The semantics of *yuè…yuè* in Mandarin Chinese: gradability, coercion, and the necessarily temporal reading

Abstract

While most of the existing analyses on the *yuè…yuè* construction in Mandarin Chinese focus on examples where both *yuè* appear in front of a gradable adjective (e.g., *Píngguǒ yuè dà yuè tián* 'the bigger an apple is, the sweeter it is'), in the paper we take a close look at a class of *yuè…yuè* sentences which involve either $yuè_1$ or $yuè_2$ appearing in front of a non-gradable predicate (e.g., *Zhāngsān yuè pǎo yuè kuài* 'Zhangsan ran faster and faster.'). We argue that this class of *yuè…yuè* sentences is semantically distinct from those with both *yuè* appearing in front of a gradable predicate: the former has a necessary temporal reading that the latter do not have. We attribute this semantic distinction to the gradability of the predicate following *yuè* and argue for a coercion-based analysis of the necessarily temporal reading. Our analysis lends support to the interval-based analysis of degrees (Kennedy 2001) and implies that the subinterval relation ($\sqsubset$) can encode a more general notion of comparison than the greater than relation ($<$).

1. Introduction

yuè…yuè sentences in Mandarin Chinese (e.g.,1) are akin to comparative correlatives in English (e.g., *the bigger an apple is, the sweeter it is.*) and have been the subject of several recent studies (Chao 1968, Li and Thomas 1981, Hsiao 2003, Lin 2007, Liu 2008a, E 2014).

(1) Píngguǒ *yuè* dà, *yuè* tián.
apple big sweet
'The bigger an apple is, the sweeter it is.'

Most attention in the previous analyses has been paid to *yuè…yuè* sentences in which the predicates following the first *yuè* (*yuè*$_1$) and the second *yuè* (*yuè*$_2$) are gradable: either gradable adjectives like *dà* 'big' and *tián* 'sweet' in (1) or gradable verbs like *xǐhuān* 'to like' and *tǎoyàn* 'to resent' in (2).

(2) Zhāngsān *yuè* xǐhuān Lìsì, wǒ *yuè* tǎoyàn Lǐsì.
like I resent
'The more Zhangsan likes Lisi, the more that I resent Lisi.'

The gradability of a predicate can be decided by whether it can be modified by a degree modifier such as *hěn* 'very'. In (3) adjectives like *dà* 'big' and *tián* 'sweet' and verbs like *xǐhuān* 'to like' and *tǎoyàn* 'to resent' are shown to be gradable.

(3) a. zhè gè píngguǒ hěn dà/tián.
this Cl apple very big/sweet
'This apple is very big/sweet.'
b. Zhāngsān hěn xǐhuān/tǎoyàn chī píngguǒ.
very like/resent eat apple
'Zhangsan likes/resents eating apples.'

Verbs like *pǎo* 'to run' and *kū* 'to cry', on the other hand, are non-gradable, as they cannot be modified by *hěn* 'very', as shown in (4).

(4) a. *Zhāngsān hěn pǎo.
very run
b. *Zhāngsān hěn kū.
very cry

Interestingly, *yuè* is allowed to precede both a gradable and a non-gradable predicate. According to whether *yuè*$_1$ or *yuè*$_2$ precedes a gradable or a non-gradable predicate, *yuè…yuè* sentences can be classified into four types as shown in the table in (5) and exemplified in (6-8).

(5) Four types of *yuè…yuè* sentences

	yuè$_2$ + gradable	*yuè*$_2$ + non-gradable
yuè$_1$ + gradable	(1) & (2)	(7)
yuè$_1$ + non-gradable	(6)	(8)

(6) Zhāngsān yuè pǎo yuè kuài.
run fast
'Zhangsan ran faster and faster.'

(7) ?Zhāngsān yuè shāngxīn yuè kū.
sad cry
'The sadder he became, the more he cried.'

(8) Zhāngsān yuè pǎo, Lǐsì yuè zhuī.
run chase
'The more Zhangsan ran, the more Lisi chased him.'

In this paper we show that *yuè…yuè* sentences with $yuè_1$ or $yuè_2$ or both preceding a non-gradable verb, exemplified by (6), (7) and (8) in (5), are semantically distinct from those where both $yuè_1$ and $yuè_2$ precede a gradable predicate (e.g., (1) and (2)): the former have a "necessarily temporal" reading that the latter do not have. The "necessarily temporal" reading is a reading that involves an increase of some property over time. For example, (6) means: Zhangsan's running speed increases over time. We attribute this semantic distinction to the gradability of the predicate following *yuè*, and based on that, we propose a semantic analysis that captures the necessarily temporal reading of (6-8).

This paper is structured as follows. Section 2 provides empirical evidence to establish the semantic distinction between the "degree reading" of (1-2) and the "necessarily temporal" reading of (6-8). Section 3 provides a brief review of Lin (2007)'s analysis of *yuè … yuè*, and the limitations of his analysis are discussed. Section 4 introduces our main assumptions and puts forward a coercion-based account. We argue that the necessarily temporal reading falls out as a result of coercion that forces the non-gradable VP to have a totally ordered domain parallel to that of a gradable predicate, where events, like degree intervals, share a common starting point and stand in a proper subpart relation. Section 5 formalizes the analysis and discusses two welcome results that follow from it. Section 6 compares the proposed account to two alternative analyses and shows that the former fares better. Section 7 considers semantics of the two other *yuè … yuè* structures: *yuè* A *yuè* $V_{non\text{-}gradable}$ (e.g., 7) and *yuè* $V_{non\text{-}gradable}$ *yuè* $V_{non\text{-}gradable}$ (e.g., 8). Section 8 concludes the paper.

2 The necessarily temporal reading vs. the degree reading

Let us start with considering the meaning of (1). Intuitively, (1) describes a correlation between two degrees—the degree to which an apple is big and the degree to which an apple is sweet: an increase in the former is accompanied with an increase in the latter. This meaning is illustrated in (9). Let's call it a 'degree reading'.

(9) Correlation between size and sweetness

Apple	Size (measured by diameter)	Sweetness
A	12 cm	10
B	10 cm	7
C	8 cm	5

The table in (9) illustrates the correlation between the size of an apple and its sweetness. Similarly, the *yuè…yuè* sentence in (2) also has a degree reading. It describes a correlation between the degree to which Zhangsan likes Lisi and the degree to which I resent Lisi: an increase in the degree of liking correlates with an increase in the degree of resentment.

In contrast, the *yuè…yuè* sentence in (6) does not have a degree reading. Rather than describing a correlation between the amount of running that Zhangsan did and his running speed, which is expressed in (10),[1] (6) has a necessarily temporal reading; it means: Zhangsan's running speed increases over time.

(10) Zhāngsān pǎo-de yuè duō, (jiù) yuè kuài.
run-De much then fast
'The more Zhangsan ran, the faster he went.'

Note that (10) minimally differs from (6) in that the former has *yuè*$_1$ preceding a gradable adjective *duō* 'much'. Their semantic difference can be seen by considering their truth-values in the two scenarios in (11)—Scenario A and Scenario B.

(11) a. Scenario A

Day	Length of running	Speed of running
1	5 miles	5.3 mph
2	4 miles	5.2 mph
3	3 miles	5.1 mph

b. Scenario B

Day	Length of running	Speed of running
1	3 miles	5.1 mph
2	3 miles	5.2 mph
3	3 miles	5.3 mph

In (11) scenario A differs from scenario B in that in the former Zhangsan's running speed decreases over time, while in the latter it increases over time. Intuitively, (6) is false in A but true

[1] In Mandarin Chinese, adverbs are attached to the verb through the functional morpheme *de*. This structure is known as the 'postverbal complement construction'. For instance, the Chinese equivalent of English sentence *Zhangsan runs fast* is expressed in (i).
(i) Zhāngsān pǎo-de hěn kuài.
run-De very fast
'Zhangsan runs fast.'

in B. In contrast, (10) is true in scenario A in which there is a positive correlation between the amount of running Zhangsan did each day and his running speed. [2] The fact that (6) is false but (10) is true in scenario A shows that these two sentences are truth-conditionally distinct. [3, 4]

It is important to note that the "necessarily temporal" reading of (6) is distinct from the "temporal" reading which Lin (2007: 195) argues that (12) has. (12) has both *yuè* appearing in front of a gradable adjective. It describes a positive correlation between the degree of hotness associated with times and the degree of my uncomfortableness. This reading, as illustrated in (13), crucially does not require the degree of hotness to increase over time.

(12) Tiānqì yuè rè, wǒ jiù yuè bùshūfu.
weather hot I then uncomfortable
'The hotter the weather is, the more uncomfortable I feel.'

(13)

Day	temperature	Degree of uncomfortness
1 ↓	100 °F ↑	9 ↑
2 ↓	85 °F ↑	5
3	72 °F	2

The question then arises: why does (6), with *yuè*$_1$ preceding a non-gradable predicate, receive a necessarily temporal reading? In the paper, we argue for an analysis that makes crucial reference to the gradability of the predicate following *yuè*. We argue that *yuè* is not a degree quantifier, unlike *hěn* 'very'. When *yuè* precedes a non-gradable predicate, there is a coercion operator that forces a non-gradable VP (e.g., Zhangsan ran) to have a totally ordered domain parallel to that of a gradable predicate, where, events, like degree intervals on a degree scale, share a common starting point and stand in a proper subpart relation. On this analysis, (6) means: for any two subevents of Zhangsan's running, e_1 and e_2, if e_1 and e_2 share the same starting point and e_2 contains e_1, e_2 is faster than e_1. This amounts to saying: the longer Zhangsan ran, the faster he went.

3 Lin (2007)'s analysis of *yuè…yuè*

Before we turn to our own analysis, it is useful to consider the existing semantic analyses in the literature. The most detailed semantic analysis of *yuè … yuè* in the literature is due to Lin (2007), who essentially models the meaning of *yuè … yuè* after that of the English comparative correlative in Beck (1997). Lin mostly focuses his attention on *yuè … yuè* sentences where both

[2] The careful reader might note that (10) is false in scenario A where an increase in the cumulative amount of running Zhangsan did (over the three days) correlates with a decrease in his running speed. In section 6, we provide more discussion on the relation between the cumulative reading of (10) and the necessarily temporal reading of (6).

[3] This same contrast holds for the English translations for (6) and (10)—'Zhangsan ran faster and faster' and 'the more Zhangsan ran, the faster he ran.' The former is false in scenario A but the latter is true.

[4] (6) can be alternatively expressed through an idiomatic expression-- *yuè lái yuè*, as shown in (i). *yuè lái yuè*, with the first *yuè* preceding the non-gradable verb *lái* 'to come' can only precede a gradable predicate, and adds a necessarily temporal reading to the sentence. Liu (2008b) provides a detailed discussion of this expression.

(i) Zhāngsān pǎo-de *yuè* *lái* *yuè* kuài.
run-de come fast.
'Zhangsan ran faster and faster.'

yuè precede a gradable predicate. He argues that like the English comparative correlative, *yuè … yuè* sentences, semantically, express an ordering relation on situations (individuals or times) based on degrees. In his analysis, *yuè* has the meaning in (14):[5]

(14) $[[yuè]] = \lambda P_{<d,<s,\, t>>}\lambda d_1 d_2 \lambda s_1 s_2 [P(d_1)(s_1) \wedge P(d_2)(s_2) \wedge d_1 < d_2]$

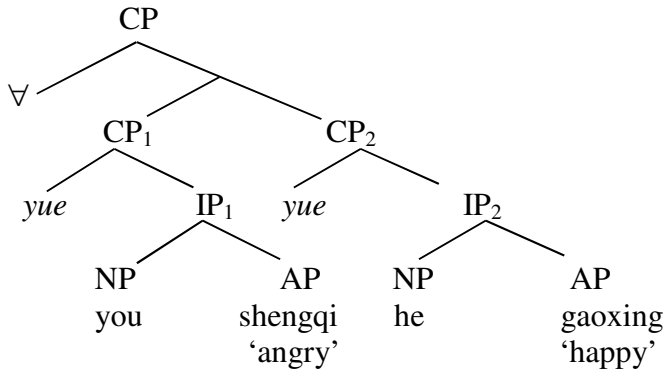
In (14) the first argument of *yuè*, *P*, is a predicate that denotes a relation between degrees and situations (of type *<d, <s, t>>*). When *yuè* composes with *P*, the result is, essentially, an ordering on the set of situations corresponding to the order of the degrees that they are related to via the input property.

To see how (14) works, let us consider the example in (15). Lin argues that (15) has the LF in (16): it consists of two clauses CP_1 and CP_2 and there is a covert universal quantifier ∀ c-commanding them.

(15) nǐ yuè shēngqì, tā (jiù) yuè gāoxìng.
you angry he then happy
'The angrier you are, the happier he is.

(Lin 2007: 169)

(16)



(Lin 2007: 188)

Semantically, Lin assumes that the adjectives *shēngqì* 'angry' and *gāoxìng* 'happy' denote a relation among individuals, degrees and situations (17). When *yuè* composes with IP_1, the result is a relation between degrees (i.e., d_1 and d_2) and situations (i.e., s_1 and s_2) such that you are angry to degree d_1 in s_1 and you are angry to degree d_2 in s_2; d_2 is greater than d_1, as shown in (18a). In the same fashion, the result of combining IP_2 with *yuè* is a relation between degrees, d_3 and d_4, and situations, s_3 and s_4, such that he is happy to degree d_3 in s_3 and he is angry to degree d_4 in s_4; d_4 is greater than d_3, as shown in (18b).

(17) a. $[[shēngqì]] = \lambda x_e \lambda d_d \lambda s_s$. angry(x)(d)(s)
b. $[[gāoxìng]] = \lambda x_e \lambda d_d \lambda s_s$. happy(x)(d)(s)

(18) a. $[[yuè\ nǐ\ shēngqì]] = [[yuè]](\lambda d_d \lambda s_s$. angry(you)(d)(s))
$= \lambda d_1 \lambda d_2 \lambda s_1 \lambda s_2 [\text{angry(you)}(d_1)(s_1) \wedge \text{angry (you)}(d_2)(s_2) \wedge d_2 > d_1]$

[5] In the paper, the following types are used: type *e* for individuals, type *d* for degrees, type *i* for times, type *v* for events, type *s* for situations, and type *t* for truth-values.

b. [[*yuè tā gāoxìng*]] = [[*yuè*]]($\lambda d_d \lambda s_s$. happy(he)(d)(s))
= $\lambda d_3 \lambda d_4 \lambda s_3 \lambda s_4$[happy (he)($d_3$)($s_3$) $\wedge$ happy (he)(d_4)(s_4) $\wedge$ $d_4 > d_3$]

The universal quantifier has the semantics in (19a). It combines with CP_1 and CP_2, and yields the semantics in (19b): [6]

(19) a. $[[\forall]] = \lambda G_{<d, <d, <s, <s, t>>>>} \lambda Q_{<d, <d, <s, <s, t>>>>} \forall d_1 d_2 s_1 s_2 [[G(d_1)(d_2)(s_1)(s_2)] \rightarrow \exists d_3 d_4 s_3 s_4 [Q(d_3)(d_4)(s_3)(s_4)]]$

b. [[$\forall$*yuè nǐ shēngqì, jiù yuè tā gāoxìng*]] = $\forall d_1 d_2 s_1 s_2$[angry(you)(d_1)(s_1) $\wedge$ angry(you)(d_2)(s_2) $\wedge$ $d_2 > d_1$] $\rightarrow$ $\exists d_3 d_4 s_3 s_4$ [$s_1 \leq s_3 \wedge s_2 \leq s_4 \wedge$ happy(he)(d_3)(d_3) $\wedge$ happy(he)(d_4)(s_4) $\wedge$ $d_4 > d_3 \wedge$ R(<d_1, s_1>, <d_3, s_3>) $\wedge$ R(<d_2, s_2>, <d_4, s_4>)]

The formula in (19b) says: for any pair of degrees d_1 and d_2, and any pair of situations s_1 and s_2 such that you are angry to degree d_1 in s_1, and you are angry to degree d_2 in s_2, and d_2 is greater than d_1, there exists a pair of degrees, d_3 and d_4, and a pair of situations, s_3 and s_4, such that s_3 is an extended situation of s_1 and s_4 is an extended situation of s_2; he is happy to degree d_3 in s_3, and he is happy to degree d_4 in s_4; d_4 is greater than d_3. This semantics adequately captures the truth-conditions of (16); namely, (16) is true if and only if an increase in the degree of angriness correlates with an increase in the degree of happiness.

However, the compositional semantics consequently assigned to *yuè … yuè* sentences with non-gradable predicates on Lin's analysis are inadequate to account for their necessarily temporal reading. Following Doetjes (1997), Lin (2007:187) proposes that non-gradable verbs lexicalize a degree argument in a manner parallel to gradable adjectives. For instance, Lin (2007:187-8) proposes the semantics in (20) for the non-gradable verb *zǒu* 'to walk', parallel to the semantics assigned to the gradable adjective *gāoxìng* 'happy' in (17b), and characterizes the contribution of the degree argument of walk in (20) as measuring the amount of walking in situation *s*.

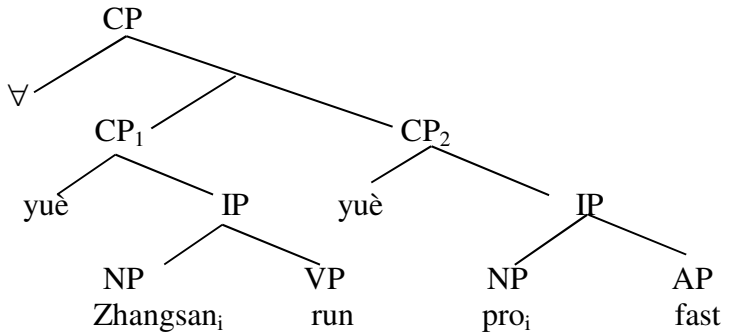
(20) [[*zǒu*]] = $\lambda x_e \lambda d_d \lambda s$. walk (x)(d)(s)

In a manner parallel to (15) above and its syntactic analysis in (16) and compositionally derived semantics in (17-19), the syntactic analysis and compositional semantics that Lin predicts for (6) (repeated below) are given in (21) and (22), respectively.

(6) Zhāngsān yuè pǎo yuè kuài.
run fast
'Zhangsan ran faster and faster.'

[6] According to Lin, R in (19b) is a causal relation that relates degrees in CP_1 to degrees in CP_2. Liu (2008a) points out that R does not have to be causal. For instance, (1a) does not necessarily express a causal relation between the size of an apple and the degree of its sweetness.

(21)



(22) a. $[[\textit{pǎo}]] = \lambda x_e \lambda d_d \lambda s_s.\ run(x)(d)(s)$

b. $[[\textit{yuè}]] = \lambda P_{<d,<s,\ t>>} \lambda d_1 \lambda d_2 \lambda s_1 \lambda s_2 [P(d_1)(s_1) \wedge P(d_2)(s_2) \wedge d_2 > d_1]$

c. $[[\textit{yuè Zhāngsān pǎo}]] = \lambda d_1 \lambda d_2 \lambda s_1 \lambda s_2 [run(Zh)(d_1)(s_1) \wedge run(Zh)(d_2)(s_2) \wedge d_2 > d_1]$

d. $[[\textit{yuè pro}_i \textit{ kuài}]]^{g[i \rightarrow Zhangsan]} = \lambda d_3 \lambda d_4 \lambda s_3 \lambda s_4 [fast(Zh)(d_3)(s_3) \wedge fast(Zh)(d_4)(s_4) \wedge d_4 > d_3]$

e. $[[\forall \textit{Zhāngsān}_i \textit{ yuè pǎo pro}_i \textit{ yuè kuài}]]^{g[i \rightarrow Zhangsan]} =$
$\forall d_1 d_2 s_1 s_2 [run(Zh)(d_1)(s_1) \wedge run(Zh)(d_2)(s_2) \wedge d_2 > d_1] \rightarrow$
$\exists d_3 d_4 s_3 s_4 [s_1 \leq s_3 \wedge s_2 \leq s_4 \wedge R(<d_1, s_1>, <d_3, s_3>) \wedge R(<d_2, s_2>, <d_4, s_4>) \wedge$
$fast(Zh)(d_3)(s_3) \wedge fast(Zh)(d_4)(s_4) \wedge d_4 > d_3]$

Intuitively, (22e) states that for all pairs of situations of Zhangsan running such that Zhangsan does a greater amount of running in the second than the first, there correspond situations of Zhangsan running fast such that the speed of the situation related to the second is greater than that related to the first. In other words, (22e) expresses a positive correlation between the amount of running that Zhangsan did and his running speed.

Problematically, then, the semantics in (22e) predicts that (6) has the same truth-conditions as (10), which should be true in Scenario A, where Zhangsan's running speed increases as the quantity of Zhangsan's running increases, contrary to fact.

(10) Zhāngsān pǎo-de yuè duō, (jiù) yuè kuài.
Zhangsan run-De much then fast
'The more Zhangsan ran, the faster he went.'

(11) a. Scenario A

Day	**Length of running**	**Speed of running**
1 ↓	5 miles ↑	5.3 mph ↑
2 ↓	4 miles ↑	5.2 mph ↑
3 ↓	3 miles	5.1 mph

We conclude from the above that Lin's analysis is empirically inadequate for *yuè . . . yuè* sentences with non-gradable predicates. In the following, we will propose our own semantic analysis of this class of *yuè…yuè* sentences.

4 The necessarily temporal reading: a coercion-based account

This section lays out a coercion-based account that explains the necessarily temporal reading of (6). Our analysis relies on two main theoretical constructs: coercion (de Swart, 1998; Sawada and Grano, 2011) and degree intervals (Kennedy 2001, Schwarzschild and Wilkinson 2002, a.o.).

4.1 Coercion

Coercion is a general term for contextual re-interpretation, triggered by violations of constraints (de Swart 1998, Sawada and Grano 2011). This notion is first employed by de Swart (1998) to explain the iterative reading of (23)—John played the sonata over and over for 3 hours.

(23) John played the sonata for 3 hours.

for-adverbials such as *for 3 years* in (23) usually selects for predicates that describe an event or a state with no inherent end point. In (24), for example, *for 3 years* is combined with the stative VP *live in Paris*.

(24) John lived in Paris for 3 years. (state)

The VP *play the sonata* in (23), on the other hand, describes an event that has an inherent end point. It is compatible with an *in*-adverbial, as shown in (25).

(25) John played the sonata in 3 hours. (event)

de Swart (1998: 360) argues that the iterative reading of (23) arises due to the conflict between the aspectual character of the eventuality description of the VP and the aspectual constraint of the adverbial phrase. This conflict triggers the presence of an invisible coercion operator, C, which forces an aspectual shift on the eventuality of the VP; that is, C maps an event with an end point to a homogeneous state compatible with an *for*-adverbial, as shown in (26).

(26) [PAST[for 3 hours[C[John play the sonata]]]].

More recently, Sawada and Grano (2011) show that coercion is also responsible for the differential interpretation of measure phrases in Japanese. Measure phrases in Japanese can receive two distinct interpretations depending on the type of adjective they combine with. They receive an absolute interpretation when preceding adjectives whose scale contains a minimal element (i.e., a lower-closed scale)(e.g., 27), or a differential interpretation when preceding an adjective with an open scale (with no minimal elements). In (28), the measure phrases specify the difference between two degrees--the degree to which the property holds of the subject and a contextually supplied standard.

(27) a. Kono sao-wa 5-do magat-teiru. (Absolute measure)
this rod-to 5-degree bend-PERF
'This rod is 5 degrees bent.'

b. Kono fusuma-wa 3-senti ai-teiru. (Absolute measure)
this sliding door-top 3-centimeter open-PERF
'This door is 3 centimeters open.'

(28) a. Kono tana-wa 2-meetoru takai (Differential measure)
this shelf-top 2-meter tall
'This shelf is 2 meters taller.'

b. Kono roopu-wa 5-inchi nagai. (Differential measure)
this rope-top 5-inch long
'This rope is 5 inches long.'

Sawada and Grano (2011) proposes that in Japanese the functional head *Meas* that introduces measure phrases is subject to a selectional restriction: *Meas* only selects for adjectives that have a minimal element. In (28) the differential interpretation of the measure phrases falls out as a result of coercion triggered by the violation of the constraint on *Meas*. The coercion operator, represented by C_s in (29), forces the gradable adjectives with an open end scale to become predicates with a contextually determined standard.

(29) a. [[*takai*]] = λx. height(x)

b. $[[C_s]]([[takai]]) = \lambda x.\ \text{height}_{\text{heigh(s)}}{}^{\uparrow}(x)$
(where s stands for a contextually determined object.)

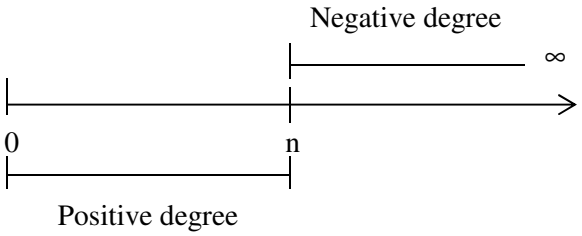
In (29a), the adjective *takai* 'tall' denotes a measure function that maps from individual *x* to *x*'s height. In (29sb), the adjective combines with C_s and returns a measure function that measures the difference between *x*'s height and a contextually determined standard (i.e., *s*'s height).

We take de Swart and Sawada and Grano's studies as suggestive that coercion is pervasive cross-linguistically. We argue that this semantic operation is also responsible for the necessarily temporal reading of *yuè…yuè* sentences with non-gradable predicates.

4.2 Degree intervals

We follow Kennedy (2001) in modeling degrees as intervals on a scale and in distinguishing two sorts of degrees, positive and negative degrees. Positive degrees are intervals that range from the lower end of a scale to some point, and negative degrees are intervals that range from some point to the upper end of the scale. The minimal element of the scale is called the zero point. Scales without a maximal element extend into infinity. For instance, for a given point *n* on a scale with a minimal but no maximal element, the interval from the zero point to *n* constitutes a positive degree and the interval from *n* to infinity, the upper end of the scale, constitutes a negative degree, as illustrated in (30).

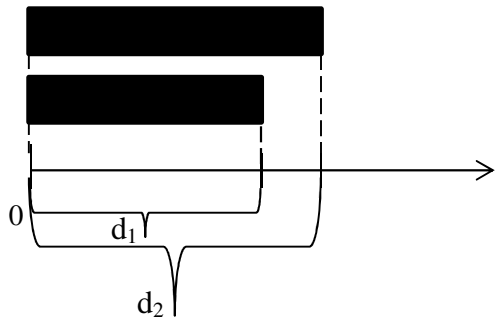
(30)



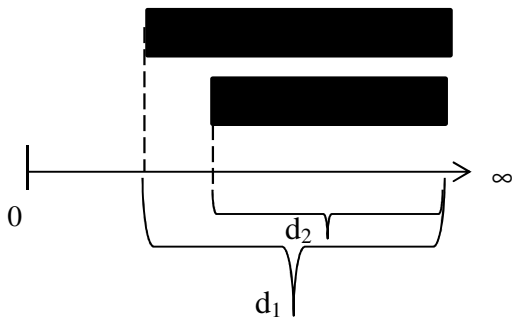
On the assumption that degrees are intervals, a comparative (e.g., 31) describes an ordering relation between two degrees based on the subinterval relation (⊏). For example, (31a) describes a subinterval relation between two positive degrees—the degree to which Mary is tall (d_1) and the degree to which John is tall (d_2) —such that d_1 is a proper subinterval of d_2 (i.e., $d_1 \sqsubset d_2$)(32a); (31b) describes a subinterval relation between two negative degrees—the degree to which Mary is short (d_1) and the degree to which John is short (d_2)—such that d_2 is a proper subinterval of d_1 (i.e., $d_2 \sqsubset d_1$) (32b). This analysis successfully accounts for the fact that (32a) and (32b) are truth-conditionally equivalent (i.e., John is taller than Mary if and only if Mary is shorter than John).

(31) a. John is taller than Mary.
b. Mary is shorter than John.

(32) a.



b.



Kennedy observes that comparatives cannot express a comparison between a positive and a negative degree, a phenomenon which he refers to as "cross-polar anomaly", as illustrated by the ill-formedness of (33). To account for this phenomenon, Kennedy (2001:58) proposes that comparative morphemes such as *–er* in English presuppose that their degree arguments are of the same sort. If degrees are of different sorts, the ordering between the two is undefined and semantic anomaly results. On this analysis, the comparative morpheme *–er* carries a presupposition to the effect that its two degree arguments share the same start point or end point, as represented in (34).

(33) *John is taller than Mary is short.

(34) $[[\text{-}er]] = \lambda d_1 \lambda d_2$: $\text{START}(d_1) = \text{START}(d_2) \vee \text{END}(d_1) = \text{END}(d_2)$. $d_1 \sqsubset d_2$

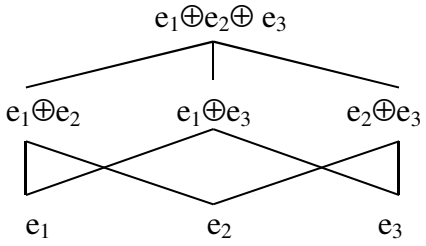
In the following section we propose that in Mandarin Chinese *yuè* carries a presupposition to the effect that the two elements (events or degrees) it orders share a common start or end point.

Violation of this requirement triggers coercion which gives rise to the necessarily temporal reading.

4.3 A coercion-based analysis

yuè combines with either a gradable adjective or a non-gradable verb. When *yuè* combines with a gradable adjective, it orders two degrees that share a common start or end point (see 14), similar to *–er* in (34). When *yuè* combines with a non-gradable verb, it orders two events. Events, unlike degrees, are not totally ordered and do not necessarily share a common start point. It has been standardly assumed that a non-gradable VP like [Zhangsan ran] denotes a set of events of Zhangsan's running, which can be modeled as a lattice in (35)(Link 1987).[7]

(35)



In (35), the set of events are partially ordered (i.e., events on the same row are not ordered with respect to each other) and they do not necessarily share a common start point (e.g., e_1, e_2 and e_3). It follows that composing a non-gradable verb with *yuè* essentially fails to satisfy the presupposition of *yuè* and results in semantic anomaly, similar to that of (33).

Just like coercion forces an iterative reading on (23) in English and a differential interpretation on the measure phrases in (28) in Japanese, we propose that in Mandarin Chinese coercion ultimately forces a necessarily temporal reading on the *yuè… yuè* sentence in (6).

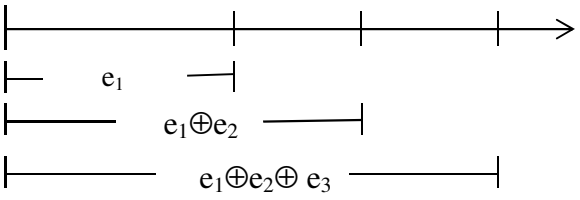
(6) Zhāngsān yuè pǎo yuè kuài.
run fast
'Zhangsan ran faster and faster.'

(36) The LF of (6): [*yuè*$_1$ [C_e[$_{VP}$ Zhangsan ran]]][*yuè*$_2$ fast]

Specifically, we propose that (6) has the LF in (36). C_e is a coercion operator that modifies the non-gradable VP [Zhangsan ran], and turns the lattice structure in (36) to a scale structure like (37).

[7] $\oplus$ is a two-place operation called 'join'. We assume that for any two elements x and y in a set S, $x \oplus y$ is defined, and $x \oplus y \in S$.

(37) Coerced 'event scale'



In (37) C_e rules out events that are not ordered with respect to each other (e.g., e_2 and e_3) and events that do not share a common starting point (e.g., $e_2 \oplus e_3$). $e_1 \oplus e_3$ is also ruled out because it is not continuous (i.e., it does not include all relevant events within a specified time span). Hence, applying the coercion operation C_e to the denotation of a non-gradable VP returns a set of totally ordered events that share a common starting point. This is parallel to the domain of the positive adjective, which consists of a set of positive degrees all beginning at the zero point of a scale.[8]

On this analysis, (6) means: for any pair of events of Zhangsan's running, e and e', if e and e' share a common starting point and e is a subinterval of e', e is slower than e'. This amounts to saying the longer Zhangsan ran, the faster he went. This analysis correctly predicts (6) to be true in scenario B in (11) (repeated below) where Zhangsan's running speed increases over time but false in scenario A where Zhangsan's running speed decreases over time.

(11) a. Scenario A

Day	Length of running	Speed of running
1	5 miles	5.3 mph
2	4 miles	5.2 mph
3	3 miles	5.1 mph

b. Scenario B

Day	Length of running	Speed of running
1	3 miles	5.1 mph
2	3 miles	5.2 mph
3	3 miles	5.3 mph

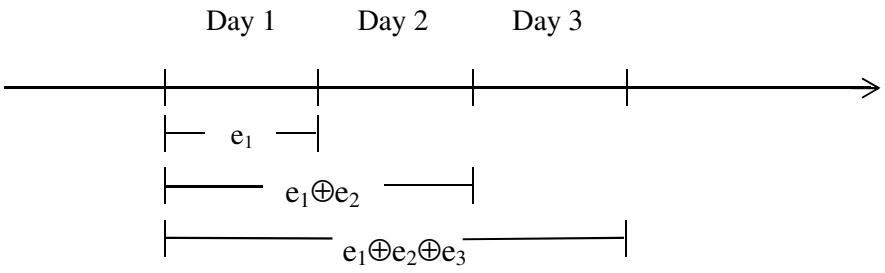
Consider again scenario A in (11). The salient subevents of Zhangsan's running over three days which share the same starting point as the whole event are the event consisting of the running on Day 1, e_1, the event consisting of the running on Days 1 and 2, $e_1 \oplus e_2$, and the event consisting of the running on Days 1, 2, and 3, $e_1 \oplus e_2 \oplus e_3$. The event e_1 is a proper subinterval of $e_1 \oplus e_2$ and $e_1 \oplus e_2 \oplus e_3$, and $e_1 \oplus e_2$is a proper subinterval of $e_1 \oplus e_2 \oplus e_3$. Associating each event with Zhangsan's final running speed in that event, i.e. the speed of Zhangsan's running on the last day that the event encompasses, it can be seen in (38) that the associated speed of $e_1 \oplus e_2$ is not greater than that of e_1, the associated speed of $e_1 \oplus e_2 \oplus e_3$ is not greater than that of $e_1 \oplus e_2$, and the

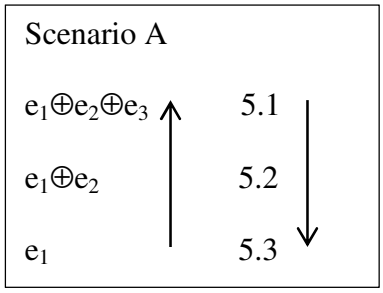
[8] Kennedy (2001:53) posits functions POS and NEG such that, for a given scale S, POS(S) returns the set of positive degrees on S and NEG(S) returns the set of negative degrees on S. The coercion operator C_e is similar in its effect to the function POS in returning a set of entities that are totally ordered and share a common starting point.

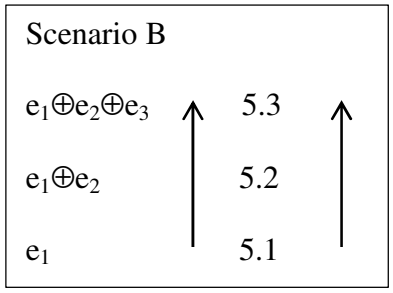
associated speed of $e_1 \oplus e_2 \oplus e_3$ is not greater than that of e_1. Clearly, then, it is not the case that if a subevent is a superinterval of another, its associated speed is also greater. Hence our analysis correctly predicts that (6) is false in Scenario A, where Zhangsan's running speed does not increase over time.

In contrast, consider Scenario B, where Zhangsan's running speed increases over time. Our proposed analysis correctly predicts that (6) is true in Scenario B. Again the salient subevents of Zhangsan's running over three days which share the same starting point as the whole event are the event consisting of the running on Day 1, e_1, the event consisting of the running on Days 1 and 2, $e_1 \oplus e_2$, and the event consisting of the running on Days 1, 2, and 3, $e_1 \oplus e_2 \oplus e_3$. The event e_1 is a proper subinterval of $e_1 \oplus e_2$ and e_3, and $e_1 \oplus e_2$ is a proper subinterval of $e_1 \oplus e_2 \oplus e_3$. Again associating with each event Zhangsan's final running speed in that event, i.e. the speed of Zhangsan's running on the last day that the event encompasses, it can be seen in (38) that the associated speed of $e_1 \oplus e_2$ is greater than that of e_1, the associated speed of $e_1 \oplus e_2 \oplus e_3$ is greater than that of e_1, and the associated speed of $e_1 \oplus e_2 \oplus e_3$ is greater than that of $e_1 \oplus e_2$. It follows that for all subevents, if one is a superinterval of another, its associated speed is also greater, as required by the truth-conditions for (6). Hence our analysis correctly predicts that (6) is true in Scenario B, where Zhangsan's running speed increases over time.

(38)







To summarize, in this section we have argued that the necessarily temporal reading of (6) falls out as a result of coercion triggered by the failure to satisfy the presupposition of *yuè*: *yuè* orders elements that share a common starting point. Specifically, when *yuè* combines with a non-gradable VP, there is a coercion operator, C_e, that forces a scale structure on the denotation of a non-gradable VP in which all events in the domain are totally ordered and share a common starting point. In the following section, we will formalize this analysis and show how the necessarily temporal reading of (6) is compositionally achieved.

5 Formal analysis

This section provides a formal account of (6) based on the analysis in section 4.3. In section 5.1, we lay out the compositional semantics of (6); in section 5.2 we discuss two welcome results that follow from the proposed analysis.

5.1 Semantic interpretation

Syntactically, we argue that (6), unlike (15), has a mono-clausal structure.[9] This claim is based on examples like (39), which share the same formation as (6), yet unlike (6), it is semantically ambiguous.

(39) Zhāngsān yuè tiào yuè gāo.
jump tall/high
'Zhangsan jumped higher and higher.'
'Zhangsan became taller and taller from jumping.'

We propose that the semantic ambiguity of (39) stems from it syntactic ambiguity. (39) has two syntactic structures as shown in (40). (40a) is mono-clausal; it is associated with the reading 'Zhangsan jumped higher and higher'. (40b) is bi-clausal; it is associated with the reading 'Zhangsan became taller and taller from jumping.'

(40) a. [$_{CP}$ Zhāngsān yuè tiào yuè gāo]. mono-clausal
b. [$_{CP}$ Zhāngsān yuè tiào], [$_{CP}$ pro$_i$ yuè gāo]. bi-clausal

Evidence in support of the two structures in (40) comes from the distributions of the morpheme *jiù* 'then' and the future aspect marker *huì* 'will' in a bi-clausal and a mono-clausal *yuè … yuè* sentence. The example in (2)(repeated below) has an unambiguously bi-clausal structure. It only allows *jiù* 'then' and *huì* 'will' to appear in front of *yuè*$_2$, but not *yuè*$_1$, as shown by the contrast of (41) and (42).

(2) Zhāngsān *yuè* xǐhuān Lìsì, wǒ *yuè* tǎoyàn Lǐsì.
like I resent
'The more Zhangsan likes Lisi, the more that I resent Lisi.'

(41) a. nǐ yuè shēngqì, tā *jiù* yuè gāoxìng.
you angry he then happy
'The angrier you are, then the happier he is.
b. nǐ yuè shēngqì, tā *huì* yuè gāoxìng.
you angry he will happy
'The angrier you are, the happier he will be.

[9] The mono-clausal parse of (6) is not crucial to our semantic proposal of the necessarily temporal reading. For ease of composition, we will not provide the full syntactic arguments here. Interested reader can refer to Fasola and Li (in preparation) for details.

(42) a. *nǐ *jiù* yuè shēngqì, tā yuè gāoxìng.
you angry he happy
b. *nǐ *huì* yuè shēngqì, tā yuè gāoxìng.
you angry he happy

In comparison, (39) allows *jiù* 'then' and *huì* 'will' to appear in front of either *yuè*$_1$ or *yuè*$_2$. In each case, however, a different reading results, as shown in (43) and (44).

(43) a. Zhāngsān *jiù* yuè tiào yuè gāo.
then jump tall/high
'Zhangsan then jumped higher and higher.'
b. Zhāngsān *huì* yuè tiào yuè gāo.
will jump tall/high
'Zhangsan will jump higher and higher.'

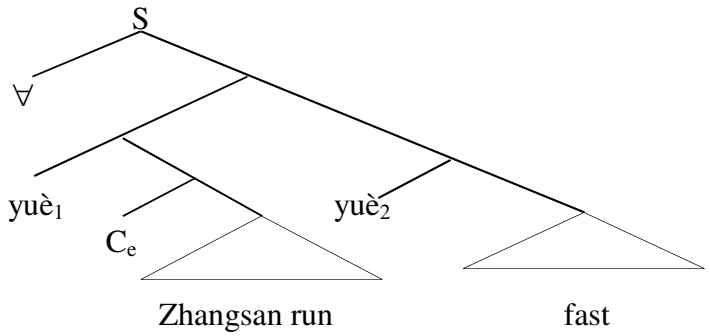
(44) a. Zhāngsān yuè tiào, *jiù* yuè gāo.
jump then tall/high
'The more Zhangsan jumped, the taller he then became.'
b. Zhāngsān yuè tiào, *huì* yuè gāo.
jump will tall/high
'The more Zhangsan jumps, the taller he will become.'

In (43), *jiù* 'then' and *huì* 'will' appear in front of *yuè*$_1$. (43a) means: 'Zhangsan then jumped higher and higher'; (43b) means: 'Zhangsan will jump higher and higher'. In both readings, *gāo* is predicated of the jumping events. In (44), *jiù* 'then' and *huì* 'will' appear in front of *yuè*$_2$, (44a) means: 'Zhangsan then became taller and taller from jumping'; (44b) means: 'Zhangsan will become taller and taller from jumping'. In these two readings, *gāo* is predicated of the subject Zhangsan. Moreover, (44) allows an overt subject *tā* 'he' to be added to the second clause, as shown in (45):

(45) a. Zhāngsān yuè tiào, tā jiù yuè gāo.
jump he then tall/high
'The more Zhangsan jumped, the taller he then became.'
b. Zhāngsān yuè tiào, tā huì yuè gāo.
jump he will tall/high
'The more Zhangsan jumps, the taller he will become.'

Based on the discussion above, we propose that (6) has the LF in (46).

(46)



(46) has a mono-clausal structure, where *yuè*$_2$ *fast* is an adverbial attaching to the main VP. Also, we follow Lin (2007) in assuming that there is a covert universal quantifier that c-commands both *yuè* phrases. C_e is a coercion operator that modifies the non-gradable VP. It introduces a superevent which all events are subintervals of and share a common starting point with. Combining C_e with a non-gradable VP yields a set of subevents totally ordered under the proper subinterval relation $\sqsubset$ and sharing a common starting point, as shown in (47b).

(47) a. $[[C_e]] = \lambda P \lambda e.\ P(e) \wedge P(E) \wedge \text{START}(e) = \text{START}(E) \wedge e \sqsubset E$

b. $[[C_e]][[VP_{\text{non-gradable}}]] = \lambda e.\ P(e) \wedge P(E) \wedge \text{START}(e) = \text{START}(E) \wedge e \sqsubset E$

We follow Lin (2007) in assigning a comparative semantics to *yuè* when it combines with a gradable predicate (48a). We propose that there is another *yuè* which is used when combining with a non-gradable VP (48b). (48b) differs from (48a) only in the type of its property argument and corresponding changes in the further arguments it expects. (48b) carries a presupposition that *yuè* only orders events that share a common starting point.

(48) a. *yuè* + AP/VP_{gradable}

$[[yuè]] = \lambda P_{<d, <e, t>>} \lambda x_1 \lambda x_2 . \exists d_1 d_2 [P(d_1)(x_1) \wedge P(d_2)(x_2) \wedge d_1 \sqsubset d_2]$

b. *yuè* + $VP_{\text{non-gradable}}$

$[[yuè]] = \lambda P_{<v,t>}\ \lambda e_1 \lambda e_2 :\ \text{START}(e_1) = \text{START}(e_2).\ P(e_1) \wedge P(e_2) \wedge e_1 \sqsubset e_2$

Now that we have the semantics of C_e and the semantics of *yuè* in place, we can compute the meaning of (6) as in (49). For simplicity, we leave out the presupposition of *yuè* in the computation.

(49) a. $[[\text{Zhangsan ran}]] = \lambda e.\ \text{run}(\text{Zh}, e)$

b. $[[C_e]] = \lambda P_{<v, t>} \lambda e_v [P(e) \wedge P(E) \wedge \text{START}(e) = \text{START}(E) \wedge e \sqsubset E]$

c. $[[C_e\ \text{Zhangsan ran}]] = \lambda e_v [\text{run}(\text{Zh}, e) \wedge \text{run}(\text{Zh}, E) \wedge \text{START}(e) = \text{START}(E) \wedge e \sqsubset E]$

d. $[[yuè_1]] = \lambda P_{<v, t>} \lambda e_1 \lambda e_2 [P(e_1) \wedge P(e_2) \wedge e_1 \sqsubset e_2]$

e. $[[yuè_1\ C_e\ \text{Zhangsan ran}]] = \lambda e_1 \lambda e_2 [\text{run}(\text{Zh}, e_1) \wedge \text{run}(\text{Zh}, e_2) \wedge \text{run}(\text{Zh}, E) \wedge e_1 \sqsubset e_2 \wedge e_1 \sqsubset E \wedge \text{START}(e_1) = \text{START}(E) \wedge e_2 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E)]$

f. $[[\text{fast}]] = \lambda d_d \lambda e_v.\ \text{fast}(d)(e)$

g. $[[yuè_2]] = \lambda P_{<d, <v, t>>} \lambda e_1 \lambda e_2 \exists d_1 d_2 [P(d_1)(e_1) \wedge P(d_2)(e_2) \wedge d_1 \sqsubset d_2]$

h. $[[yuè_2\ \text{fast}]] = \lambda e_1 \lambda e_2 \exists d_1 d_2 [\text{fast}(d_1)(e_1) \wedge \text{fast}(d_2)(e_2) \wedge d_1 \sqsubset d_2]$

i. $[[\forall]] = \lambda P_{<v, <v, t>>} \lambda Q_{<v, <v, t>>} \forall e_1 e_2 [P(e_1)(e_2) \rightarrow Q(e_1)(e_2)]$

j. $[[\forall yuè_1\ C_e$ Zhangsan ran $yuè_2$ fast$]] = \forall e_1e_2[[\text{run}(\text{Zh}, e_1) \wedge \text{run}(\text{Zh}, e_2) \wedge \text{run}(\text{Zh}, E) \wedge e_1 \sqsubset e_2 \wedge e_1 \sqsubset E \wedge \text{START}(e_1) = \text{START}(E) \wedge e_2 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E)] \rightarrow \exists d_1d_2[\text{fast}(d_1)(e_1) \wedge \text{fast}(d_2)(e_2) \wedge d_1 \sqsubset d_2]$

k. $[[\exists \forall\ yuè_1\ C_e$ Zhangsan ran $yuè_2$ fast$]] = \exists E \forall e_1e_2[[\text{run}(\text{Zh}, e_1) \wedge \text{run}(\text{Zh}, e_2) \wedge \text{run}(\text{Zh}, E) \wedge e_1 \sqsubset e_2 \wedge e_1 \sqsubset E \wedge \text{START}(e_1) = \text{START}(E) \wedge e_2 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E)] \rightarrow \exists d_1d_2[\text{fast}(d_1)(e_1) \wedge \text{fast}(d_2)(e_2) \wedge d_1 \sqsubset d_2]$

(By Existential Closure)

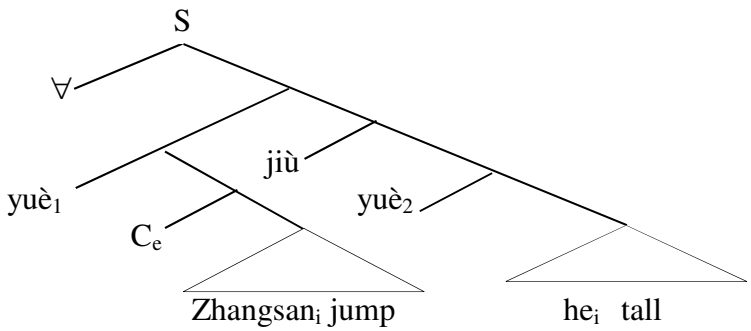
(49k) says: there is an event of Zhangsan running all of whose subintervals which have the same starting point as this event are such that if one is a superinterval of the other, then its associated speed, which we take to be its final speed, is greater than that of the other. In other words, there is an event of Zhangsan running such that for all subevents which have the same starting point as the main event, the longer a subevent lasts, the greater its associated speed. Or, paraphrasing roughly, we may also say that this semantics expresses that Zhangsan ran faster and faster, as desired. Note that in (49k) the superevent E can be a "single continuous" running event or one made up of "multiple discontinuous" running events (e.g., scenario B in 11). It captures our intuition that (6) can be true in a situation where there is a single continuous running event where Zhangsan ran faster and faster, or in a situation where there are multiple running events.

Let us now turn to a bi-clausal *yuè … yuè* sentence, for example, (45a)(repeated below). Intuitively, this sentence describes a (magical) situation where jumping makes one become taller: Zhangsan became taller and taller from jumping.

(45) a. Zhāngsān yuè tiào, tā (jiù) yuè gāo.
jump he then tall/high
'Zhangsan became taller and taller from jumping.'

We propose that (45a) has the LF in (50) and the compositional semantics in (51).

(50)



(51) a. $[[\text{Zhangsan jump}]] = \lambda e.\ \text{jump}(\text{Zh}, e)$

b. $[[C_e]] = \lambda P_{<v,t>}\lambda e_v[P(e) \wedge P(E) \wedge \text{START}(e) = \text{START}(E)]$

c. $[[C_e$ Zhangsan jump$]] = \lambda e_v[\text{jump}(\text{Zh}, e) \wedge \text{jump}(z, E) \wedge \text{START}(e) = \text{START}(E) \wedge e \sqsubset E]$

d. $[[yuè_1]] = \lambda P_{<v,t>}\lambda e_1\lambda e_2[P(e_1) \wedge P(e_2) \wedge e_1 \sqsubset e_2]$

e. $[[yuè_1\ C_e$ Zhangsan jump$]] = \lambda e_1\lambda e_2[\text{jump}(\text{Zh}, e_1) \wedge \text{jump}(\text{Zh}, e_2) \wedge \text{jump}(\text{Zh}, E) \wedge e_1 \sqsubset e_2 \wedge \text{START}(e_1) = \text{START}(E) \wedge e_1 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E) \wedge e_2 \sqsubset E]$

f. $[[he_i\ \text{tall}]]^{g[i \rightarrow \text{Zh}]} = \lambda d_d\lambda s_s.\ \text{tall}(\text{Zh})(d)(s)$

g. $[[yuè_2]] = \lambda P_{<d, <s, t>>}\lambda s_1\lambda s_2\exists d_1 d_2[P(d_1)(s_1) \wedge P(d_2)(s_2) \wedge d_1 \sqsubset d_2]$

h. $[[yuè_2\ he_i\ tall]]^{g[i\rightarrow Zh]} = \lambda s_1\lambda s_2\exists d_1 d_2[tall(Zh)(d_1)(s_1) \wedge tall(Zh)(d_2)(s_2) \wedge d_1 \sqsubset d_2]$

i. $[[\forall\ldots jiù]] = \lambda P_{<v, <v, t>>}\lambda Q_{<s, <s, t>>}\forall e_1 e_2[P(e_1)(e_2) \rightarrow \exists s_1 s_2[Q(s_1)(s_2) \wedge R(e_1, s_1) \wedge R(e_2, s_2)]]$

j. $[[\forall yuè_1\ C_e$ Zhangsan jump jiù $yuè_2\ he_i$ tall$]]^{g[i\rightarrow Zh]} =$
$\forall e_1 e_2[[jump(Zh, e_1) \wedge jump(Zh, e_2) \wedge jump(Zh, E) \wedge e_1 \sqsubset e_2 \wedge START(e_1) = START(E) \wedge e_1 \sqsubset E \wedge START(e_2) = START(E) \wedge e_2 \sqsubset E] \rightarrow \exists s_1 s_2[tall(Zh)(d_1)(s_1) \wedge tall(Zh)(d_2)(s_2) \wedge d_1 \sqsubset d_2 \wedge R(e_1, s_1) \wedge R(e_2, s_2)]]$

k. $[[\exists\forall yuè_1\ C_e$ Zhangsan jump jiù $yuè_2\ he_i$ tall$]]^{g[i\rightarrow Zh]} =$
$\exists E\forall e_1 e_2[[jump(Zh, e_1) \wedge jump(Zh, e_2) \wedge jump(Zh, E) \wedge e_1 \sqsubset e_2 \wedge START(e_1) = START(E) \wedge e_1 \sqsubset E \wedge START(e_2) = START(E) \wedge e_2 \sqsubset E] \rightarrow \exists s_1 s_2[tall(Zh)(d_1)(s_1) \wedge tall(Zh)(d_2)(s_2) \wedge d_1 \sqsubset d_2\ \wedge R(e_1, s_1) \wedge R(e_2, s_2)]]$

(By Existential Closure)

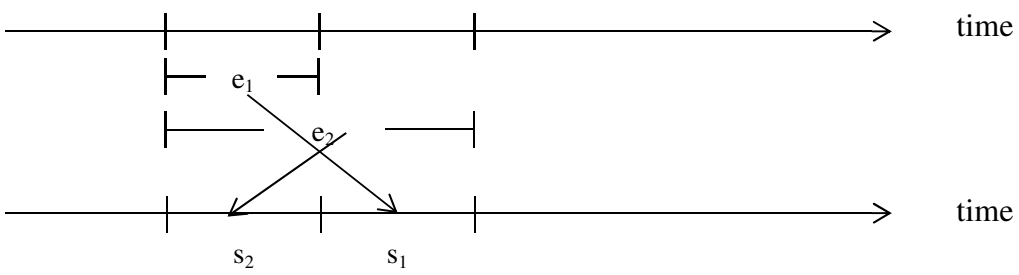
(51k) says: there is an event E of Zhangsan's jumping; for any pair of subevents e_1 and e_2, if e_1 and e_2 share the same starting point as E and e_1 is a proper subpart of e_2, e_1 is associated with situation s_1 and e_2 is associated with situation s_2 such that Zhangsan in taller in s_2 than in s_1.

Unlike the mono-clausal *yuè… yuè* sentence in (6), the bi-clausal *yuè… yuè* sentence in (45a) contains the morpheme *jiù*, which can be either covertly or overtly present. We follow Lin (2007) in assuming that *jiù* is a syncategorematic item, which is interpreted together with ∀. It contributes the relation *R* that connects the set of pairs of events denoted by [$yuè_1$ + $VP_{non\text{-}gradable}$] in (51e) with the set of pairs of situations denoted by [$yuè_2$ + AP] in (51h). In Lin's analysis, *R* indicates causality. However, as Liu (2008a) points out, *R* does not have to be causal. In (45a), for example, the relation between Zhangsan's jumping and his becoming taller can be just coincidental. Nonetheless, *R* is not unconstrained. We argue that in examples like (6-8) where *yuè* precedes a non-gradable predicate, *R* is subject to the following constraint:

(52) The temporal constraint of *R*:
For any pair of events e_1 and e_2, if e_1 is a proper subinterval of e_2, and R associates e_1 with s_1 and e_2 with s_2, s_2 cannot temporally precedes s_1.

The constraint in (52) ensures that a superevent will not be paired with an earlier state than a subevent. It rules out diagrams like (53).

(53)



With this constraint in place, our semantics correctly predicts (54) to be false in a situation like (55).

(54) Zhāngsān yuè qīpiàn tā-de-qīzi, tā-de-qīzi yuè shāngxīn.
cheat his wife his wife sad
'The more Zhangsan cheated on his wife, the sadder his wife became.'

(55) Scenario: There are two cheating events, e_1 and e_2. The wife found out about the second cheating event, e_2; then she found out about the first cheating event, e_1.

Given the scenario in (55), the state of sadness associated with the second cheating event, say s_1 temporally precedes the state of sadness associated with first cheating event, say s_2. However, even though the wife is sadder in s_1 than in s_2, (54) is still intuitively false in this scenario.[10]

5.2 Two welcome results

Our analysis brings two welcome results. First, Liu (2008a) observes that the non-gradable VP in in a *yuè…yuè* sentence must be atelic (i.e., states or activities). It cannot be an achievement or an accomplishment VP. Liu dubs this phenomenon as 'unbounded condition'.

(56) a. *tā yuè *dàodá shān-dǐng*, yuè gāoxìng. (achievement)
he arrive mountain-top happy
b. *tā yuè *chī yí-gè-píngguǒ*, yuè gāoxìng. (accomplishment)
he eat one-cl-apple, happy

Our analysis actually derives this 'unbounded condition'. Recall that we have assumed that when *yuè* combines with a non-gradable VP, a covert coercion operator intervenes. The denotation of the non-gradable VP modified with the covert coercion operator C_e is made up of events, all of which are subintervals of the main event and share a common starting point, much like the set of positive degrees on a given scale, all of which further satisfy the same property P denoted by the VP (see 47). That is, this set of events satisfies the subinterval property, which states that if a predicate is true at some interval *i*, it is also true at every subinterval of *i* (Bennett & Partee 1972). Atelic predicates satisfy the subinterval property, but telic predicates do not. Hence if a coercion operator is applied to an achievement or accomplishment VP, there will be no proper subevents which satisfy the property denoted by the VP. Consequently, the denotation of the VP modified by the coercion operator will only consist in the single event E introduced by the coercion operator. Since there is thus not a plurality of events, the condition that *yuè* contributes that all subevents such that one is a proper subinterval of another must satisfy some further condition will be satisfied vacuously, since there are no subevents of E such that one is a proper subinterval of another. If there is a ban on vacuous quantification in natural language, these structures will be ruled out on the grounds of semantic anomaly. In this way, we capture the data in (56) and explain Liu's observation.

The second welcome result of our analysis involves overt adverbs of quantification modifying *yuè…yuè* sentences. Lin (2007) and Liu (2008a) observe that in *yuè. . . yuè* sentences with gradable predicates, an overt adverbial quantifier such as *tōngcháng* 'usually' overwrites the default universal quantificational force of these sentences, as can be observed in the contrast

[10] With the constraint in (52), we can also explain why the yuè A yuè V structure (e.g., 7) sounds odd in the out of the blue context. The discussion can be found in section 7.1.

between (57) and (58). (57a) means that for all pairs of apples x_1 and x_2, if x_1 is bigger than x_2, x_1 is sweeter than x_2. With the presence of *tōngcháng* 'usually', the sentence then has the meaning in (58b), which says: for most pairs of apples, x_1 and x_2, if x_1 is bigger than x_2, x_1 is sweeter than x_2.

(57) a. píngguǒ yuè dà, yuè tián.
apple big sweet
'The bigger an apple is, the sweeter it usually is.'
b. $\forall x_1\, x_2[[\text{apple}(x_1) \wedge \text{apple}(x_2) \wedge x_1 \text{ is bigger than } x_2] \rightarrow [x_1 \text{ is sweeter than } x_2]]$

(58) a. *tōngcháng*, píngguǒ yuè dà, yuè tián.
usually apple big sweet
'The bigger an apple is, the sweeter it usually is.'
b. MOST $x_1\, x_2$ [apple(x_1) $\wedge$ apple(x_2) $\wedge$ x_1 is bigger than x_2] [x_1 is sweeter than x_2]

In a *yuè… yuè* sentence with a non-gradable VP such as (6), *tōngcháng* 'usually' quantifies over the super-event rather than the subevents. [11] This can be seen by considering (59) in the scenario in (60).

(59) *tōngcháng*, Zhāngsān yuè pǎo yuè kuài.
usually run fast
'Zhangsan usually ran faster and faster.

(60) Scenario: Zhangsan participated in a running test, where his speed was recorded every 5 minutes. Below were the records.

5th minute	10th minute	15th minute	20th minute	25th minute
5.1 mph	5.2 mph	5.1 mph	5.4 mph	5.5 mph

In (60), Zhangsan's running speed increases over most subinterval pairs but not all. In particular, Zhangsan's running speed increases from the 5th minute to the 10th, 20th, and 25th minutes, and also increases from the 10th minute to the 20th and 25th minutes, and from the 15th minute to the 20th and 25th minute, and from the 20th to the 25th minute, but does not increase from the 10th to the 15th minute, nor from the 5th to the 15th minute. This scenario thus satisfies (61b) but is one in which (59) is intuitively false. Thus, the correct semantic representation of (59) is (61a), and not (61b).

[11] Beck (2012) makes a similar observation about the adverbial quantifier *moistens* 'usually' in conditionals like (i) in German.

(i) Otto rannte *moistens* schneller, je mehr er trainierte.
Otto ran usually faster the more he practiced
'Otto usually ran faster and faster, the more he practice.'

She observes that *moisten* 'usually' in (i) does not talk about the relevant subevents, but quantifies over big events (Beck 2012: 97).

(61) a. MOSTE [run(Zh, E)] [$\forall e_1 e_2$. run(Zh, e_1) $\wedge$ run(Zh, e_2) $\wedge$ START(e_1) = START(E) $\wedge$ START (e_2) = START(E) $\wedge$ $e_1 \sqsubset$ E $\wedge$ $e_2 \sqsubset$ E $\wedge$ $e_1 \sqsubset$ e_2] $\rightarrow$ $\exists d_1 d_2$[fast(d_1)(e_1) $\wedge$ fast(d_2)(e_2) $\wedge$ $d_1 \sqsubset d_2$]

b. $\exists$E [MOST$e_1 e_2$ [run(Zh, e_1) $\wedge$ run(Zh, e_2) $\wedge$ run(Zh, E) $\wedge$ $e_1 \sqsubset e_2$ $\wedge$ $e_1 \sqsubset$ E $\wedge$ START(e_1) = START(E) $\wedge$ $e_2 \sqsubset$ E$\wedge$ START(e_2) = START(E)][$\exists d_1 d_2$ fast(d_1)(e_1) $\wedge$ fast(d_2)(e_2) $\wedge$ $d_1 \sqsubset d_2$]

If we adopt the principle that an overt adverb of quantification overwrites the quantifier with the widest scope, we can account for all the readings of *yuè . . . yuè* sentences with overt adverbs of quantification, such as (58) and (59).

To summarize, in this section we provided a formal analysis of the necessarily temporal reading based on the discussion in section 3.3. As the reader might be aware, there exist other possible analyses that can also capture the necessarily temporal reading of (6). In the following section, we look at some of these proposals and show that they are less desirable than our analysis.

6 Alternative analyses

In this section, we mainly compare the coercion-based analysis to two alternative proposals. One assumes that non-gradable verbs can be associated with a cumulative degree through a null operator (section 6.1); the other assumes that non-gradable verbs lexicalize a temporal argument but gradable predicates cannot (section 6.2). We show that these analyses face problems that are not easy to solve. In section 6.3, we briefly introduce Beck (2012)'s analysis of *John ran faster and faster* in English and explain why we do not adopt it for Chinese.

6.1 Association with Degrees

The analysis to be discussed in this section can be regarded as a conservative extension of Lin (2007)'s analysis. Recall that Lin's analysis of (6) fails essentially because he assumes that non-gradable verbs lexicalize a degree argument that measures the quantity (i.e. either the cumulative or the non-cumulative amount) of an event. If we assume that non-gradable verbs can only be associated with a degree that measures the cumulative amount of an event, then we can successfully capture the truth-values of (6) in the two scenarios in (11). Let us assume that this cumulative amount is contributed by an implicit measure function μ_{cum}, as shown in (62).

(62) Zhāngsān yuè [μ_{cum} + pǎo] yuè kuài.
run fast
'Zhangsan ran faster and faster.'

(11) a. Scenario A

Day	Length of running	Speed of running
1 ↓	5 miles ↑	5.3 mph ↑
2 ↓	4 miles ↑	5.2 mph ↑
3 ↓	3 miles ↑	5.1 mph ↑

b. Scenario B

Day	Length of running	Speed of running
1 ↓	3 miles	5.1 mph
2 ↓	3 miles	5.2 mph ↓
3	3 miles	5.3 mph

Suppose that the running events on Day 1, Day 2 and Day 3 are e_1, e_2 and e_3, respectively. They together form a super event *E*. The cumulative amount of e_1 in *E* is defined as an amount measured from the beginning of *E* through e_1; the cumulative amount of e_2 in *E* is an amount measured from the beginning of *E* through e_2; and the cumulative amount of e_3 in *E* is an amount measured from the beginning of *E* through e_3. It is easy to see that in scenario A, as the cumulative amount of running increases, its running speed decreases, while in scenario B, as the cumulative amount of running increases, its running speed also increases. Thus, it correctly predicts that (6) to be true in B but false in A.

However, the above analysis has a major theoretical drawback; namely, the measure function μ_{cum} is not properly motivated. There is no independent evidence for why a non-gradable VP in a *yuè … yuè* construction must be associated with a cumulative rather than a non-cumulative amount. Moreover, in this analysis *yuè* is treated on a par with other degree modifiers (e.g., *hěn* 'very')--they all compose with predicates that contain a degree argument. Such an analysis fails to capture the contrast in (3) and (4): *yuè* combines with a gradable as well as a non-gradable predicate, but *hěn* only combines with a gradable predicate.

6.2 Association with times

In another alternative approach, we can attribute the semantic difference between *yuè… yuè* sentences with gradable predicates (e.g., 1 and 2) and those with non-gradable predicates (e.g., 6) to the semantic distinction between gradable predicates and non-gradable verbs; that is, gradable predicates do not contain a time argument in their semantics while non-gradable verbs do, and that gradable predicates do contain a degree argument, while non-gradable predicates do not.[12] On this analysis, the verb *pǎo* 'to run' has the semantics in (63a). It denotes a relation among individual *x*, time *t* and situation *s* such that *x* runs at *t* in *s*. The gradable adjective *gāoxìng* 'happy' has the semantics in (63b), which is a relation among individual *x*, degree *d* and situation *s* such that *x* is happy to degree *d* in *s*.

(63) a. $[[pǎo]] = \lambda x_e \lambda t_i \lambda s_s.\ run(x)(t)(s)$ $\quad$ $\langle e, \langle \mathbf{i}, \langle s, t\rangle\rangle\rangle$

b. $[[gāoxìng]] = \lambda x_e \lambda d_d \lambda s_s.\ happy(x)(d)(s)$ $\quad$ $\langle e, \langle \mathbf{d}, \langle s, t\rangle\rangle\rangle$

yuè has two different interpretations depending on whether the predicate it composes with is a gradable predicate or a non-gradable verb(64). When *yuè* combines with a non-gradable verb, the result is a set of pairs of events ordered based on their temporal precedence, which gives rise to the necessarily temporal reading.

[12] See Li & Fasola (2010) for a more detailed discussion on this approach.

(64) a. $[[yuè]] = \lambda P_{<i,<v,\,t>>}\, \lambda e_1 \lambda e_2 \exists t_1 \exists t_2\, [P(t_1)(e_1) \wedge P(t_2)(e_2) \wedge t_2 > t_1]$ *Non-gradable*

b. $[[yuè]] = \lambda P_{<d,<s,\,t>>}\, \lambda s_1 \lambda s_2 \exists d_1 \exists d_2\, [P(d_1)(s_1) \wedge P(d_2)(s_2) \wedge d_2 > d_1]$ *Gradable*

Although the above analysis provides a straightforward account for the necessarily temporal reading of (6), it is built upon an assumption that is not sufficiently justified. Namely, gradable predicates (including gradable adjectives and gradable verbs) cannot take a temporal argument. Lin (2009), on the basis of comparatives in Mandarin Chinese, explicitly argues against this claim. He argues that in the comparative in (65) the adjective *kāixīn* takes both a temporal argument and a location argument, as shown in (66).

(65) tā zuótiān zài-xuéxiào bǐ wǒ jīntiān zài-jiālǐ kāixīn.
he yesterday at-school I today at-home happy
'He was happier at school yesterday than I am at home today.'

(66) $[[kāixīn]] = \lambda d \lambda l \lambda i \lambda x.$ x's happiness at location l at time $i \geq d$.

Beyond that, it is well-know that in Mandarin Chinese there is no clear morphological distinction between adjectives and verbs. Both categories allow direct affixation of an aspect marker, as shown in (67).

(67) a. píngguǒ hóng-le.
apple red-asp
'Apples have turned red.'

b. tā zǒu-le.
he walk-asp
'He has left.'

If adjectives do differ from non-gradable verbs in not being able to take a temporal argument, then it is hard to explain why they pattern with non-gradable verbs in (67). Exploring what predicates can lexicalize a temporal argument is beyond the scope the paper; we will leave it for future work.

6.3 Beck (2012)

Lastly, Beck (2012) proposes a semantic analysis for the English sentence *Otto ran faster and faster*. She argues that the necessarily temporal reading of (68a) is due to a plural sequence operator, PL^{seq}, whose function is to divide a big event into a set of sequential subevents, as shown in (68b).

(68) a. Otto ran faster and faster.

b. The situation can be divided into a sequence of relevant subevents such that in each of them, Otto's speed exceeded his speed in the predecessor event.

Beck also argues that PL^{seq} is also present in constructions like (69b) and (69c), which has the same type of necessarily temporal reading as (68a) and (69a).[13]

(69) a. Nutella was getting more and more expensive.
b. Nutella got more expensive each year.
c. The more the price of chocolate rose, the more expensive Nutella got.

In the paper, we do not adopt PL^{seq} in our analysis of *yuè …yuè* in Chinese, because Beck does not discuss how PL^{seq} is licensed. It is not obvious to us how in Chinese *yuè … yuè* sentences the gradability of the predicate conditions the presence of PL^{seq}.

7 Other types of *yuè… yuè* sentences

In this section, we consider whether our coercion-based analysis can be extended to other types of *yuè…yuè* sentences containing a non-gradable V. In section 7.1, we examine the semantics of *yuè…yuè* sentences with a non-gradable V_2 (*yuè* A *yuè* $V_{non\text{-}gradable}$)(e.g., 7); in section 7.2, we examine those with both a non-gradable V_1 and V_2 (*yuè* $V_{non\text{-}gradable}$ *yuè* $V_{non\text{-}gradable}$)(e.g., 8).

7.1 *yuè* A *yuè* $V_{non\text{-}gradable}$

Let us consider the *yuè…yuè* sentence in (7)(repeated below), where $yuè_1$ precedes a gradable adjective and $yuè_2$ precedes a non-gradable verb (*yuè* A *yuè* $V_{non\text{-}gradable}$). Unlike its *yuè* $V_{non\text{-}gradable}$ *yuè* A counterpart in (70), many speakers we consulted reported that (7) sounds odd when uttered out of the blue. However, it becomes acceptable in the context in (71), where (7) is preceded by (70) and they together describe a mutual causal relation between the state of being sad and the event of crying.

(7) ?Zhāngsān yuè shāngxīn yuè kū. *yuè* A *yuè* $V_{non\text{-}gradable}$
sad cry
'The sadder he became, the more he cried.'

(70) Zhāngsān yuè kū yuè shāngxīn *yuè* $V_{non\text{-}gradable}$ *yuè* A
cry sad
'The more Zhangsan cried, the sadder he became.'

(71) Zhāngsān yuè kū yuè shāngxīn, yuè shāngxīn yuè kū.
cry sad sad cry
'The more Zhangsan cried, the sadder he became; the sadder he became, the more he cried.'

In this section, we show that our analysis accounts for the necessarily temporal reading of (7) in (71) and also provides an explanation for the infelicity of (7) in the out-of-the-blue context.

[13] It is important to note that not every comparative correlative in English has a temporal interpretation. Comparing (69c) to (i) below, the latter lacks a temporal interpretation. This contrast shows that the temporal reading of (69c) is triggered by the use of the verb *rose* and *got*.
(i) The more expensive the price of chocolate was, the more expensive Nutella was.

In the same fashion as we analyze (6), we propose that (7) has the LF in (72) and the semantics in (73).

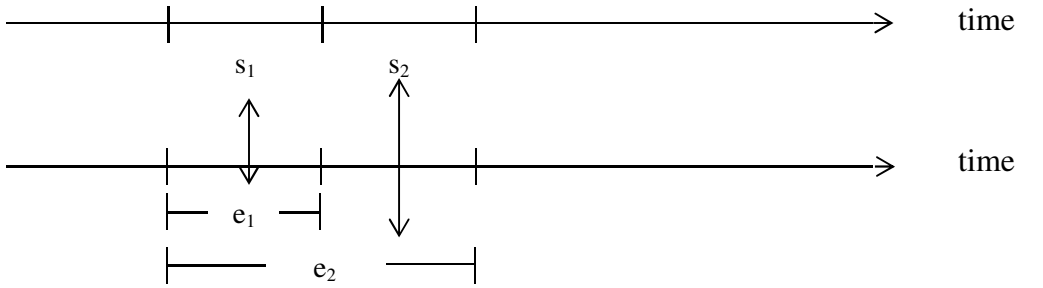
(72) The LF of (7): $\forall$[$_{CP1}$ yuè$_1$ [Zhangsan$_i$ sad], [$_{CP2}$ yuè$_2$[C_e[pro$_i$ cry]]].

(73) $[[(7)]] = \forall s_1 s_2 \exists d_1 d_2 [[\text{sad}(\text{Zh})(d_1)(s_1) \wedge \text{sad}(\text{Zh})(d_2)(s_2) \wedge d_1 \sqsubset d_2] \rightarrow \exists E \exists e_1 e_2 [\text{cry}(\text{Zh}, E) \wedge \text{run}(\text{Zh}, e_1) \wedge \text{cry}(\text{Zh}, e_2) \wedge e_1 \sqsubset e_2 \wedge \text{START}(e_1) = \text{START}(E) \wedge e_1 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E) \wedge e_2 \sqsubset E \wedge R(s_1, e_1) \wedge R(s_2, e_2)]]$

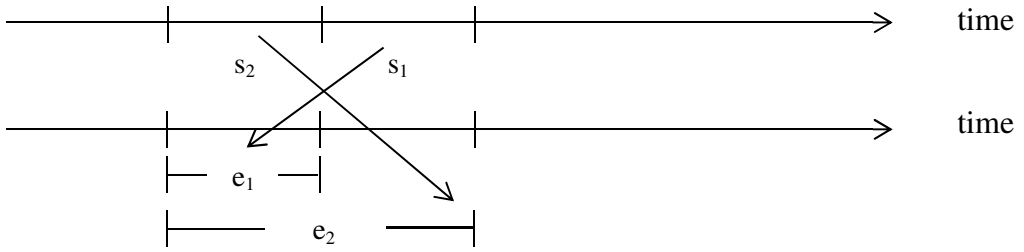
(73) says: for any pair of situations s_1 and s_2, if Zhangsan is sadder in s_2 than in s_1, s_2 is associated with e_2 and s_1 is associated with e_1 such that e_1 and e_2 are subevents of Zhangsan's running; e_2 contains $e_1$and they share the same starting point.

Note that the truth-conditions in (73) say nothing about the temporal precedence of s_1 and s_2. There are two possibilities: (i) s_1 precedes s_2, which corresponds to the order of s_1 and s_2 on a degree scale of sadness, and (ii) s_2 precedes s_1, which is the reverse order of s_1 and s_2 on a degree scale of sadness. These two possibilities are demonstrated by the diagrams in (74) and (75).

(74)



(75)



Given that the relation *R* in (73) is subject to the temporal constraint in (52) (repeated below), the diagram in (75) is ruled out.

(52) The temporal constraint of *R*:
For any pair of subevents e_1 and e_2, if e_1 is a proper subinterval of e_2, *R* must associate e_1 with a state that temporally precedes the state associated with e_2.

Therefore, our analysis predicts that (7) is infelicitous to be used in an out-of-the-blue context where Zhangsan's sadness does not increase over time.

7.2 *yuè* $V_{non\text{-}gradable}$ *yuè* $V_{non\text{-}gradable}$

Finally, our analysis also extends to the *yuè…yuè* sentence in (8)(repeated below) where both *yuè₁* and *yuè₁* precede a non-gradable verb (hence, *yuè* $V_{non\text{-}gradable}$ *yuè* $V_{non\text{-}gradable}$). Intuitively, (8) describes two concurrent events--the event of Zhangsan's running and the event of Lisi's chasing.

(8) Zhāngsān yuè pǎo, Lǐsì yuè zhuī.
run chase
'The more Zhangsan ran, the more Lisi chased him.'

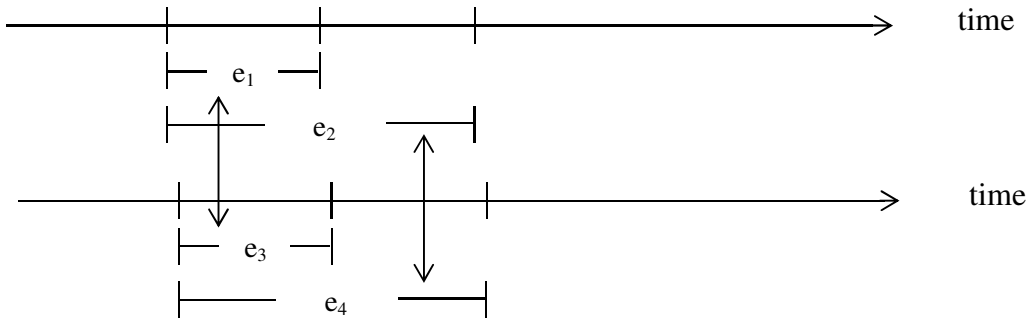
On our analysis, (8) has LF in (76) and the truth-conditions in (77).

(76) the LF of (8): $\forall[_{CP1}$ yuè$_1$ $[C_e$ [Zhangsan ran]], $[_{CP2}$ yuè$_2[C_e$[Lisi chased]]].

(77) $[[(8)]] = \exists E \forall e_1 e_2[[\text{run}(Zh, e_1) \wedge \text{run}(Zh, e_2) \wedge \text{run}(Zh, E) \wedge e_1 \sqsubset e_2 \wedge e_1 \sqsubset E \wedge \text{START}(e_1) = \text{START}(E) \wedge e_2 \sqsubset E \wedge \text{START}(e_2) = \text{START}(E)] \rightarrow \exists e_3 e_4 \exists E'[\text{chase}(L, e_1) \wedge \text{chase}(L, e_2) \wedge \text{chase}(L, E') \wedge e_3 \sqsubset e_4 \wedge e_3 \sqsubset E \wedge \text{START}(e_3) = \text{START}(E') \wedge e_4 \sqsubset E \wedge \text{START}(e_4) = \text{START}(E') \wedge R(e_1, e_3) \wedge R(e_2, e_4)]$

(77) says: for any pair of subevents of Zhangsan's running, e_1 and e_2, if e_1 is contained in e_2 and they share the same starting point, e_1 and e_2 are associated with e_3 and e_4 respectively; e_3 and e_4 are subevents of Lisi's chasing; e_3 is contained in e_4, and they share the same starting point. This reading is illustrated by the diagram in (84). It correctly captures the necessarily temporal reading of (8).

(78)



8 Conclusion

In this paper, we have shown that in Mandarin Chinese *yuè…yuè* sentences with non-gradable predicates (e.g., (6-8)) are semantically distinct from those with gradable predicates (e.g., (1-2)): the former have a necessarily temporal reading that the latter do not have. We argued that this necessarily temporal reading arises as a result of coercion triggered by the failure to satisfy the presupposition of *yuè*: *yuè* only compares entities that share the same start/end point. Specifically, when *yuè* composes with a non-gradable verbal predicate, the VP is coerced to denote a set of events, which, like degree intervals, are totally ordered under a proper subinterval relation and share a common starting point.

Our semantic analysis has appealed to degree intervals and to a symmetry between degrees and events, insofar as a coercion operator may apply to the denotation of a non-gradable VP and returns a set of events which admits an ordering parallel to that of positive degrees. Our account thus supports the claim of Kennedy (2001) that a natural language semantics which models degrees as intervals on a scale is superior to one which models degrees as points and, more generally, supports the view that comparison in natural language evaluates intervals, of whatever type, which share a common start or end point.

Our analysis also points to a non-trivial difference between the proper subinterval relation ($\sqsubset$) and the greater than relation ($<$), which are often used interchangeably in the description of comparisons. On the standard degree-based analyses, the truth-conditions of a simple comparative like (79) can be represented in two possible ways, as shown in (80). In (80a) the comparative relation is captured by a greater than relation between two degree points on a scale; in (80b) it is captured by as a proper subinterval relation between two degree intervals.

(79) John is taller than Mary is.

(80) a. $\exists d_1 \exists d_2[\text{tall}(d_1)(J) \wedge \text{tall}(d_2)(M) \wedge d_2 < d_1]$ the greater than analysis
b. $\exists d_1 \exists d_2[\text{tall}(d_1)(J) \wedge \text{tall}(d_2)(M) \wedge d_2 \sqsubset d_1]$ the proper subinterval analysis

Although (80a) and (80b) are extensionally equivalent, they differ in whether they are compatible with direct comparisons of events. As our analysis of *yuè* suggests, the subinterval relation is compatible with both comparisons of degree intervals and comparisons of events, whereas the greater than relation is only limited to comparisons of degrees. Therefore, in this regard, the subinterval relation encodes a more general notion of comparison than the greater than relation.

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