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On the ambidirectionality of Thai mid-scale predicates:* How to get more 'warm' by getting less 'hot'

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Abstract This paper presents new data on the semantic interaction between gradable predicates and the Thai particle *kʰɯ̂n*. When the particle composes with *rɔ́ːn* (*hot*) and *nǎːw* (*cold*), it describes temperature increases and decreases, respectively, in much the same way as English *get hotter* and *get colder*. However, when it composes with so-called mid-scale predicates like *ʔùn* (*warm*), it can describe increases *or decreases*, as long as the change is toward temperatures described as *ʔùn* (*warm*). We first consider two types of analyses where (i) *ʔùn* has an inherent central orientation much like English *mild* or (ii) *kʰɯ̂n* describes changes oriented toward the threshold of the gradable predicate it combines with. We argue against analyses of type (i) and (ii) and show that they predict unattested interpretations. We offer a semantic account for *kʰɯ̂n* in which the particle essentially picks an *alternative* gradable predicate to the one it composes with, and describes changes whose degree ends up lower than where it started on the alternative predicate's scale.

Keywords: gradability, scale, degrees, alternatives, Thai

1 Introduction

The Thai morpheme *kʰɯ̂n*, when combining with gradable predicates, forms change-of-degree constructions (1) whose semantic contribution is, at first sight, similar to that of English *get more* constructions (2).

(1) mɯ̂ːa-kíː man **nǎːw** mâːk lɤːj tɔːn-níː **ʔùn** **kʰɯ̂n** lɛ́ːw
a moment ago it **cold** very EMP now **warm** **KHUEN** already
'It was very **cold**. Now the temperature is **moderate**.'

(2) It was very **cold**, but it **got warmer**

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However, unlike English *get more* constructions, which always describe degree changes that *follow* the orientation of the predicate they combine with, *k^hɯ̂n* can also describe changes that go *against* the orientation of the predicate it combines with. Thai speakers readily interpret *ʔùn k^hɯ̂n* (*warm* KHUEN) as describing a temperature *decrease* in (3) whereas, even in a similar context, English speakers always interpret *get warmer* as corresponding to a temperature *increase*, as underlined by the natural insertion of *even* in (4).

(3)

mûːa-kíː	man	**rɔ́ːn**	mâːk	lɤ̌ːj	tɔːn-níː	**ʔùn**	**k^hɯ̂n**	lɛ́ːw
a moment ago	it	**hot**	very	EMP	now	**warm**	**KHUEN**	already

‘It was very **hot**. Now the temperature is **moderate**.’

(4) It was very **hot**, but it **got** (even) **warmer**

In this paper, we establish three empirical generalizations:

i. *k^hɯ̂n* yields *ambidirectionality*: it can describe changes either preserving or reversing the ordering of the scale of the predicate it combines with;

ii. this ambidirectionality is restricted to so-called *mid-scale predicates*: *k^hɯ̂n* can reverse the ordering of *ʔùn* (*warm*), but not of *rɔ́ːn* (*hot*) or *nǎːw* (*cold*);

iii. *k^hɯ̂n* is a *degree operator*: it combines with gradable predicates to build an expression that can itself combine with degree modifiers

We offer a semantic analysis of *k^hɯ̂n* that accounts for these facts. This paper is organized as follows: in Section 2, we first briefly sketch an account of English *get more* constructions and then situate *k^hɯ̂n* constructions within degree semantics. In Section 3, we consider and reject two possible analyses of the ambidirectionality of *k^hɯ̂n* constructions: (i) an analysis where the relevant Thai mid-scale predicates, unlike English *warm*, inherently define central orderings much like English *mild*; and (ii) an analysis where *k^hɯ̂n* retrieves the threshold of its complement predicate and describes any change that approaches that threshold. In Section 4, we propose and develop a formal analysis in which *k^hɯ̂n* picks a *gradable alternative* to its complement and describes a decrease on the *alternative*’s scale. In Section 5, we discuss the consequences of analyzing *k^hɯ̂n* in terms of alternatives. In Section 6, we open questions about how *k^hɯ̂n* constructions relate to other uses of the particle, to *loŋ*, its polar counterpart, and to semantic and pragmatic observations on English, indicating that ambidirectionality possibly spans across languages.

2 Degree semantics

2.1 English

We adopt a degree semantics framework (Cresswell 1976; Kennedy & McNally 2005; a.o.) where gradable predicates map their arguments onto degrees on a scale. Degrees are a specific type in the semantic ontology: the semantic entries for *warm*, *hot*, and *cold* that we give in (5) are all functions of type $< e,d >$. *warmth*, *heat*, and *coldness* denote *scales*, functions that order entities along some dimension and return their corresponding degree. Crucially, one can define algebraic operations and relations on degrees, such as *greater than* ($>$), *less than* ($<$), or *equal to* ($=$).

(5) a. $[\![\text{warm}]\!] = \lambda x_e.\ warmth(x)$.
b. $[\![\text{hot}]\!] = \lambda x_e.\ heat(x)$.
c. $[\![\text{cold}]\!] = \lambda x_e.\ coldness(x)$.

Different authors propose different analyses for how expressions of type $< e,d >$ ultimately predicate truth in their bare affirmative uses, instead of simply referring to a degree. The different mechanisms they propose all aim at deriving the principle in (6), where θ is a function that takes a scale as an argument and returns a contextually determined degree, a *threshold*. What (6) means is that a gradable predicate holds true of an entity if and only if the degree of that entity on the predicate's scale is greater than a contextually-determined threshold on the scale.

(6) For any entity x and gradable predicate P: *x is P* is true iff $[\![P]\!](x) \geq \theta([\![P]\!])$

In this paper, we need to make explicit the lexical scalar relations in (7). (7a) captures relations between orderings: *warm* and *hot* share the same orientation, which is opposite to that of *cold*. (7b) captures the threshold relations between *hot*, *warm*, and *cold*: what is *hot* necessarily is also *warm*, and what is *warm* necessarily is not *cold*.

(7) a. For any x, y: $warmth(x) > warmth(y)$ iff $heat(x) > heat(y)$
iff $coldness(x) < coldness(y)$
b. For any x, θ: $heat(x) > \theta(heat) \rightarrow warmth(x) > \theta(warmth)$
$warmth(x) > \theta(warmth) \rightarrow coldness(x) < \theta(coldness)$

Degree semantics makes for a very straightforward compositional account of degree constructions. (8) gives a semantic denotation for *more* and illustrates its composition with *warm*, *hot*, and *cold*.

(8) $[\![\text{more}]\!] = \lambda P_{ed}.\lambda y_e.\lambda x_e.\ P(x) > P(y)$.

a. ⟦warmer⟧ = ⟦more⟧(⟦warm⟧) = $\lambda y_e.\lambda x_e.\ warmth(x) > warmth(y)$.

b. ⟦hotter⟧ = ⟦more⟧(⟦hot⟧) = $\lambda y_e.\lambda x_e.\ heat(x) > heat(y)$.

c. ⟦colder⟧ = ⟦more⟧(⟦cold⟧) = $\lambda y_e.\lambda x_e.\ coldness(x) > coldness(y)$.

In (9), we give a semantic entry for change-of-degree *get* and illustrate how it composes with *warmer*, *hotter*, and *colder*.[1]

(9) ⟦get⟧ = $\lambda P_{e,ed}.\lambda x_e.\ P(x_{start}, x_{end})$.

a. ⟦get warmer⟧ = ⟦get⟧(⟦warmer⟧) = $\lambda x_e.\ warmth(x_{end}) > warmth(x_{start})$.

b. ⟦get hotter⟧ = ⟦get⟧(⟦hotter⟧) = $\lambda x_e.\ heat(x_{end}) > heat(x_{start})$.

c. ⟦get colder⟧ = ⟦get⟧(⟦colder⟧) = $\lambda x_e.\ coldness(x_{end}) > coldness(x_{start})$.

Note that given the scalar relations in (7) and the above derivations not appealing to the threshold function θ, the semantics we derive for *get warmer* and *get hotter* are synonymous with each other and antonymous to the semantics we derive for *get colder*. Whether this aspect of the result is empirically valid is not directly relevant here, for what we are primarily interested in is that we derive the same direction for *get hotter* and *get warmer*, opposed to that of *get colder*. That being said, we invite the skeptical reader to keep in mind the standard semantic-pragmatic division where expressions can be literal synonyms and yet be appropriately used in different contexts.

2.2 Thai

The semantic entries above correctly capture that *get warmer* and *get hotter* characterize temperature increases, as opposed to *get colder*, which characterizes temperature decreases. By modeling any gradable predicate as denoting a scale, and in virtue of compositionality, degree semantics can give a general account of *get more* constructions. As a matter of fact, the same increase vs decrease pattern obtains with other sets of adjectives along other dimensions: *get wetter* and *get damper* characterize increases in water saturation, as opposed to *get drier*, which characterizes decreases; *get darker* and *get dimmer* characterize increases in darkness, as opposed to *get brighter*, which characterizes decreases.[2]

Thai *k*^{h}*ɯ̂n* constructions look very much like English *get more* constructions. In examples (10) and (11), *k*^{h}*ɯ̂n* first combines with a gradable predicate and then

1 We use subscripts on entity variables to anchor measures to the start and end of a degree change.

2 We present dimensions in a way that makes the three cases parallel for the sake of illustration, but of course, speaking of *luminosity*, for example, would reverse the picture in the latter case. We do not discuss such considerations in this paper as they do not affect the validity of our account.

with a degree modifier.[3] The resulting interpretation is that of a change following the predicate's orientation, with the degree modifier measuring the intensity of the change. As evident from the English translations, this is exactly parallel to *get more* constructions. In fitting with this parallel, the k^h*ɯ̂n* constructions in (10) and (11) *cannot* be interpreted in the opposite directions, i.e. they *cannot* be translated as *get less* constructions. In other words, the k^h*ɯ̂n* constructions in (10) and (11) are *unidirectional*. The semantic contribution of the degree modifiers brings further support to a *get more* analysis, by discarding resultative analyses that would simply translate k^h*ɯ̂n* as *become*. A resultative analysis would expect the k^h*ɯ̂n* phrases in (10) to respectively mean *became five degrees warm*, *became very wet*, and *became very dark*. However, the degree modifiers actually qualify the intensity of the change; the temperature need not be five degrees, the soil need not be very wet, and the room need not be very dark at the end of the changes.

(10) a. ʔaːkàːt rɔ́ːn $\mathrm{k^h}$ɯ̂n hâː oŋsǎː
weather hot KHUEN five degree
'The weather got five degrees hotter / #hot / #less hot'

b. din pìːak $\mathrm{k^h}$ɯ̂n mâːk
soil wet KHUEN much
'The soil got much wetter / #wet / #less wet'

c. hɔ̂ːŋ mɯ̂ːt $\mathrm{k^h}$ɯ̂n mâːk
room dark KHUEN much
'The room got much darker / #dark / #less dark'

(11) a. ʔaːkàːt nǎːw $\mathrm{k^h}$ɯ̂n hâː oŋsǎː
weather cold KHUEN five degree
'The weather got five degrees colder / #cold / #less cold'

b. din hɛ̂ːŋ $\mathrm{k^h}$ɯ̂n mâːk
soil dry KHUEN much
'The soil got much drier / #dry / #less dry'

c. hɔ̂ːŋ sawàːŋ $\mathrm{k^h}$ɯ̂n mâːk
room bright KHUEN much
'The light in the room got much brighter / #bright / #less bright'

We can define a semantic entry, represented as ⟦GETMORE⟧ in (12), denoting the degree that corresponds to the difference between the final and the initial degree of a change on the predicate's scale. For the sake of simplicity, we treat degrees as real

3 The symbol # in the translations indicates unattested interpretations.

numbers in (12) so that only non-null positive differences correspond to increases on the predicate's scale. An additional mechanism must then ensure that bare predications state that the denoted degree is positively non-null (see principle (6)) and degree modifiers can then directly qualify the difference degree d (12b).

(12) $[\![\text{GetMore}]\!] = \lambda P_{ed}.\ \lambda x_e.\ \iota d : P(x_{end}) - P(x_{start}).$

a. $[\![\text{GetMore}]\!]([\![\textit{rɔ́ːn}]\!]) = \lambda x_e.\ \iota d : heat(x_{end}) - heat(x_{start}).$

b. $[\![\text{GetMore } \textit{rɔ́ːn}]\!]([\![\textit{hâː oŋsǎː}]\!]) = \lambda x_e.\ [\![\text{GetMore } \textit{rɔ́ːn}]\!](x) = 5^o.$

Thai mid-scale predicates, however, challenge the parallelism with English. Resultative interpretations like *become five degrees warm* are still unattested, but the direction of the change need no longer follow the orientation of the adjective from the English translations in (13). This is particularly clear with (13a), which can describe not only gains of five degrees, but also *losses* of five degrees, as long as that loss results in a weather that still counts as literally *ʔùn*.

(13) a. ʔaːkàːt ʔùn kʰɯ̂n hâː oŋsǎː
weather warm KHUEN five degree

'The weather got five degrees warmer / #warm / less hot'

b. din cʰɯ́ːn kʰɯ̂n mâːk
soil damp KHUEN much

'The soil got much damper / #damp / less damp'

c. hɔ̂ːŋ saluːa kʰɯ̂n mâːk
room dim KHUEN much

'The light in the room got much dimmer / #dim / less dim'

If the picture was entirely parallel to English, with [[GetMore]] being an adequate semantic denotation for *kʰɯ̂n* and Thai mid-scale predicates being semantic equivalents of the English adjectives above, the examples in (13) should pattern with the examples in (10) and only characterize increases. In order to account for the ambidirectionality exhibited in (13), we will have to break the parallelism with English. This can be done in two ways: (i) the semantics of the Thai mid-scale predicates is inherently different from that of the English adjectives we have used in our translations or (ii) the semantics of *kʰɯ̂n* is different from the *get more*-like denotation in (12). In the next section, we discuss two approaches that analyze mid-scale *kʰɯ̂n* constructions as oriented toward a central value on a scale, one doing so following (i) and the other by following (ii). We argue against those two specific analyses, and proceed to develop our own account. We rule out option (i) as a dead-end by showing that *warm* is a legitimate semantic equivalent of *ʔùn*. We consequently embrace option (ii) but argue that the semantic analysis of *kʰɯ̂n* needs to be sophisticated enough to capture the specificity of mid-scale predicates on the basis of lexical scalar relations like (7).

3 Centrality approaches

3.1 Lexical centrality

In this section, we explore the option of revising the assumption of an equivalence between the sets of English and Thai gradable predicates. More precisely, we question the equivalence between *warm*, *damp*, *dim*, and, respectively, *ʔùn*, *cʰúːn* and *sa-lŭːa*. When we introduced the notion of *mid-scale predicates*, we did so by using ostensive examples, leaving it as an informal paraphrase for 'predicates that stand *between* two alternative gradable predicates.' When conceived as such, it is not surprising to observe that they can enter in constructions that describe degree changes that practically move away from the ranges of degrees characterized by their alternatives. In fact, as Horn (1989: 240) noted, associating mid-scale predicates with a central ordering may come off as even more intuitive than with a polar ordering, and revising centrality may be a process that needs to be developed:

> It is only for children who have not yet acquired the subtleties of full scalar competence that *warmer* can mean *less hot*, *closer to (exactly) warm*.

That being said, there are gradable predicates that truly define a central ordering in English when compared to polar antonyms. One such predicate is *mild*. Much in the same way that one finds *warm* weathers between *cold* and *hot* weathers, one also finds *mild* weathers between *cold* and *hot* weathers. The two adjectives *warm* and *mild*, however, differ in a crucial way. As we saw in (7), *warm* defines an ordering that parallels that of *hot* and is directly opposed to that of *cold*, whereas the ordering that *mild* defines is homomorphic neither to that of *hot* nor to that of *cold* (14).[4]

(14) X is milder than Y $\not\rightarrow$ X is hotter than Y; $\not\rightarrow$ X is less hot than Y
X is milder than Y $\not\rightarrow$ X is colder than Y; $\not\rightarrow$ X is less cold than Y

Indeed, *mild* orders temperatures according to their proximity to a contextually average temperature. More formally, it defines a scale such that degrees get greater as the temperature gets closer to a contextual average. As a result, when *mild* enters a *get more* construction, it can describe temperature increases as well as

4 One can infer from X being milder than Y that, literally, X must be *either* hotter *or* less hot than Y and that it must be *either* colder *or* less cold than Y, but one cannot infer one specific disjunct without further information.

temperature decreases depending on whether the origin of the change was above or below average. (15) either conveys that the temperatures will increase or that they will decrease, depending on whether the weather is hot or chilly on the day of utterance.[5]

(15) It is unpleasantly hot/chilly today, but the weather will get milder tomorrow.

From this observation, one could conclude that Thai mid-scale predicates are truly central, and that the phenomenon of ambidirectionality boils down to the kind of centrality exhibited by *mild*. One could even speculate from Horn's remark that all mid-scale predicates start off as central and only some of them see their orientation further revised to parallel that of a scalemate. From there, it should not be surprising to find at least three truly central gradable predicates in Thai. However, those Thai mid-scale predicates cannot be analyzed as truly central. Unlike *mild*, the Thai mid-scale predicates actually define the same ordering as one of their alternative gradable predicates, in much the same way that *warm* defines the same ordering as *hot*. In fact, ambidirectionality only occurs in *kʰûːn* constructions. When *ʔùn*, for example, enters a simple comparative *kwàː* construction rather than a change-of-degree *kʰûːn* construction as in (16), it behaves differently from *mild* and parallel to *warm*. Indeed, (16) can only mean that the temperature is *higher* at the speaker's location, when *milder* would be compatible with the weather being *lower* at the speaker's location.

(16) ʔaːkàːt tʰîː-nîː *ʔùn* *kwàː* tʰîː-nân
weather here *warm than* there
'It is warmer/#milder here than it is there'

To the extent that the Thai predicates behave identically in simple comparative constructions to the English adjectives from our translations, and to the extent that ambidirectionality only occurs in change-of-degree *kʰûːn* constructions, maintaining the semantic parallelism between the Thai and English predicates while giving *kʰûːn* a special semantics seems more parsimonious than revising our assumptions about the Thai gradable predicates. The rest of this paper is, therefore, concerned with a proper semantic analysis of *kʰûːn*. Before laying out our proposal in Section (4), we argue against analyzing *kʰûːn* as simply expressing closer proximity to its complement's threshold.

5 Admittedly, *get milder* seems to unidirectionally communicate temperature increases when modified by a degree construction as in (i).

i. The weather forecast predicted that it should get 5 to 10 degrees milder tomorrow.

3.2 Proximity to threshold

We now turn to approaches that maintain a parallelism between the English and Thai gradable predicates and give *k^hɯ̂n* a special semantics. As we reviewed in Section (2), in degree semantics each gradable predicate expresses a scale and is associated with a threshold on that scale, which determines the truth of bare predications of the predicate, as stated in principle (6). Since a threshold can be described as a *point* on a scale, one can approach it from two sides.[6] As a result, one can approach *ʔùn*/*warm*'s threshold not only from cold temperatures, i.e. by increasing from degrees situated below *ʔùn*/*warm*'s threshold, but also from hot temperatures, i.e. by decreasing from degrees situated above *ʔùn*/*warm*'s threshold. We can therefore define a denotation that characterizes any move toward a predicate's threshold regardless of whether the origin is above or below it and thus derive ambidirectionality, as in (17).

(17) $[\![\text{C}]\!] = \lambda P_{ed}.\lambda x_e.|P(x_{end}) - \theta(P)| < |P(x_{start}) - \theta(P)|.$

a. $[\![\text{C}]\!]([\![\text{ʔùn}]\!]) = \lambda x_e.|warmth(x_{end}) - \theta(warmth)| < |warmth(x_{start}) - \theta(warmth)|.$

b. $[\![\text{C}]\!]([\![\text{rɔ́ːn}]\!]) = \lambda x_e.|heat(x_{end}) - \theta(heat)| < |heat(x_{start}) - \theta(heat)|.$

(17a) characterizes changes whose destination is closer to *ʔùn*'s threshold than their origin, regardless of the direction of the change. In particular, (17a) captures temperature decreases as long as the temperature remains above the threshold of *ʔùn*. However, there are two problems with the semantics in (17). First, it can also describe decreases when it combines with *rɔ́ːn*, as long as they take place above *rɔ́ːn*'s threshold (17b). Decrease interpretations are not available for *rɔ́ːn k^hɯ̂n* however, as we saw in example (10). Second, it does not capture increases that occur *above* *ʔùn*'s threshold, because such degree changes end *further* from *ʔùn*'s threshold than they started (18).

(18) man *ʔùn* jùː-lɛ́ːw lɛ́ːw jaŋ *ʔùn* *k^hɯ̂n* ʔìːk
it warm already then yet warm KHUEN even
'It was already warm and it got even warmer'

Before we present the analysis we defend, we want to consider one last centrality approach that draws on prototype theory (Kamp & Partee 1995; Hampton 2007; a.o.).

6 This is not meant as a claim about degree ontology or against interval representations of degrees in particular.

3.3 Proximity to prototype

The general idea behind prototype theory is to associate predicates with prototypes. A standard example is that of *bird*, whose prototype is usually proposed to have wings and the ability to fly as salient features. A creature can be a bird without presenting those features (e.g. moas had no wings and could not fly) but the creature can nonetheless be compared and measured against the prototype of *bird*. One could also assign prototypes to dimensional predicates like *cold*, *warm*, and *hot*. In particular, one could propose that the prototypes of mid-scale predicates like *warm* target central values, while the prototypes of predicates like *hot* target extreme, unbounded values. Equipped with such prototypes, one could define the semantics of *kʰɯ̂n* as characterizing changes approaching the predicate's prototype: in the case of mid-scale predicates, those would be changes toward central values, while they would be changes toward extreme values in other cases. That would account for the ambidirectionality of mid-scale predicates in *kʰɯ̂n* constructions, and also maybe for positive bare uses of mid-scale predicates, which speakers seem to reserve for a range of central values only, while they seem to prefer using a stronger alternative for higher values despite the mid-scale predicate presumably still being literally true. At the same time, one would still need to account for the unidirectionality of simple *kwàː* comparatives in Thai and of a wide range of degree constructions in other languages more generally, including English *get more* and simple comparative constructions. Rather than overwriting scales with prototypes, one option would be to integrate prototypes within a degree semantic framework alongside scales and use prototypes in denotations of ambidirectional constructions and scales in denotations of unidirectional constructions.

We think that the intuition behind a prototype-based approach is on the right track, but we propose to instead capture the centrality of mid-scale predicates utilizing the notion of *alternatives*, which independently play a role in generating scalar implicatures like (19).

(19) It is warm $\rightsquigarrow$ *it is not hot*

4 Formal account

As we just mentioned, we want to capture mid-scalarity without introducing new objects in our ontology. We take it that what defines a mid-scale predicate is the existence of gradable alternatives, informally put, both "to its left" and "to its right." English *warm* is a mid-scale predicate: it has an alternative to its left (*cold*) and an alternative to its right (*hot*). Formally speaking, this is captured by the lexical scalar relations in (7): *hot* is an alternative to the right of *warm* because they share the same orientation (7a) and what is hot necessarily is also warm (7b); *cold* is an alternative to the left of *warm* because they have opposite orientations (7) and what is *warm* necessarily is not *cold* (7b). The same is true of *ʔùn* in relation to *rɔ́ːn* and *nǎːw*, and of the other triplets too.

4.1 First approximation

The observation of ambidirectionality in Thai, we argue, does not stem from fundamental differences with English adjectives: one finds mid-scale predicates both in English (e.g. *warm*) and in Thai (e.g. *ʔùn*). We propose that ambidirectionality arises in Thai but not in English because only Thai has an expression whose semantics singles out mid-scale predicates, namely *kʰɯ̂n*. Since a predicate's relation with its gradable alternatives is what determines its mid-scalarity, we give *kʰɯ̂n* an alternative-dependent denotation. As a first approximation, *kʰɯ̂n* characterizes changes where the degree of an entity ends up passing the predicate's threshold after crossing that of the alternative (20).[7]

(20) For α_P a scalar alternative to P,
$[\![k^h\hat{ɯ}n]\!] = \lambda P_{ed}.\ \lambda x_e.\ \ \theta(P) < P(x_{end}) \ \ \wedge \ \ \alpha_P(x_{start}) > \theta(\alpha_P) > \alpha_P(x_{end})$.

7 We introduce α_P as a free variable rather than as one bound by an existential quantifier, as in (i).

i. $\lambda P_{ed}.\ \lambda x_e.\ \theta(P) < P(x_{end}) \wedge \exists \alpha_{\mathbf{P}}\ [\alpha_P(x_{start}) > \theta(\alpha_P) > \alpha_P(x_{end})]$.

While a free variable analysis raises the question of how the variable gets instantiated (a question we leave open), the semantic entry in (i) makes incorrect predictions about (ii) and (iii).

ii. talɔ̀ːt dɯːan t^hîː p^hàːn maː t^húk wan p^hárɯ́hàt ʔaːkaːt *ʔùn* *kʰɯ̂n* kwàː wan kɔ̀ːn nâː
entire month past every Thursday weather warm KHUEN than day before
'Every Thursday over the past month, the weather got warmer / less hot than the day before.'

iii. wan-níː ʔaːkaːt mâj *ʔùn* *kʰɯ̂n*
today weather not warm KHUEN
'Today, the weather did not get warmer/less hot'

If *kʰɯ̂n* introduced an existentially bound variable as in (i), since it appears in the scope of a universal quantifier in (ii) then that sentence should be consistent with a situation where the temperatures alternated between increasing from cold to warm, and decreasing from hot to warm-but-not-hot, i.e. where each Thursday was closer to 'exactly warm' than the preceding Wednesday, even if some Wednesdays were hot and some chilly. This is not the case: (ii) either means that the temperature increased from cold to warm each Wednesday-Thursday, or decreased from hot to warm-but-not-hot each Wednesday-Thursday. Similarly, since *kʰɯ̂n* is in the scope of a negation operator in (iii), and as long as the presumed existential operator cannot end up taking scope over negation, (iii) should only receive an interpretation where there was no temperature change at all. While (iii) is indeed consistent with temperature persistence, it is also consistent with situations where there was an increase or a decrease, as long as the change did not occur in the expected direction. We thank Haoze Li and Yimei Xiang for respectively bringing our attention to (ii) and (iii).

For P = *ʔùn* (*warm*) and α_P = *rɔ́ːn* (*hot*), we get changes where the *rɔ́ːn*-degree of an entity *starts above* *rɔ́ːn*'s threshold and *ends below* it: given the orientation of *rɔ́ːn* (*hot*), no longer satisfying its threshold means a temperature *decrease*. For α_P = *nǎːw* (*cold*), we get changes where the *nǎːw*-degree of an entity *starts above* *nǎːw*'s threshold and *ends below* it: given the orientation of *nǎːw* (*cold*), no longer satisfying its threshold means a temperature *increase*. This shows how the existence of alternatives to the left *and* to the right of *ʔùn* produces ambidirectionality when *ʔùn* combines with *k*^{h}*ûm*: when interpreted with *rɔ́ːn* as the alternative, *ʔùn k*^{h}*ûm* describes temperature decreases, but when *nǎːw* is the alternative, *ʔùn k*^{h}*ûm* describes temperature increases.

By contrast, the same semantic entry derives no ambidirectionality for predicates whose alternatives uniformly stand on one side. For P = *rɔ́ːn* (*hot*) and α_P = *nǎːw* we get changes where the *nǎːw*-degree of an entity *starts above* *nǎːw*'s threshold and ends *below it*: given the orientation of *nǎːw* (*cold*), no longer satisfying its threshold means a temperature *increase*. For α_P = *ʔùn* (*warm*), on the other hand, we end up with a contradiction stemming from the strength relation in (7b). The first conjunct in (20) characterizes changes that *end above* P's threshold, but the second conjunct characterizes changes that end *below* α_P's threshold. The existence of a degree that would be both *above* *rɔ́ːn* (*hot*)'s threshold and yet *below* *ʔùn* (*warm*)'s threshold would be a direct contradiction of (7b). As a result, *ʔùn* is not a viable alternative to *rɔ́ːn* when it comes to composition with *k*^{h}*ûm*. Since only α_P = *nǎːw* gives a coherent interpretation to *rɔ́ːn k*^{h}*ûm*, it can only receive a temperature *increase* interpretation. For P = *nǎːw*, α_P can be either *ʔùn* or *rɔ́ːn*. Since the α_P-degree starts above and ends below α_P's threshold, and since *ʔùn* and *rɔ́ːn* share the same orientation, no longer satisfying the threshold of either means a temperature *decrease*.

4.2 Non-factive changes

(20) demonstrates how incorporating scalar alternatives into a semantic entry makes it possible to generate the kind of ambidirectionality observed with *k*^{h}*ûm*. As we illustrated above, when P = *ʔùn*, the result corresponds to an increase or a decrease, depending on whether α_P = *nǎːw* or α_P = *rɔ́ːn*. Note, however, that (20) is *factive* in the sense that at the start of the change, α_P should *actually* apply, but at the end of the change, it is P that should actually apply *instead*. In fact, this does not have to be the case, as shown in (21). In (21a), the alternative *nǎːw* in fact does not apply at the start of the change and the predicate *ʔùn* still does not apply at the end of the change, and in (21b) the alternative *rɔ́ːn* still applies at the end of the change.

(21) a. mɯ̂ːa-waːn ʔaːkàːt mâj *nǎːw* tɛ̀ː kɔ̂ː mâj *ʔùn* wan-níː ʔaːkaːt *ʔùn*
yesterday weather not *nǎːw* but also not *ʔùn* today weather warm
k^h*ɯ̂n* tɛ̀ː kɔ̂ː jaŋ mâj *ʔùn*
KHUEN but also still not warm

'Yesterday the weather was not cold, but it was not warm either. Today it got warmer but it is still not warm.'

b. ʔaːkaːt *ʔùn* *k*^{h}*ɯ̂n* tɛ̀ː kɔ̂ː jaŋ *rɔ́ːn*
weather warm KHUEN but also still *rɔ́ːn*

'The weather got closer to being just warm but it is still hot'

We need a non-factive version of (20) which will still describe changes in terms of scalar alternatives so it can produce ambidirectionality specifically for mid-scale predicates, but which will also no longer impose actually passing or crossing the threshold of the predicate or its alternative. Our situation at this point is reminiscent of Klein's (1980) enterprise of deriving the meanings of comparatives from the meanings of positive adjectives. Klein basically proposed to paraphrase comparative constructions like *x is warmer than y* as *x is warm and y is not*, but applying the paraphrase strictly would incorrectly derive factivity. Contrary to what the paraphrase suggests, one need not commit to Svalbard *actually* being warm now when claiming that Svalbard is now *warmer* than ten years ago. The solution that Klein proposed was that comparatives locally *relativize* the denotation of gradable predicates. Formally speaking, from a degree-semantic perspective, and even though Klein's project was to do away with the semantic type of degrees, this means that comparatives can locally manipulate thresholds. If we were to model the semantics Klein proposed for the comparative morpheme within a degree-semantic framework, (22) would be a possible implementation, where $s \sim \theta$ means that s corresponds to any function that respects principles like (7) and that maps a scale to a threshold, just like θ does, but need not define the exact same thresholds that θ does. A particular case of s is one that maps a scale to a threshold situated between the two entities being compared.

(22) $\lambda P_{ed}.\, \lambda y_e.\, \lambda x_e.\, \exists s \sim \theta\ [P(x) > s(P) > P(y)].$

(22) quantifies over possible threshold functions s and states that there exists one that places the threshold between the degrees of the first and the second entities. It is important to note that the quantification is essentially formal: (22) does not actually shift the threshold function θ that the speaker uses to judge whether a gradable predicate applies to an entity generally. We can draw on Klein's solution and quantify over threshold functions in a similar way to define the non-factive version of (20) given in (23).

(23) For α_P a scalar alternative to P,
$[\![k^h\hat{\text{ɯ}}\text{n}]\!] = \lambda P_{ed}.\ \lambda x_e.\ \exists s \sim \theta\ [\ s(P) < P(x_{end})\ \wedge$
$\alpha_P(x_{start}) > s(\alpha_P) > \alpha_P(x_{end})\ ].$

At first sight, it can look like (24) is a more efficient equivalent of (23), for it does not involve any quantification machinery. For this reason, one could be tempted to do away with quantification over threshold functions after all: unlike Klein, we have already enriched our semantic ontology with degrees, which have the advantage of giving us a semantics for comparatives that does not require quantification over threshold functions.[8]

(24) $\lambda P_{ed}.\ \lambda x_e.\ P(x_{end}) > P(x_{start})\ \wedge\ \alpha_P(x_{end}) < \alpha_P(x_{start}).$

The problem with (24), however, is that it can no longer characterize temperature decreases when P = *ʔùn*; the first conjunct then qualifies increases, which clashes with α_P = *rɔ́ːn*, and the second conjunct accordingly qualifying decreases. Replacing the first conjunct in (24) with $\theta(P) < P(x_{end})$ would not be a solution either, for *k*^{h}*ɯ̂n* is not factive, as we saw. And we cannot simply drop the first conjunct altogether: doing so would then incorrectly predict ambidirectionality for *rɔ́ːn k*^{h}*ɯ̂n* because of the existence of α_P = *ʔùn*. In support of (23), on the other hand, since both conjuncts there are in the scope of the existential quantification on *s*, we preserve the mid-scale-predicate-specific ambidirectionality that we derived with our first approximation. Indeed, there exists no $s \sim \theta$ such that $s(heat^P) < heat^P(x_{end})\ \wedge\ s(warmth^{\alpha_P}) > warmth^{\alpha_P}(x_{end})$ for any x. Informally put, no threshold function respecting the scalar relations in (7) can possibly give *ʔùn* (*warm*) a threshold that would be *above* the threshold it gives *rɔ́ːn* (*hot*).

4.3 Final proposal

The semantic entry in (23) is still empirically inadequate on two points. First, it is of type $< ed, e\mathbf{t} >$ when it should be of type $< ed, e\mathbf{d} >$ as we saw in Section (2.2). Second, it incorrectly predicts that *ʔùn k*^{h}*ɯ̂n* could describe temperature decreases that take place *below* *ʔùn*'s threshold. The symbol $\sim$ we introduced in (23) is meant to constrain *s* to threshold functions that are consistent with lexical scalar relations like (7). A function *s* giving *ʔùn* (*warm*) and *rɔ́ːn* (*hot*) thresholds corresponding to *actually cold* temperatures would respect the principles in (23), as long as for any x, $heat(x) > s(heat) \rightarrow warmth(x) > s(warmth)$. For this reason, (23) predicts that *ʔùn k*^{h}*ɯ̂n* should be a possible description for decreases of already cold temperatures, contrary to the facts. To address these two points, we propose our final semantic entry for *k*^{h}*ɯ̂n* in (25).

8 We want to thank Elena Herberger for bringing our attention to this pitfall.

(25) For α_P a scalar alternative to P,

$$[\![k^h\hat{\mathrm{u}}\mathrm{n}]\!] = \lambda P_{ed}.\ \lambda x_e.\ \iota d : |P(x_{end}) - P(x_{start})| \wedge$$
$$\exists c\ [\ c \leq \alpha_P(x_{end})\ \wedge\ c > \theta(P)\ ] \wedge$$
$$\exists s \sim \theta\ [\ s(P) < P(x_{end})\ \wedge\ \alpha_P(x_{start}) > s(\alpha_P) > \alpha_P(x_{end})\ ].$$

The denotation is now of type $< ed, e\mathbf{d} >$, for the first line picks the degree d corresponding to the magnitude of the change. Degree modifiers can then explicitly quantify the magnitude, like in English comparatives (*3in taller than*), and in the absence of a degree modifier there must be a mechanism that saturates the degree variable (see principle (6)). The second line introduces what we call *continuations*: it states that there must exist a degree c that is both lower or equal to the end degree on the scale of the alternative predicate and above the predicate's actual threshold.[9] This rules out decreases that take place below *ʔùn*'s threshold: for *ʔùn kʰûn* to describe decreases, one must pick α_P = *rɔ́ːn* (*hot*). Thus, in that case, the continuation statement says that there must be a degree *less hot* than (or equal to) the end degree that, at the same time, passes *ʔùn*'s (*warm*) actual threshold. If the decrease takes place above *ʔùn*'s (*warm*) actual threshold, then the statement is automatically satisfied: the final temperature itself corresponds to a degree c that is trivially equal to the end degree and that passes *ʔùn*'s actual threshold. The decrease *cannot* take place below *ʔùn*'s actual threshold, though, for there can be no temperature less hot than or equal to a cold temperature that would still count as actually *ʔùn* (*warm*): one cannot describe a decrease within the cold region using *ʔùn kʰûn*. By contrast, one can use it to describe an *increase* in the cold region: increase interpretations obtain when α_P = *nǎːw*. The continuation statement in that case says that there must exist a degree *less cold* than the end degree that passes *ʔùn*'s (*warm*) actual threshold. Since all the degrees that pass *ʔùn*'s threshold correspond to temperatures that are less cold than cold temperatures, there are plenty to satisfy the continuation statement.

5 Consequences

Our semantic analysis stands out from the other approaches we discussed in this paper in that it gives an central role to the *alternatives* of *kʰûn*'s complement. Observing any modulation in the meaning of a *kʰûn* construction stemming from the manipulation of its predicate's alternatives would, therefore, lend further support

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9 The notation in (25) assumes the existence of degrees c that belong to P's scale and α_P's scale at the same time. One could prefer to quantify over entities instead, as in (i).

i. $\exists y\ [\ \alpha_P(y) \leq \alpha_P(x_{end})\ \wedge\ P(y) > \theta(P)\ ]$

to our proposal. In this section, we want to briefly approach this point from two different angles. First, as we have been discussing temperature predicates throughout this paper, we have focused on the English adjectives *hot*, *warm*, and *cold*. English offers a much wider range of predicates to qualify temperatures. One in particular, *cool*, seems to fit naturally between *warm* and *cold* and given its shared orientation with *cold*, qualifies as a mid-scale predicate. If one were to find a counterpart for *cool* in Thai, one should expect it to exhibit the same kind of ambidirectionality as *ʔùn* when it enters a *k^hûn* construction. Upon comparing temperatures that elicit uses of different Thai predicates, one finds that *jen* comes off as less extreme than *nǎːw* (*cold*), suggesting that it could be translated as *cool*. A crucial difference with the English, however, is that what Thai speakers would typically describe as *jen*, as compared to what they would typically describe as *nǎːw*, not only tends to have lower temperatures but also tends to be of an inherently different kind. For example, while *jen* can be a natural label for water in a drinking glass, *nǎːw* cannot and seems mostly restricted to describing the sensation of apparent temperature. At this point, the question of how one defines an alternative becomes central. As a matter of fact, Thai speakers clearly deem increase interpretations of *jen k^hûn* unnatural. From there, one can conclude either that our proposal makes the wrong prediction, or that the heterogeneity of *jen* and *nǎːw* prevents them from constituting real alternatives, at least as understood in the context of *k^hûn* constructions. There are, however, exceptional and very limited cases where both *jen* and *nǎːw* can be considered as labels. Granting that both can compete as labels for describing the weather, Thai speakers note that while *actually* using *jen k^hûn* to communicate a temperature increase is still ruled out, conceiving of such an increase interpretation makes more sense than it does for *nǎːw k^hûn*, which can never conceivably receive an increase interpretation.

Secondly, we want to sketch a less impressionistic method of inquiry. An experimental context may offer a better controlled and, therefore, more efficient way of systematically showing the impact of a predicate's alternatives on the interpretation of *k^hûn* constructions. *Ad-hoc* scales, by their very contextual nature, could prove highly valuable, as they easily lend themselves to experimental manipulations. To the extent that ad-hoc scales invoke the salient notion of alternatives, the denotation we defined makes direct predictions about the following setup. The ad-hoc scale should consist of one main predicate representing the ad-hoc mid-scale predicate and two other predicates representing the ad-hoc alternatives. One alternative should apply to a strict subset ranking higher on the ad-hoc scale than what the ad-hoc mid-scale predicate applies to, while the other alternative should only apply to what comes lower than the ad-hoc mid-scale predicate's region on the scale. Only when *k^hûn* combines with the ad-hoc mid-scale predicate should it be able to receive both an increase and a decrease interpretation on the ad-hoc scale. We leave this project open to further experimental investigation.

6 Open discussion

In this paper, we left some empirical observations aside that may touch on the issue of ambidirectionality in different ways. First, we should note that *k^hûn* has many usages besides forming change-of-degree constructions. Suwannarat & Ratitamkul (2014) took on the project of systematically comparing *k^hûn* with the English particle *up*. As evident from their work, the two words indeed share a number of characteristic features. Particularly relevant here is the analogy with *warm up*, whose meaning seems very close to *get warmer*. However, unlike *ʔùn k^hûn* and like *get warmer*, *warm up* is unidirectional. Besides, *up* does not seem to enter in a one-to-one correspondence with *k^hûn* when it comes to composition with gradable predicates. As we saw, *nǎːw k^hûn* describes temperature decreases—changes that follow *nǎːw*'s (*cold*) orientation—but one cannot do so using *cool up* (and least so using *cold up* for *cold* is not even a verb). As far as Thai change-of-degree constructions are concerned, *k^hûn* competes with its polar counterpart, *loŋ* (*down*). While the judgments we collected make clear that *ʔùn k^hûn* can indeed describe temperature decreases, our consultants also made clear that they prefer to describe such decreases using *ʔùn loŋ*. Higher temperatures seem to universally be conceived of as positive by default, and *k^hûn* is similarly conceived of as a positive marker opposed to *loŋ*, much as *up* is positively opposed to *down*. The *welcome* aspect of some decreases from extreme to more moderate values can be seen as aligning with *k^hûn* communicating an increase on the connotation side, even though on the denoting side the polarity of *loŋ* would align better with the objectivity of the decrease. This view raises questions about the interaction between connotation and denotation. At the same time, it seems that shifting between connotation and denotation is not a fully general phenomenon. As we just noted, *nǎːw k^hûn* necessarily describes decreases toward cold temperatures, which typically come with a negative connotation, and despite the usually positive perception of temperature increases from cold to less cold temperatures, *nǎːw k^hûn* can never receive an increase interpretation. Moreover, we have so far not succeeded in eliciting a systematic pattern of interpretations for *loŋ* change-of-degree constructions the way we have for *k^hûn* change-of-degree constructions.

Finally, we want to bring up some cross-linguistic considerations. Horn noted that English-speaking children can use *warmer* to communicate *less hot*, and we have received anecdotal confirmation of such uses through personal communication. While Horn's citation suggests a maturational analysis, the Thai judgments we report here, coming from adult speakers, challenge that view. The empirical observations and the analysis in this paper urge for experimental investigation of younger speakers' judgments across languages. Finally, as a potential cross-linguistic bridge, we want to mention meta-linguistic uses of English *more*, as in *it used to be extremely hot, but now it's more, like, 'warm.'* This is *de facto* a description of a decrease, and it explicitly exploits a comparison between two alternatives, namely *hot* and *warm*. One Thai speaker that we consulted explicitly referred to alternatives when clarifying a decrease interpretation for *ʔùn kʰɯ̂n*, saying that *ʔùn* (*warm*) becomes a better label than *rɔ́ːn* (*hot*) after the decrease. Given the metalinguistic nature of those English *more* constructions and the grammatical nature of the Thai *kʰɯ̂n* constructions (where degree modifiers can equally qualify the intensity of increases and decreases) and in light of the connotation considerations above, the present observations raise intriguing questions about how pragmatic phenomena in one language relate to options incorporated in the grammar of another.

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