Degrees are accessed indirectly? A new look at Chinese *bi*-comparatives[1]

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Abstract. Two aspects of Chinese adjectival *bi*-comparatives (*bi*-comparatives) remain underexplored. First, a critical morphosyntactic difference between bare (i.e., those without differential phrases) and differential (i.e., those with differential phrases) *bi*-comparatives is that the morpheme *chu*, literally meaning 'beyond/exceed', is exclusively licensed in the latter, but not in the former. Second, *bi*-comparatives do not freely allow measure phrases (MPs) as the standard of comparison unless there are sufficiently specific contexts. These observations are taken as indications that degrees may only be accessible in some constructions. I propose that (i) bare *bi*-comparatives do not characterize an ordering of degrees, but a directed scale segment (Schwarzschild, 2020); and (ii) while characterizing a directed segment, differential *bi*-comparatives allow the mapping of the segment onto a degree specified by the differential phrase, a role fulfilled by *chu* (à la Wellwood, 2015). Taken together, Chinese *bi*-comparatives may constitute a case where degrees are not encoded in the lexical semantics of gradable adjectives, but introduced via a functional morpheme (Wellwood, 2015; Bochnak et al., 2020).

Keywords: comparatives, states, segments, degrees, functional morphemes

1. Introduction

One prominent way of constructing comparatives in Chinese involves using the morpheme *bi*, which typically signifies the comparative nature of such constructions, as schematized in (1).

(1) X *bi* Y Dimension (Differential Phrase)

Descriptively, X represents items being compared and Y represents the standard of comparison, with the dimension of comparison indicated by either gradable adjectives (GAs) or verbs. On the surface, the differential phrase is considered optional (e.g., Xiang, 2005). This paper will focus on *bi*-comparatives that utilize GAs to indicate dimensions of comparison, such as (2).

(2) a. ZS bi **LS** gao.
ZS BI LS tall
'ZS is taller than LS.'

b. ZS bi LS gao **5-gongfen**.
ZS BI LS tall 5-cm
'ZS is 5 cm taller than LS.'

I designate (2a) as '**bare *bi*-comparatives**', which refer to comparative constructions without differential phrases, and (2b) as '**differential *bi*-comparatives**', which are comparatives that include a differential phrase indicating the extent of difference between the two compared items along a specific dimension.

Current analyses of Chinese adjectival *bi*-comparatives largely center around a debate between phrasal (e.g., Xiang, 2005; Lin, 2009) and clausal (e.g., Liu, 1996, 2011; Hsieh, 2017; Erlewine, 2018) approaches. However, two aspects of Chinese adjectival *bi*-comparatives remain underexplored. First, despite the general surface structure sketched in (1), a critical morphosyntactic difference exists between bare and different *bi*-comparatives, i.e., the morpheme *chu*,

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literally meaning 'beyond/exceed', is exclusively licensed in the latter, as in (3b).

(3) a. *ZS bi LS gao-**chu**.
ZS BI LS tall-CHU
Intended: 'ZS is taller than LS.'

b. ZS bi LS gao-**chu** *(5-gongfen).
ZS BI LS tall-CHU 5-cm
'ZS is 5 cm taller than LS.'

The ungrammaticality of (3a) shows that *chu* is disallowed when there is no differential phrase, whereas it can be suffixed to a GA only when a differential phrase is present, as in (3b), whose meaning is the same as (2b). The same pattern may also be observed in *bi*-comparatives involving GAs that are not associated with traditional measurement units, such as (4).

(4) a. *ZS bi LS congming-**chu**.
ZS BI LS smart-CHU
Intended: 'ZS is smarter than LS.'

b. ZS bi LS congming-**chu** *(hen-duo).
ZS BI LS smart-CHU very-many
'ZS is much smarter than LS.'

congming 'smart' (which is classified as a non-linear GA in Klein (1980)) lacks inherent measurement units, unlike adjectives such as *gao* 'tall'. To convey differences in individuals' degrees of smartness within an appropriate context, speakers typically employ vague expressions such as *henduo* 'many/much' or *hao-ji-bei* 'several times', as illustrated in (4b), where their presence is naturally compatible with *chu*. This pattern, as exemplified in (3) and (4), raises a crucial question: Why is the morpheme *chu* restricted to differential *bi*-comparatives while being excluded from bare *bi*-comparatives?

Second, canonically, both bare and differential *bi*-comparative do not freely allow measure phrases (MPs) to be the standard of comparison, as in (5). From a cross-linguistic perspective, Chinese, like its counterpart English, is categorized as having a positive setting for the 'Degree Semantics Parameter' (DSP), which posits that 'a language {does/does not} have gradable predicate (type $\langle d,\langle e,t\rangle\rangle$ and related), i.e., lexical items that introduce degree arguments'(Beck et al., 2009). This parameter setting predicts that both languages exhibit expressions that refer to degrees and combine with degree operators. Specifically, (i) English and Chinese are predicted to allow a comparison with a degree denoted by an MP, as in 'Sheldon is taller than **180 cm**'; and (ii) both are predicted to freely allow comparatives with differential phrases, such as 'Sheldon is **5 cm** taller than Leonard'. However, the [+DSP] setting for Chinese incorrectly predicts the grammaticality of (5a) and (5b), while it correctly predicts (2b).

(5) a. ??/*ZS bi **180-gongfen** gao.
ZS BI 180-cm tall
Intended: 'ZS is taller than 180 cm.'

b. ??/*ZS bi **180-gongfen** gao 5-gongfen.
ZS BI 180-cm tall 5-cm
Intended: 'ZS is 5 cm taller than 180 cm.'

The two examples in (5) are derived from the two examples in (2) where the individual *LS* is replaced by the MP *180-gongfen* '180-cm' [2]. The result is ungrammatical or seriously degraded. If Chinese and English comparatives are parallel in terms of the [DSP] setting, the ungrammat-

[2]Concerning the availability of MPs as the standard of comparison in Chinese adjectival *bi*-comparatives, complications typically arise depending on the specific GA involved. First, for GAs associated with traditional measurement units, such as *gao* 'tall', *chang* 'long', and *kuan* 'wide', MPs may be licensed as the standard of comparison if preceding discourses provide the same MPs. Second, for GAs like *re* 'hot' and *leng* 'cold', MPs can serve as the standard of comparison only if they represent a temperature value that meets or exceeds the contextually determined threshold. Finally, for GAs such as *kuai* 'fast' and *man* 'slow', MPs are categorically disallowed as the standard of comparison, irrespective of the discourse context. Beck et al. (2009: 22) report that (i) is grammatical, which is viewed as a strong piece of evidence supporting [+DSP] for Chinese.

icality of examples like (5) raises another question: How to explain the canonical unavailability of MPs as the standard of comparison in Chinese adjectival *bi*-comparatives?

The two underexamined aspects above offer significant insights into the syntax and semantics of Chinese adjectival *bi*-comparatives, suggesting two implications. First, the obligatoriness of MPs in the presence of *chu*, as in (3a), suggests that degrees may be accessible in some constructions but not in others, provided that MPs are analyzed as direct predicates of degrees (Schwarzschild, 2005). Second, the canonical unavailability of comparison with a degree specified by an MP, as shown in (5), indicates that GAs in Chinese may lack a degree argument. To provide a more principled account of these patterns, I proposed that (i) bare *bi*-comparatives do not characterize an ordering of degrees, but a directed segment (Schwarzschild, 2020); and (ii) while also characterizing a directed segment, differential *bi*-comparatives allow the mapping of the segment onto a degree specified by the differential phrase, a role fulfilled by *chu* (à la Wellwood, 2015). Taken together, Chinese adjectival *bi*-comparatives may constitute a case where degrees are not encoded in the lexical semantics of gradable predicates, but introduced via a functional morpheme (Wellwood, 2015; Bochnak et al., 2020).

2. Previous studies

As noted above, the debate between phrasal and clausal approaches—namely, Direct Analysis (e.g., von Stechow, 1984; Lechner, 2004) versus Reduction Analysis (e.g., Bhatt and Takahashi, 2011) has been extended to the analysis of Chinese adjectival *bi*-comparatives. In the Direct Analysis, the standard of comparison introduced by *bi* is an individual-denoting DP, and there is a covert comparative morpheme MORE equivalent to the English *-er/more* that is a three-place predicate, taking the target, the standard, and the predicate of comparison (e.g., Xiang, 2005; Lin, 2009) as arguments. Semantically, the covert MORE, represented as $\text{MORE}_{\text{phrasal}}$ following Luo et al. (2022), functions as the comparative operator that applies the predicate of comparison to the target and to the standard and then asserts a *greater-than* relation between them along the dimension denoted by the adjectival predicate (Heim, 1985). Let's take (2a) as an example, and its LF is shown in (6), and its semantic computation proceeds as in (7).

(6) LF: $[_{\text{TP}}$ ZS $[_{bi\text{P}}$ bi LS$]$ $[_{\text{DegP}}$ $[_{\text{Deg'}}$ $\text{MORE}_{\text{phrasal}}]$ $[_{\text{AP}}$ gao$]]]]$

(7) a. $[\![\textit{gao}\text{ 'tall'}]\!] = \lambda d\lambda x.\textbf{height}(x) \geqslant d$

b. $[\![\text{MORE}_{\text{phrasal}}]\!] = \lambda G_{\langle d,et\rangle}\lambda y\lambda x.\textbf{max}(\lambda d.G(d)(x)) > \textbf{max}(\lambda d'.G(d')(y))$

c. $[\![(2\text{a})]\!] = [\![\text{MORE}_{\text{phrasal}}]\!]\ ([\![\text{tall}]\!])\ ([\![\text{ZS}]\!])\ ([\![\text{LS}]\!])$
$= \textbf{max}(\lambda d.\textbf{height}(z) \geqslant d) > \textbf{max}(\lambda d'.\textbf{height}(l) \geqslant d')$

d. $[\![(2\text{a})]\!] = 1$ iff $\textbf{height}(z) > \textbf{height}(l)$

Note that the morpheme *bi* here is taken to be semantically vacuous. One important feature of such an analysis is that the size of the constituent introduced by *bi* is syntactically transparent

(i) Lisi bi **yi-mi-qi** gao.
Lisi BI 1-m-7 tall
'Lisi is taller than 1.7m.'

However, for all sixteen native speakers consulted for this paper, (i) is consistently judged to be ungrammatical or severely unacceptable without a very specific context. I will leave this complication for future research.

and there is no reduction operation involved in the derivation, as shown in (6).

In the Reduction Analysis, a comparative deletion is involved in the constituent introduced by *bi*, i.e., a copy of the predicate of comparison inside the *bi*-phrase is deleted (Liu, 1996, 2011; Hsieh, 2017; Erlewine, 2018[3]). The underlying structure for (2a) is shown in (8) and the semantic derivation proceeds as in (9).

(8) LF: $[_{\text{TP}}[_{\text{DegP}}\ [_{\text{Deg}}\ \text{MORE}_{\text{clasual}}][[\text{bi LS gao}][\text{ZS gao}]]]]$

(9) a. $[\![\text{MORE}_{\text{clausal}}]\!] = \lambda D_{1\langle dt\rangle}\lambda D_{2\langle dt\rangle}.\mathbf{max}(D_2) > \mathbf{max}(D_1)$

b. $[\![\textit{gao}\ \text{`tall'}]\!] = \lambda d\lambda x.\mathbf{height}(x) \geqslant d$

c. $[\![\text{ZS}\ \textit{gao}\ \text{`tall'}]\!] = \lambda d.\mathbf{height}(z) \geqslant d$

d. $[\![\text{LS}\ \textit{gao}\ \text{`tall'}]\!] = \lambda d'.\mathbf{height}(l) \geqslant d'$

e. $[\![\text{(2a)}]\!] = [\![\text{MORE}_{\text{clausal}}]\!]\ ([\![\text{ZS}\ \textit{gao}\ \text{`tall'}]\!])\ ([\![\text{LS}\ \textit{gao}\ \text{`tall'}]\!])$
$= \mathbf{max}(\lambda d.\mathbf{height}(z) \geqslant d) > \mathbf{max}(\lambda d'.\mathbf{height}(l) \geqslant d')$

f. $[\![\text{(2a)}]\!] = 1$ iff $\mathbf{height}(z) > \mathbf{height}(l)$

Both Liu (1996) and Hsieh (2017) assume that the constituent headed by *bi* is an adjunct left-adjoined to the predicate of comparison, as exemplified in (8), and *bi* is semantically vacuous. There is a covert comparative morpheme, represented as $\text{MORE}_{\text{clausal}}$ (again, following Luo et al. (2022)) similar/equivalent to the English morpheme *-er/more*. As (9) illustrates, one core feature of the semantic derivations is that there is a deleted copy of the GA inside the *bi*-phrase, indicating that Chinese *bi*-comparatives parallel to their English counterparts to some extent.

While the two approaches here may initially appear effective, they are subject to challenges posed by the underexamined aspects outlined in the preceding section. First, existing analyses often fail to provide a clearer account of the semantics of differential *bi*-comparatives. For instance, Xiang (2005) and Gu and Guo (2015) observe that differential phrases such as *5-gongfen* '5 cm' in (2a) are structurally optional. If following this line of observation, we may speculate that the covert comparative morpheme MORE is functionally analogous to its counterpart in English, exhibiting two distinct variants, depending on the presence or absence of a differential phrase in the structure, as schematized in (10) (e.g., Morzycki, 2016: 172).

(10) a. $[\![\text{MORE}_{\text{clausal}}]\!] = \lambda D_{1\langle dt\rangle}\lambda D_{2\langle dt\rangle}.\mathbf{max}(D_2) > \mathbf{max}(D_1)$

b. $[\![\text{MORE}_{\text{clausal-diff}}]\!] = \lambda D_{1\langle dt\rangle}\boldsymbol{\lambda d}\lambda D_{2\langle dt\rangle}.\mathbf{max}(D_2) - \mathbf{max}(D_1) \geqslant \boldsymbol{d}$

The $\text{MORE}_{\text{clausal}}$ in (9a) is used as an illustrative example of this speculation. A key challenge for its variant in (10b) is that it fails to account for the dependency between the morpheme *chu* and the differential phrase, as evidenced in (3) and (4). Particularly, the role of *chu* in differential *bi*-comparatives under this approach remains undefined or is entirely unaccounted

[3]Erlewine's (2018) analysis diverges in certain respects from the account presented in (8) and (9). He proposes that the morpheme *bi* in Chinese comparatives functions categorically as a clausal conjunction, linking the target and the standard, both of which are TPs. The derivation of (2a) follows from the standard principles of Chinese clausal syntax, where the standard TP serves as the complement of *bi*, while the target occupies its specifier position. Semantically, *bi* is analyzed as a two-place comparative operator, functionally analogous to (9a). However, Erlewine's analysis faces a number of challenges. For a comprehensive evaluation of his approach, see Lin (2022).

for. Second, a fundamental assumption shared by both the Direct Analysis and the Reduction Analysis is that Chinese adjectival *bi*-comparatives characterize an ordering of degrees, predicated on the assumption that Chinese GAs lexically encode a degree argument, as in (7a) and (9b). Both approaches predict that examples such as (5a) should be grammatical; however, this prediction is not empirically supported, as MPs are categorically disallowed from serving as the standard of comparison in Chinese without sufficiently specific contexts. In other words, the unavailability of MPs serving as the standard of comparison seems to present a potential challenge to the oft-adopted degree-based approaches for Chinese *bi*-comparatives.

However, according to von Stechow (1984), the availability of differential MP readings, as exemplified in (2b) and (3b), which explicitly denote the difference between two individuals' heights, may serve as evidence that degrees are semantic primitives in the language. Following this line of thought, to account for the ungrammaticality of constructions such as (5a) and (5b), one possible approach is to impose an *ad hoc* stipulation where MPs are syntactically disallowed in Chinese adjectival *bi*-comparatives. However, such a restriction would be highly unusual, as it would preclude elements that quantify over degrees from being directly interpreted (Schwarzschild, 2005) in comparatives, while simultaneously maintaining that the comparative morpheme MORE encodes a *greater-than* relation between degrees in comparatives. On the other hand, an alternative approach is to assume that degrees in Chinese are accessed indirectly through a functional morpheme. Building on the structural dependency between *chu* and differential phrases, this paper aims to pursue such an account. This analysis further implies that bare and differential *bi*-comparatives in Chinese may exhibit distinct syntactic and semantic properties, a hypothesis that this paper seeks to support.

3. Ingredients

In this section, I will outline three approaches to comparatives that will be adopted and integrated in this paper, i.e., the states-based approach (Wellwood, 2015; Cariani et al., 2023), segmental semantics (Schwarzschild, 2012, 2013, 2020), and equivalency classes (Bale, 2006).

3.1. The states-based approach

According to the states-based approach developed by Wellwood (2015) and Cariani et al. (2023), GAs denote properties of neodavidsonian states. Within this framework, GAs lexically involve both a contextually-determined threshold property and a background state structure. Positive uses of GAs rely on the threshold property, while GAs in comparatives make use of degrees that represent elements of the background structure. The lexical semantics of a GA like *tall* looks as in (11), with the threshold property indicated as $\mathbf{tall}_C$, and the background property indicated as the functional restriction to states in an ordering of height states.

(11) $[\![\text{tall}]\!]^{c,\sigma} = \lambda s_v : s \in Dom(\langle D_{\mathbf{height}}, \succ_{\mathbf{height}} \rangle).\mathbf{tall}_{\mathrm{C}}(s)$ $\langle vt \rangle$

With this lexical semantics in hand, the use of a GA in a positive form asserts that the threshold property holds of a state that the subject is in. The states-based approach capitalizes on the order-theoretic properties of gradable stative predicates and implements this context sensitivity via a contextual index on the GA. The use of a GA in a comparative, on the other hand, asserts that the background property holds of a state that the subject is in, and that the measurement of this state exceeds the measurement of some other state.

For the comparative in (12a), Cariani et al. (2023) posit that the comparative morphology bypasses the GA's threshold property and allows the GA to directly access the background ordering. Specifically, Cariani et al. (2023) assume that there is a silent morpheme DEG that helps the GA discard the threshold property, as in (13c-d). The interpretation of (12a) is derived as in (13) based on the structure in (12b), abbreviating the *than*-clause as δ (Wellwood, 2015).

(12) a. Joe is taller than Katie.

b. LF: $[_{\mathrm{S}}\ [_{\mathrm{DP}}\ \mathrm{Joe}_{[+\mathrm{ho}]}]\ [_{\mathrm{AP}}\ [_{\mathrm{DegP}}\ [_{\mathrm{Deg'}}\ \mathrm{MUCH}\ \textit{-er}][_{\textit{than}\mathrm{P}}\ \delta]][_{\mathrm{A'}}\ \mathrm{DEG\ tall}]]]$

(13) a. $[\![\mathrm{Deg'}]\!]^A = \lambda d \lambda v.A(\mu)(v) > d$

b. $[\![\mathrm{DegP}]\!]^A = \lambda v.A(\mu)(v) > \delta$

c. $[\![\mathrm{DEG}]\!]^A = \lambda P_{vt}\lambda v_v.\mathbf{bg}(P, v)$ 'given *P*, being in the background associated with *P*'

d. $[\![\mathrm{DEG\ tall}]\!]^A = \lambda s.\mathbf{bg}(\mathbf{tall}_C)(s)$

e. $[\![\mathrm{AP}]\!]^A = \lambda s.\mathbf{bg}(\mathbf{tall}_C)(s)\ \&\ A(\mu)(s) > \delta$ PM

f. $[\![\mathrm{S}]\!]^A = [\![\mathrm{DP}]\!]\ \&\ [\![\mathrm{AP}]\!] = \lambda s.\mathbf{ho}(s, j)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)\ \&\ A(\mu)(s) > \delta$ PM

g. $[\![(12\mathrm{b})]\!]^A = \top$ iff $(\exists s)(\mathbf{ho}(s, j)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)\ \&\ A(\mu)(s) > \delta)$

θ-marked syntactic arguments are interpreted as properties of eventualities, which flows from the neodavidsonian framework (Champollion, 2015), so that the subject *Joe* is of the same type as the predicate. The structure of the *than*-clause is given schematically in (14a), and its internals are exactly like its corresponding main clause, except that the complex *much* and ABS[4] combine with a GA. The interpretation of the *than*-clause in (12a) is derived as in (14b).

(14) a. $[_{\textit{than}\mathrm{P}}$ than Op_i [Katie tall [t_i [much_μ ABS]]]]

b. $[\![(14\mathrm{a})]\!]^A = [\![\mathrm{than}]\!]\ ([\![Op_i\ [\ \mathrm{Katie\ tall}\ [\mathrm{t}_i\ [\mathrm{much}_\mu\ \mathrm{ABS}]]]]]\!]^A)$
$= [\lambda D_{dt}.\mathbf{max}(D)](\lambda d'.(\exists s')(\mathbf{ho}(s', k)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s')\ \&\ A(\mu)(s') > d'))$
$= \mathbf{max}(\lambda d'.(\exists s')(\mathbf{ho}(s', k)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s')\ \&\ A(\mu)(s') > d'))$

Combining (13f) with (14b) delivers the truth condition in (15), which says that Joe is in a state in the domain of the background structure associated with the contextually-determined property of being tall, the measurement of which exceeds any such state of Katie.

(15) $[\![\mathrm{Joe\ is\ taller\ than\ Katie}]\!]^A = \top$ iff $(\exists s)(\mathbf{ho}(s, j)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)\ \&\ A(\mu)(s) >$
$\mathbf{max}(\lambda d'.(\exists s')(\mathbf{ho}(s', k)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s')\ \&\ A(\mu)(s') > d')))$

We can see from (15) that one important feature of the states-based approach for comparatives is that states are mapped to degrees by a measure function introduced by the comparative morphology[5], i.e.$[\![\mathrm{MUCH}_\mu]\!]^A$.

[4]According to Wellwood (2015), an expression of $\langle v,d\rangle$ is linked to an overt variable degree by the morpheme ABS, whose semantics is exemplified as below: $[\![\mathrm{ABS}]\!] = \lambda g \lambda d \lambda v.g(v) \succcurlyeq d$ (type $\langle vd,\langle d,vt\rangle\rangle$).This morpheme links the interpretation of *much* to the trace of an operator, i.e., *Op*, whose *wh*-movement is interpreted as a λ-abstraction over degrees by Predicate Abstraction.

[5]Wellwood (2015) follows Bresnan (1973) and assumes that the comparative morpheme *more* in English can be decomposed into *much* and *-er*. Moreover, the morpheme *much* may appear in both comparatives involving nouns

3.2. Segmental semantics

Schwarzschild (2012, 2013, 2020) develop a semantics based on segments and further proposes that degree constructions, such as comparatives, make use of quantification over segments, i.e., a directed scale segment. According to Schwarzschild (2012), a directed scale segment features a scale and two points, one of which is the **START** point of the segment and the other is the **END** point of the segment. The following are notations for the semantics of scale segments detailed in Schwarzschild (2020: 235).

(16) Segmental semantic notations

a. σ — variable over scalar segments

b. **START**(σ) — the first element of σ (a degree)

c. **END**(σ) — the second element of σ (a degree)

d. μ_σ — the third element of σ (a measure function)

e. $\nearrow(\sigma)$ — σ is a rising segment

A scale segment is a triple consisting of a measure function that assigns degrees (16d), and two degrees in the range of the function (16b-c). **START**(σ) represents the starting point of the segment, and **END**(σ) the ending point of the segment. A segment is rising, represented as $\nearrow(\sigma)$, if its end is higher than the start. Let's use (17a) to illustrate how this works.

(17) a. Kim is taller than Leonard.

b. $[_{\text{degP}}$ Kim $[_{\text{deg'}}$ $[_{\text{deg}}$ END$]$ $[_{\text{DegP}}$ $[_{\text{AP}}$ tall$]$ $[_{\text{Deg'}}$ $[_{\text{Deg}}$ er$]$ $[_{\text{PP}}$ than Leonard $]]]]]$

Schwarzschild adopts the structure in (17b) and further argues that END and *than* are treated on a par with thematical roles of predicates. The semantic computation for (17a) proceeds below:

(18) a. $[\![\text{than}]\!]^c = \lambda y \lambda \sigma.\textbf{START} = \mu_\sigma(y)$ — $\langle e, \sigma t\rangle$

b. $[\![\text{PP}]\!]^c = \lambda \sigma.\textbf{START} = \mu_\sigma(l)$ — σt

c. $[\![\text{tall}]\!]^c = \lambda \sigma.\mu_\sigma = \textbf{HT}$ — σt

d. $[\![\text{er}]\!]^c = \lambda \sigma.\nearrow(\sigma)$ — σt

e. $[\![\text{DegP}]\!]^c = \lambda \sigma.\mu_\sigma = \textbf{HT}\ \&\ \nearrow(\sigma)\ \&\ \textbf{START} = \mu_\sigma(l)$ — σt

f. $[\![\text{END}]\!]^c = \lambda x \lambda \sigma.\textbf{END} = \mu_\sigma(x)$[6] — $\langle e, \sigma t\rangle$

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and verbs, as shown in the following:

(i) a Joe bought as **much** coffee as Donald did.

b Joe ran as **much** as Donald did.

Wellwood (2015) interprets *much* as relative to any assignment of values to variables, A, as in (ii).

(ii) $[\![\text{much}_\mu]\!]^A = A(\mu)$

Here, μ ranges over measure functions of type $\langle v,d\rangle$, where d represents the type of degrees. Potential values for μ could be VOLUME, TEMPERATURE, or DURATION.

[6]There is a type mismatch between END and DegP here. To circumvent this issue, Schwarzschild (2020: 237) proposes a rule called 'Segment Identification', as stated in the following:

"Let α be a node with two daughters, β and γ. Let β of type $\langle e,\sigma t\rangle$ and γ of type $\langle \sigma t\rangle$, then $[\![\alpha]\!]^{g,c} = \lambda x \lambda \sigma.[\![\beta]\!]^{g,c}(x)(\sigma)\ \&\ [\![\gamma]\!]^{g,c}(\sigma)$ (σ is the semantic type for segment)."

g. $[\![\text{degP}]\!]^c = \lambda\sigma.\mathbf{END} = \mu_\sigma(k)\ \&\ \mu_\sigma = \mathbf{HT}\ \&\ \nearrow(\sigma)\ \&\ \mathbf{START} = \mu_\sigma(l)$ $\qquad \sigma t$

h. $[\![(17a)]\!]^c = (\exists\sigma)(\mathbf{END} = \mu_\sigma(k)\ \&\ \mu_\sigma = \mathbf{HT}\ \&\ \nearrow(\sigma)\ \&\ \mathbf{START} = \mu_\sigma(l))$

(18h) says that there is a rising segment of the height scale that begins with Leonard's degree of height on the scale and ends with Kim's degree of height on the scale.

3.3. Equivalency classes

Bale (2006) hypothesizes that GAs are associated with binary relations, i.e., the interpretation of GAs consists of a domain D of individuals and a graph G, a subset of $D\times D$. Such relations lay the foundation to the establishment of primary scales that are directly relevant to the interpretation of comparatives. Such a scale can be constructed in the following three steps.

Step 1 Define equivalency relation
The first step in forming a scale is to define equivalency relation, which can be achieved by associating each member in the domain with a set of elements that are indistinguishable from it, relative to the binary relation. The domain is represented in the following:

(19) $\langle D_\zeta, \{\langle x,y\rangle : x,y \in D_\zeta\ \&\ x \text{ has as much } A \text{ as } y\}\rangle$

ζ refers to relations like *tall* and *hot*, and the domain of such a relation is a subset of the domain of ordinary individuals in a given context. Then, we need to work out how to group into sets all the individuals that are equal to each other according to this relation. These sets define the equivalency classes. Bale (2006) defines the equivalency relation in terms of substitution, namely two individuals are equivalent in terms of the relation ζ if and only if they can substitute for one another without changing the truth values of statements involving ζ. For two individuals, a is equivalent to b (i.e., $a \sim b$) if and only if the following condition is met:

(20) $(\forall x \in D_\zeta)((a \succcurlyeq_\zeta x \Leftrightarrow b \succcurlyeq_\zeta x)\ \&\ (x \succcurlyeq_\zeta a \Leftrightarrow x \succcurlyeq_\zeta b))$

According to (20), two individuals a and b are equivalent to each other if and only if every individual to which a is related, b is also related and vice versa.

Step 2 Form equivalency classes
The next step is to form equivalency classes (Es) by grouping all the individuals that are equivalent to each other into the same set. For any quasi-order ζ, the set of Es is defined in (21).

(21) Let e_ζ be a function from D_ζ to $POW(D_\zeta)$ such that
$\forall x \in \zeta(e_\zeta(x) = \{y\text{: } y \in D_\zeta \&\ x \sim y\})$

The function is from the individuals in the domain of the relation ζ onto an equivalency class. Based on the definition in (21), the set of equivalency classes can be defined as follows:

(22) The set of equivalency classes E_ζ for ζ
$E_\zeta = \{X \subseteq D_\zeta \mid (\exists x \in D_\zeta)(X = e_\zeta(x))\}$

Based on the two definitions here, E_ζ contains all subsets of the domain of ζ such that every individual in the subset is equivalent to every other individual in the subset.

Step 3 Build a linear order
After establishing equivalency classes, the next step is to introduce a linear order on the set con-

taining each equivalency classes. This can be achieved by making use of the relation underlying connected quasi-order between individuals. A linear order $\succcurlyeq_\zeta$ is defined below[7]:

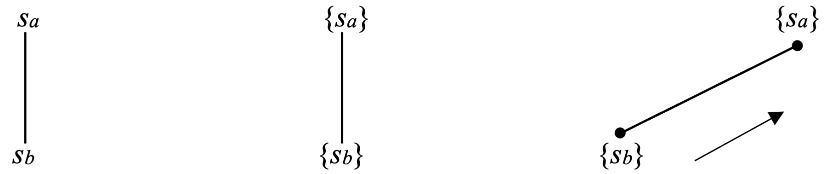
(23) A linear order on E_ζ
$\forall X,Y \in E_\zeta\ (X \succcurlyeq_\zeta Y)$ iff $\exists x,y[(x \in X)\ \&\ (y \in Y)\ \&\ \zeta(x,y)]$

An equivalency class X is equal to or greater than an equivalency class Y iff the members of X bears the relation ζ to the members of Y. For instance, if ζ were the relation *has as much height as*, then $X \succcurlyeq Y$ if and only if the members of X has as much height as the members of Y.

3.4. A synthesis

This paper will develop an analysis that synthesizes the three theoretical frameworks above. Specifically, I propose that a segment is a connected region ordering equivalency classes (Bale, 2006), whose ordering base consists of states held by individuals (Wellwood, 2015; Cariani et al., 2023). Given that such a segment is connected, transitive, reflexive, and anti-symmetric, each *E*, which comprises a set of states, is linearly ordered. When a comparative characterizes a directed scale segment, the start and end points of this segment correspond, respectively, to two equivalency classes—each consisting of a set of states, as sketched below.

(24)



(a) individual states (b) equivalency classes (c) a rising segment

The resulting order of *E*s creates a structure that lays a foundation to characterize comparatives. Under the scenario in (24), the comparative '*a* is taller than *b*' is to characterize a rising segment whose start point is the equivalency class containing *b*'s height state and end point is the equivalency class containing *a*'s height state. This conceptualization of a directed scale segment aims to offer a novel perspective and tool for understanding comparatives.

4. The compositional semantics of Chinese adjectival *bi*-comparatives

This section proposes a new semantic analysis of Chinese adjectival *bi*-comparatives, with the central objective of demonstrating that bare and differential *bi*-comparatives exhibit both syntactic and semantic distinctions.

4.1. GAs and segments

GAs in Chinese may receive different interpretations in a range of constructions, as in (25).

(25) a. zhe-ge-ren na-me (***hen**) **gao**, wo kending pao-bu-guo ta.
DEM-Clf-person that-ME very tall 1SG definitely run-NEG-surpass 3SG
'This guy is so tall, I definitely cannot outrun him.' (✓ positive GA)

[7]Bale (2006:131-132) demonstrates that $\succcurlyeq_\zeta$ is connected, transitive, reflexive, and anti-symmetric, based on the condition that ζ is a connected quasi-order. In other words, $\succcurlyeq_\zeta$ has all the properties of a linear order.

b. **Context**: ZS is a two-year-old baby. Whenever talking to her friends, ZS's mom always says the following sentence with a hand gesture showing his son's height:
wo-de-erzi you na-me (***hen**) **gao**, neng mo-dao yizi le.
1SG-GEN-son have that-ME very tall, can touch-to chair SFP
'My son is that tall, and (he) can even reach to the chair now.' (* positive GA)

The GA *gao* 'tall' in (25a) elicit positive readings where the morpheme *hen* is prohibited, a morpheme that is usually obligatorily required for positive interpretations of GAs (e.g., Grano, 2012; Liu, 2018). Contrastingly, *gao* in (25b), where *hen* is similarly disallowed, fails to yield a positive reading. This disparity between (25a) and (25b) in terms of GA interpretations, at least, points to a descriptive generalization: GAs in examples like (25a) where they receive positive readings morphosyntactically differ from those in examples (25b) where they do not, despite sharing identical surface forms. To capture such a property of GAs, based on Cariani et al. (2023), I assume that there is a silent morpheme BG (background) immediately preceding the GA in *bi*-comparatives that helps the GA discard the threshold property.

(26) a. $[\![\textit{gao} \text{ 'tall'}]\!]^c = \lambda s_v.\mathbf{tall}_\mathrm{C}(s)$

b. $[\![\mathrm{BG}]\!]^c = \lambda P_{vt}\lambda v_v.\mathbf{bg}(P, v)$ 'given *P*, being in the background associated with *P*'

c. $[\![\mathrm{BG}\ \textit{gao}]\!]^c = [\![\mathrm{BG}]\!]^c([\![\textit{gao} \text{ 'tall'}]\!]^c) = \lambda s.\mathbf{bg}(\mathbf{tall}_C)(s)$

According to Cariani et al. (2023), bare GAs inherently encode a contextually-determined property—specifically, the threshold property, as exemplified in (26a). GAs in adjectival *bi*-comparatives are essentially positive forms that are interpreted as invoking state structures and expressing properties. When a GA appears in comparatives, a silent morpheme BG invokes background (**bg**) function, which inputs a property and outputs its background structure (i.e., an overall ordering of states of height, and states of being tall are part of this broader ordering).

Then, following Schwarzschild (2020), I posit the existence of a silent operator that combines with an AP, resulting in a predicate of segments. This operator is represented as *\$* composed of an 'S' for scale and a line through it representing a segment, as in Schwarzschild (2020: 246). The operator is initially defined in (27) below where *f* is a variable over a set of states.

(27) $[\![\$]\!]^c = \lambda f_{vt}\lambda\sigma_\sigma.\sigma \sqsubseteq \{S \subseteq f : \exists s \in f.(S = s^{\text{-}\zeta})\}$ (first version)

As mentioned before, I propose that a segment is a connected region that orders equivalency classes, where the ordering base is the states held by individuals. Thus, given a set of states, denoted as f_{vt}, a segment characterized by a comparative is constructed from a set of equivalency classes formed out of this set of states. This can be represented as $\sigma \sqsubseteq \{S \subseteq f : \exists s \in f.(S = s^{\text{-}\zeta})\}$, which is essentially equivalent to $\sigma \sqsubseteq Dom(D_{\text{-}\zeta}, \succsim_{\text{-}\zeta})$, namely the domain of a segment consists of a set of equivalency classes of states and each equivalency class is linearly ordered. The subset relation $\sqsubseteq$ is adopted in line with Schwarzschild and Wilkinson (2002). Furthermore, adjectival *bi*-comparatives of superiority are morpho-syntactically distinguished from adjectival *bi*-comparatives of inferiority through GAs, as exemplified in (28).

(28) a. ZS bi LS **gao**.
ZS BI LS tall
'ZS is taller than LS.'

b. ZS bi LS **ai**.
ZS BI LS short
'ZS is shorter than LS.'

Given this morphosyntactic feature of Chinese adjectival *bi*-comparatives, I propose that the segment operator *\$* not only introduces a predicate of segments but also specifies the direction of these segments when occurring in the structure. This directional characterization is dependent on whether the operator combines with positive or negative GAs. Specifically, when the operator combines with a positive GA, it introduces a predicate of a rising segment; conversely, when it combines with a negative GA, it introduces a predicate of a falling segment.

(29) a. $[\![\$]\!]^c = \lambda f_{vt}\lambda\sigma_\sigma.\sigma \sqsubseteq \{S \subseteq f : \exists s \in f.(S = s^{\text{-}\zeta})\}\ \&\ \sigma_C$ (final version)

b. $[\![\$\,[\text{BG}\ \mathit{gao}]]\!]^c = [\![\$]\!]^c([\![[\text{BG}\ \mathit{gao}]]\!]^c)$
$= [\lambda f_{vt}\lambda\sigma_\sigma.\sigma \sqsubseteq \{S \subseteq f : \exists s \in f.(S = s^{\text{-}\zeta})\}\ \&\ \sigma_C](\lambda s.\mathbf{bg}(\mathbf{tall}_C)(s))$
$= \lambda\sigma.\sigma \sqsubseteq Dom(D_{\text{-}H}, \succcurlyeq_{\text{-}H})\ \&\ \nearrow(\sigma)$

The definition for the operator *\$* in (27) is refined in (29a) in which σ_C is used to represent the direction of the segment determined by contextually supplied GAs, as illustrated in (29b).

4.2. The standard marker

Descriptively, the morpheme *bi* functions to introduce the standard of comparison that is in a contrastive relation with its corresponding target of comparison (Liu, 2011). To interpret the semantic function of *bi*, I synthesize the semantics of *than* in English comparatives, as proposed in degree-based approaches (e.g., von Stechow, 1984; Rullmann, 1995; Kennedy, 1999), with the semantics assigned to *than* in segmental semantics by Schwarzschild (2020)—the standard marker introducing the start point of a segment. Specifically, I propose that *bi* performs two functions: (a) introducing the start point of a segment characterized by an adjectival *bi*-comparative; and (b) taking the characteristic function of a set of states and outputting the maximal state that the set maps to an equivalency class corresponding to the start point of the segment. The semantics of *bi*[8] is formalized in (30).

(30) $[\![bi]\!]^c = \lambda g_{vt}\lambda\sigma_\sigma.\mathbf{START}(\sigma) = (\mathbf{max}(g))^{\text{-}\zeta}$ $\langle vt, \sigma t\rangle$

With the respect to the internal structure of *bi*P, following Liu (1996, 2011) and Erlewine (2018), I posit that there is an instance of AP within it, which forms a small clause with DP but is subject to obligatory deletion (Hsieh, 2017). The internal structure of the *bi*P is given schematically in (31a), based on the example in (2a). The interpretation of the *bi*P in (31a) is interpreted as in (31b) and (31c).

(31) a. $[_{bi\text{P}}\ \text{bi}\ [_{\text{SC}}\ \text{LS}_{[+\text{ho}]}\ \cancel{\text{BG gao}}]]$

b. $[\![[_{\text{SC}}\ \text{LS}_{[+\text{ho}]}\ \cancel{\text{BG gao}}]]\!]^c = [\![\text{LS}_{[+\text{ho}]}]\!]^c\ \&\ [\![\text{BG gao}]\!]^c = \lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)$

c. $[\![bi\text{P}]\!]^c = [\![bi]\!]^c([\![\text{SC}]\!]^c)$
$= [\lambda g_{vt}\lambda\sigma_\sigma.\mathbf{START}(\sigma) = (\mathbf{max}(g))^{\text{-}\zeta}](\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s))$
$= \lambda\sigma.\mathbf{START}(\sigma) = (\mathbf{max}(\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}$

According to (31c), the *bi*P in (31b) is interpreted as denoting the start point of the segment which corresponds to an equivalency class containing the maximal height state held by LS.

[8] In the existing literature, the grammatical status of *bi* is quite indeterminate. There have been a variety of observations regarding *bi* in Chinese comparatives. Syntactically, it is argued to be a preposition (Liu, 1996, 2011), a verbal head (Erlewine, 2007), a comitative (Gu and Guo, 2015), or a conjunction (Erlewine, 2018). In this paper, I do not take a specific stance on these observations and simply treat *bi* as a morpheme introducing the standard of comparison in Chinese *bi*-comparatives and semantically functioning like *than* in English comparatives.

4.3. The comparative morpheme

Liu (2018) argues that *bijiao* is an overt comparative morpheme in Chinese, as shown in (32).

(32) a. ZS **bijiao** gao.
ZS MORE tall
'ZS is taller.'

b. ZS bi LS (***bijiao**) gao.
ZS BI LS MORE tall
'ZS is taller than LS.'

From the gloss for *bijiao* in (32a), it can be seen that Liu interprets it as a counterpart to *more* in English. However, this morpheme must not overtly appear in comparatives, as illustrated in (32b), in which its occurrence would immediately lead to ungrammaticality[9]. Liu (2018) claims that *bijiao* serves as the default overt comparative morpheme in Chinese, occurring in comparative constructions where an explicit standard of comparison is syntactically unexpressed (e.g., (32a)). In contrast, its covert allomorph BIJIAO manifests exclusively in comparatives where the standard of comparison is explicitly introduced by the morpheme *bi* (e.g., (32b)).

While I remain agnostic towards Liu's proposal, built on his insight, through an examination of the CCL corpus at Peking University and BCC corpus[10], it is observed that the morpheme *jiao*, a part of *bijiao*, can appear overtly in *bi*-comparatives, either immediately preceding GAs (33a) or the *bi*-phrase (33b).

(33) a. ...feiyong **bi** chuzu-che **jiao** gao yi-xie.
fare BI rent-car JIAO high one-little
'... the fare is a bit higher than taxi.'

b. ...yang-yu yang-niao **jiao** **bi** yang-ge hai heping yi-xie.
raise-fish raise-bird JIAO BI raise-pigeon even peaceful one-little
'...raising fish and birds is more peaceful than raising pigeons.'

As evidenced by these examples, it appears that the morpheme *jiao* assumes a role in Chinese adjectival *bi*-comparatives, despite its usual absence in comparatives. Descriptively, *jiao* contributes to the expression of comparison-related meanings, as exemplified in (34a).

(34) a. ZS **jiao** gao.
ZS JIAO tall
'ZS is taller.' $\nrightarrow$ ZS is tall.

b. ZS **geng** gao.
ZS even.more tall
'ZS is even taller.' $\rightarrow$ ZS is tall.

The degree adverb *geng* 'even-more' in (34b), according to Liu (2018), not only signals a comparative meaning but also demands that both the standard of comparison and the target of comparison hold true for the property represented by the GA. Conversely, *jiao* in (34a) simply requires ZS to be taller than the individual in a salient context, without presupposing that either ZS or the contextually salient individual is tall. Therefore, based on the descriptive evidence that the morpheme *jiao* may overtly occur in *bi*-comparatives and semantically contributes to a *greater-than* meaning, I argue that *jiao* functions as a comparative morpheme in Chinese, which may assume a covert form in comparatives like those (2), which I represent as JIAO.

[9] Liu (2018) explores certain phonological rules in Chinese as an explanation for the ungrammatical nature of examples like (32b). Nonetheless, I maintain a neutral stance on Liu's account and leave the evaluation of his explanations for future research.

[10] The Center for Chinese Linguistics (CCL) corpus: `http://ccl.pku.edu.cn:8080/ccl_corpus/index.jsp`, and the BCC corpus: `https://bcc.blcu.edu.cn`.

Previous studies (e.g., Liu, 1996, 2011; Lin, 2009, 2022) have proposed the presence of a covert comparative morpheme MORE preceding GAs in *bi*-comparatives, which semantically encodes a *greater-than* relation. The evidence presented above supports this argument, suggesting that this covert morpheme actually has an overt occurrence, i.e., *jiao*. This strongly indicates that Chinese adjectival *bi*-comparatives utilize a comparative morpheme to establish comparative interpretations, rather than relying on the standard marker *bi* (Xiang, 2005; Erlewine, 2018). Its proposed semantics is exemplified in (35), following Schwarzschild (2020).

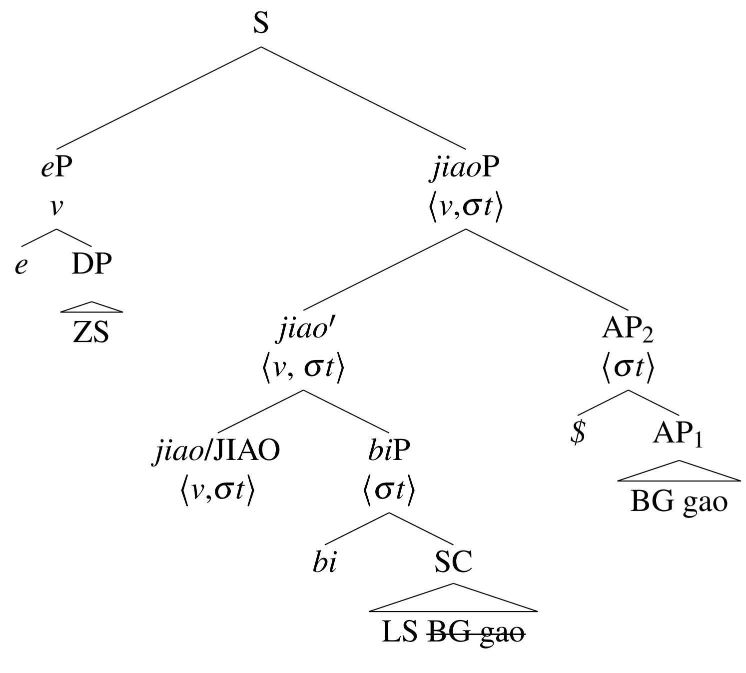
(35) $[\![jiao/\text{JIAO}]\!]^c = \lambda s \lambda \sigma.\mathbf{END}(\sigma) = s^{\text{-}\zeta}$ $\langle v, \sigma t\rangle$

Here, s and σ represent variables over states and segments, respectively. In essence, *jiao* and its covert allomorph JIAO are semantically equivalent to *more*/*-er* in English comparatives in the sense of Schwarzschild (2020)[11], which introduces the end point of a directed segment. According to the definition above, the end point of the segment corresponds to an equivalency class containing a height state held by an individual, represented as $s^{\text{-}\zeta}$ following Bale (2006).

4.4. Bare *bi*-comparatives

Based on the fundamental issues outlined above, I assign the structure in (36) to (2a).

(36)



The structure is motivated on the following grounds. First, *jiao*, as a comparative morpheme in Chinese adjectival *bi*-comparatives, is predominantly covert, represented by JIAO here (i.e., an allomorph of *jiao*), which may be morphosyntactically realized, as seen in (33). Second, building on the well-established structural analysis of comparatives in English (e.g., Bresnan, 1973; Heim, 2000; Bhatt and Pancheva, 2004), I propose that *jiao*/JIAO independently projects a *jiao*P, which selects AP and *bi*P as its arguments. Under this analysis, *jiao*/JIAO first merges

[11]In Section 3.2, the end point of a directed segment is introduced by the head of degP—END in the structure assigned to comparatives. Yet, I follow another option explored by Schwarzschild (2020:251) which takes the comparative marker to introduce the end point of the segment (i.e., of type $\langle d, \sigma t\rangle$), as in (i).

(i) $[\![more/-er]\!] = \lambda d \lambda \sigma.\mathbf{END}(\sigma) = d$

with *bi*P, resulting in the surface structure observed in (33b). To achieve the surface word order in examples like (33a), *bi*P undergoes optional movement to a higher position in the structure, e.g., [Spec, FocP], due to the focus-sensitivity of *bi*P (Liu, 2011). It is crucial to acknowledge two significant distinctions between adjectival *bi*-comparatives and English comparatives: a) the comparative morpheme in the former, i.e., *jiao*/JIAO, is treated as a head projecting *jiao*P; b) in adjectival *bi*-comparatives, AP functions as an internal argument of the comparative morpheme, whereas in English comparatives, it is typically regarded as the main predicate.

With all the requisite assumptions in place, the interpretation of (36) proceeds below.

(37) a. $[\![\mathrm{AP}_2]\!]^c = [\![\$]\!]^c([\![\mathrm{AP}_1]\!]^c) = \lambda\sigma.\sigma \sqsubseteq Dom(D_{\text{-}H},\succcurlyeq_{\text{-}H})\ \&\ \nearrow(\sigma)$

b. $[\![bi\mathrm{P}]\!]^c = \lambda\sigma.\mathbf{START}(\sigma) = (\mathbf{max}(\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}$

c. $[\![jiao']\!]^c = [\![jiao]\!]^c\ \&\ [\![bi\mathrm{P}]\!]^c$
$= \lambda s'\lambda\sigma.\mathbf{END}(\sigma) = s'^{\text{-}H}\ \&\ (\mathbf{max}(\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}$

d. $[\![jiao\mathrm{P}]\!]^c = [\![jiao']\!]^c\ \&\ [\![\mathrm{AP}_2]\!]^c$
$= \lambda s'\lambda\sigma.\mathbf{END}(\sigma) = s'^{\text{-}H}\ \&\ (\mathbf{max}(\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}$
$\&\ \sigma \sqsubseteq Dom(D_{\text{-}H},\succcurlyeq_{\text{-}H})\ \&\ \nearrow(\sigma)$

e. $[\![e\mathrm{P}]\!]^c = [\![e]\!]^c([\![\mathrm{DP}_{[+\mathrm{ho}]}]\!]^c) = [\lambda P_{vt}.\varepsilon s'(P(s'))](\lambda s.\mathbf{ho}(s,z)) = (\varepsilon s')(\mathbf{ho}(s',z))$

f. $[\![\mathrm{S}]\!]^c = \top$ iff
$(\exists\sigma)(\mathbf{END}(\sigma) = ((\varepsilon s')(\mathbf{ho}(s',z)))^{\text{-}H}\ \&\ \mathbf{START}(\sigma) = (\mathbf{max}(\lambda s.\mathbf{ho}(s,l)\ \&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}$
$\&\ \sigma \sqsubseteq Dom(D_{\text{-}H},\succcurlyeq_{\text{-}H})\ \&\ \nearrow(\sigma))$

Some clarification is required at this point. First, there exists a type mismatch between *jiao* and *bi*P, as well as between *jiao'* and AP_2. This mismatch can be resolved by applying the 'Segment Identification' rule (Schwarzschild, 2020: 237), as illustrated in footnote 6 and reformulated in (38) in accordance with the states-based approach.

(38) **Segment Identification**(states-based version)
'Let α be a node with two daughters, β and γ. Let β of type $\langle v,\sigma t\rangle$ and γ of type $\langle\sigma t\rangle$, then $[\![\alpha]\!]^{g,c} = \lambda v\lambda\sigma.[\![\beta]\!]^{g,c}(v)(\sigma)\ \&\ [\![\gamma]\!]^{g,c}(\sigma)$.'

Following this rule, *jiao* and *bi*P, as well as *jiao'* and AP_2, combine intersectively, as illustrated in (37c) and (37d), respectively. Second, DP *ZS* is θ-marked, which expresses predicates of the type *vt*. Following Wellwood (2015: 75), I assume that the DP combines with a silent indefinite determiner *e* (interpreted using ε operator), which is the indefinite counterpart of ι and does not presuppose uniqueness (see von Heusinger (1997)). This is explicated in (37e). Also it is crucial to note that the state held by ZS must be commensurate with the state held by the standard LS, namely the start and end points of the segment characterized by the *bi*-comparative must both correspond to equivalency classes consisting solely of height states . Thus, the end point of the segment is represented as $\mathbf{END}(\sigma) = ((\varepsilon s')(\mathbf{ho}(s',z)))^{\text{-}H}$, indicating that ZS's state is a member of an equivalency class containing height states. Putting everything together, (2a) has the truth condition in (37f), which is true just in case there is a rising segment that begins with an equivalency class containing the height state held by LS and ends with an equivalency class containing the height state held by ZS. Thus, bare adjectival *bi*-comparatives characterize a directed segment by accessing equivalency classes of sets of states held by individuals, which directly blocks degree-denoting MPs as the standard of comparison.

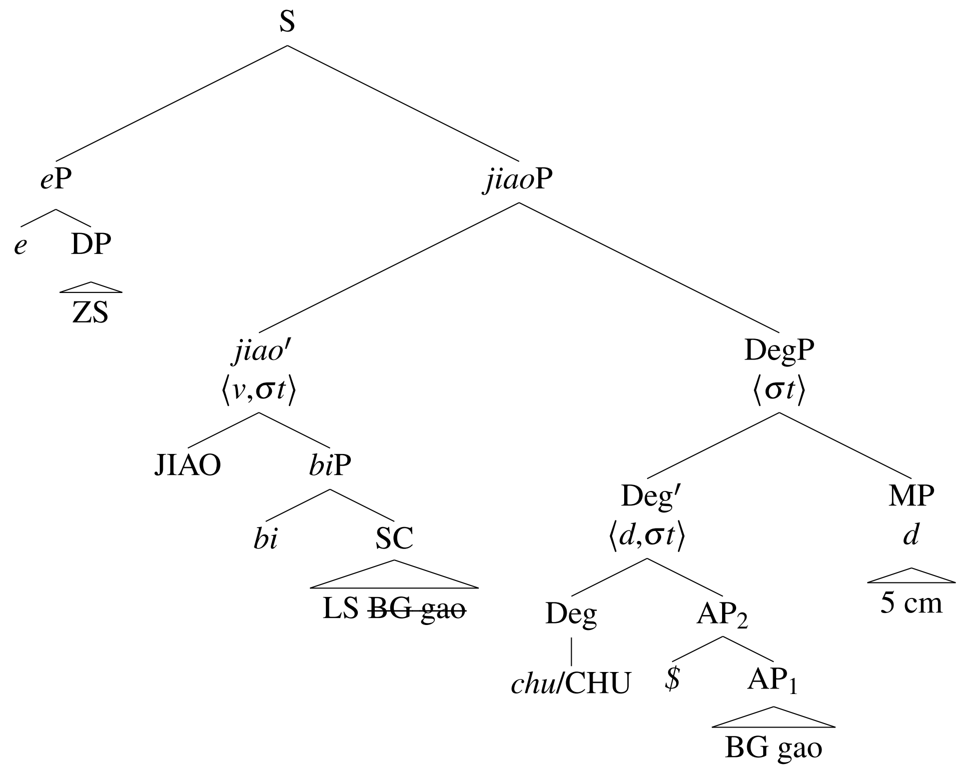
4.5. Differential *bi*-comparatives

One crucial morphosyntactic distinction between bare and differential *bi*-comparatives lies in the possible occurrence of the morpheme *chu* 'beyond/exceed' only in the latter. Interestingly, this morpheme may also occur in another type of comparative constructions in Mandarin, i.e., transitive comparatives, in which GAs, on the surface, appear to function as a three-place predicate and a differential phrase is obligatory. This is illustrated in (39).

(39) Zhangsan gao-**chu** Lisi *(5-gongfen).
Zhangsan tall-CHU Lisi 5-cm
'Zhangsan is 5 cm taller than Lisi.'

The morpheme *chu* can be suffixed to the surface GA *gao* 'tall' in both *bi*-comparatives like (2b) and transitive comparatives like (39), but only in the presence of an MP. Grano and Kennedy (2012) categorize it as a member of an inventory of degree morphemes, represented as a null head μ, whose semantic and syntactic function is to introduce a degree argument. To characterize the role of *chu* in differential *bi*-comparatives, I follow Gu and Guo (2015) and posit that the morpheme *chu*/CHU is a functional morpheme projecting a Degree Phrase in the structure. I assign the structure in (40) to the differential *bi*-comparative in (2b).

(40)



To interpret (40), I follow Grano and Kennedy (2012) and argue that the morpheme *chu*/CHU is a functional morpheme that introduces a degree argument, i.e., mapping a segment onto a degree, based on the idea that degrees are intervals (Schwarzschild and Wilkinson, 2002). *chu*/CHU is defined in (41) below in which Σ is a variable ranging over a set of segments.

(41) $[\![chu/\text{CHU}]\!]^c = \lambda\Sigma_{\sigma t}\lambda \boldsymbol{d}\lambda\sigma.\Sigma(\sigma)\ \&\ \mu(\sigma) \geqslant \boldsymbol{d}$

Based on the definition in (41), (40) is interpreted in the following.

(42) a. $⟦\text{Deg}'⟧^c = ⟦\text{Deg}⟧^c(⟦\text{AP}_2⟧^c) = \lambda d \lambda \sigma.\sigma \sqsubseteq Dom(D_{\text{-}H}, \succeq_{\text{-}H})\ \&\ \nearrow(\sigma)\ \&\ \mu(\sigma) \geqslant d$

b. $⟦\text{DegP}⟧^c = ⟦\text{Deg}'⟧^c(⟦\text{MP}⟧^c) = \lambda \sigma.\sigma \sqsubseteq Dom(D_{\text{-}H}, \succeq_{\text{-}H})\ \&\ \nearrow(\sigma)\ \&\ \mu(\sigma) \geqslant \mathbf{5\ cm}$

c. $⟦\text{S}⟧^c = ⟦\textit{jiao}\text{P}⟧^c(⟦e\text{P}⟧^c)$
$= \lambda \sigma.\mathbf{END} = ((\varepsilon s')(\mathbf{ho}(s', z)))^{\text{-}H}\ \&\ \mathbf{START}(\sigma) = (\mathbf{max}(\lambda s.\mathbf{ho}(s, l)$
$\&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}\ \&\ \sigma \sqsubseteq Dom(D_{\text{-}H}, \succeq_{\text{-}H})\ \&\ \nearrow(\sigma)\ \&\ \mu(\sigma) \geqslant \mathbf{5\ cm}$

d. $⟦\text{S}⟧^c = \top$ iff $(\exists \sigma)(\mathbf{END} = ((\varepsilon s')(\mathbf{ho}(s', z)))^{\text{-}H}\ \&\ \mathbf{START}(\sigma) = (\mathbf{max}(\lambda s.\mathbf{ho}(s, l)$
$\&\ \mathbf{bg}(\mathbf{tall}_C)(s)))^{\text{-}H}\ \&\ \sigma \sqsubseteq Dom(D_{\text{-}H}, \succeq_{\text{-}H})\ \&\ \nearrow(\sigma)\ \&\ \mu(\sigma) \geqslant \mathbf{5\ cm})$

There is a type mismatch between *jiao*′ ($\langle v, \sigma t \rangle$) and DegP ($\langle \sigma t \rangle$), which would be resolved by the ‘Segment Identification’ rule described in (38). Given the projection of DegP headed by the morpheme *chu*/CHU in the syntax of differential *bi*-comparatives, as in (40), the interpretation of differential *bi*-comparatives, to some extent, diverges from that of bare *bi*-comparatives. This distinction is elucidated in (42a-b), in which it is demonstrated that the Deg head introduces a degree argument. The syntactic structure above DegP is interpreted in a manner consistent with the analysis provided in (37). In a word, the differential *bi*-comparative in (2b) has the truth condition in (42d), which says that it is true just in case there is a rising segment that starts with an equivalency class containing LS’s height state, ends with an equivalency class containing ZS’s height state, and is measured 5 cm. The core idea is that a pivotal difference between bare and differential *bi*-comparatives lies in the accessing of degrees facilitated by a functional morpheme in the latter. That is why *chu*/CHU can only occur in differential *bi*-comparatives. Overall, differential *bi*-comparatives build a directed segment based on equivalency classes of sets of states and access degrees indirectly via the functional morpheme which maps the segment onto a degree. This rules out the permissibility of having a direct comparison with a degree, given that MPs directly predicate of degrees (Schwarzschild, 2005).

5. Conclusion

From a descriptive point of view, two important features of Chinese adjectival *bi*-comparatives have been underexplored: (a) the canonical prohibition against MPs from serving as the standard of comparison both in bare and differential *bi*-comparatives; and (b) the exclusive licensing of the morpheme *chu* in differential *bi*-comparatives. Building on these observations, I propose that the *bi*-phrase, which functions as the standard phrase, characterizes an ordering of equivalency classes whose ordering base is states (Wellwood, 2015). This semantic constraint inherently precludes degree-denoting MPs from serving as the standard of comparison in both bare and differential *bi*-comparatives. I further argue that degrees in Chinese adjectival *bi*-comparatives are accessed indirectly, i.e., via a functional morpheme. This may potentially offer support for some cross-linguistic patterns observed by Bochnak et al. (2020) which argues that a range of functional morphemes, such as comparative morphemes and degree modifiers, introduce degrees. However, as briefly noted in footnote 1, there are cases where MPs can serve as the standard of comparison when certain GAs function as the main predicate of comparison, provided appropriate discourse contexts are established. The semantics proposed here aims to provide a foundation for future research to explore the sources of variation in the restrictions on MPs as standards of comparison in Chinese adjectival *bi*-comparatives.

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