future work.

The rest of the paper is organized as follows. §2 presents challenges to the canonical view, paving the background for the current proposal. §3 presents our proposal: comparison is conducted by gradable adjectives. §4 analyzes English data, showing the division of labor between gradable adjectives and *-er/more*: the latter works as an additive particle similar to *another*, denoting an increase and demonstrating anaphoricity. §5 extends the empirical scope to cross-linguistic phenomena, addressing what kind of additivity effects can appear in *-er*-less languages like Chinese. We analyze Chinese *gèng* as an additive particle similar to *moreover*, updating a contextual threshold for the positive use of gradable adjectives. §6 discusses further theoretical implications and concludes.

2 The canonical view and challenges

Within the canonical view on English comparatives (see §2.1), comparison, i.e., establishing the ordering relation '>', is contributed by morpheme *-er/more*. We argue that this view on *-er/more* meets challenges both within and across languages (see §2.2). The discussion suggests that cross-linguistically, comparison should rather be conducted by gradable adjectives.

2.1 The canonical analysis on English comparatives

Within formal semantics, the canonical analysis of English comparatives (see e.g., von Stechow 1984, Heim 1985, Kennedy 1999, Schwarzschild 2008, Beck 2011, among others) is built on these assumptions:

(11) a. A **gradable adjective** conveys the meaning of a scale, a totally ordered set of degrees (which are of type d).

b. Comparison is between the measurements of the **target** and the **standard** along a scale, i.e., between degrees, not between entities.

c. **Comparative morpheme** *-er/more* performs comparison by expressing the relation '>' between two degrees.

As shown in (12), the meaning of a gradable adjective contains a **measure function**, mapping an entity to a degree (see (12a) and Kennedy 1999). Usually an operator '$\geq$' is also included, making $[\![\text{tall}]\!]$ a relation between a degree d and an entity x (see (12b) and Cresswell 1976, Hellan 1981, von Stechow 1984, Heim 1985).[3]

(12) a. $[\![\text{tall}]\!]_{\langle ed\rangle} \stackrel{\text{def}}{=} \lambda x.\text{HEIGHT}(x)$ a measure function of type $\langle ed\rangle$

b. $[\![\text{tall}]\!]_{\langle d,et\rangle} \stackrel{\text{def}}{=} \lambda d.\lambda x.\text{HEIGHT}(x) \geq d$ a relation between d and x
$\rightsquigarrow$ the height of x reaches the degree d, i.e., x is tall to degree d

Based on (12b), the **positive use** (see (13)) and **measure construction** (see (14)) of a gradable adjective can be immediately accounted for.

In (13) and (14), $[\![\text{tall}]\!]$ takes two arguments: a degree argument (here POS in (13) and $5'8''$ in (14)) and an entity argument (here Lucy).[4]

3. We can use a type shifter to bridge (12a) and (12b): $\lambda G_{\langle ed\rangle}.\lambda d.\lambda x.G(x) \geq d$.

(13) [[Lucy is POS tall]] ⇔ HEIGHT(Lucy) ≥ POS **Positive use**
(i.e., the height measurement of Lucy reaches the threshold of being tall.)
(POS: a silent, context-dependent free variable that represents the threshold of being tall, see Bartsch & Vennemann 1972, Cresswell 1976, von Stechow 1984, Kennedy 1999)

(14) [[Lucy is 5 feet 8 inches tall]] ⇔ HEIGHT(Lucy) ≥ 5′8″ **Measure**
(i.e., the height measurement of Lucy reaches 5′8″.)

The meaning of a **degree question** (see (15)) is naturally built on degree abstraction. (15) means the set of degrees reached by the height of Lucy (see Hausser & Zaefferer 1978, Hausser 1983's categorial approach to questions).

(15) [[how tall is Lucy]] ⇔ λd.HEIGHT(Lucy) ≥ d **Degree question**
(This set is equivalent to $\{d \mid d \leq \text{HEIGHT(Lucy)}\}$)

Inspired by subcomparatives like (16), the canonical analysis of comparatives assumes an elided gradable adjective in the *than*-clause (see Bresnan 1973, Bresnan 1975, Chomsky 1977).[5] As shown in the LF in (17), the derivation of a comparative involves degree abstraction in both the matrix and the *than*-clause.

(16) The bathtub is wider than the door is tall. **Subcomparative**

(17) [[Lucy is tall**er** than Mary is ~~tall~~]] ⇔ HEIGHT(Lucy) > HEIGHT(Mary)
LF: [-er [λd.Mary is d-tall]] [$\lambda d'$.Lucy is d'-tall]

Eventually, comparative morpheme *-er* conducts comparison (see (18)). The core semantics of *-er* is thus a '>' relation between two degrees. To take care of semantic composition under the canonical analysis, *-er* is often defined as a relation between two sets of degrees, comparing the largest degree of each set (see (18a) and (18b) for two slightly different implementations).[6]

4. The use of capital letters is to indicate lack of phonology, following Kayne (2005b).
5. Here (17) is a **clausal** comparatives, which is arguably distinct from **phrasal** comparatives (see e.g., Larson 1988, Schwarzchild & Wilkinson 2002 for more discussion).
6. Adjustments are needed for comparatives with a numerical differential, e.g.,

(i) [[-er]] $\stackrel{\text{def}}{=} \lambda d.\lambda D_1.\lambda D_2.\text{MAX}(D_2) \geq \text{MAX}(D_1) + d$
(including a differential argument d for (18a))

(18) *-er* essentially performs comparison between two degrees:
$[\![\text{-er}]\!]_{\langle d,\langle d,t\rangle\rangle} \stackrel{\text{def}}{=} \lambda d_1.\lambda d_2.d_2 > d_1$

a. $[\![\text{-er}]\!]_{\langle\langle dt\rangle,\langle dt,t\rangle\rangle} \stackrel{\text{def}}{=} \lambda D_1.\lambda D_2.\text{MAX}(D_2) > \text{MAX}(D_1)$
($\text{MAX} \stackrel{\text{def}}{=} \lambda D.\iota d[d \in D \wedge \forall d'[d' \in D \rightarrow d' \leq d]]$) (see e.g., Beck 2011)

b. $[\![\text{-er}]\!]_{\langle\langle dt\rangle,\langle dt,t\rangle\rangle} \stackrel{\text{def}}{=} \lambda D_1.\lambda D_2.\exists d[d \in D_2 \wedge d \notin D_1]$
(see e.g., Schwarzschild 2008)
(For the LF in (17) $\rightsquigarrow \exists d$ s.t. Lucy is d-tall but Mary isn't)

2.2 Challenges to the canonical view

If, as shown in the above canonical analysis of English comparatives, the semantics of *-er/more* is indeed to perform comparison (see (18)), it is puzzling how comparison is performed in *-er*-less languages like Chinese and Japanese (see (7) and (8)). Here we argue that even in *-er*-ful languages like English, comparison is performed by gradable adjectives, rather than morpheme *-er/more*.

First, although the use of *-er/more* is required in comparatives, actually all uses of gradable adjectives involve comparison, and in general, conducting comparison does not rely on the use of *-er/more*.

As illustrated in (19), these uses of gradable adjective *tall* all involve the comparison between the height of Lucy and a certain height degree, resulting in a '$\geq$' relation between degrees, but *-er/more* is not used. Thus, *-er/more* is not a necessary component for operating comparison.

(19) a. $[\![\text{Lucy is POS tall}]\!] \Leftrightarrow \text{HEIGHT}(\text{Lucy}) \geq \text{POS}$ **Positive use** (= (13))

b. $[\![\text{Lucy is } 5'8'' \text{ inches tall}]\!] \Leftrightarrow \text{HEIGHT}(\text{Lucy}) \geq 5'8''$
Measure (= (14))

c. $[\![\text{how tall is Lucy}]\!] \Leftrightarrow \lambda d.\text{HEIGHT}(\text{Lucy}) \geq d$
Degree Question (= (15))

d. $[\![\text{Lucy is as tall as Bill (is)}]\!] \Leftrightarrow \text{HEIGHT}(\text{Lucy}) \geq \text{HEIGHT}(\text{Bill})$
Equative

Second, intuitively, the meaning distinction between the presence vs. absence of *-er/more* is not about whether there is a comparison, but often about (i) what constitutes the comparison standard and/or (ii) the size of the differential.

In the minimal pair in (20), without the use of *-er*, (20a) means that Lucy's height is compared with POS, a context-dependent threshold of being tall, while

with the use of *-er*, (20b) means that Lucy's height is compared with Mary's. Thus (20a) and (20b) differ with regard to what the comparison standard is.

(20) a. Mary is not tall. Lucy is POS tall. $\rightsquigarrow$ HEIGHT(Lucy) $\geq$ POS

b. Mary is not tall. Lucy is taller. $\rightsquigarrow$ HEIGHT(Lucy) $\geq$ HEIGHT(Mary)

Then in the minimal pair in (21), as addressed in the literature on crisp judgment (see Kennedy 2007), with the use of *-er*, (21b) is true under any scenario where Lucy's height exceeds Mary's, i.e., (21b) has the same meaning as (17). However, without using *-er*, (21a) is true only in scenarios where Lucy 'stands out' enough, i.e., Lucy's height exceeds Mary's by a large enough difference.

Intuitively, in interpreting (21a), we also feel that Mary's height plays the role of an 'anchor' or **comparison class**, having an influence on the value of the context-dependent POS, which Lucy's height is compared to (see (21a-i) vs. (21a-ii)). Thus we feel that (21a) and (21b) differ with regard to both comparison standard and differential.

(21) a. Compared to Mary, Lucy is tall. **Implicit comparison**
(i) Compared to 2-year-old toddlers, Lucy is tall.
(ii) (Even) compared to professional basketball players, Lucy is tall.

b. Compared to Mary, Lucy is taller. **Explicit comparison**
(= (17): Lucy is taller than Mary is)

Third, more fundamentally, gradable adjectives contribute the meaning of a scale, i.e., a totally ordered set of degrees, and this ordering is the base of comparison.

Cross-linguistically, gradable adjectives have antonyms, indicating that in addition to mapping an entity to a scalar value (e.g., a degree) along a scale, the lexical semantics of gradable adjectives also includes a component reflecting the direction of comparison.

As illustrated in (22), *tall* and *short* are antonyms in English, thus ⟦tall⟧ and ⟦short⟧ basically share the same measure function, i.e., mapping the same entity x to the same scalar value, HEIGHT(x). However, the lexical meaning of ⟦tall⟧ and ⟦short⟧ involves different directions, represented as different comparison operators in (22a) and (22b): '$\geq$' vs. '$\leq$'.

(22) a. $[\![\text{tall}]\!]_{\langle d,et\rangle} \stackrel{\text{def}}{=} \lambda d.\lambda x.\text{HEIGHT}(x) \geq d$ (= (12b))

b. $[\![\text{short}]\!]_{\langle d,et\rangle} \stackrel{\text{def}}{=} \lambda d.\lambda x.\text{HEIGHT}(x) \leq d$

Overall, the above discussion suggests that (i) performing comparison does not necessarily involve the use of *-er*, (ii) the use of *-er* is more relevant to the interpretation of standard or differential, and (iii) the meaning of gradable adjectives already includes comparison operators which are direction-sensitive. Thus, most naturally, comparison should be performed by gradable adjectives, not morphemes like *-er*.

In this sense, various uses of gradable adjectives are fundamentally making comparison. Across languages and within one language, various gradable-ajective-based constructions differ rather with regard to the parameters of (i) comparison standard and (ii) differential. Below, we present detailed formal implementation of this unfied perspective on comparison, along with the discussion on how English *-er*/*more* and Chinese *gèng* affect the differential and standard.

3 Proposal: gradable adjectives and comparison

We follow Zhang & Ling (2021) to present a unified perspective on comparison, using **interval subtraction**, instead of **inequalities between two degrees**, to characterize comparison. §3.1 addresses how the meaning of gradable adjectives encodes comparison, and then §3.2 –§3.6 demonstrate the meaning derivation of various gradable-adjective-based constructions in English.[7]

3.1 The semantics of gradable adjectives

As shown in (24/25) and illustrated in Fig. 1 and Fig. 2, the semantics of gradable adjective *tall*/*short* can be characterized as a subtraction relation among three scalar values, which are all represented as **intervals** (of type $\langle dt\rangle$), i.e., convex sets of degrees (of type d):[8]

7. The current paper is distinct from Zhang & Ling (2021) in two aspects. First, we explicitly encode the parameters of comparison standard and differential in the semantics of gradable adjectives. Second, we address the direction difference between *tall* and *short*.

8. A totally ordered set P is convex iff for any elements a and b in the set (suppose $a \leq b$), any element x such that $a \leq x \leq b$ is also in the set P. Thus intervals can be written with their upper and lower bounds: square brackets '[' and ']' mean **closed** lower and upper bounds, and round parentheses '(' and ')' mean **open** lower and upper bounds. E.g.,

(i) $\{x \mid I_{\min} \leq x \leq I_{\max}\} = [I_{\min}, I_{\max}]$ A left- and right-closed interval
$\{x \mid I_{\min} < x \leq I_{\max}\} = (I_{\min}, I_{\max}]$ A left-open and right-closed interval

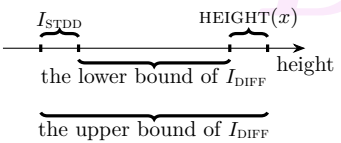

Fig. 1: The meaning of *tall* (see (24))

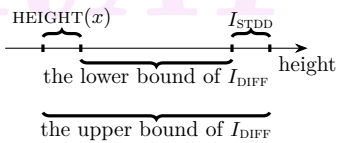

Fig. 2: The meaning of *short* (see (25))

(23) a. the height measurement of comparison target, x: $\text{HEIGHT}_{\langle e,dt\rangle}(x)$

b. the interval standing for the comparison standard: I_{STDD}

c. the interval standing for the distance between the above two: I_{DIFF}.
(i) The **lower bound** of I_{DIFF} is the **minimal difference**
(ii) The **upper bound** of I_{DIFF} is the **maximal difference**

(24) $[\![\text{tall}]\!] \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\lambda I_{\text{STDD}}.\lambda x.\underbrace{I_{\text{DIFF}} \subseteq [0,+\infty)}_{\text{non-negative presupposition (cf. (70))}} \text{HEIGHT}(x) \subseteq \iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$

(i.e., the height of x is compared to a value not higher than $\text{HEIGHT}(x)$)

$\{x \mid I_{\min} \leq x < I_{\max}\} = [I_{\min}, I_{\max})$ A left-closed and right-open interval
$\{x \mid I_{\min} < x < I_{\max}\} = (I_{\min}, I_{\max})$ A left- and right-open interval

A singleton set like $\{x \mid x = 3''\}$ can be written as $[3'', 3'']$. We write positive and negative infinity as '$+\infty$' and '$-\infty$'. Thus '$\text{HEIGHT}(x) \subseteq (-\infty, d^c_{\text{POS}})$' means that the height of x does not reach the threshold degree d^c_{POS}. Although in our actual world, somebody's height cannot be a value below zero, it is not our concern at this moment.

The interval subtraction between two intervals I_1 and I_2 results in the largest range of possible differences between any two points in I_1 and I_2:

(ii) $\underbrace{[y_1, y_2]}_{\textbf{minuend: target's measurement}} - \underbrace{[x_1, x_2]}_{\textbf{subtrahend: standard}} = \underbrace{[y_1 - x_2, y_2 - x_1]}_{\textbf{difference: differential}}$

Thus, given the subtrahend $[a, b]$ and the difference $[c, d]$,

(iii) Minuend $= [b + c, a + d]$ (defined when $b + c \leq a + d$)

Given the minuend $[a, b]$ and the difference $[c, d]$,

(iv) Subtrahend $= [b - d, a - c]$ (defined when $b - d \leq a - c$)

See Moore (1979) for details on intervals and interval arithmetic.

(25) $[\![\text{short}]\!] \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\lambda I_{\text{STDD}}.\lambda x.\underbrace{I_{\text{DIFF}} \subseteq [0,+\infty)}_{\text{non-negative presupposition (cf. (71))}} \text{HGHT}(x) \subseteq \iota I[I_{\text{STDD}} - I = I_{\text{DIFF}}]$

(i.e., the height of x is compared to a value not lower than HEIGHT(x))

The lexical semantics in (24/25) is distinct from the canonical analysis (see (12b), repeated here as (26)) mainly in three aspects.

(26) $[\![\text{tall}]\!]_{\langle d,et\rangle} \stackrel{\text{def}}{=} \lambda d.\lambda x.\text{HEIGHT}(x) \geq d$ (= (12b))

First, the canonical analysis in (26) contains only one degree argument, but (24/25) contains **two scalar-value arguments**: I_{DIFF} and I_{STDD}. By explicitly encoding the scalar values standing for (i) the differential and (ii) the standard in the semantics of gradable adjectives, the current analysis shows more clearly the details of the operation of comparison, helping reason about how differentials and standards contribute to comparison and get further modified or restricted.

Second, the canonical analysis in (26) uses inequality to represent comparison, while in (24/25), comparison is represented by **interval subtraction**. This is related to the previous aspect. Subtraction enables to characterize the relation among three scalar values represented as intervals (i.e., HEIGHT(x), I_{STDD}, and I_{DIFF} in (24/25)), instead of two degrees (i.e., HEIGHT(x) and d in (26)).

Third, the canonical analysis uses degree semantics, while the current proposal follows Zhang & Ling (2021) and adopts **interval semantics**. Degrees (of type d) are pointed elements on a scale, while intervals are convex sets of degrees. Thus, intervals represent scalar values in a more generalized way, characterizing both pointed, precise values and not-very-precise values. Human languages naturally support the comparison between not-very-precise values and motivate the use of interval semantics. E.g.,

(27) Lucy is a bit taller than every boy is.
$\rightsquigarrow$ HEIGHT(Lucy) is compared with a range of boys' heights

A pair of antonyms (e.g., [[tall]] vs. [[short]]) differ with regard to the direction of comparison/subtraction. Intuitively, for [[tall]] (see (24) and Fig. 1), HEIGHT(x) is compared with a standard interval I_{STDD} lower than (or equal to) HEIGHT(x) along the scale, while for [[short]] (see (25) and Fig. 2), HEIGHT(x) is compared with a standard interval I_{STDD} above (or equal to) HEIGHT(x).

It is worth noting that in (24) and (25), the non-negative presupposition for the difference (i.e., $I_{\text{IDFF}} \subseteq [0,+\infty)$) means that comparison expressed by English gradable adjectives corresponds to a **non-strict inequality**. E.g., [[tall]] and [[short]] essentially address to what extent HEIGHT(x) **occurs at or is above/below** the standard I_{STDD} (cf. Chinese gradable adjectives, see §5.1).

Another thing worth noting is that, as shown in Fig. 1 and 2, HEIGHT(x) and I_{STDD} are positions along the same scale (here a **scale of height**). However, I_{DIFF} is conceptually distinct: it is a distance between positions, or in other words, a value along a **scale of height differences**.

This is also evidenced by examples like (28). The expression *o'clock* is used to mark degree **positions** along a timeline, while units like *hour* are used to measure **differences/distances** between time positions.

(28) She arrived at 10 o'clock, exactly 1 hour earlier than scheduled.

a. The measurement of target (her actual arrival): $[10:00, 10:00]$

b. I_{STDD}: the scheduled arrival time, i.e., $[11:00, 11:00]$

c. I_{DIFF}: [1h, 1h]

The Chinese data in (29) also supports the claim that I_{DIFF} is conceptually different. To form a question on **the position along a timeline**, adjective *zǎo* 'early' is used, as in (29a).[9] In contrast, if the question is about **the time difference**, adjective *jiǔ* 'long' is used, as in (29b). Such phenomena are not unexpected, given that there is a conceptual distinction between I_{DIFF} and I_{STDD}: I_{DIFF} denotes temporal differences, while I_{STDD} and the actual arrival time denote positions along the timeline (see Xiang 2005 for a similar view).

(29) a. Tā dào-de duó **zǎo**?
3SG arrive-LNK how-much early
'How early did she arrive?'

b. Tā dào-de (bǐ yùjì) zǎo (le) duó **jiǔ**?
3SG arrive-LNK STDD expected early ASP how-much long
'By how long did she arrive earlier (than expected)?'

As summarized in (30), various uses of gradable adjectives all express comparison, but differ with regard to what serve as the two scalar-value arguments, i.e., I_{DIFF} and I_{STDD}. We present more details in §3.2–§3.6.

9. The *wh*-word for degree in Chinese is *duó*/*duō*, which is segmentally identical to the adjective *duō* 'many/much'. Arguably *duó*/*duō* modifies the adjective indirectly with a silent NUMBER/AMOUNT mediating in between (see Kayne 2005a).

(30) **Various uses of gradable adjectives in English**

	I_{STDD}	I_{DIFF}
Positive use (see §3.2)	**Contextual threshold:** $[d^c_{\text{POS}}, d^c_{\text{POS}}]$	$[0, +\infty)$ **(or further restricted by a modifier like *very*)**
Measure constructions (see §3.3)	**Absolute zero point:** $[0, 0]$	**restricted by a measure phrase**
Degree questions (see §3.4)	**Contextual threshold or absolute zero point**	**(interval abstraction)**
Equatives (see §3.5)	**Measurement of the standard**	$[0, +\infty)$
Comparatives (see §3.6)	**Measurement of the standard**	$[\![\text{-er}]\!]_{\langle dt \rangle} : (0, +\infty)$ **(or further restricted by a numerical differential)**

3.2 The semantics of the positive use

The positive use addresses a comparison with a context-dependent threshold. As illustrated in (31–34), for the positive use of gradable adjectives *tall*/*short*, (i) the differential argument I_{DIFF} is an unspecified, non-negative interval that stands for the range of height difference, while (ii) the standard argument I_{STDD} is a context-dependent threshold of being tall or short.

(31) $[\![\text{Lucy is POS tall}]\!] \Leftrightarrow \textsc{height}(\text{Lucy}) \subseteq \iota I[I - \underbrace{[d^c_{\text{POS}}, d^c_{\text{POS}}]}_{I_{\text{STDD}}} = \underbrace{[0, +\infty)}_{I_{\text{DIFF}}}]$

$\Leftrightarrow \textsc{height}(\text{Lucy}) \subseteq [d^c_{\text{POS}}, +\infty)$

(i.e., the height of Lucy reaches the contextual threshold of being tall)

(32) $[\![\text{Lucy is not POS tall}]\!] \Leftrightarrow [\![\text{not}]\!][\![\text{Lucy is POS tall}]\!]$

$\Leftrightarrow \textsc{height}(\text{Lucy}) \subseteq (-\infty, d^c_{\text{POS}})$

(i.e., the height of Lucy doesn't reach the threshold of being tall)

(33) $[\![\text{Chloe is POS short}]\!] \Leftrightarrow \textsc{height}(\text{Chloe}) \subseteq \iota I[[d^c_{\text{POS}'}, d^c_{\text{POS}'}] - I = [0, +\infty)]$

$\Leftrightarrow \textsc{height}(\text{Chloe}) \subseteq (-\infty, d^c_{\text{POS}'}]$

(i.e., Chloe's height is the same as or below the threshold of being short)

(34) $[\![$Chloe is not POS short$]\!] \Leftrightarrow [\![not]\!][\![$Chloe is POS short$]\!]$
$\Leftrightarrow \textsc{height}(\text{Chloe}) \subseteq (d^c_{\text{POS}'}, +\infty)$
(i.e., the height of Chloe is above the contextual threshold of being short)

Of course, under a given context, the threshold of being short and the threshold of being tall are usually different, as evidenced by sentences like (35):

(35) $[\![$Mary is neither POS_1 tall nor POS_2 short$]\!]$
$\Leftrightarrow \underbrace{\textsc{height}(\text{Mary}) \subseteq (d^c_{\text{POS}_2}, +\infty)}_{[\![\text{not POS}_2 \text{ short}]\!]} \wedge \underbrace{\textsc{height}(\text{Mary}) \subseteq (-\infty, d^c_{\text{POS}_1})}_{[\![\text{not POS}_1 \text{ tall}]\!]}$
$\Leftrightarrow \textsc{height}(\text{Mary}) \subseteq (d^c_{\text{POS}_2}, d^c_{\text{POS}_1})$

In the positive use of gradable adjectives, as illustrated in (37) and (38), degree modifiers like *very*, *quite*, *a bit*, and *extremely* can be included to further restrict the range of I_{DIFF} (see (36)), i.e., to what extent the measurement of the target is above (see (37)) or below (see (38)) the contextual threshold d^c_{POS}.

In this sense, I_{DIFF}, as a scalar value on a scale of height differences (not a scale of heights!), can further undergo measurement and comparison along this scale of differences. In (37) and (38), $d^c_{\text{DIFF-POS}}$ and $d^c_{\text{DIFF-POS}}{}'$ mean contextual thresholds of being large or small along a scale of height differences.[10]

(36) Degree modifiers like $[\![\text{very}]\!]_{\langle dt,dt\rangle}$ take an interval as input and return a more restricted one (by set intersection). E.g., $[\![$very$]\!]$ takes $[0, +\infty)$ as input and returns one with a higher lower bound, $[d', +\infty)$ (here $d' > 0$).

10. According to the canonical analysis, e.g., Kennedy and McNally (2005a), Section 6.2: 'Roughly speaking, the difference between, for example, *expensive* and *very expensive* is that the latter denotes a property whose meaning is just like the former's, except that **the relative standard is raised by some amount**'. The current analysis yields the same truth condition as the canonical analysis, but the effect of including a degree modifier like *very* is to restrict I_{DIFF}, rather than to raise the value of the standard d_{POS}.

We believe that conceptually, the current analysis is advantageous at the discourse level. E.g., for (i), it is reasonable to assume that the height of every girl is compared to the same threshold of being short.

(i) Q: How short are the girls? $\rightsquigarrow$ For every girl x, compare $\textsc{height}(x)$ with d^c_{POS}
A: Lucy is short. Jessica is very short. Mary is also a bit short.

(37) a. ⟦Jessica is very POS tall⟧
$\Leftrightarrow$ HEIGHT(Jessica) $\subseteq \iota I[I - [d^c_{\text{POS}}, d^c_{\text{POS}}] = [d^c_{\text{DIFF-POS}}, +\infty)]$
$\Leftrightarrow$ HEIGHT(Jessica) $\subseteq [d^c_{\text{POS}} + d^c_{\text{DIFF-POS}}, +\infty)$
(i.e., (i) Jessica's height reaches the threshold of being tall, d^c_{POS}, and (ii) the difference between HEIGHT(Jessica) and d^c_{POS} is large enough, reaching the threshold $d^c_{\text{DIFF-POS}}$ along a scale of height differences)

b. ⟦Jessica is quite POS tall⟧
$\Leftrightarrow$ HEIGHT(Jessica) $\subseteq \iota I[I - [d^c_{\text{POS}}, d^c_{\text{POS}}] = \underbrace{[d^c_{\text{DIFF-POS}}, {d^c_{\text{DIFF-POS}}}']}_{\substack{\text{i.e., } I_{\text{DIFF}} \text{ is within} \\ \text{a range of height differences}}}]$
$\Leftrightarrow$ HEIGHT(Jessica) $\subseteq [d^c_{\text{POS}} + d^c_{\text{DIFF-POS}}, {d^c_{\text{POS}} + d^c_{\text{DIFF-POS}}}']$

(38) a. ⟦Betty is a bit POS short⟧
$\Leftrightarrow$ HEIGHT(Betty) $\subseteq \iota I[[d^c_{\text{POS}}, d^c_{\text{POS}}] - I = \underbrace{[0, d^c_{\text{DIFF-POS}}]}_{\substack{\text{i.e., the upper bound of } I_{\text{DIFF}} \\ \text{does not exceed } d^c_{\text{DIFF-POS}}}}$
$\Leftrightarrow$ HEIGHT(Betty) $\subseteq [d^c_{\text{POS}} - d^c_{\text{DIFF-POS}}, d^c_{\text{POS}}]$

b. ⟦Betty is extremely POS short⟧
$\Leftrightarrow$ HEIGHT(Betty) $\subseteq \iota I[[d^c_{\text{POS}}, d^c_{\text{POS}}] - I = \underbrace{[d^c_{\text{DIFF-POS}}, +\infty)}_{\substack{\text{i.e., the lower bound of } I_{\text{DIFF}} \text{ is} \\ \text{a very high threshold}}}$
$\Leftrightarrow$ HEIGHT(Betty) $\subseteq (-\infty, d^c_{\text{POS}} - d^c_{\text{DIFF-POS}}]$

3.3 The semantics of the measurement construction

Measurement constructions address a comparison with the absolute zero point.

As illustrated in (39), in a measurement construction, (i) the differential argument I_{DIFF} is restricted by a measure phrase (here *5 feet 8 inches*), while (ii) the standard argument I_{STDD} is the **absolute zero point** along a scale.[11]

In natural language, bare numerals can have (i) an 'at least' interpretation and (ii) a strengthened 'exactly' interpretation (see Spector 2013 for a review), projecting to the two readings of measurement sentences (see (39a) and (39b)).

11. According to their formal properties and what mathematical operations they support, scales can be divided into four levels: **nominal scales**, **ordinal scales** (equipped with an ordering), **interval scales** (equipped with an ordering and a unit that supports the measurement of differences), and **ratio scales** (equipped with an ordering, a unit, and an absolute zero point) (see Stevens 1946). Obviously, measurement constructions require the existence of a zero point, i.e., a ratio scale. See Sassoon (2010) and Zhang & Ling (2021) for discussion on how this 4-level distinction of scales is relevant to natural language.

(39) ⟦Lucy is 5 feet 8 inches tall⟧

a. 'At least' interpretation of *5 feet 8 inches*:
⟦39⟧ ⇔ HEIGHT(Lucy) ⊆ $\iota I[I - [0,0] = [5'8'', +\infty) \cap [0, +\infty)]]$
⇔ HEIGHT(Lucy) ⊆ $[5'8'', +\infty)$

b. 'Exactly' interpretation of *5 feet 8 inches*:
⟦39⟧ ⇔ HEIGHT(Lucy) ⊆ $\iota I[I - [0,0] = [5'8'', 5'8''] \cap [0, +\infty)]]$
⇔ HEIGHT(Lucy) ⊆ $[5'8'', 5'8'']$

As illustrated in (40), for a gradable adjective like *short*, the subtraction between the standard I_{STDD} (which is $[0,0]$) and the measurement of target (here HEIGHT(Chloe), e.g., $[5', 5']$) would result in a negative value, violating the non-negative presupposition of I_{DIFF} and leading to ungrammaticality.

(40)# Chloe is 5 feet short. $[0,0] -$ HEIGHT(Chloe) is negative (see Fig. 2)
Context: Chloe's measurement falls at the position $[5', 5']$ on a height scale.

3.4 The semantics of degree questions

Degree questions address a comparison relative to a reference position, typically a zero point or a context-dependent threshold. Intuitively, we seek an answer that addresses the **position** of the target on a scale (e.g., *how early did she arrive* in (29a)) or the **distance** between the target's position and the reference position (e.g., *by how long did she arrive earlier* in (29b)).

Addressing the distance is straightforward under the current proposal. As illustrated in (41–42), (i) the differential I_{DIFF} is abstracted to form a degree question, while (ii) the standard argument I_{STDD} can be either the absolute zero point along a scale (see (41a)) or the context-dependent threshold of being tall/short (see (41b/42)). Thus a degree question essentially denotes a set of intervals: a set of distances relative to a reference (see Hausser & Zaefferer 1978, Hausser 1983 for categorial approaches to questions).

(41) ⟦How tall is Lucy⟧ ⇔ λI_{DIFF}.HEIGHT(Lucy) ⊆ $\iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$

a. I_{STDD} is equal to $[0,0]$: **No evaluativity**
⟦41⟧ ⇔ λI_{DIFF}.HEIGHT(Lucy) ⊆ $\iota I[I - [0,0] = I_{\text{DIFF}}]$

b. I_{STDD} is equal to $[d^c_{\text{POS}}, d^c_{\text{POS}}]$: **Evaluativity**: ⇝ Lucy is tall
⟦41⟧ ⇔ λI_{DIFF}.HEIGHT(Lucy) ⊆ $\iota I[I - [d^c_{\text{POS}}, d^c_{\text{POS}}] = I_{\text{DIFF}}]$
(i.e., to what extent is Lucy above the threshold of being tall)

(42) $[\![\text{How short is Chloe}]\!] \Leftrightarrow \lambda I_{\text{DIFF}}.\text{HEIGHT}(\text{Chloe}) \subseteq \iota I[I_{\text{STDD}} - I = I_{\text{DIFF}}]$
I_{STDD} is equal to $[d^c_{\text{POS}}, d^c_{\text{POS}}]$: **Evaluativity**: $\rightsquigarrow$ Chloe is short
$[\![42]\!] \Leftrightarrow \lambda I_{\text{DIFF}}.\text{HEIGHT}(\text{Chloe}) \subseteq \iota I[[d^c_{\text{POS}}, d^c_{\text{POS}}] - I = I_{\text{DIFF}}]$
(i.e., to what extent is Chloe below the threshold of being short)

For a degree question based on *tall*, when I_{STDD} is the zero point (see (41a)), there is no evaluativity in interpreting the degree question. E.g., for (41a), Lucy is not necessarily tall, because HEIGHT(Lucy) does not necessarily reach d^c_{POS}.

However, when I_{STDD} is the context-dependent threshold of being tall/short (see (41b/42)), there is evaluativity in interpreting the degree question. E.g., in interpreting (41b), since I_{DIFF} is presupposed to be non-negative, HEIGHT(Lucy) must reach the threshold d^c_{POS}, i.e., Lucy is tall. Similarly, as illustrated in (42), there is evaluativity in interpreting *how short is Chloe*, i.e., Chloe is short, and this degree question addresses to what extent Chloe is short.

Answerhood operator $\mathbf{Ans}_{\text{DIFF}}$ (of type $\langle\langle dt, t\rangle, dt\rangle$, see (43)) takes a set of intervals as input and returns the most informative one (see Dayal 1996 on the notion of answerhood). When $\mathbf{Ans}_{\text{DIFF}}$ is applied to a degree question like (41) or (42), the most informative answer (i.e., an interval) is returned, addressing the distance between the measurement of the target (e.g., HEIGHT(Lucy) or HEIGHT(Chloe)) and the reference position (see Fig. 3).

(43) An answerhood operator $\mathbf{Ans}_{\text{DIFF}}$ is defined for a set of intervals p s.t.
$\exists I[p(I) \wedge \forall I'[[p(I') \wedge I' \neq I] \rightarrow I \subset I']]$
When defined, $\mathbf{Ans}_{\text{DIFF}} \stackrel{\text{def}}{=} \lambda p_{\langle dt,t\rangle}.\iota I[p(I) \wedge \forall I'[[p(I') \wedge I' \neq I] \rightarrow I \subset I']]$

We further define two type-shifters, **Position-M** (see (44), for gradable adjectives like *tall*) and **Position-S** (see (45), for gradable adjectives like *short*), to compute the **position of the target** from its distance away from the reference position I_{STDD} (i.e., $[0,0]$ or $[d^c_{\text{POS}}, d^c_{\text{POS}}]$, see Fig. 3).

(44) $\mathbf{Position\text{-}M} \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$ **Minuend position**
(I_{STDD} is $[0,0]$ or $[d^c_{\text{POS}}, d^c_{\text{POS}}]$) (see footnote 8: (iii))

(45) $\mathbf{Position\text{-}S} \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\iota I[I_{\text{STDD}} - I = I_{\text{DIFF}}]$ **Subtrahend position**
(I_{STDD} is $[d^c_{\text{POS}}, d^c_{\text{POS}}]$) (see footnote 8: (iv))

E.g., for (41a), *how tall is Lucy* (with $[0,0]$ as the reference position), if $\mathbf{Ans}_{\text{DIFF}}[\![(41a)]\!]$ is $[5'8'', 6']$, it means that the distance between HEIGHT(Lucy) and the zero point is between $5'8''$ and $6'$. $\mathbf{Position\text{-}M}[\mathbf{Ans}_{\text{DIFF}}[\![(41a)]\!]]$ means the position where HEIGHT(Lucy) is at along this scale of heights (see Fig. 3).

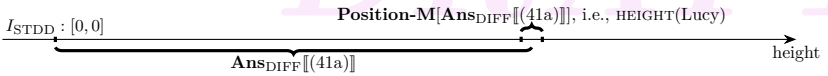

Fig. 3: Interpreting *how tall is Lucy* with the reference position at the zero point

3.5 The semantics of equatives

As illustrated in (46–47), in equatives, (i) the differential argument I_{DIFF} is a default, unspecified, non-negative interval, i.e., $[0, +\infty)$, while (ii) the standard I_{STDD} is the measurement of the comparison standard, i.e., the information in addressing 'how tall Bill is' (for (46)) or 'how short Ann is' (for (47)).

(46) [[Lucy is as tall as Bill (is) ~~tall~~]]
$\Leftrightarrow$ HEIGHT(Lucy) $\subseteq \iota I[I - \underbrace{[\![\text{as Bill is } \sout{\text{tall}}]\!]}_{I_{\text{STDD}}} = \underbrace{[0, +\infty)}_{I_{\text{DIFF}}}]$

a. [[as Bill is ~~tall~~]]: **Position-M**[**Ans**$_{\text{DIFF}}$[[how tall Bill is]]], i.e., HGHT(B)

b. [[46]] $\Leftrightarrow$ HEIGHT(Lucy) $\subseteq \iota I[I -$ HEIGHT(Bill) $= [0, +\infty)]$
$\rightsquigarrow$ The height of Lucy is equal to or above the height of Bill

(47) [[Chloe is as short as Ann (is) ~~short~~]]
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq \iota I[\underbrace{[\![\text{as Ann is } \sout{\text{short}}]\!]}_{I_{\text{STDD}}} - I = \underbrace{[0, +\infty)}_{I_{\text{DIFF}}}]$

a. [[as Ann is ~~Short~~]]: **Position-S**[**Ans**$_{\text{DIFF}}$[[how short A. is]]], i.e., HT(A)

b. [[47]] $\Leftrightarrow$ HEIGHT(Chloe) $\subseteq \iota I[$HEIGHT(Ann) $- I = [0, +\infty)]$
$\rightsquigarrow$ The height of Chloe is equal to or below the height of Ann

In (46) and (47), we assume that [[as Bill is ~~tall~~]] and [[as Ann is ~~short~~]] are embedded clauses that contain an elided gradable adjective. We follow the above recipe for degree questions and apply **Ans**$_{\text{DIFF}}$ and type-shifters **Position-M**/**Position-S**. Eventually, these embedded clauses denote the position where Bill/Ann is mapped to along a relevant scale, which further serves as the standard I_{STDD} in computing the meaning of the matrix clause (see Fleisher 2018, Fleisher 2020, Zhang & Ling 2021 for a similar view).[12]

12. It is worth noting that in the analysis of (46) and (47), with the use of type-shifters **Position-M**/**Position-S**, we consider [[as Bill is ~~tall~~]] and [[as Ann is ~~short~~]] denoting **positions along a height scale**, and thus at the matrix-clause level, comparison is conducted between parallel items, i.e., positions along a height scale.

A welcome consequence is that in interpreting equatives like (46) and (47), the (un)availability of evaluativity (e.g., we infer from (47) that both Chloe and Ann are short) corresponds to the (un)availability of evaluativity of the embedded degree questions. Degree question *how short Ann is* is evaluative, and thus (47) is evaluative. Degree question *how tall Bill is* is not necessarily evaluative (see (41a) vs. (41b)), and thus (46) is not necessarily evaluative.

3.6 The semantics of comparatives

In comparatives, (i) the differential argument I_{DIFF} is contributed by morpheme *-er/more*, a **positive (not non-negative!) interval**, which can further get restricted by a numerical differential, while (ii) the standard I_{STDD} is similar to that of equatives, i.e., a position along a relevant scale that addresses the measurement of the comparison standard (e.g., (48); see also footnote 12).

Without applying **Position-M/Position-S**, ⟦as Bill is ~~tall~~⟧ and ⟦as Ann is ~~short~~⟧) would denote rather the **distance between Bill/Ann and a certain reference position along a height scale**. As a consequence, at the matrix-clause level, comparison would be conducted between parallel items that are distances: how far the measurement of the target (here Lucy/Chloe) is away from the reference position vs. how far the comparison standard (here Bill/Ann's measurement) is away from the reference position.

(i) ⟦Lucy is as tall as Bill (is) ~~tall~~⟧
⇔ Lucy's measure (i.e., her distance from I_{REF}) $\subseteq \iota I[I - \underbrace{[\![\text{as Bill is } \sout{\text{tall}}]\!]}_{I_{\text{STDD}}} = \underbrace{[0, +\infty)}_{I_{\text{DIFF}}}]$
⟦as Bill is ~~tall~~⟧: $\textbf{Ans}_{\text{DIFF}}$⟦how tall Bill is⟧, i.e., Bill's distance away from reference position I_{REF} along a height scale

Obviously, whether (i) it's the two positions along a scale that are under comparison or (ii) it's the two distances (away from the same reference position) that are under comparison, these two distinct implementations result in the same truth condition.

The application of **Position-M/Position-S** (i.e., comparing two positions, see (46) and (47)) seems conceptually simpler, but the non-application of **Position-M/Position-S** (i.e., comparing two distances away from a reference position) is empirically motivated:

(ii) Mona is more happy than Jude is sad. (Kennedy 1999, Zhang & Ling 2021)
⇝ **Comparing two distances**: how Mona's happiness is above the threshold of being happy vs. how Jude's sadness is above the threshold of being sad

This flexibility in the meaning derivation of equatives (i.e., comparing two positions vs. comparing two distances) is also carried over to the meaning derivation of comparatives (see §3.6, where we adopt the 'comparing two positions' analysis for simplicity).

We thank Daiki Matsuoka for comments and discussion on this issue.

(48) [[than every boy is ~~tall~~]] = **Position-M** [$\mathbf{Ans}_{\text{DIFF}}$[[how tall every boy is]]]
i.e. $\iota I[\forall x[\text{boy}(x) \rightarrow \text{HEIGHT}(x) \subseteq I]]$
$\rightsquigarrow$ the most informative interval I s.t., for each boy x, $\text{HEIGHT}(x) \subseteq I$, i.e., the interval ranging from the height of the shortest boy to that of the tallest boy, which can be written as $[d_{\text{shortest}}, d_{\text{tallest}}]$

Based on the analysis of the *than*-clause in (48), (49) shows how the meaning of a comparative is composed from [[-er]] and the meaning of the *than*-clause. Eventually, (49) means that Lucy's height is above that of the tallest boy.

(49) [[Lucy is taller than every boy (is) ~~tall~~]]
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - [\![\text{than every boy is } \sout{\text{tall}}]\!] = (0, +\infty)]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - \iota I[\forall x[\text{boy}(x) \rightarrow \text{HEIGHT}(x) \subseteq I]] = (0, +\infty)]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - [d_{\text{shortest}}, d_{\text{tallest}}] = (0, +\infty)]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq (d_{\text{tallest}}, +\infty)$

The default positive interval [[-er]] can be further restricted by a numerical differential like *about 2 inches*. As illustrated in (50), the more restricted interval I_{DIFF} is $[2'' - \varepsilon, 2'' + \varepsilon]$. Thus eventually, (50) means that Lucy's height is within the interval $[d_{\text{tallest}} + 2'' - \varepsilon, d_{\text{shortest}} + 2'' + \varepsilon]$, and this interval is defined if among the boys, the tallest one does not exceed the shortest one too much. Similarly, in (51), *much* also plays the role of restricting [[-er]].

(50) [[Lucy is about 2 inches taller than every boy (is) ~~tall~~]]
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - [d_{\text{shortest}}, d_{\text{tallest}}] = \underbrace{(0, +\infty) \cap [2'' - \varepsilon, 2'' + \varepsilon]}_{I_{\text{DIFF}}:[\![\text{about 2 inches ...-er }]\!]}]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq [d_{\text{tallest}} + 2'' - \varepsilon, d_{\text{shortest}} + 2'' + \varepsilon]$
(defined when $d_{\text{tallest}} + 2'' - \varepsilon \leq d_{\text{shortest}} + 2'' + \varepsilon$)

(51) [[Lucy is much taller than every boy (is) ~~tall~~]]
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - [d_{\text{shortest}}, d_{\text{tallest}}] = \underbrace{(0, +\infty) \cap [d^{c}_{\text{DIFF-POS}}, +\infty)}_{I_{\text{DIFF}}:[\![\text{much ...-er }]\!]}]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq [d_{\text{tallest}} + d^{c}_{\text{DIFF-POS}}, +\infty)$

For *less-than* comparatives, based on our intuition that the meaning of *less tall* and *shorter* are equivalent, we propose to decompose *less* into (i) [[-er]] and (ii) an operator OPPOSITE, which reverses the direction of comparison.

As shown in (52), OPPOSITE takes a gradable adjective as input and changes the direction of comparison.

(52) $[\![\text{OPPOSITE}]\!]_{\langle\langle dt,\langle dt,et\rangle\rangle,\langle dt,\langle dt,et\rangle\rangle\rangle} \stackrel{\text{def}}{=} \lambda G_{\langle dt,\langle dt,et\rangle\rangle}.\lambda I_{\text{DIFF}}.\lambda I_{\text{STDD}}.\lambda x.$
$G\text{-DIMENSION}(x) \subseteq \iota I[I - I_{\text{STDD}} = [0,0] - I_{\text{DIFF}}]$
e.g., $\text{OPPOSITE}[\![\text{tall}]\!] = [\![\text{short}]\!]$

(53) illustrates the meaning of a *less-than* comparative. Eventually, (53) means that Lucy's height is below that of the shortest boy, i.e., Lucy is shorter than every boy is (see also (54) below).

(53) $[\![$Lucy is less tall than every boy (is) ~~tall~~$]\!]$
$\Leftrightarrow [\![$Lucy is [OPPOSITE tall] er than every boy (is) ~~tall~~$]\!]$
$\Leftrightarrow [\![$Lucy is [short]er than every boy (is) ~~tall~~$]\!]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[[d_{\text{shortest}}, d_{\text{tallest}}] - I = \underbrace{(0,+\infty)}_{I_{\text{DIFF}}:[\![\text{er}]\!]}]$
$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq (-\infty, d_{\text{shortest}})$

Comparatives based on the use of a gradable adjective like *short* are derived in a similar way, as illustrated in (54–56).[13]

13. Comparatives with a gradable like *short* are somehow special with regard to evaluativity. As illustrated in (i), different from equative sentence (i-a) and the *less-short* sentence (i-c), the sentence with *shorter*, (i-b), does not have evaluativity. We do not have a firm answer yet, but only a guess.

It is likely that for (i-a)/(i-c), [as Ann is] and [than Ann is] contain an elided *short*, thus their meaning inherits the evaluativity of the degree question *how short is Ann*.

However, for (i-b), it seems possible that [than Ann is], which eventually denotes the position standing for HEIGHT(Ann) along a height scale, contains an elided *tall*, and thus [than Ann is] corresponds to the degree question *how tall is Ann* and has no evaluativity (see (ii) and Büring 2007 for more discussion on this possibility).

(i) a. Chloe is as short as Ann is. (= (47))
$\models$ Chloe is short $\wedge$ Ann is short ✓ evaluativity

b. Chloe is shorter than Ann is. (similar to (54/55)
$\not\models$ Chloe is short $\vee$ Ann is short No evaluativity!

c. Chloe is less short than Ann is. (similar to (56))
$\models$ Chloe is short $\wedge$ Ann is short ✓ evaluativity

(ii) Unfortunately, the ladder was shorter than the house was high.
(Büring 2007: (2a))

(54) ⟦Chloe is shorter than every boy (is) ~~tall~~⟧
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq \iota I[[d_{\text{shortest}}, d_{\text{tallest}}] - I = \underbrace{(0, +\infty)}_{I_{\text{DIFF}}:[\![\text{-er}]\!]}]$
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq (-\infty, d_{\text{shortest}})$ **No evaluativity**
(i.e., Chloe is shorter than the shortest boy)

(55) ⟦Chloe is at most 2 inches shorter than every boy (is) ~~tall~~⟧
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq \iota I[[d_{\text{shortest}}, d_{\text{tallest}}] - I = \underbrace{(0, +\infty) \cap (-\infty, 2'')}_{I_{\text{DIFF}}:[\![\text{at most 2 inches ...-er}]\!]}]$
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq [d_{\text{tallest}} - 2'', d_{\text{shortest}})$ **No evaluativity**
(defined when $d_{\text{tallest}} - 2'' < d_{\text{shortest}}$)
(i.e., Chloe is shorter than every boy, but the difference is at most $2''$)

(56) ⟦Chloe is less short than every boy (is) ~~short~~⟧
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq \iota I[I - [d_{\text{shortest}}, d_{\text{tallest}}] = \underbrace{(0, +\infty)}_{I_{\text{DIFF}}:[\![\text{er}]\!]}]$
$\Leftrightarrow$ HEIGHT(Chloe) $\subseteq (d_{\text{tallest}}, +\infty)$ **Evaluativity**
(i.e., everyone is short, but Chloe is taller than the boys)

To sum up this section, all uses of gradable adjectives convey the meaning of comparison, and the meaning of comparison is mainly expressed via (i) the direction of subtraction and (ii) the non-negativeness of the difference.

4 English *-er/more* vs. *another*

Having shown how gradable adjectives take the responsibility of conducting comparison, we now show that English morpheme *-er/more* works like additive particle *another*, denoting a positive difference, i.e., an increase. §4.1 shows the parallelism between *-er/more* and *another*. §4.2 presents a unified account for various uses of *-er/more*. §4.3 discusses the anaphoricity of *-er/more*.

4.1 Parallelism between *-er/more* and *another*

As noted by Greenberg (2010) and Thomas (2010), *more* has an **additive use** similar to *another*. As illustrated in (57), both *more* and *another* denote an increase on a base item in **the domain of entities**. The most natural interpretation of (57c) is that *more* denotes an amount (of chocolate) above zero, which can but does not necessarily exceed the amount of two bars (the base amount).

(57) **Increase in the domain of entities: Additive use**

a. I ate $\underbrace{\text{an}^{x}\ \text{apple}}_{\text{base item}}$. Then I ate $\underbrace{\textbf{another}^{y}\ (\text{apple})}_{\text{increase}}$. Across sentences

b. $\underbrace{\text{A}^{x}\ \text{girl}}_{\text{base item}}$, Sue, met $\underbrace{\textbf{another}^{y}\ \text{girl}}_{\text{increase}}$, Mary. Within the same sentence

c. I ate $\underbrace{\text{two}^{x}\ \text{bars of chocolate}}_{\text{base item}}$. Then I ate (a bit) $\underbrace{\textbf{more}^{y}}_{\text{increase}}$.

We can adopt the same additivity-based perspective in understanding the use of *-er/more* in comparatives. In (58), *more* denotes an increase on a base item in **the domain of scalar values**: moving a lower value for some distance (i.e., an increase conveyed by ⟦-er/more⟧) results in a higher value.

(58) **Increase in the domain of scalar values: Comparative use**

a. $\underbrace{\text{Mary is tall}}_{\text{base item: HEIGHT(Mary)}}$. Sue is tall $\underbrace{\textbf{er}}_{\text{increase}}$. Across sentences

b. Sue is tall $\underbrace{\textbf{er}}_{\text{increase}}$ $\underbrace{\text{than Mary is } \sout{\text{tall}}}_{\substack{\text{base item:}\\ \text{HEIGHT(Mary)}}}$. Within the same sentence

Thus as shown in (59) and (60), ⟦-er/more⟧ and ⟦another⟧ have parallel semantics: denoting an increase (i.e., a positive difference, cf. the non-negative interval argument I_{DIFF} in the lexical semantics of gradable adjectives, see (24) and (25)), based on a salient base item in the context.

(59) ⟦-er/more/another⟧ (In the domain of intervals: ⟦-er/more⟧ $\stackrel{\text{def}}{=} (0, +\infty)$)

a. denotes an increase in the domain of entities or scalar values

b. presuppose there is a salient base that the increase is anaphoric to

(60) The parallelism between the domains of entities and intervals

Domain	Indefinites	Definites	Additive words	Additivity+Restriction
D_e	***someone***	***Mary***	***another***	***another girl, Mary***
$D_{\langle dt \rangle}$	***some (amount)***	***3 feet***	***-er/more***	***3 feet ...-er/more***

As additive particles, *-er/more* and *another* are also parallel in passing the classical tests for presupposition triggers (see also Zhang & Ling 2021 and §4.3): tests of projection (see (61)) and tests of local satisfaction (see (62)).

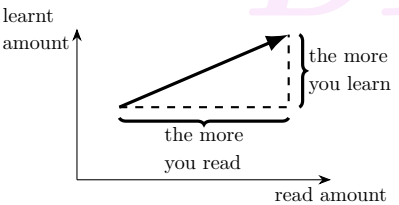

Fig. 4: Correlation between increases along two dimensions: *The more you read, the more you learn.*

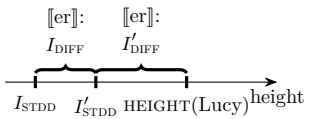

Fig. 5: Accumulating increases: *Lucy is taller and taller.*

(61) **Tests of projection**: all these sentences presuppose the existance of a salient base item that the increase is anaphoric to.

a. It is possible that **another** girl came.

b. It is possible that **more** alcohol was consumed. **Additive use**

c. It is possible that Lucy is tall**er**. **Comparative use**

(62) **Tests of local satisfaction** (for the presupposition)

a. Either Mary was not there, or **another** girl gave a talk.

b. Either they didn't have a beer, or **more** alcohol was consumed.

c. Either Mary is not that tall, or she is tall**er**.

4.2 Various uses of *-er/more*

The **correlative use** of *-er/more*, as illustrated in (63) and Fig. 4, means a correlation between changes along two dimensions. When the two changes are in the same direction (i.e., two increases), the correlation is positive (see (63a)). When the two changes are in opposition direction (i.e., an increase and a decrease), the correlation is negative (see (63b) with a sketched analysis).

(63) **Correlative**

a. The **more** you read, the **more** you learn. (see Fig. 4)

b. The tall**er** you are, the **less** mobile and quick you are.
$\approx$ the answer to the degree question '$\lambda I_{\text{DIFF}}.\text{HEIGHT}(x) \subseteq \iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$' determines the answers to the questions '$\lambda I_{\text{DIFF}}.\text{MOBILITY}(x) \subseteq \iota I[I'_{\text{STDD}} - I = I_{\text{DIFF}}]$' and '$\lambda I_{\text{DIFF}}.\text{SPEED}(x) \subseteq \iota I[I''_{\text{STDD}} - I = I_{\text{DIFF}}]$'

Multi-head comparatives (see e.g., von Stechow 1984, Zhang 2024) like (64) can be considered a further extension of the correlative use of *-er/more*.[14] (64) expresses a change of the gradient of the correlation: how wealth distribution is more tilted than in the past (see Zhang 2024 for a detailed discussion).

(64) **Fewer** people own **more** of the overall wealth, and **fewer** companies own **more** market share. **Multi-head comparative**

The **repetitive use** of *-er/more* involves a series of conjunction, expressing a series of increases. As illustrated in Fig. 5, (65b) means that there are accumulated increases along a height scale, leading to higher and higher position values: from I_{STDD} to I'_{STDD} to HEIGHT(Lucy).

(65) **Repetitive use of *-er/more***

a. Janice had a little lamb and **another** and **another** and **another**.

b. Lucy is tall $\underbrace{\textbf{er}}_{I_{\text{DIFF}}}$ and tall $\underbrace{\textbf{er}}_{I'_{\text{DIFF}}}$. (see Fig. 5)

$\Leftrightarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - \underbrace{I'_{\text{STDD}}}_{I'_{\text{STDD}} \subseteq \iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]} = I'_{\text{DIFF}}]$

Additive particles like *-er/more* and *another* can also be used **along with universal quantifiers**, meaning the accumulation of increases (i.e., the effect is similar to a series of conjunctions, see Bumford 2015). (66) means that along with a timeline, there is a gradual accumulation along a scale of book quality μ (see (66a)) or an accumulation of stories (see (66b)).

(66) a. Every year Mary wrote a **more** interesting book. (Bumford 2015)
$\approx \forall N \exists I_{\text{IDFF}}[\mu(\text{book-of-year}_N) \subseteq \iota I[I - \mu(\text{book-of-year}_{N-1}) = I_{\text{DIFF}}]]$
$\rightsquigarrow$ Towards higher and higher positions along a scale of book quality

b. Everyday there is **another** story to write. $\rightsquigarrow$ Accumulating stories
$\approx \forall N \exists x[\text{stories-by-day}_N - \text{stories-by-day}_{N-1} = x]$

4.3 The anaphoricity of *-er/more*

The above discussion reveals a distinction between the **additive** use (see (57) and the use of *another* in (65) and (66)) and the **comparative** use (see (58)).

14. (64) is from https://www.deseret.com/opinion/2020/9/14/21436415/guest-opinion-america-capitalism-strengths-dark-side-too-far-inequality-divisiveness-wealth-gap.

For the comparative use, an increase is a distance along a scale, and the increase is anaphoric to a base item that is a position along the scale.

On the other hand, for the additive use, both an increase and the base item the increase is anaphoric to are the same kind of things (e.g., in (57c), both the base item x and the increase y denote chocolate).

The theory of QUD (Question under discussion, see Roberts 1996/2012) provides a unified perspective on the anaphoricity of these additive particles (see Beaver & Clark 2009, Thomas 2011, Zhang & Ling 2021 for a similar view). For both the additive and comparative use, the increase is anaphoric to a discourse-salient, positive, non-overlap partial answer to the Current Question (CQ), leading to increased informativeness than the partial answer.

In a domain of entities, a positive, partial answer is in a part-whole relation to the complete answer. The lack of a positive partial answer means the lack of a salient base item that can support the additive use of *more* (see (67b)).

(67) **Current question (CQ): What did you eat?**

a. I ate $\underbrace{\text{two bars of chocolate}}_{\substack{\text{base item:}\\ \text{a partial answer to the CQ}}}$. Then I ate (a bit) $\underbrace{\text{more}}_{\text{increase}}$. (= (57c))

b# I didn't eat a bar of chocolate. Then I ate more.

In a domain of scalar values, a partial answer indicates a position that addresses the CQ in a less informative way than a complete answer.

Thus for gradable adjectives like *tall*, a partial answer denotes a position lower than the complete answer along a height scale (see (68a), a higher height value corresponds to a higher level of informativeness in addressing the CQ *how tall is Sue*); while for *short*, a partial answer denotes a position higher than the complete answer along a height scale (see (68b), a lower height value corresponds to a higher level of informativeness in addressing the CQ *how short is Chloe*).

(68) a. $\underbrace{\text{Bill is 5 feet 8 inches tall}}_{\substack{\text{base item} - \textsc{height}(\text{Bill})\\ \text{a partial answer to the CQ}}}$. Sue is tall $\underbrace{\text{er}}_{\text{increase}}$. **CQ: how tall is Sue?**

b. $\underbrace{\text{Ann is 5 feet tall}}_{\substack{\text{base item} - \textsc{height}(\text{Ann})\\ \text{a partial answer to the CQ}}}$. Chloe is short $\underbrace{\text{er}}_{\text{increase}}$. **CQ: how short is Chloe?**

This QUD-based view on the anaphoricity of *-er/more* explains an observation about **incomplete comparatives**, comparatives without an overt *than*-part (see Sheldon 1945, Schwarzschild 2010, Li 2023 for relevant discussion).

As illustrated in (69), when a *than*-phrase is overtly present, the comparison standard can be a degree expression like *6 feet* (see (69a)) or an anaphora

referring back to a degree (see (69b)). However, in an incomplete comparative like (69c/69d), only the measurement of a counterpart to the target, here HEIGHT(Mary), but not a degree expression, can play the role of standard.

Under the current analysis, *-er* needs to be anaphoric to a discourse-salient **position** along a height scale. When there is a *than*-phrase/clause, this *than*-expression plays the role of I_{STDD} (see §3.6), satisfying the anaphoricity requirement of *-er*. However, for incomplete comparatives like (69c/69d), only HEIGHT(Mary) can be a discourse-salient position, playing the role of I_{STDD}. In (69c), the degree expression *6 feet* actually denotes the distance between HEIGHT(Mary) and the zero point (see §3.3). In (69d), presumably, the contextual threshold of being tall lacks discourse salience.

(69) a. Lucy is taller than 6 feet. $\text{HEIGHT}(\text{Lucy}) \subseteq (6', +\infty)$

b. Mary is not 6^u feet tall. Lucy is taller than that$_u$. $\text{HT}(\text{L}) \subseteq (6', +\infty)$

c. Mary is not 6 feet tall. Lucy is taller.
$\rightsquigarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - \text{HEIGHT}(\text{Mary}) = (0, +\infty)]$
$\not\rightsquigarrow \text{HEIGHT}(\text{Lucy}) \subseteq (6', +\infty)$

d. Mary is not POS tall. Lucy is taller.
$\rightsquigarrow \text{HEIGHT}(\text{Lucy}) \subseteq \iota I[I - \text{HEIGHT}(\text{Mary}) = (0, +\infty)]$
$\not\rightsquigarrow \text{HEIGHT}(\text{Lucy}) \subseteq (d^c_{\text{POS}}, +\infty)$

5 Comparison in Chinese and the use of *gèng*

This section extends the above analysis of comparison to languages without morphemes like English *-er*/*more*. §5.1 addresses how comparison is expressed by gradable adjectives in Chinese. We propose that while in English, gradable adjectives essentially encode a non-strict inequality (see §3: (24/25) and Table (30)), in *-er*-less languages like Chinese, gradable adjectives encode a strict inequality, making a morpheme like *-er*/*more* unnecessary. §5.2 addresses the use of Chinese *gèng* and Japanese *motto*, morphemes often used in comparatives, and shows that these morphemes work like additive particle *moreover*, updating the contextual threshold for the positive use of a gradable adjective. §5.3 compares *gèng* with *hái*, another additive particle in Chinese.

5.1 Comparison and gradable adjectives in Chinese

Similar to English gradable adjectives (see (24) and (25) in §3.1), the lexical semantics of Chinese gradable adjectives can also be characterized as a subtraction relation among three scalar values, as shown in (70) and (71).

However, we propose that there is a crucial difference between English *tall*/*short* and Chinese *gāo*/*ǎi*. As shown in (24/25), the meaning of English gradable adjectives includes a **non-negative presupposition**. Thus, English gradable adjectives essentially encode a **non-strict** inequality: the measurement of the target **reaches** I_{STDD}. In comparatives (see §3.6), comparative morpheme *-er*/*more* brings a positive difference, $(0, +\infty)$, leading to strict inequality.

On the other hand, as shown in (70/71), the meaning of Chinese gradable adjectives includes a **positive presupposition**. Thus, Chinese gradable adjectives essentially encode a **strict** inequality: the measurement of the target **exceeds** I_{STDD}. As a consequence, I_{DIFF} is positive by default and does not need a morpheme like English *-er*/*more* for expressing strict inequality.

(70) $[\![\text{gāo}]\!] \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\lambda I_{\text{STDD}}.\lambda x.\underbrace{I_{\text{DIFF}} \subseteq (0, +\infty)}_{\text{positive presupposition (cf. (24))}} \text{HEIGHT}(x) \subseteq \iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$

(71) $[\![\text{ǎi}]\!] \stackrel{\text{def}}{=} \lambda I_{\text{DIFF}}.\lambda I_{\text{STDD}}.\lambda x.\underbrace{I_{\text{DIFF}} \subseteq (0, +\infty)}_{\text{positive presupposition (cf. (25))}} \text{HGHT}(x) \subseteq \iota I[I_{\text{STDD}} - I = I_{\text{DIFF}}]$

Various uses of Chinese gradable adjectives are summarized in (72) and largely parallel to English phenomena (see (30) and §3).[15]

(72) **Various uses of gradable adjectives in Chinese**

	I_{STDD}	I_{DIFF}
Positive use	**Contextual threshold:** $[d^c_{\text{POS}}, d^c_{\text{POS}}]$	$(0, +\infty)$ **(or further restricted by a modifier like *hěn*)**
Measure constructions	**Absolute zero point:** $[0, 0]$	**restricted by a measure phrase**
Degree questions	**Contextual threshold or absolute zero point**	**(interval abstraction)**
***bǐ*-comparatives**	**Measurement of the standard: *bǐ*-phrase**	$(0, +\infty)$ **(or further restricted by a numerical differential)**

15. Chinese has several constructions to express equatives, which involve extra complications orthogonal to the current paper (see Zhang 2020, 2023 (Section 2.4) for discussion).

The positive use addresses a comparison with a context-dependent threshold. Thus as illustrated in (73), the difference argument I_{DIFF} is the default positive interval, $(0, +\infty)$, while the standard argument I_{STDD} is a context-dependent threshold of being tall or short.

Under the current analysis, there is a subtle difference between the positive use in English and Chinese. In English, being tall means **reaching** the threshold d^c_{DIFF} (see (31)), while in Chinese, being tall means **exceeding** d^c_{DIFF} (see (73a)). However, given that neither the threshold d^c_{STDD} is overtly expressed nor the difference $[0, +\infty)$ or $(0, +\infty)$ has an overt numerical restriction, this distinction between 'reaching' and 'exceeding' does not apparently affect truth conditions.

(73) **Positive use in Chinese**

a. Wǒ hěn gāo.
1SG very tall
'I am tall.'
$[\![(73a)]\!] \Leftrightarrow \textsc{height}(\text{me}) \subseteq \iota I[I - [d^c_{\text{POS}}, d^c_{\text{POS}}] = (0, +\infty)]$
$\Leftrightarrow \textsc{height}(\text{me}) \subseteq (d^c_{\text{POS}}, +\infty)$
(i.e., my height **exceeds** the contextual threshold of being tall)
(cf. $[\![(31)]\!] \Leftrightarrow \textsc{height}(\text{Lucy}) \subseteq [d^c_{\text{POS}}, +\infty)$)

b. Tā hěn ǎi.
3SG very short
'She is short.'
$[\![(73b)]\!] \Leftrightarrow \textsc{height}(\text{she}) \subseteq \iota I[[d^c_{\text{POS}}, d^c_{\text{POS}}] - I = (0, +\infty)]$
$\Leftrightarrow \textsc{height}(\text{she}) \subseteq (-\infty, d^c_{\text{POS}})$
(i.e., her height is below the contextual threshold of being short)

The measurement construction addresses a comparison with a zero point. Thus as illustrated in (74), the difference argument I_{DIFF} is expressed via the numerical measurement (e.g., 1.7m), while the standard argument I_{STDD} is the zero point along a height scale. The semantic derivation of (74a) and the ungrammaticality of (74b) are exactly parallel to English data (see §3.3).

(74) **Measurement constructions in Chinese** (see also Zhang 2019 and Zhang 2023 (Section 2.1) for more patterns)

a. Lèlè (yǒu) yì-mǐ-qī gāo.
Lèlè EXIST one-meter-seven tall
'Lèlè is 1.7m tall.'
$[\![(74a)]\!] \Leftrightarrow \text{HEIGHT}(\text{Lèlè}) \subseteq \iota I[I - [0,0] = [1.7\text{m}, +\infty) \cap (0, +\infty)]$
$\Leftrightarrow \text{HEIGHT}(\text{Lèlè}) \subseteq [1.7\text{m}, +\infty)$
(i.e., Lèlè's height reaches 1.7m $\rightsquigarrow$ the 'at least' reading as in (39a))

b. *Mǐmǐ (yǒu) yì-mǐ-wǔ ǎi.
Mǐmǐ EXIST one-meter-five short
Intended: 'Lèlè is (as short as) 1.5m.'
$\rightsquigarrow [0,0] - \text{HEIGHT}(\text{Mǐmǐ})$ is negative (see also Fig. 2 and (40))

Degree questions address a comparison relative to a reference position, typically a zero point or a context-dependent threshold, as shown in (75). Thus, just like in English (see §3.4), degree questions in Chinese involve an abstraction of the difference variable I_{DIFF} and denote a set of intervals: a set of distances relative to a reference position.

When I_{STDD} is the context-dependent threshold of being tall/short, there is evaluativity in interpreting the degree question. When I_{STDD} is the zero point (only for gradable adjectives like *tall*, but not for *short*), there is no evaluativity.

Like in English, $\textbf{Ans}_{\text{DIFF}}$ (see (43)) can be applied to return the most informative interval I_{DIFF}. Two type-shifters, **Position-M** (see (44), for gradable adjectives like *tall*/*gāo*) and **Position-S** (see (45), for gradable adjectives like *short*/*ǎi*), can be applied to compute the **position of the target** from its distance away from the reference position I_{STDD} (i.e., $[0,0]$ or $[d^c_{\text{POS}}, d^c_{\text{POS}}]$, see Fig. 3).

(75) **Degree questions in Chinese**

a. Lèlè (yǒu) duó gāo?
Lèlè EXIST how-much tall
'How tall is Lèlè?' **With or without evaluativity** (see (41))
$[\![(75a)]\!] \Leftrightarrow \lambda I_{\text{DIFF}}.\text{HEIGHT}(\text{Lèlè}) \subseteq \iota I[I - I_{\text{STDD}} = I_{\text{DIFF}}]$

b. Mǐmǐ (yǒu) duó ǎi?
Mǐmǐ EXIST how-much short
'How short is Mǐmǐ?' **With evaluativity** (see (42))
$[\![(75b)]\!] \Leftrightarrow \lambda I_{\text{DIFF}}.\text{HEIGHT}(\text{Mǐmǐ}) \subseteq \iota I[I_{\text{STDD}} - I = I_{\text{DIFF}}]$

In Chinese *bǐ*-comparatives, the difference argument I_{DIFF} is the default positive interval, $(0, +\infty)$, which can further get restricted by a numerical differential

(see (76)). The standard I_{STDD} is provided by the *bǐ*-phrase, i.e., a position along a relevant scale that addresses the measurement of the comparison standard.[16]

(76) **Comparatives in Chinese**

a. Lèlè bǐ Mǐmǐ gāo (wǔ límǐ)
Lèlè STDD Mǐmǐ taller five centimeter
'Lèlè is (5cm) taller than Mǐmǐ.'
$[\![(76a)]\!] \Leftrightarrow \text{HEIGHT}(\text{Lèlè}) \subseteq \iota I[I - \text{HEIGHT}(\text{Mǐmǐ}) = (0, +\infty) \cap [5\text{cm}, +\infty)]$

b. Mǐmǐ bǐ Lèlè ǎi (wǔ límǐ).
Mǐmǐ STDD Lèlè shorter five centimeter
'Mǐmǐ is (5cm) shorter than Lèlè.'
$[\![(76b)]\!] \Leftrightarrow \text{HEIGHT}(\text{Mǐmǐ}) \subseteq \iota I[\text{HEIGHT}(\text{Lèlè}) - I = (0, +\infty) \cap [5\text{cm}, +\infty)]$

5.2 The use of Chinese *gèng* (and Japanese *motto*)

We have shown that in languages like Chinese and Japanese, comparatives do not require the use of a morpheme like English *-er/more* (see §5.1 and (7b/8b)).

However, in Chinese and Japanese, comparatives can contain a sometimes optional morpheme. In Japanese comparatives, *motto* can be optionally inserted before a predicative (see (77)) or an attributive gradable adjective (see (78)).

(77) Rika-wa Makoto-yori (**motto**) taka-i.
Rika-TOP Makoto-STDD MOREOVER tall-PRES
'Rika is taller than Makoto.' (cf. (8b): without *motto*)

(78) Mary-wa John-yori (**motto**) takusan-no ronbun-o kaita.
Mary-TOP John-STDD MOREOVER many-GEN paper-ACC wrote
'Mary wrote more papers than John.' (Beck, Oda & Sugisaki 2004: (1))

In Chinese comparatives, *gèng* is optional before a predicative gradable adjective (see (79)), while it is required before an attributive one (see 80)).

16. In addition to *bǐ*-comparatives, Chinese has other types of comparative constructions (see Zhang 2023 (Sections 2.3 and 4)). There has been a debate on whehter Chinese *bǐ*-comparatives are phrasal or clausal comparatives. We tend to agree with Lin (2022)'s view that *bǐ*-comparatives are phrasal comparatives (also see Zhang 2023 (Section 4)).

(79) Lèlè bǐ Mǐmǐ (**gèng**) gāo.
Lèlè STDD Mǐmǐ MOREOVER tall
'Lèlè is taller than Mǐmǐ.' (cf. (7b/76a): without *gèng*)

(80) Lèlè bǐ Mǐmǐ mǎi-le *(**gèng**) duō de shū.
Lèlè STDD Mǐmǐ buy-ASP MOREOVER many RELZ book
'Lèlè bought more books than Mǐmǐ.' (*gèng*: required for an attributive)

The literature on Chinese *gèng* and Japanese *motto* notes three distinctions between these morphemes and English *-er/more*.

First, the interpretation of comparatives with the presence of *gèng/motto* seems to involve evaluativity. According to Beck, Oda & Sugisaki (2004), with the presence of *motto*, (77) means that Rika is even taller than Makoto, i.e., there is an evaluative meaning that Makoto already exceeds the threshold of being tall. Similarly, according to Liu (2010) and Chen (2023) (cf. Guo 2022), with the presence of *gèng*, (79) suggests that Mǐmǐ is tall.

Second, as pointed out by Beck, Oda & Sugisaki (2004), Ma (2019), and Zhang (2023), the use of Chinese *gèng* / Japanese *motto* in comparatives is incompatible with the presence of a numerical differential, as illustrated in (81)/(82).[17]

(81) *Rika-wa Makoto-yori **motto** go senti se-ga taka-i.
Rika-TOP Makoto-STDD MOREOVER five centimeter back-NOM tall-PRES
Intended: 'Rika is even (5 cm) taller than Makoto.' (cf. (8b/77))

17. Is the use of English *even* compatible with the overt presence of a numerical differential in a comparative? As far as we know, out of blue, sentence (i) sounds weird to some native speakers (Jim Wood: personal communication). It is likely that without context, whether *even* is associated with *5 cm* or *Mary* remains unclear and affects judgments. Sentence (i) would sound good in a context where others are only slightly taller than Mary, and the difference between Lucy's and Mary's height is as large as 5 cm. Thus *even* is compatible with a numerical differential at least when it is associated with the numerical differential itself. Thus, with regard to this (in)compatibility with a numerical differential in a comparative, Chinese *gèng* and Japanese *motto* have an entirely different behavior from English *even*.

(i) ?Lucy is even 5 cm taller than Mary.

(82) *Lèlè bǐ Mǐmǐ **gèng** gāo wǔ líimǐ.
Lèlè STDD Mǐmǐ MOREOVER taller five cm
Intended: 'Lèlè is even (5 cm) taller than Mǐmǐ.' (cf. (76a/79))

Third, as pointed out by Chen (2023), Chinese *gèng* has an additive use. Example (83) involves no overt use of gradable adjectives at all.[18]

(83) Jīnqián mǎi-bú-dào yǒu-yì, **gèng** mǎi-bú-dào àiqíng
money buy-NEG-get friendship MOREOVER buy-NEG-get love
'Money cannot buy friendship. Moreover, it cannot buy love.'

Comparatives with Chinese *gèng* or Japanese *motto* are reminiscent of English implicit comparison (see (84)) and sentences with *moreover* (see (85)).

Implicit comparison like (84) is essentially a positive use (see §3.2), meaning that Lucy's height reaches a threshold that is contextually updated based on Mary's height. According to our intuitive interpretation of (84a) and (84b), without *even* or *still*, these implicit comparison sentences imply that Mary is not tall, and Lucy reaches a contextually updated threshold that is higher than Mary's height but might not exceed a regular threshold (see Sawada 2009). With the use of *even* or *still*, (84a) and (84b) mean that Mary is already tall, yet Lucy's height reaches a new threshold that Mary's height does not.

In other words, a positive inference about Mary's height in these implicit comparison sentences in (84) invokes the use of particles like *even* or *still*.

(84) a. (Even) compared to Mary, Lucy is tall. **Implicit** (= (21a))

b. Compared to Mary, Lucy is **still** tall. **Implicit comparison**
⇝ Lucy's height reaches a threshold that Mary's height doesn't.

The use of *moreover* in (85) has an additive meaning, suggesting that the presence of chaos indicates a new level of how the situation is bad.

(85) War brings depression. **Moreover**, it brings chaos.
⇝ Chaos reaches a badness level that depression alone doesn't.

Based on the above observations, we propose that *gèng*/*motto* are additive particles of the type of *also*/*even*/*still*/*moreover*, operating on a prejacent proposition and addressing the connection between the prejacent and alternatives.

18. This additive use in (83) is distinct from the additive use of *more* in (57c) in §4.1. In (57c), in *more* (*chocolate*), *more* is actually *much*+*-er*, i.e., the gradable adjective here is *much*. Cf. In *more intelligent / beautiful*, *more* is an allomorph of *-er*.

Fig. 6: ⟦Lèlè bǐ Mǐmǐ gèng gāo⟧: compared with Mǐmǐ, Lèlè is tall (see (87a)).

Specifically, as shown in (86), ⟦gèng/motto⟧(p) (i) asserts their prejacent p and (ii) presupposes the existence of a contextually updated threshold that p exceeds but alternatives alone don't.

(86) ⟦gèng/motto⟧(p)

a. asserts the prejacent p

b. presupposes that the prejacent p and alternatives are associated with scalar values on a scale, and compared with alternatives, p exceeds a positive level that alternatives don't (see Fig. 6)

As sketched out in (87) and illustrated in Fig. 6, a Chinese *bǐ*-comparative with *gèng* (i) presupposes a contextually updated threshold of being tall/short, $I^{C>\text{HT(Mǐmǐ)}}_{\text{POS}}$ (or $I^{C<\text{HT(Lèlè)}}_{\text{POS}}$), that exceeds the measurement of the comparison standard in being tall/short, and (ii) asserts that the measurement of the target further exceeds this threshold for being tall/short.

In this sense, though the presence of *gèng* in a comparative does not explicitly affect truth conditions, the presence of *gèng* brings the effect of enhancing informativeness, compared to corresponding sentences without *gèng*.

In (87a), compared to the measurement of the comparison standard (i.e., HEIGHT(Mǐmǐ)), $I^{C>\text{HT(Mǐmǐ)}}_{\text{POS}}$ is a higher value and enhances the informativeness in addressing a Current Question like *how tall Lèlè is*.

Similarly, in (87b), compared to the comparison standard (i.e., HEIGHT(Lèlè)), $I^{C<\text{HT(Lèlè)}}_{\text{POS}}$ is a lower value along a scale of heights and thus enhances the informativeness in addressing *how short Mǐmǐ is*.

(87) a. ⟦Lèlè bǐ Mǐmǐ **gèng** gāo⟧ (= (79), see Fig. 6)
≈ Compared with Mǐmǐ, $\underbrace{\text{Lèlè is tall}}_{\substack{\text{prejacent of } gèng,\\ \text{associated with an enhanced threshold}}}$
≈ HEIGHT(Lèlè) $\subseteq \iota I[I - I^{C>\text{HT(Mǐmǐ)}}_{\text{POS}} = (0, +\infty)])$
(here $I^{C>\text{HT(Mǐmǐ)}}_{\text{POS}} \subseteq \iota I[I - \text{HEIGHT(Mǐmǐ)} = (0, +\infty)]$)
i.e., the contextual threshold of being tall is above HEIGHT(Mǐmǐ), and HEIGHT(Lèlè) is above this threshold $I^{C>\text{HT(Mǐmǐ)}}_{\text{POS}}$

b. ⟦Mǐmǐ bǐ Lèlè **gèng** ǎi⟧
≈ Compared with Lèlè, Mǐmǐ is short

$\approx$ HEIGHT(Mǐmǐ) $\subseteq \iota I[I^{C_{<\text{HT(Lèlè)}}}_{\text{POS}} - I = (0, +\infty)])$
(here $I^{C_{<\text{HT(Lèlè)}}}_{\text{POS}} \subseteq \iota I[\text{HEIGHT(Lèlè)} - I = (0, +\infty)])$
i.e., the contextual threshold of being short is below HEIGHT(Lèlè), and HEIGHT(Mǐmǐ) is below this threshold $I^{C_{<\text{HT(Lèlè)}}}_{\text{POS}}$

The proposal in (86) is apparently similar to an implementation of the canonical analysis of English comparatives, as illustrated in (88) (see also (18b) in §2.1). However, there is a crucial difference. In (88), degrees which the target's measurement reaches but the standard doesn't are not necessarily considered contextual thresholds of being tall. Thus the interpretation of (88) does not involve evaluativity: it might be the case that neither Lucy nor Mary is tall.

In contrast, the interpretation of (87) (see also Fig. 6) involves evaluativity: the target's measurement exceeds a contextual threshold of being tall. In other words, in (87a), Lèlè is tall, and in (87b), Mǐmǐ is short.

(88) $[\![$Lucy is taller than Mary is$]\!]$ (see (18b))
$\Leftrightarrow \exists d[d \in \{d \mid \text{Lucy is } d\text{-tall}\} \wedge d \notin \{d \mid \text{Mary is } d\text{-tall}\}]$
i.e., there is a height d that Lucy's height reaches but Mary's height doesn't

The proposal in (86) naturally explains our intuitions on the use of *gèng*.

First, including *gèng*/*motto* often seems semantically optional, without apparently affecting truth conditions. This is because, under the current proposal, *gèng*/*motto* affects the threshold d^{C}_{POS} and enhances it to a level more informative than the measurement of the comparison standard, but this kind of threshold is never overtly expressed in natural language anyway.

Second, the current proposal explains the seeming evaluativity in interpreting *gèng*-sentences. In (87a) and Fig. 6, given that the target's measurement exceeds a contextually updated threshold, it naturally follows that Lèlè is tall.

However, the reported evaluative meaning for the standard (here 'Mǐmǐ is tall' for (87a)) is an implicature, rather than a presupposition, as evidenced by the cancellability shown in (89) (cf. Liu 2010, Chen 2023).

(89) Lèlè bǐ Mǐmǐ **gèng** gāo, dāngrán, Mǐmǐ bú suàn gāo.
Lèlè STDD Mǐmǐ MOREOVER tall of-course Mǐmǐ NEG count tall
'Lèlè is taller than Mǐmǐ, but of course, Mǐmǐ cannot be considered tall.'

(90) is a naturally occurring example found on the internet.[19] The most natural interpretation of (90) is that the speaker wants to become taller, i.e.,

19. (90): https://www.chunyuyisheng.com/pc/qa/0bqUEp80ZHyf_qHw8yoXtg/

above a contextual threshold that is above his current height (which is quite low). It is likely that the speaker would be satisfied with an average height. In this sense, alternatives to the prejacent of *gèng* play the role of 'anchor', affecting the positive threshold (see also discussion on implicit comparison in (21)).

(90) Zhǎng-de hěn ǎi, zěnyàng cái kěyǐ biàn-de **gèng** gāo?
grow-LNK very short, how only can become-LNK MOREOVER tall
'I am short, and how can I become taller?'

Similarly, the evaluative meaning is also cancellable for Japanese *motto*:

(91) Rika-wa Makoto-yori **motto** takusan-no ronbun-o kai-ta.
Rika-TOP Makoto-STDD MOREOVER many-GEN paper-ACC write-PST
Shikashi Makoto-ga sore-hodo takusan-no ronbun-o kai-ta
but Makoto-NOM that-degree many-NO paper-ACC write-PST
wake-de-wa-nai
meaning-COP-TOP-NEG.
'Rika wrote even more papers than Makoto, but it doesn't mean that Makoto wrote so many papers.' (Toshiko Oda: personal communication)

It is worth noting that in Chinese, an attributive expression with a comparative meaning (e.g., *a longer novel*, *more books* in (80)) requires the presence of *gèng*. For a sentence like (80), the presence of *gèng* is legitimate even if Mǐmǐ only bought one book. Thus *gèng* does not bring an evaluative presupposition.[20]

Third, under the current proposal, the prejacent of *gèng* (see (87)) actually involves the positive use of a gradable adjective: for (87a), Lèlè is tall. Thus the incompatibility of *gèng*/*motto* with a numerical differential (see (81/82)) is also naturally accounted for. A contextual threshold for the positive use is never overt in natural language. Consequently, the positive use is never compatible with a specific numerical differential (see also the tables in (30) and (72)).

However, just like degree modifiers like *very* / *a bit* can be used to vaguely characterize how the measurement of the target is above the contextual threshold (i.e., the size of I_{DIFF}) in the positive use (e.g., *Jessica is very tall*, see (37/38)), the use of *gèng* is compatible with degree modifiers like *yì-diǎn* (see (92)).

20. Although in Chinese, the presence of *gèng* is required in an attributive comparative like (80), the case of Japanese *motto* is different. For a Japanese attributive comparative like (78), the presence of *motto* is optional. We do not know how to explain this difference between Chinese and Japanese data at this moment, so this issue is left for future work.

(92) a. Lèlè bǐ Mǐmǐ **gèng** gāo **yì-diǎn**.
Lèlè STDD Mǐmǐ MOROVER tall one-bit
'Compared to Mǐmǐ, Lèlè is somehow tall.'

b. **gèng** shèng **yì-chóu**
MOREOVER be.better one-tally
'exceed a bit'

Fourth, by analyzing *gèng* along with additive particles like *moreover*, the current proposal also explains the additive use of *gèng* like (83) (see (93)).

(93) a. Money cannot buy friendship. Moreover, it cannot buy love. (≈ (83))
b. War brings depression. Moreover, it brings chaos. (= (85))

We assume that the additive use of *gèng*/*moreover* in (93) is based on the accommodation of a contextually relevant scale: e.g., the measurement of price for (93a), how bad the situation is for (93b) (see Greenberg 2018, Zhang 2022 for a similar idea in analyzing English *even*, another additive particle).

Roughly speaking, (93a) (i) presupposes a contextual threshold that is above the price of friendship and (ii) asserts that the price of love is above this threshold. (93b) (i) presupposes a contextual threshold that is above the badness of depression and (ii) asserts that the badness of chaos is above this threshold.

As an additive particle similar to *moreover*, *gèng* can appear at a syntactically higher position in a *bǐ*-comparative, leading to an additive use dubbed 'multiple degree comparatives', as illustrated in (94) (see also Kennedy & McNally 2005b). (94) means that the height difference between Lèlè and Mǐmǐ exceeds a contextual threshold of height difference. Depending on the stress position, the prejacent of *gèng* has two different sets of alternatives: the one associated with the standard (see (94a)) or the target (see (94b)).

(94) Lèlè **gèng** bǐ Mǐmǐ gāo.
Lèlè MOREOVER STDD Mǐmǐ tall
'Lèlè is taller to Mǐmǐ by more.'

a. **Shared Standard Interpretation** (stress on *Lèlè*):
Someone is taller than Mǐmǐ by a certain difference. Moreover, Lèlè is taller than Mǐmǐ by a larger difference.
Height ordering (from low to high): Mǐmǐ, someone, Lèlè

b. **Shared Target Interpretation** (stress on *Mǐmǐ*):
Lèlè is taller than someone by a certain difference. Moreover, Lèlè is

taller than Mǐmǐ by a larger difference.
Height ordering (from low to high): Mǐmǐ, someone, Lèlè

In these examples of additive use (see (93/94)), the prejacent of *gèng/moreover* and alternatives are in two distinct sentences, in contrast with comparatives with *gèng* (see e.g., (79/87)), where the prejacent part and its alternative appear within the same sentence. Actually for the additive use, a single-sentence construction is also possible (see (95/96)). (96) shows a slight difference between two standard markers: *bǐ* (see (96a)) vs. *bǐqǐ* (see 96b).

(95) Bǐqǐ yǒu-yì, jīnqián **gèng** mǎi-bú-dào àiqíng
compared-to friendship money MOREOVER buy-NEG-get love
'Money cannot buy friendship. Moreover, it cannot buy love.' (see (83))
(with stress on *àiqíng* 'love')

(96) a. Lèlè **bǐ** **Bōbō** (gèng) bǐ Mǐmǐ gāo.
Lèlè STDD Bōbō MOREOVER STDD Mǐmǐ tall
✓Shared Standard (with stress on *Lèlè*): B is taller than M. Moreover, L is taller than M.
#Shared Target: L is taller than B. Moreover, L is taller than M.

b. Lèlè **bǐqǐ** **Bōbō** gèng bǐ Mǐmǐ gāo.
Lèlè compared-to Bōbō MOREOVER STDD Mǐmǐ tall
✓Shared Standard (with stress on *Lèlè*): B is taller than M. Moreover, L is taller than M.
✓Shared Target (with stress on *Mǐmǐ*): L is taller than B. Moreover, L is taller than M.

Finally, the use of *gèng* also supports a series of additive computation. (97) means that every year, his height exceeds a threshold of being tall, which exceeds his height in the previous year.

(97) tā yì nián bǐ yì nián **gèng** gāo.
3SG one year STDD one year MOREOVER tall
'He is taller every year.' Comparative
$\approx \text{his-height-in-year}_N \subseteq \iota I[I - \underbrace{I_{\text{POS}}^{C_{>\text{HT}}N-1}}_{I_{\text{POS}}^{C_{>\text{HT}}N-1} \subseteq \iota I[I - [\text{his-height-in-year}_{N-1}\ ] = (0,+\infty)]} = (0,+\infty)]$

5.3 Chinese *gèng* vs. Chinese *hái*

In addition to *gèng*, Chinese comparatives can also contain other additive particles, such as *hái*. As illustrated in (98), the use of *gèng* and *hái* has a similar effect, and both sentences can be translated as 'Lèlè is even taller than Mǐmǐ'.[21]

(98) a. Lèlè bǐ Mǐmǐ **gèng** gāo.
Lèlè STDD Mǐmǐ MOREOVER tall
'Lèlè is even taller than Mǐmǐ.'

b. Lèlè bǐ Mǐmǐ **hái** gāo.
Lèlè STDD Mǐmǐ STILL tall
'Lèlè is even taller than Mǐmǐ.'

Ma (2019) points out two distinctions between *gèng* and *hái*. First, as illustrated in (99), only the use of *hái* (see (99a)), but not the use of *gèng* (see (99b)), is compatible with the presence of a numerical differential.

(99) a. Lèlè bǐ Mǐmǐ **hái** gāo wǔ límǐ.
Lèlè STDD Mǐmǐ STILL tall five centemeter
'Lèlè is furthermore taller than Mǐmǐ by 5 cm.'

b. *Lèlè bǐ Mǐmǐ **gèng** gāo wǔ límǐ.
Lèlè STDD Mǐmǐ MOREOVER tall five centemeter
Intended: 'Lèlè is furthermore taller than Mǐmǐ by 5 cm.'

Second, as illustrated in (100), only the use of *hái* (see (100a)), but not the use of *gèng* (see (100b)), is felicitous for a comparison with metaphorical or hyperbolic meaning.

(100) a. Lèlè bǐ shīzi **hái** yǒnggǎn.
Lèlè STDD lion STILL brave
'Lèlè is even braver than lions.'

21. In the existing literature on Chinese *gèng*, Liu (2010) claims that *gèng* has an evaluative presuppositon (e.g., (98a) presupposes that the comparison standard, Mǐmǐ, is already tall), while Chen (2023) analyzes *gèng* along with English *even*. It seems to us that due to the meaning similarity between (98a) and (98b), their analysis actually works for *hái*, rather than *gèng*. A detailed comparison among theories is for another occasion.

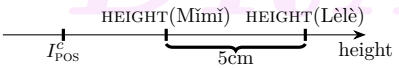

Fig. 7: ⟦Lèlè bǐ Mǐmǐ hái gāo (5cm)⟧: Lèlè is even (5 cm) taller than Mǐmǐ. (see (102))

b.#Lèlè bǐ shīzi **gèng** yǒnggǎn.
Lèlè STDD lion MOREOVER brave
Intended: 'Lèlè is braver than lions.'

Given these distinctions, we propose that Chinese *hái* has a meaning similar to English *even* (see Greenberg 2018, Zhang 2022). As shown in (101) and illustrated in Fig. 7, it is the use of *hái* (rather than *gèng*) that brings such an evaluative presupposition: both the prejacent and alternatives exceed the threshold for the positive use.

(101) ⟦hái⟧(p)

a. asserts the prejacent p

b. presupposes that both the prejacent and alternatives exceed a contextual positive threshold along a scale, while the prejacent further exceeds alternatives (see Fig. 7)
⇝ in a comparative, both the target and the standard exceed I^c_{POS}

Our analysis of *gèng* (see (86)) and *hái* (see (101)) naturally explains the two observations of Ma (2019).

In a comparative with the use of *hái* (see Fig. 7), the target (here HEIGHT(Lèlè)) is compared with the standard (here HEIGHT(Mǐmǐ)), not with a contextual threshold I^c_{POS}. In other words, the prejacent of *hái* is a genuine comparative, not a positive use (cf. (87)). Thus it is possible to include a numerical differential to specify the value of height difference.

(102) ⟦(99a)⟧ ≈ Compared to Mǐmǐ, HÁI Lèlè is 5 cm taller.
(i.e., compared to Mǐmǐ, Lèlè is further taller by 5 cm)

Then for a comparison to convey metaphorical or hyperbolic meaning (see (100)), it is crucial that the comparison standard should already exceed the threshold for the positive use. Thus naturally, as shown by the contrast between Fig. 6 and Fig. 7, *hái*, but not *gèng*, satisfies this requirement.

6 Discussion and conclusion

In this paper, by zooming into the components of comparison (i.e., the target, the standard, and their difference), we have demonstrated a new perspective on cross-linguistic universals and variation on comparison expressions. We have shown that comparison is universally performed by gradable adjectives. Gradable adjectives like *tall* and *short* differ with regard to their direction. Languages with vs. without morphemes like *-er/more* differ with regard to whether gradable adjectives encode, by default, the meaning of non-strict vs. strict inequality.

Based on this understanding of comparison, we have discussed the semantic contribution of cross-linguistic particles used in comparatives, focusing on English *-er/more* and Chinese *gèng*. We analyze them as two kinds of additive particles: (i) English *-er/more* is similar to *another*, while (ii) Chinese *gèng* is similar to *moreover*. Thus the current work also connects the notion of scalarity (or comparison along a scale with ordering) with the notion of additivity.

Our current work suggests a few new directions for further investigation.

First, to account for cross-linguistic variation, we need to consider parameters both at the language level and at a more fine-grained construction level.

Beck (2009) (see also Beck, Oda & Sugisaki 2004), a pioneering work on cross-linguistic variation of comparatives, collects data from 14 languages and proposes that with regard to expressing comparison, languages vary along three parameters: (i) whether ontologically, there are degrees; (ii) whether there can be a lambda abstraction over a degree variable; (iii) whether a degree argument can be overtly observed for a gradable adjective.

In this paper, we have shown that even within the same language, there is construction-level variation, and constructions in different languages can share universals. For example, English implicit and explicit comparison (see (20) and (21)) differ with regard to whether an overt degree argument that represents a difference (i.e., a numerical differential) can be observed. On the other hand, English implicit comparison and Chinexe *bǐ*-comparatives with *gèng* are parallel in making a comparison with a contextually relevant positive threshold. Evidently, in the same language, different constructions often co-exist, based on different ontological assumptions and showing parametric variation.

Second, the connection between scalarity and additivity provides a new perspective on many linguistic phenomena. Traditionally, (i) the investigation of comparatives and scalarity in a domain of scalar values and (ii) the investigation of additive particles like *also/even* in a domain of entities are separate. In analyzing English *-er/more* as well as Chinese *gèng* / Japanese *motto*, we have

shown the connection between scalarity and additivity (see also Greenberg 2018, Zhang 2022's analysis of English *even*).

Scalarity/additivity-related phenomena share similar patterns with regard to **anaphoricity** and **informativeness**. Presumably, these phenomena all involve an anaphoricity between some base item and an increase, and increase is essentially towards increased informativeness.

A further issue is that human languages have a vast variety of addtivity effects. As shown in this paper, English *-er/more* is similar to *another*, working on a DP level, in a domain of entities or scalar values. Chinese *gèng* and Japanese *motto* are similar to English *moreover* (as well as *also/even/still*), working at a propositional level. The variation among addtive particles and across languages provides a rich empirical ground for linguistic investigation.

For example, according to Heim's (1991) 'maximize presupposition', which requires an overt marking of presuppositional meaning, the presence of additive particles is often obligatory if their existential presuppositional requirement is satisfied. However, as illustrated in (103/104), it seems that English and Chinese differ with regard to which additive particles are obligatory or optional.

(103) **English: *another* is obligatorily required; *also* is optional**

a. *A girl came. A girl also came.

b. A girl came. Another girl (also) came. (*also*: optional)

(104) **Chinese: *again* is obligatory; *another* is optional**

lái-le yí-gè rén, yòu lái-le (lìng)-yí-gè rén.
come-ASP one-CL person again come-ASP (other)-one-CL person
'A person came. Another person also came'

Finally, along the discussion, we have skipped over many issues which require to be analyzed at the morphology/syntax-semantics interface. In particular, the distinction between predicative vs. attributive comparatives in Chinese (see e.g., (79/80)) and their different requirement on the presence of *gèng* require another paper for a thorough discussion. Why words like *another* and *moreover* include a morpheme like *-er* also needs more investigation.

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