Color, Context and Compositionality

Chris Kennedy Louise McNally

September 13, 2007
International Conference on Adjectives
Université de Lille

Today's talk

- The challenge of color adjectives for a truth conditional semantics
- Previous responses and their shortcomings
- A more detailed look at the linguistic facts
- A new semantics of color and response to the challenge
- Concluding thoughts

Foundational assumptions

- *Truth conditionality*
  The semantic value of a sentence is a function from facts about the world to a unique value in {0,1}.
- *Compositionality*
  Which function a particular sentence denotes is determined by its syntax and the semantic values of its constituents.

Foundational assumptions

- These assumptions, in particular the view that sentence meaning is truth conditional, have been challenged by a number of philosophers of language, including Wittgenstein, Austin, and more recently, Charles Travis.
- In this talk, we focus on the challenge presented by color adjectives, illustrated by the following story from Travis 1997 (p. 89).

A story

Pia's Japanese maple is rull of russet leaves. Believing that green is the colour of leaves, she paints them.

A story

Pia's Japanese maple is rull of russet leaves. Believing that green is the colour of leaves, she paints them.

A story

Returning, she reports, 'That's better. The leaves are green now.' She speaks truth.

A story

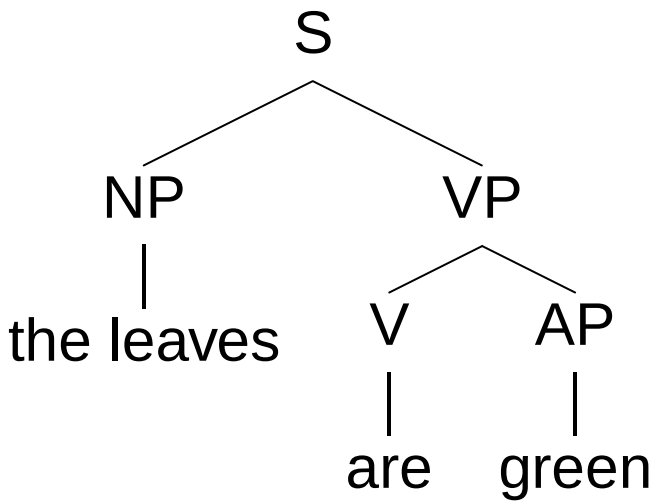
A botanist friend then phones, seeking green leaves for a study of green-leaf chemistry. 'The leaves (on my tree) are green,' Pia says. 'You can have those.' But now Pia speaks falsehood.

A story

A botanist friend then phones, seeking green leaves for a study of green-leaf chemistry. 'The leaves (on my tree) are green,' Pia says. 'You can have those.' But now Pia speaks falsehood.

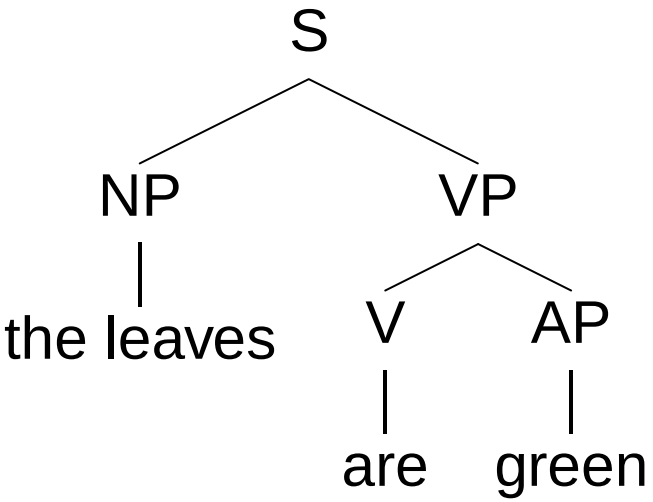
Variable truth

(1)



Variable truth

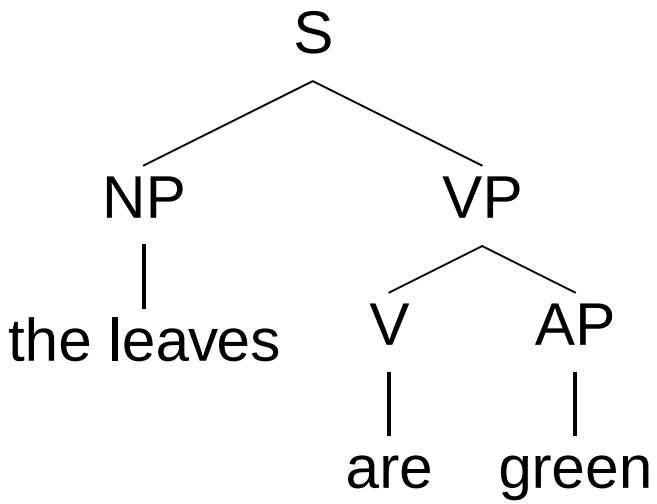
(1)



- TRUE as a comment on Pia's artistry

Variable truth

(1)



- TRUE as a comment on Pia's artistry
- FALSE as an invitation to the botanist

Implications

- Travis: Even on a “stipluated semantics”, (1) (and other sentences like it containing color adjectives) “is compatible with various distinct conditions for its truth.”
- This conclusion is inconsistent with the Foundational Assumptions.

Pragmatic contextualism

Travis' conclusion is that we should give up Truth Conditionality:

- The semantic value of a sentence at most imposes some necessary conditions under which it may be true (as well as conditions under which it may be used), but those conditions need not be sufficient, and the content of the sentence does not define a function from contexts to truth.
- Truth and truth conditions are not an issue of sentence meaning, but rather an issue of sentence use.

Responses

Two responses to this challenge have been suggested in the literature.

Deny the facts

Sainsbury 2001:

- The content of the adjective *green* is nonspecific enough to render (1) true in both situations
- Our intuitions about the falsity of (1) (when said to the botanist) are due to a misguided tendency to assume that it is made true in a particular way.

Deny the facts

This approach may be exactly right for some cases. Consider (2) said of a refrigerator with nothing but a puddle of milk in it:

(2) There's milk in the refrigerator.

Travis claims that (2) makes the same sort of point as (1):

- TRUE as a comment on someone's cleaning habits
- FALSE in response to a request for milk a friend's coffee

Deny the facts

- We find it very hard to judge (2) false, in either context.
- We do, however, accept Travis' claims about (1), so we will assume that denying the facts is not an option when it comes to color adjectives.

Semantic contextualism

The second option is to derive truth conditional variability of sentences with color adjectives via the normal mechanisms of a compositional, truth conditional semantics by hypothesizing that some aspect of a color term's meaning is context dependent.

Hidden variables

Szabó 2001: a color adjective denotation includes a variable P that picks out the part of an object that the core property encoded by the adjective is applied to in order to assess truth.

(3) $[\![\textit{green}]\!] = \lambda P \lambda C \lambda x . \textbf{green}(P)(C)(x)$

P is typically fixed by the context, so *The leaves are green* is true just in case a contextually determined (and presumably sufficiently large) part of the leaves are green (relative to a comparison class C).

Hidden variables

Truth conditional variability is a function of how *P* is valued:

- When Pia admires her leaves, *P* picks out the surface area of the adjective's argument, and *is green* denotes the property of being superficially green.
- When Pia responds to the botanist, *P* picks out the entirety of the adjective's argument, *is green* denotes the property of being entirely green.
- In the first case, the *is green* is true of the painted leaves; in the second case, it is not.

Hidden variables

Color adjectives may very well include a variable that restricts their application to parts of their arguments, but there are reasons to believe that it is not a complete account of Travis' challenge:

- The intuitions about (1) don't change if Pia immerses her leaves in a dye that turns all (relevant) parts green.
- Color adjective meaning can vary systematically in ways that cannot be captured merely by reference to the part structure of their arguments (or to comparison classes).

Indexical predicates

Rothschild and Segal 2007: color adjectives are full-blown indexical predicates that can denote distinct properties in different contexts of utterance.

(4) $[\![\textit{green}]\!]^{C_i} = \textbf{green}_i$

The denotation of *green* in a context C_i is the property $\textbf{green}_i$ which holds of an object x just in case x is green according to the standards for greenness in C_i.

Indexical predicates

On this view, Pia's comment on her artistry and Pia's response to the botanist have different truth conditions because *green* denotes distinct properties in the two utterances:

(5) **green**$_a$(**the leaves**)

(6) **green**$_b$(**the leaves**)

Assuming that **green**$_a$ is true of painted leaves but **green**$_b$ is not, the observed judgments follow.

Indexical predicates

BENEFIT: This approach can handle the Travis facts without positing hidden variables.

COST: It is not clear what constraints there are on possible valuations of a particular adjective in different contexts.

Indexical predicates

BENEFIT: This approach can handle the Travis facts without positing hidden variables.

COST: It is not clear what constraints there are on possible valuations of a particular adjective in different contexts.

- For Rothschild and Segal, this is a matter of psychology, not semantics.

Indexical predicates

BENEFIT: This approach can handle the Travis facts without positing hidden variables.

COST: It is not clear what constraints there are on possible valuations of a particular adjective in different contexts.

- For Rothschild and Segal, this is a matter of psychology, not semantics.
- We disagree.

Indexical predicates

Could *green* denote the property in (7)?

(7) **green**$_V$ = *naturally or artificially green*

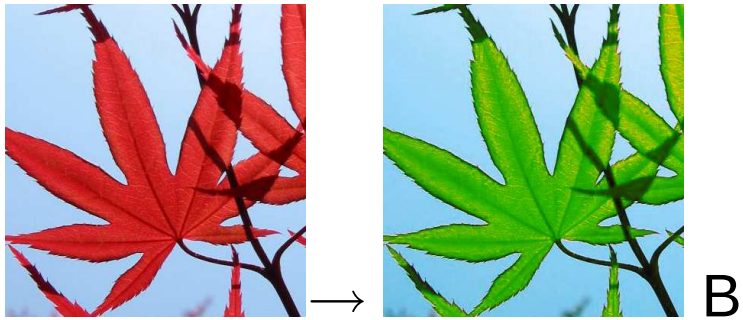
Indexical predicates

Could *green* denote the property in (7)?

(7) **green**$_V$ = *naturally or artificially green*

green$_V$ is true of both leaf A and leaf B.

A



B

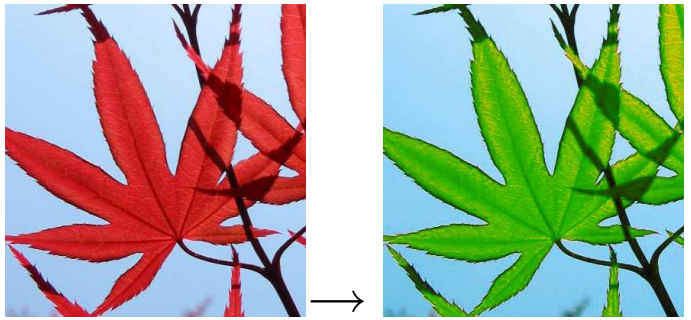
Indexical predicates

However, if **green**$_V$ were a possible valuation of *green*, (8) could be read as synonymous with (9).

(8) ??Leaf A is **green**$_V$, and so is leaf B.

(9) Leaf A is either naturally green or artificially green, and so is leaf B.

A



B

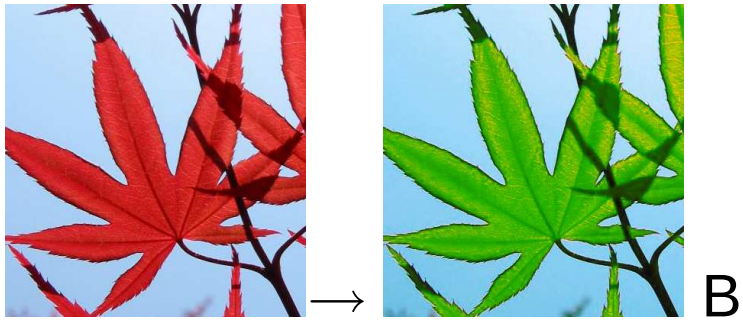
Indexical predicates

Instead, (8) is more like (10), which is odd because it violates the identity conditions on ellipsis.

(8) ??Leaf A is **green**$_V$, and so is leaf B.

(10) ??The tallest building on Main Street is a bank, and so is that piece of land over there.

A



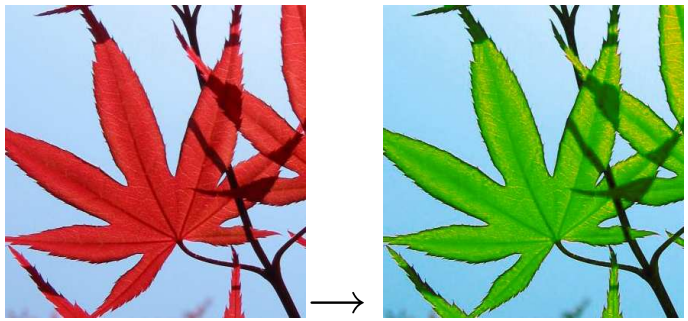
B

Indexical predicates

Even more problematic is the fact that *green* cannot be understood to denote the property in (11).

(11) **green**$_p$ = *artificially green*

A



B

Indexical predicates

Even more problematic is the fact that *green* cannot be understood to denote the property in (11).

(11) **green**$_p$ = *artificially green*

This would allow for (12) to be true, contrary to fact.

(12) Leaf B is **green**$_p$, but leaf A is not.

A

→

B

Indexical predicates

These facts are not beyond the explanatory reach of an indexical account of color adjectives:

- Assume that **green**$_v$ and **green**$_p$ are not "psychologically natural" valuations of *green*.

They should, however, lead us to ask whether there are semantic (grammatical) factors at work here.

A linguistic perspective

What can we learn by taking a closer look at the linguistic properties of color adjectives?

- There is little work in formal semantics on the meanings of color adjectives beyond general discussions of vagueness.
- Previous work has focused almost exclusively on unmodified, predicative forms of color adjectives.

A linguistic perspective

We need to explore a broader range of data than has previously been considered, with an eye towards answering the following questions:

- Do the differences in meaning that give rise to Travis effects have grammatical consequences and correlates?
- How many different kinds of meanings do color adjectives have?

A new story

Pia decides to paint some red leaves different shades of green.

A new story

Pia decides to paint some red leaves different shades of green.

A new story

Pia decides to paint some red leaves different shades of green.

She also has some naturally green leaves, also of varying shades.

A new story

Pia's artist friend walks in and asks if she can have some green leaves to include in a mixed-media piece.

Pia invites her to sort through the leaves and take any leaves she wants.

A new story

Next Pia's botanist friend walks in and asks if she can have some green leaves for a research project.

Pia invites her to choose some leaves as well.

The artist

The artist can justify her choices by saying:

(13) This leaf is green.
This leaf is not green.

(14) This leaf is greener than that one.
This leaf is not as green as that one.
This leaf is less green than that one.
This leaf is not green enough.
This leaf is too green.
This leaf is completely/perfectly green.
This leaf is pretty/really green.
This leaf is not so green.

The botanist

The botanist has only two options:

(13) This leaf is green.
This leaf is not green.

(15) #This leaf is greener than that one.
#This leaf is not as green as that one.
#This leaf is less green than that one.
#This leaf is not green enough.
#This leaf is too green.
#This leaf is completely/perfectly green.
#This leaf is pretty/really green.
#This leaf is not so green.

The botanist

Moreover, if the botanist accepts any of the sentences in (16)...

(16) A is greener than B.
B is not as green as A.
B is less green than A.
B is not green enough.
A is too green.
A is completely/perfectly green.
A is pretty/really green.
B is not so green.

The botanist

...it would be very difficult for her to reject (17).

(17) C is green.

If she does reject it, she can do so only based on the quality/quantity of color, not how the leaf got to be that way.

Gradable and non-gradable color

These facts show that there are both semantic and grammatical differences between uses of *green* that distinguish between leaves on the basis of why they are green (chlorophyll vs. paint) vs. how they are green (hue, saturation, etc.).

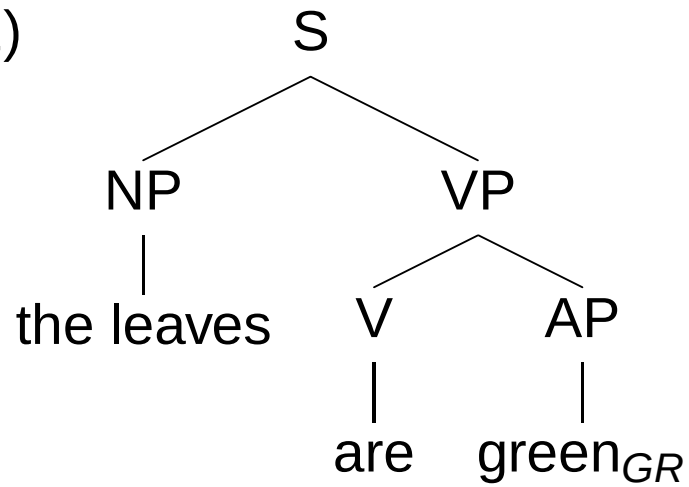
- The former is NON-GRADABLE.
- The latter is GRADABLE.

The gradable/non-gradable distinction is cashed out in different ways in different theories, but is ultimately a matter of meaning.

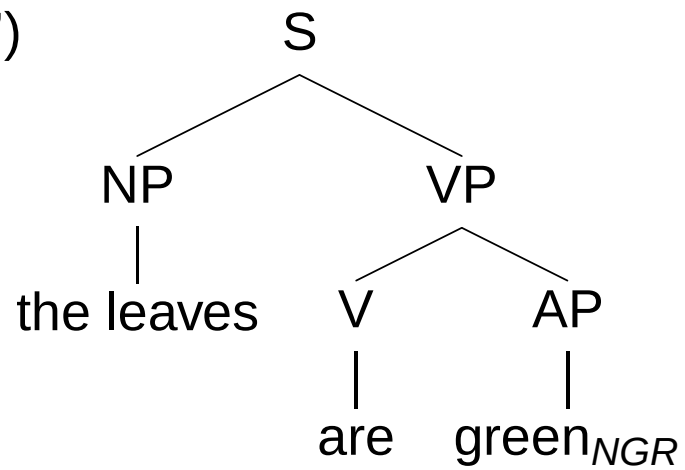
Problem solved?

But if the two uses of *green* in (1) involve different meanings, then the fact that sentences in which they appear can have different truth conditions should come as no surprise!

(1)



(1')



Travis' response

This line of reasoning amounts to saying that color adjectives are ambiguous. Travis has the following to say about this:

> *"If words are ambiguous in English, there must be a way of saying just what these ambiguities are; so a fact as to how many ways ambiguous they are." (1997, p. 90)*

Formalizing the gradable/non-gradable distinction will provide one answer. But we also want a detailed picture of what color adjectives mean on their gradable and non-gradable uses.

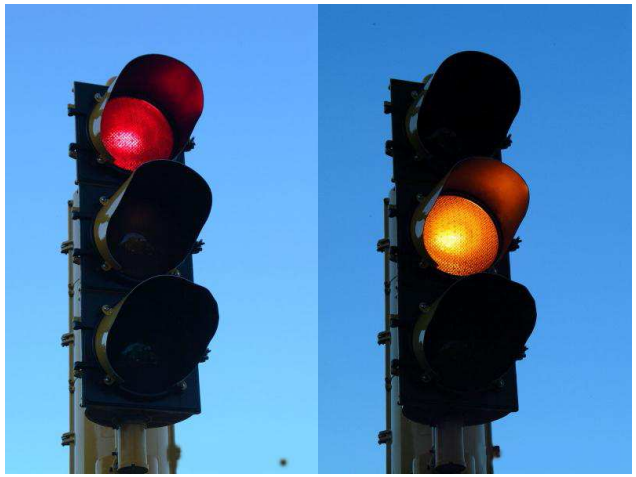
Nongradable color

This meaning should distinguish naturally green leaves from artificially green ones, but “natural” $\neq$ “not man-made”.

Nongradable color

(18) #This signal is redder than that one.

(19) #That signal is not as red as this one.



Nongradable color

I only use pens with blue ink. I ask a colleague for a pen, so she hands me one and says:

(20) Take this one, it's blue.

If it turns out to have black ink, I could say (21), but (22) would be obnoxious.

(21) You're mistaken, that one's black.

(22) ??Thanks, but I want one that's bluer.

Nongradable color

Naturalness is also not a sufficient condition: the color should also be *distinctive*:

(23) This sunburn is redder than that one.

(24) ??The doctor is looking for someone with red sunburn.

(24) is odd because it implies either that sunburn is classified according to color, or that the doctor is an idiot (or both).

Classification by color

Having the property denoted by the nongradable color adjective correlates with having other properties that provide the basis for classification:

- Demonstrating the presence of chlorophyll or that the plant will reproduce more leaves of the same color.
- Indicating that one must stop or may go.
- Producing blue writing vs. writing of another color.

These correlations are not a matter of degree: they either obtain or they do not.

Gradable color

On their gradable meanings, color adjectives have two distinct kinds of interpretations, which differ in the dimension relative to which they measure how an object manifests a color:

- COLOR QUANTITY: a measure of how much of the object is the relevant color.
- COLOR QUALITY: a measurement of how closely an object's color approximates or diverges from a "center" or prototype.

Color quantity

The quantity reading involves a measure of how much of the object is the relevant color, and is brought out by proportional modifiers:

(25) Pia painted the leaves part/half/completely green.

(26) Instead of jerseys with blue stripes this year, the team is wearing shirts that are entirely/100% blue.

(27) He's celebrating Bastille Day by wearing pants that are 1/3 blue, 1/3 white and 1/3 red.

Color quality

The quality reading expresses a measure of how closely an object's color approximates or diverges from a center or prototype:

(28) I see that your leaves are all completely painted, but some are greener than others. Try to ensure that the colors are identical.

(29) Your painting is coming along, though it still needs some work: the sky is blue, but it isn't blue enough, and the clouds are too white. Try modifying your pigment mixtures.

Color quality

The color quality reading is somewhat indeterminate, as there are different ways to measure proximity to a color center or prototype:

- hue, saturation, brightness
- other physical and perceptual characteristics of color
- combinations of these?

Scale structure

Only quantity scales appear to have minimal values:

(30) (??)The Honda is half green, half blue.

(31) The other car is half grey, half blue.

Scale structure

Both quantity and quality interpretations use scales with maximum values, but contrasts like the following show that maximality is marked differently:

(32) The baby's eyes were perfectly blue; #but they could have been bluer.

(33) The baby's shirt was completely blue, but it could have been a bluer shade of blue.

These distinctions need further investigation, but they also constitute evidence for a semantic (dimensional) distinction between color quantity and color quality.

Fixing the dimension

Further evidence for this conclusion comes from the interpretation of comparatives: (34) can have either meaning in (35a-b), but not the one in (35c).

(34) This apple is redder than that one.

(35) a. $\textbf{quantity-of-red}(\mathbf{a}_1) \succ \textbf{quantity-of-red}(\mathbf{a}_2)$
b. $\textbf{quality-of-red}(\mathbf{a}_1) \succ \textbf{quality-of-red}(\mathbf{a}_2)$
c. *$\textbf{quantity-of-red}(\mathbf{a}_1) \succ \textbf{quality-of-red}(\mathbf{a}_2)$

Fixing the dimension

The same effect is observed in other gradable adjectives that can express different kinds of measurements:

(36) Chicago is larger than Los Angeles.

(37) a. $\textbf{population}(\textbf{c}) \succ \textbf{population}(\textbf{la})$
b. $\textbf{area}(\textbf{c}) \succ \textbf{area}(\textbf{la})$
c. $*\textbf{population}(\textbf{c}) \succ \textbf{area}(\textbf{la})$

Semantics

Our semantic analysis is based on the assumption that the core meaning of a color term is associated with the nominal form, and that the adjectival meanings are derived from this.

The nominal core

Color nouns are names of colors. Their extensions are vague (because colors are continuous), but they are otherwise similar to other abstract/substance-denoting nouns.

(38) $[\![green_N]\!]$ = **green**
$[\![red_N]\!]$ = **red**
$[\![blue_N]\!]$ = **blue**
$[\![yellow_N]\!]$ = **yellow**

Nongradable color adjectives

A nongradable color adjective denotes the property of having the color named by the noun as an essential characteristic:

(39) $[\![green_A^{nongr}]\!] = \lambda x$.**green** is an essential characteristic of x

The nongradable meaning is type $\langle e, t \rangle$.

Nongradable color adjectives

A nongradable color adjective denotes the property of having the color named by the noun as an essential characteristic:

(39) $[\![green_A^{nongr}]\!] = \lambda x.\textbf{char}(\textbf{green})(x)$

The nongradable meaning is type $\langle e, t \rangle$.

Vagueness in nongradable color

How exactly nongradable color is manifested depends on the relation between the color and the correlated classifying property:

- Demonstrating the presence of chlorophyll only requires greenness at a certain point in time (green leaves can turn brown).
- Indicating that one may go only requires greenness of a specific portion of a traffic signal.
- Producing blue ink only requires the presence of blue ink inside the pen.

Vagueness in nongradable color

This variability introduces a certain vagueness into the semantics for nongradable color: We specify no generalized satisfaction conditions for nongradable color beyond the correlation between manifesting the relevant color somehow, somewhere, at some point, and having the correlated classifying property.

Gradable color adjectives

A gradable color adjective denotes a measure function that maps an object onto a degree that represents how it manifests the color named by the noun, relative to quantity of color or quality of color:

(40) $[\![green_A^{quant}]\!] = \lambda x$.the amount of x that is **green**

(41) $[\![green_A^{qual}]\!] = \lambda x$.the degree to which the color of x diverges from **green**

The gradable meanings are type $\langle e, d \rangle$.

Gradable color adjectives

A gradable color adjective denotes a measure function that maps an object onto a degree that represents how it manifests the color named by the noun, relative to quantity of color or quality of color:

(40) $[\![green^{quant}_{A}]\!] = \lambda x.\textbf{quant}(\textbf{green})(x)$

(41) $[\![green^{qual}_{A}]\!] = \lambda x.\textbf{qual}(\textbf{green})(x)$

The gradable meanings are type $\langle e, d \rangle$.

Gradable color adjectives

Gradable color adjectives form properties by combining with degree morphology:

(42) $[\![pos]\!] = \lambda g_{\langle e,d\rangle} \lambda x . g(x) \succ \textbf{stnd}(g)$

(43) $[\![very]\!] = \lambda g_{\langle e,d\rangle} \lambda x . g(x) \succ \textbf{stnd}(g_{\{x|pos(g)(x)\}})$

(44) $[\![-er]\!] = \lambda g_{\langle e,d\rangle} \lambda x \lambda y . g(y) \succ g(x)$

The (unmodified) positive form involves a null degree morpheme *pos* that introduces a relation to a standard of comparison.

Vagueness in gradable color

As it does with other gradable adjectives, *pos* introduces vagueness into the semantics of gradable color.

(45) His face is (very) red.

(46) That apple is (very) red.

Two parameters of vagueness

The vagueness in gradable color is different in nature from in nongradable color.

(47) Every boy$_i$ was tall$_{\textbf{stnd}_i}$.

(48) Every leaf and traffic light was green.

Three ways of being green

(1) The leaves are green.

Three ways of being green

(1) $[\![\text{The leaves are green}_{\langle e,t\rangle}]\!] = 1$ iff:

char(**green**)(**the leaves**)

Three ways of being green

(1) $[\![\text{The leaves are green}^{\langle quant, \langle e,d \rangle \rangle}]\!] = 1$ iff:

char(**green**)(**the leaves**)
quant(**green**)(**the leaves**) $\succ$ **stnd**(**quant**(**green**))

Three ways of being green

(1) $[\![\text{The leaves are green}^{\langle e,d\rangle}_{qual}]\!] = 1$ iff:

char(**green**)(**the leaves**)
quant(**green**)(**the leaves**) $\succ$ **stnd**(**quant**(**green**))
qual(**green**)(**the leaves**) $\succ$ **stnd**(**qual**(**green**))

Three ways of being green

(1) "The leaves are green." $\longmapsto$

char(**green**)(**the leaves**)
quant(**green**)(**the leaves**) $\succ$ **stnd**(**quant**(**green**))
qual(**green**)(**the leaves**) $\succ$ **stnd**(**qual**(**green**))

Different utterances of (1) are "compatible with different ways of being true" because they may be utterances of different propositions.

Three ways of being green

(1) "The leaves are green." $\longmapsto$

char(**green**)(**the leaves**)
quant(**green**)(**the leaves**) $\succ$ **stnd**(**quant**(**green**))
qual(**green**)(**the leaves**) $\succ$ **stnd**(**qual**(**green**))

Different utterances of (1) are "compatible with different ways of being true" because they may be utterances of different propositions.

Color adjectives are not an argument for pragmatic contextualism!

Szabó 2001

There may very well be reason to posit an additional part variable in the semantic representation of color adjectives:

(49) A: This apple is completely red.
B: No, it's not completely red: it's red only on the outside, not on the inside.

But this will not help us explain either the color quality or nongradable meanings of a color adjective.

Rothschild and Segal 2007

The three types of color adjective denotations we have argued for could be derived in an indexical account. But there are two disadvantages to this:

- We have no explanation for why we see these particular denotations, and only these three denotations.
- The distinction between indexicality and context sensitivity becomes extremely weak. Color terms are not indexical in the way that e.g. deictic pronouns are.

Color and the typology of adjective ambiguity

The indexical account masks the fact that color adjective ambiguity is deeply similar to the ambiguities found in other classes of adjectives:

- gradable vs. nongradable: nationality terms, relational adjectives
- quality vs. quantity: *wet, cooked, ...*

We can captures these correlations by positing a grammatical basis for the semantic distinctions underlying these ambiguities, avoiding recourse to the power of indexicality.

Color terms and the semantics of derivation

On our analysis, color adjectives are similar to denominal adjectives such as *woolen, wooden, ...*, which show a gradable/nongradable ambiguity.

Further study of the semantics of these adjectives should yield a theory of:

- the range of semantic mappings from nouns to adjectives;
- the semantic role of morphology in this mapping.

The linguistic perspective

- Once context dependence is identified in meaning, it's a fast and slippery slope to the conclusion that everything is indexical.
- But easily overlooked data, such as the interaction of color adjectives and degree morphology, shows that humans limit the semantic space of possibilities and grammaticize those limits into distinct meanings.
- This is why a linguistic perspective on the issue is essential.

Color, Context and Compositionality

Chris Kennedy Louise McNally

September 13, 2007
International Conference on Adjectives
Université de Lille

The derivation of color

In Yélî, basic color terms are reduplicated forms of nouns referring to objects that manifest the color (Levinson 2000):

mtye	‘red parrot species’	mtyemtye	‘red’
kpaapî	‘white cockatoo’	kpaapîkpaapî	‘white’
kpêdê	‘tree species’	kpêdêkpêdê	‘black’
mgîdî	‘night’	mgîdîmgîdî	‘black, dark’
wulu	‘spit’	wuluwulu	‘dark-red’

All other color expressions are ‘descriptive’ and syntactically complex. Do we find a difference in Travis contexts?

The botanist again

Use of degree modification forces a type $\langle e, d \rangle$ meaning:

(50) A is greener than B.

(51) **qual**(**green**)(**A**) $\succ$ **qual**(**green**)(**B**)

That's why if the botanist accepts (51) (on either the quality or quantity reading; the former is most natural here)...

The botanist again

She should also accept (52), assuming the color of the leaf meets the appropriate contextual standard.

(52) C is green.

(53) **qual**(**green**)(**C**) $\succ$ **stnd**(**qual**(**green**))

Color and comparison

A is a real Japanese maple leaf and B is a paper leaf. Neither leaf is green in the 'naturally green' sense, however (55)— but not (54)— is both felicitous and true.

(54) ??A is greener than B.

(55) A is closer to (being) green than B.

This is similar to other vague, nongradable predicates:

(56) That rock is closer to (being) a chair than that pile of dirt.

A

B