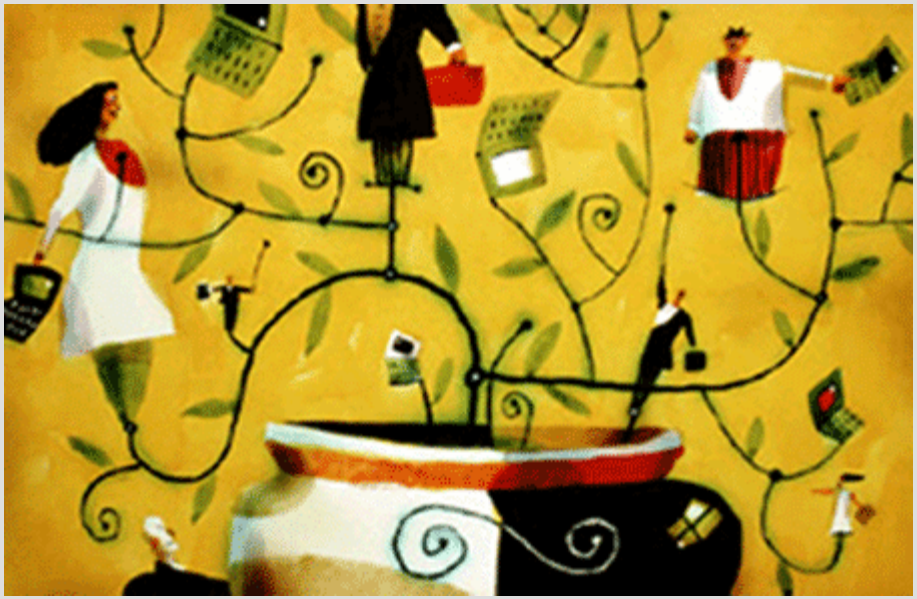
User-Centered Website Development: A Human-Computer Interaction Approach



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With a foreword by:
Jared M. Spool, Founding Principal,
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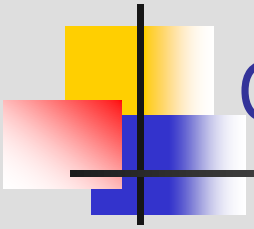
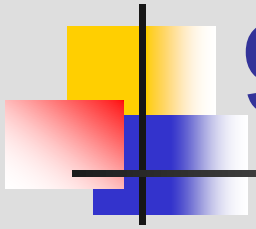
PowerPoint slides by Dan McCracken, with thanks to Rosalee Wolfe, S. Jane Fritz of St. Joseph's College, and Rhonda Schauer



Credits

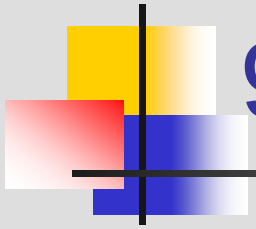
- Slides 7 and 35-44: Daniel D. McCracken.
- Slide 29: Courtesy of American Honda Motor Co., Inc.
- Slide 31: Courtesy of Crate&Barrel.
- Slide 33: Courtesy of Mattel, Inc.
- Slide 45: Estate of Horace W. McCracken.



9. Color

In this chapter you will learn about:

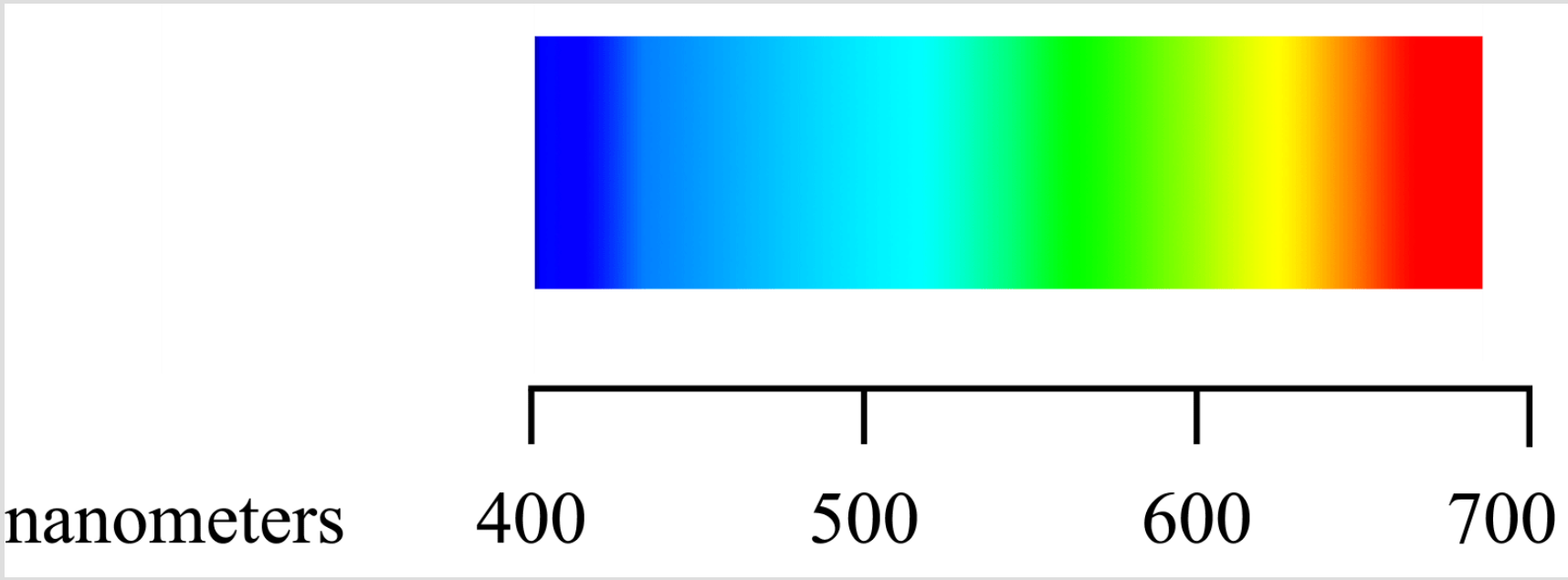
- Physical and perceptual aspects of color
- Several color models and the advantages of each
- Four color-harmony schemes
- Some examples of color in nature, relating them to our vocabulary of color
- Tool programs available to you for studying color
- How color can make Web pages pleasing and easy to read



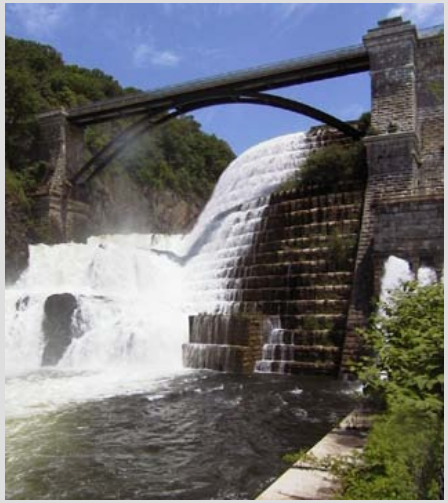
9.2 The Physics of Color

- The spectrum of visible light
- The electromagnetic spectrum
- Human response to color

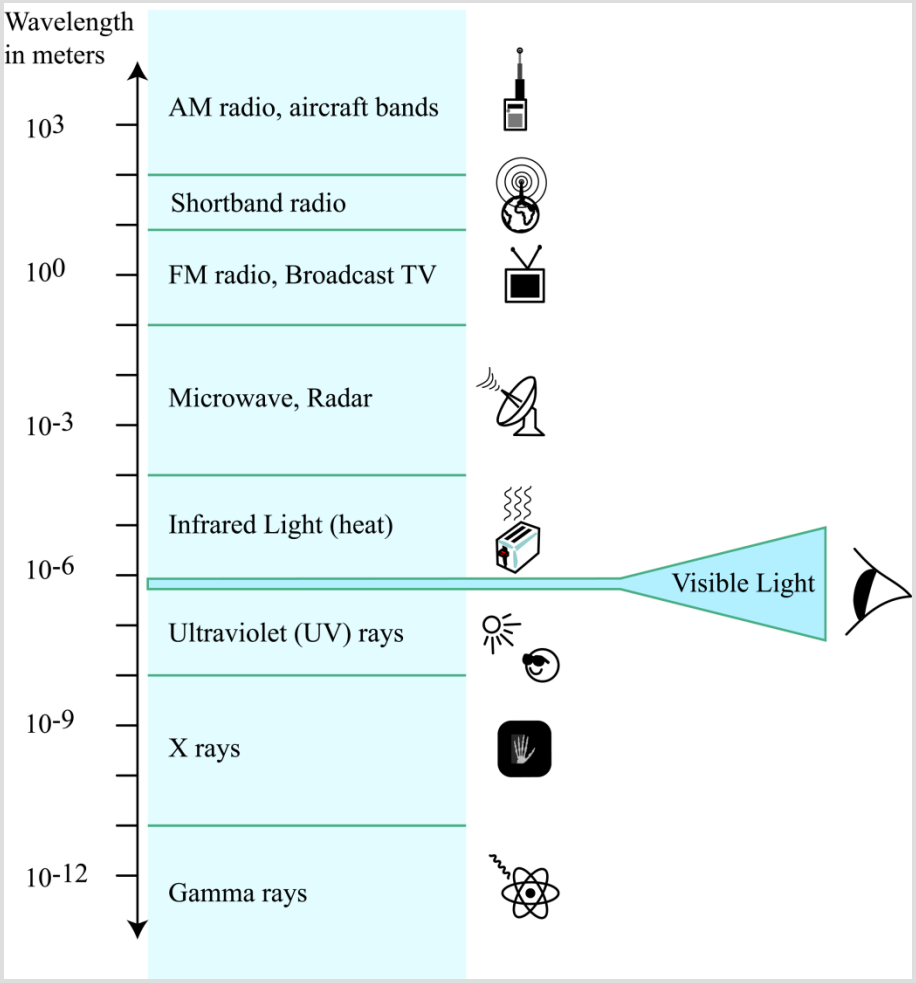
The spectrum of visible light



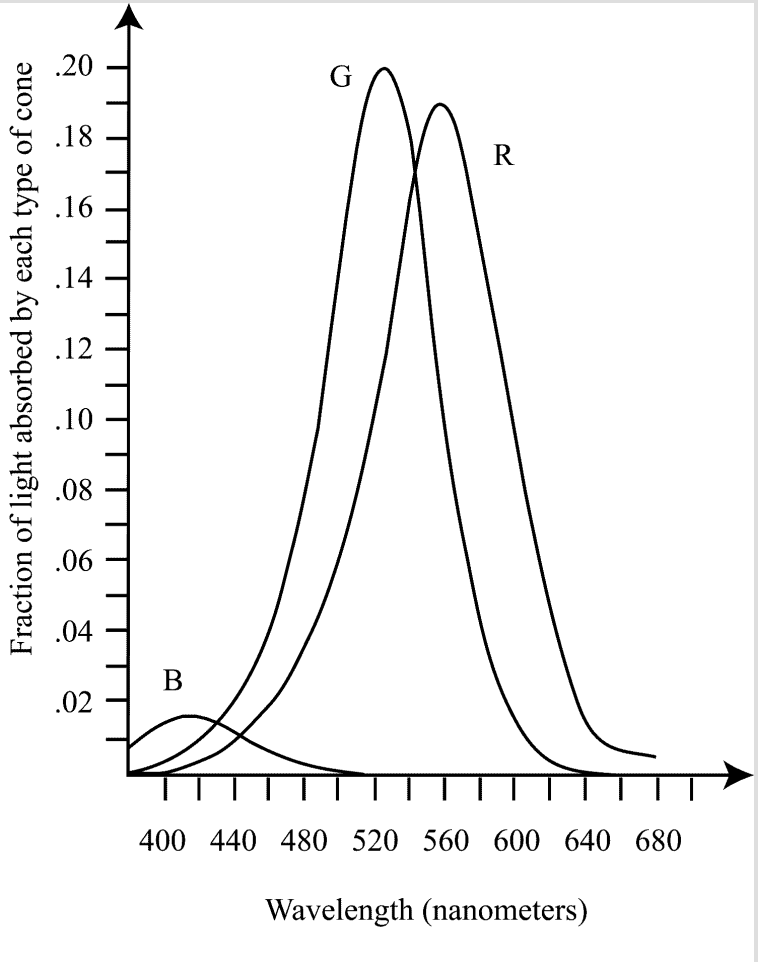
The spectrum as seen in nature

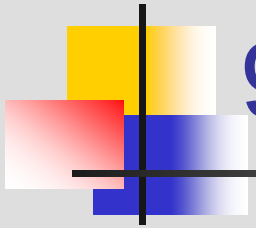


The electromagnetic spectrum, of which visible light is a very thin band



Human response to color

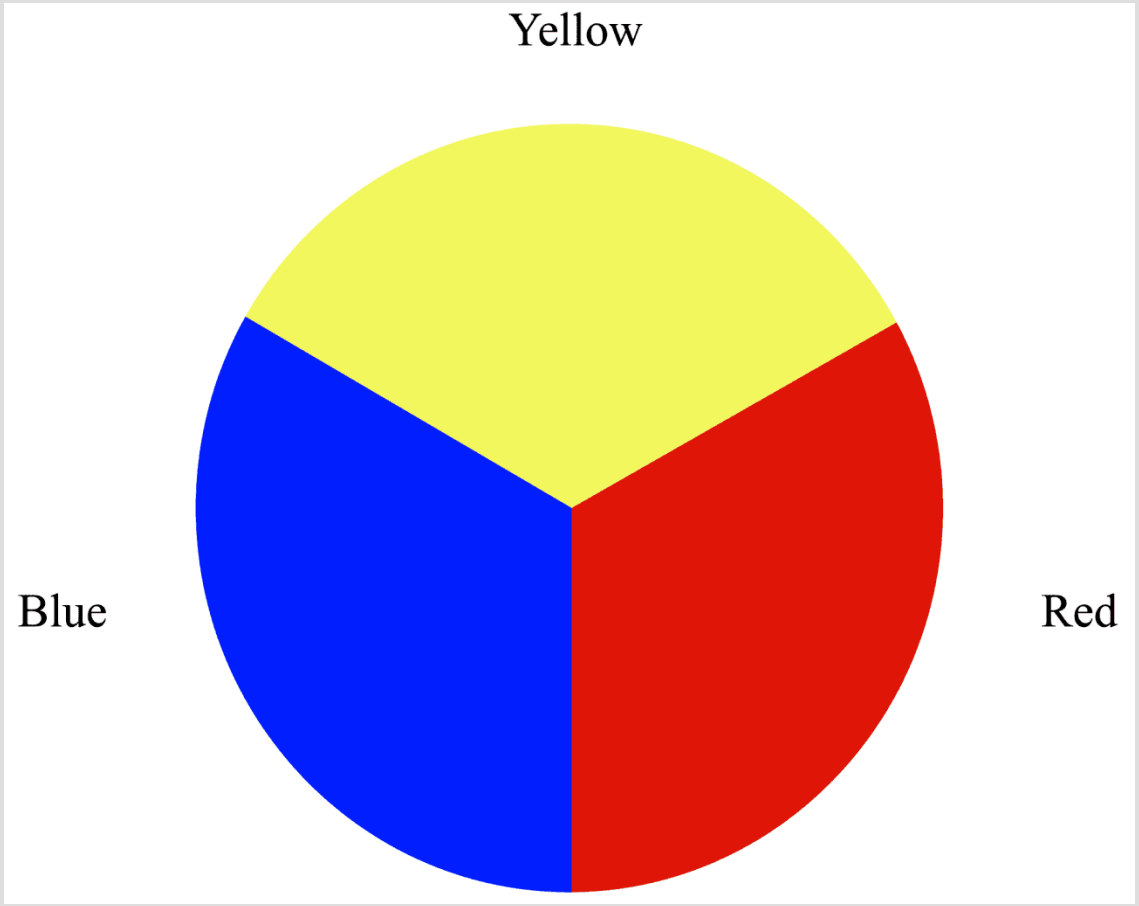




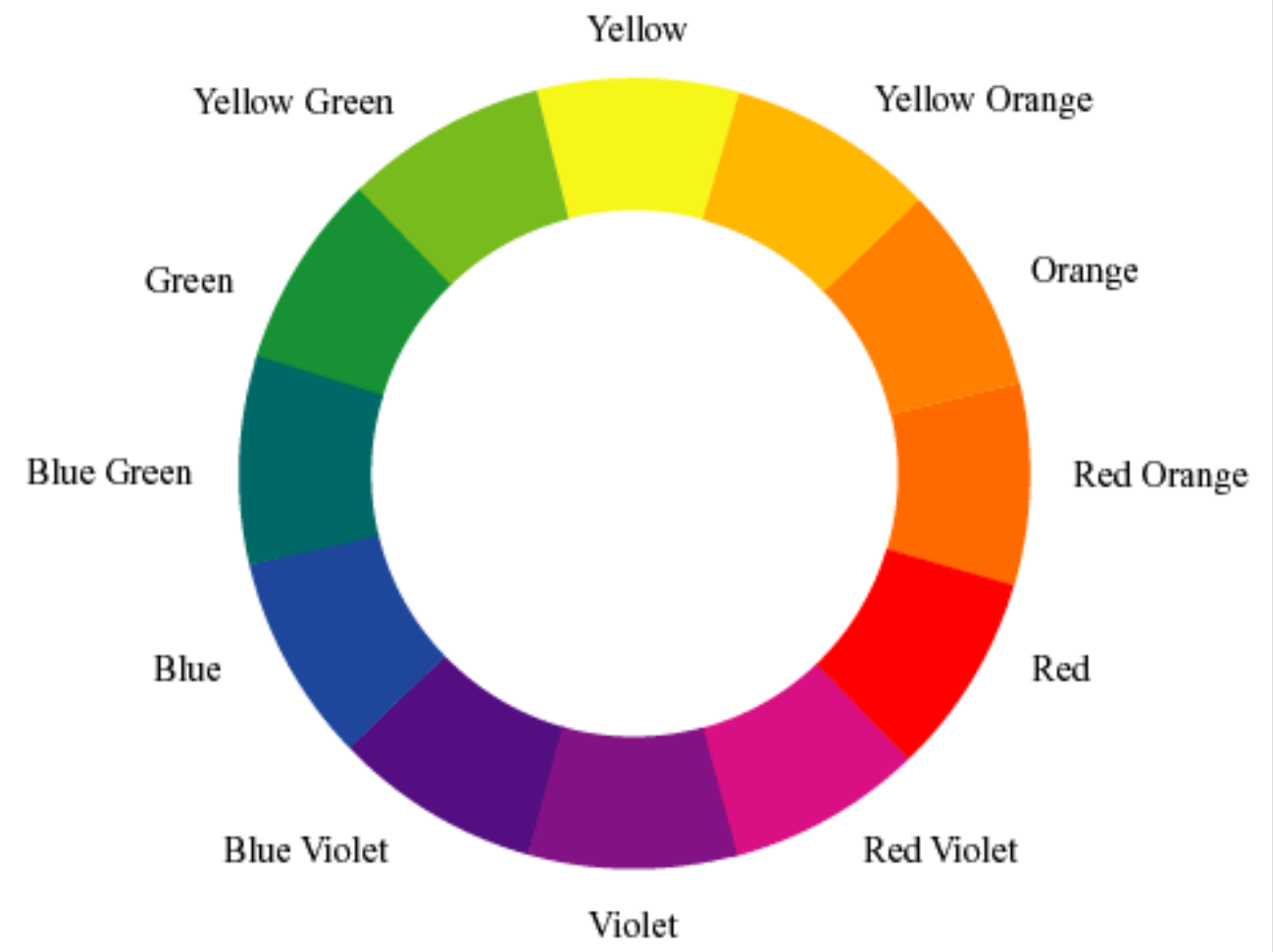
9.3 Color Models

- An artist's color wheel: red, yellow, and blue (RYB)
- Additive color: red, green, blue (RGB)
- Subtractive color: cyan, magenta, yellow, and black (CMYK)
- Hue, saturation, and brightness (HSB)

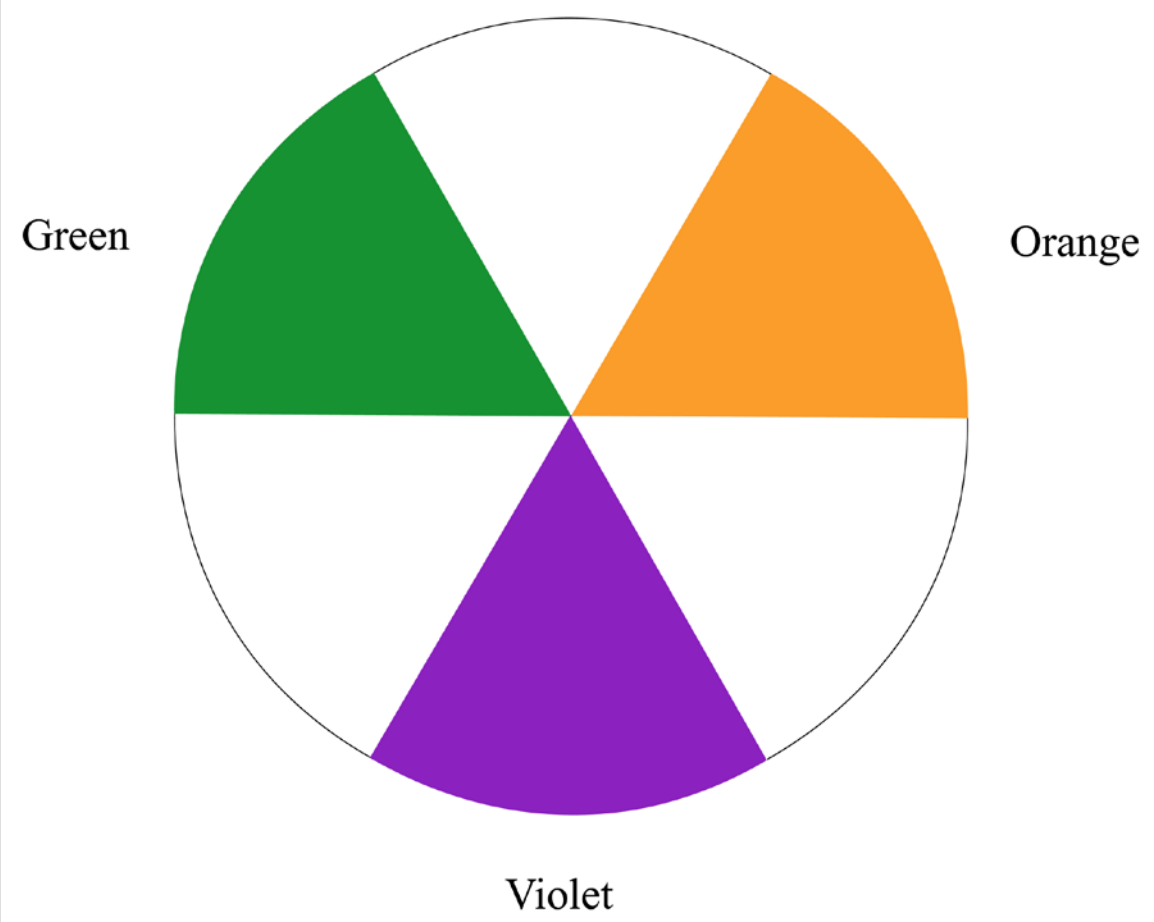
The artist's model: red, yellow, and blue



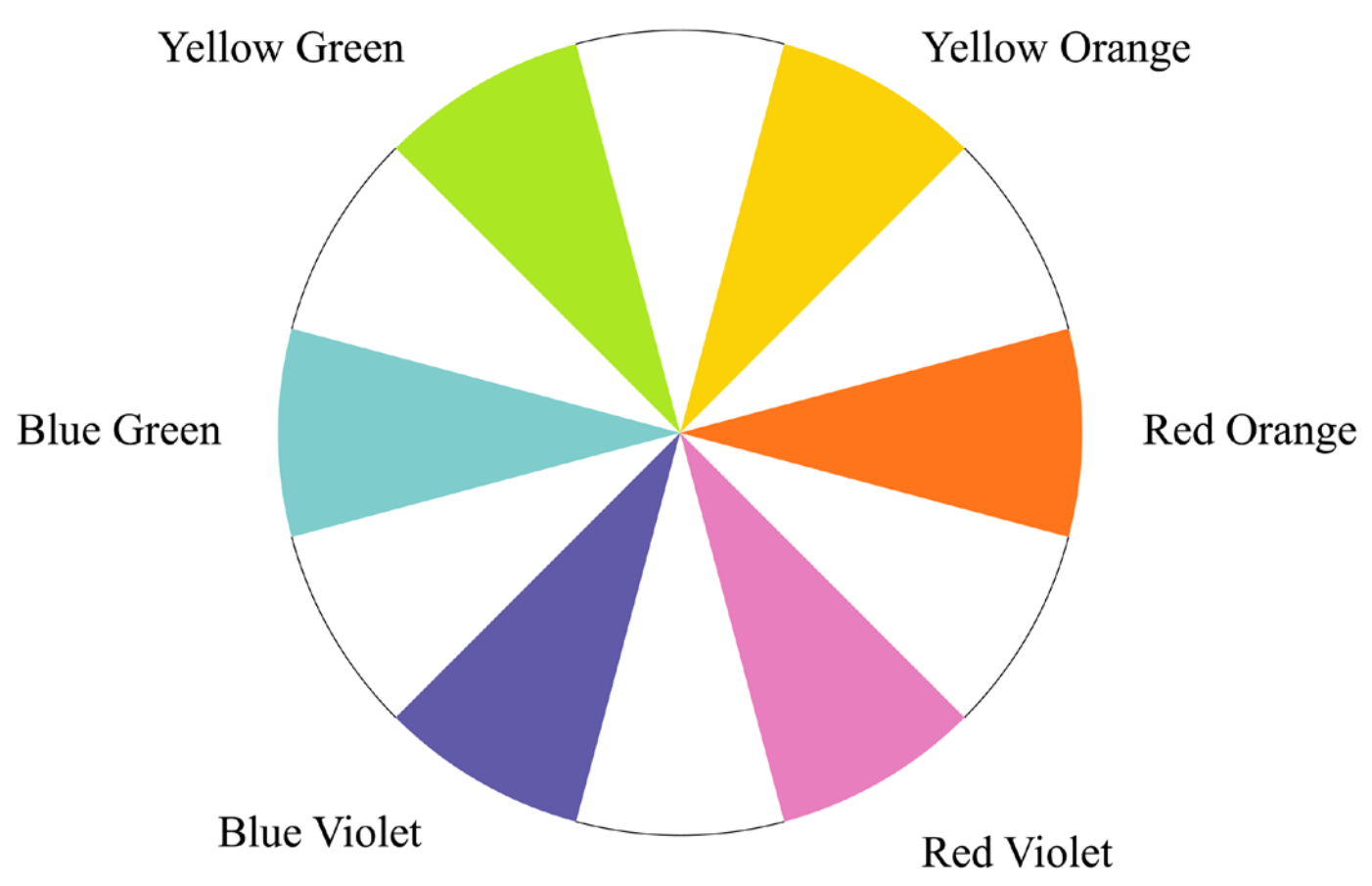
An artist’s color wheel



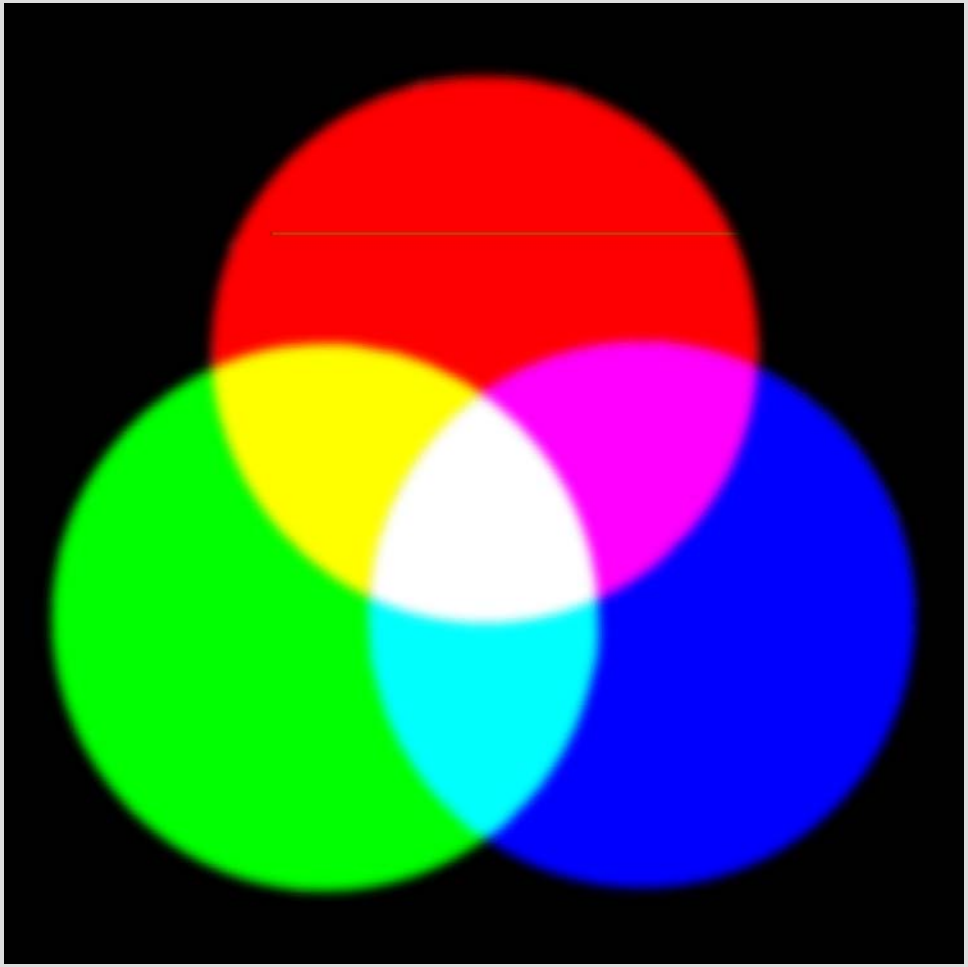
The secondary colors

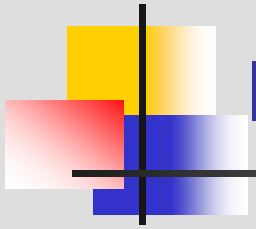


The tertiary colors



Additive color: things that emit light, especially monitors (RGB)

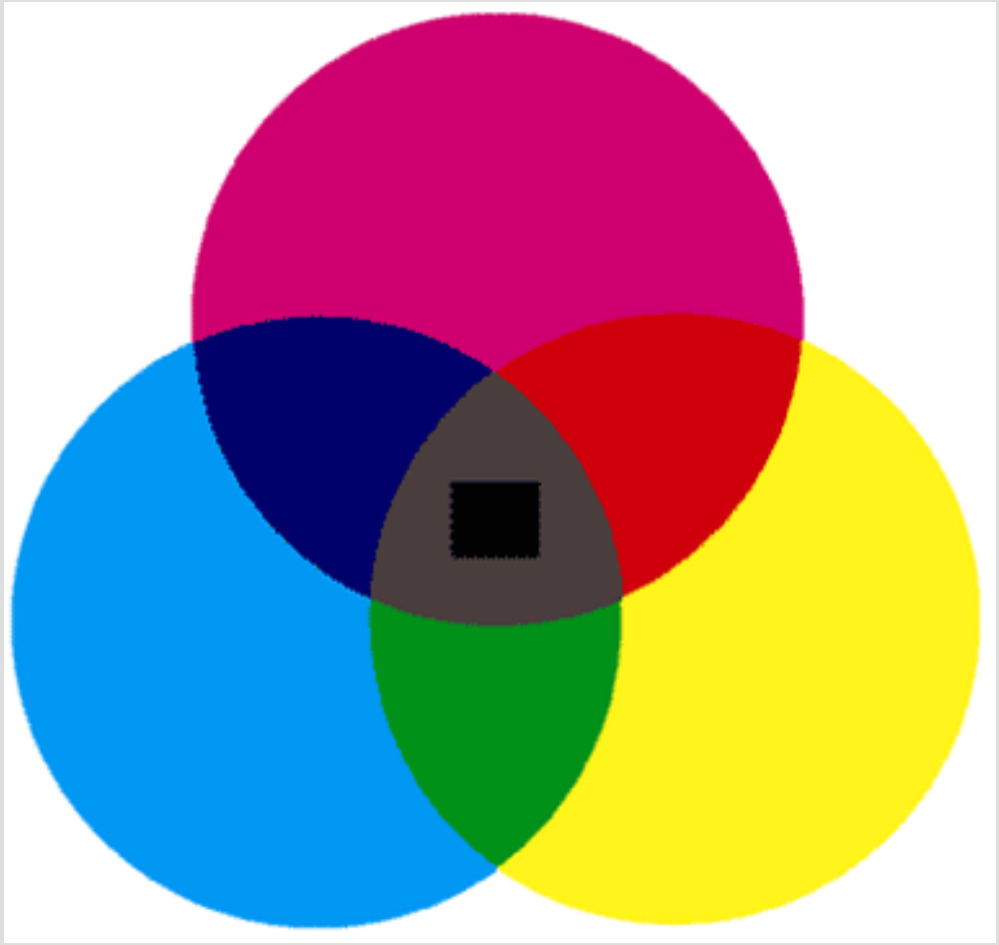


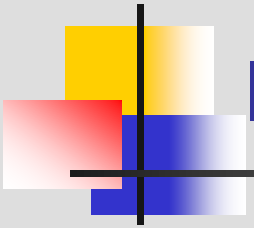


In additive color . . .

- Red + Green = Yellow
- Red + Blue = Magenta
- Green + Blue = Cyan
- Red + Green = *Yellow*? Yes, when you *add* colors. Paint and print *subtract* colors.

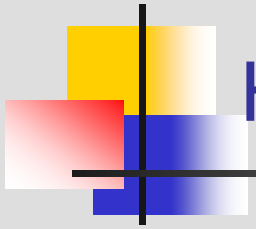
Subtractive color: things that reflect (and selectively absorb) light (CMYK)





In subtractive color . . .

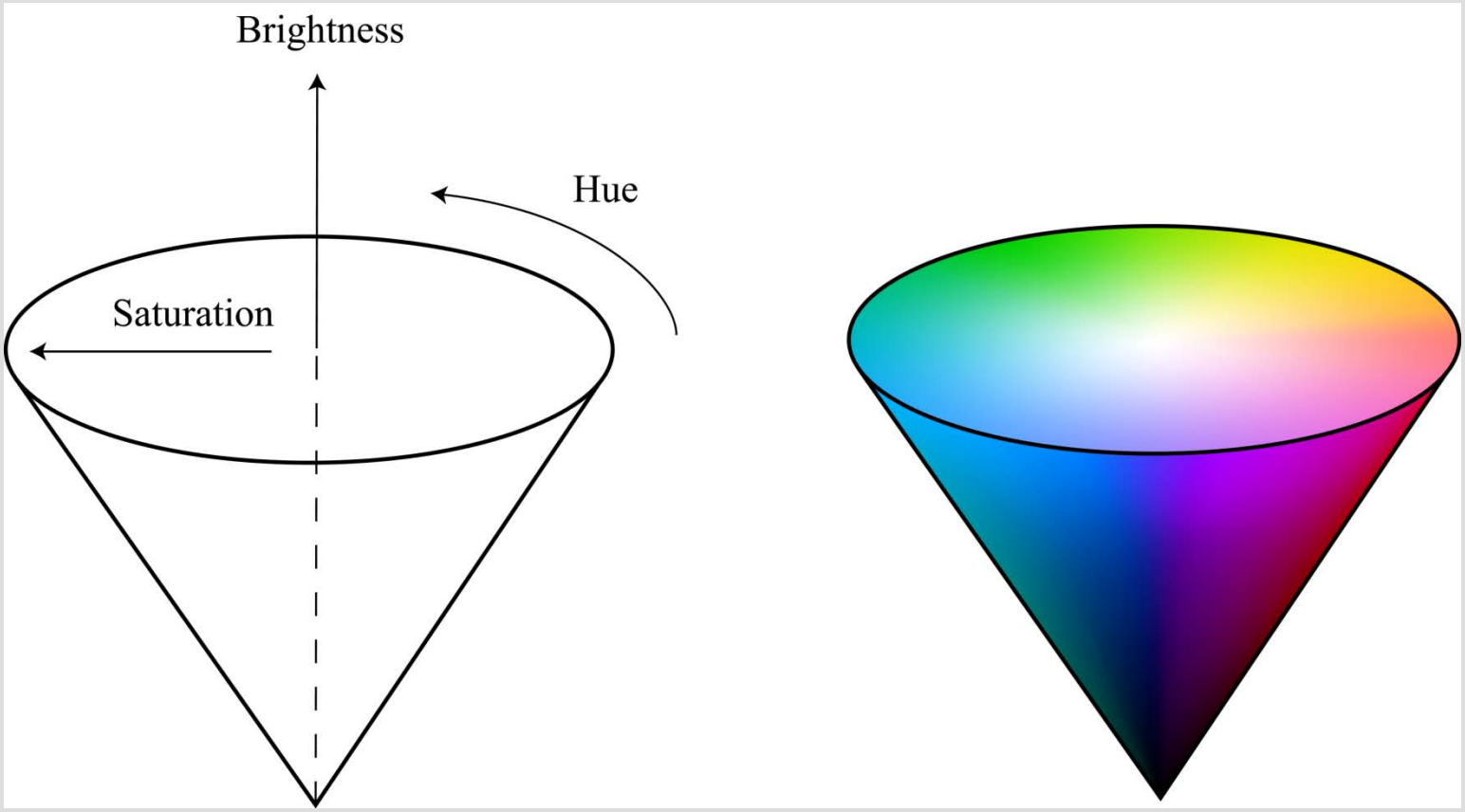
- Cyan subtracts red
- Magenta subtracts green
- Yellow subtracts blue
- In photography, that's it: all three together subtract all light, giving black
- In print, the dyes aren't that good, and we need black ink too
- Hence, four-color printing: CMYK
- K from blacK; B already means Blue

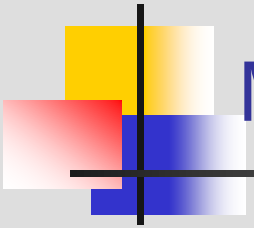


HSB: Hue, Saturation, and Brightness

- Hue: where a color lies around a color wheel: red, green, yellow, blue-green, etc.
- Saturation: the “purity” of a color; a fully-saturated color has no white mixed with it, in paint terms
- Brightness: light, dark, or in between?
- In everyday use, most people probably are thinking of hue when they speak of color

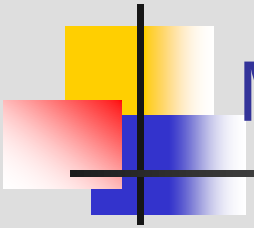
The color cone: hue, saturation, and brightness in relation to each other





More on saturation

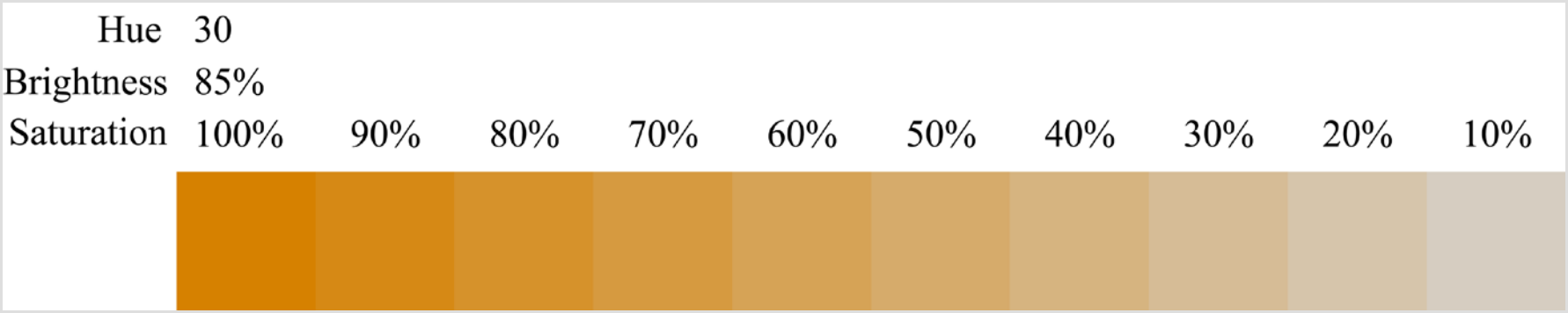
- White, black, and all grays are zero percent saturated
- A color becomes more saturated as it moves away from gray to a pure color
- A pure (fully-saturated) color, in RGB terms, in one that contains:
  - Only red, green, or blue, or
  - Only yellow (= red + green), or
  - Only magenta (= red + blue)
  - Only cyan (= blue + green)



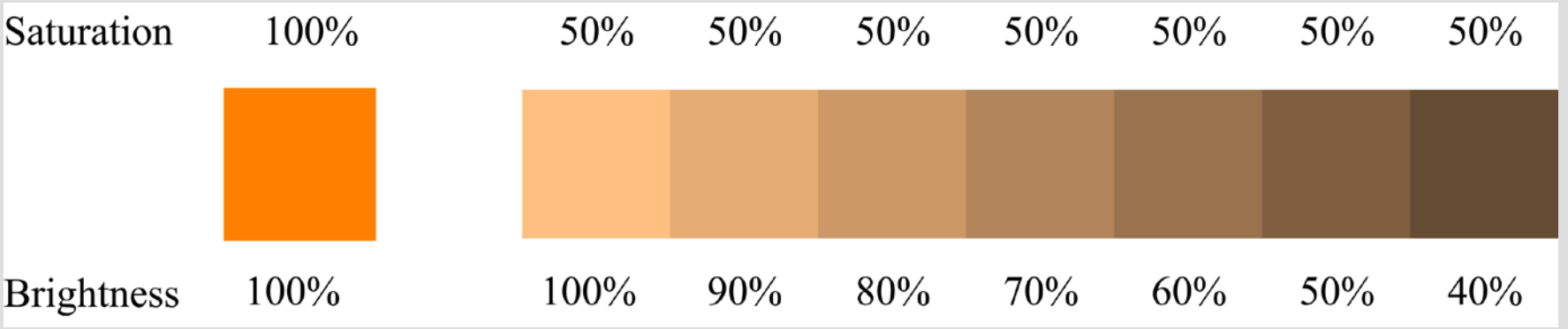
More on saturation, continued

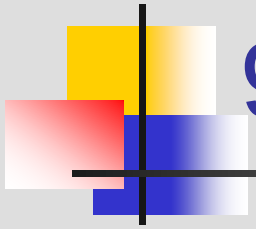
- Note: the previous slide said nothing about the brightness of those pure colors
- A saturated color can be a brilliant yellow, but
- It can be a deep crimson, or midnight blue
- The flower pictures, Slides 35 to 44, show many combinations of brightness and saturation

Varying saturation, with brightness held constant



Varying brightness, with saturation held constant

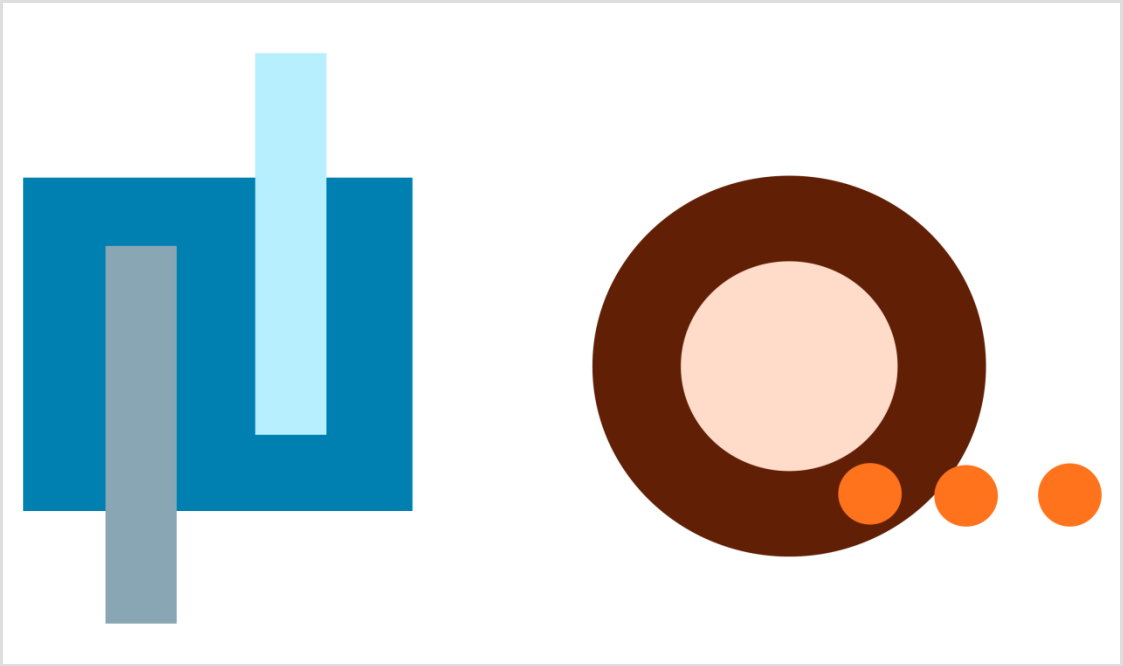




9.4 Four Color-Harmony Schemes

- Monochromatic: colors of same or similar hue, differing in brightness and/or saturation
- Complementary: colors approximately opposite each other on a color wheel
- Analogous: colors adjacent to each other, from any segment of a color wheel
- Triadic: three colors approximately equally spaced around a color wheel

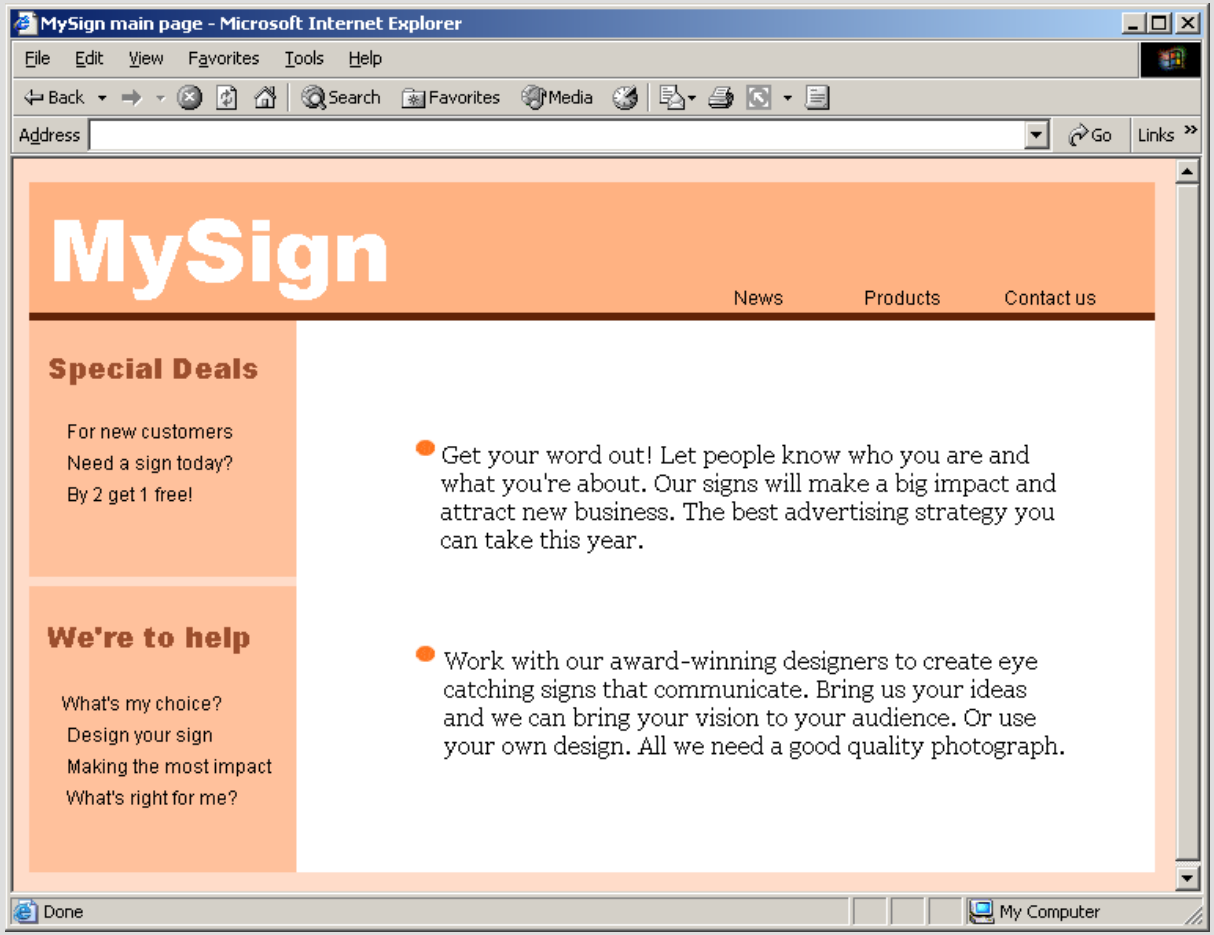
Monochromatic color harmony: colors of same hue, differing in brightness and/or saturation



All blue

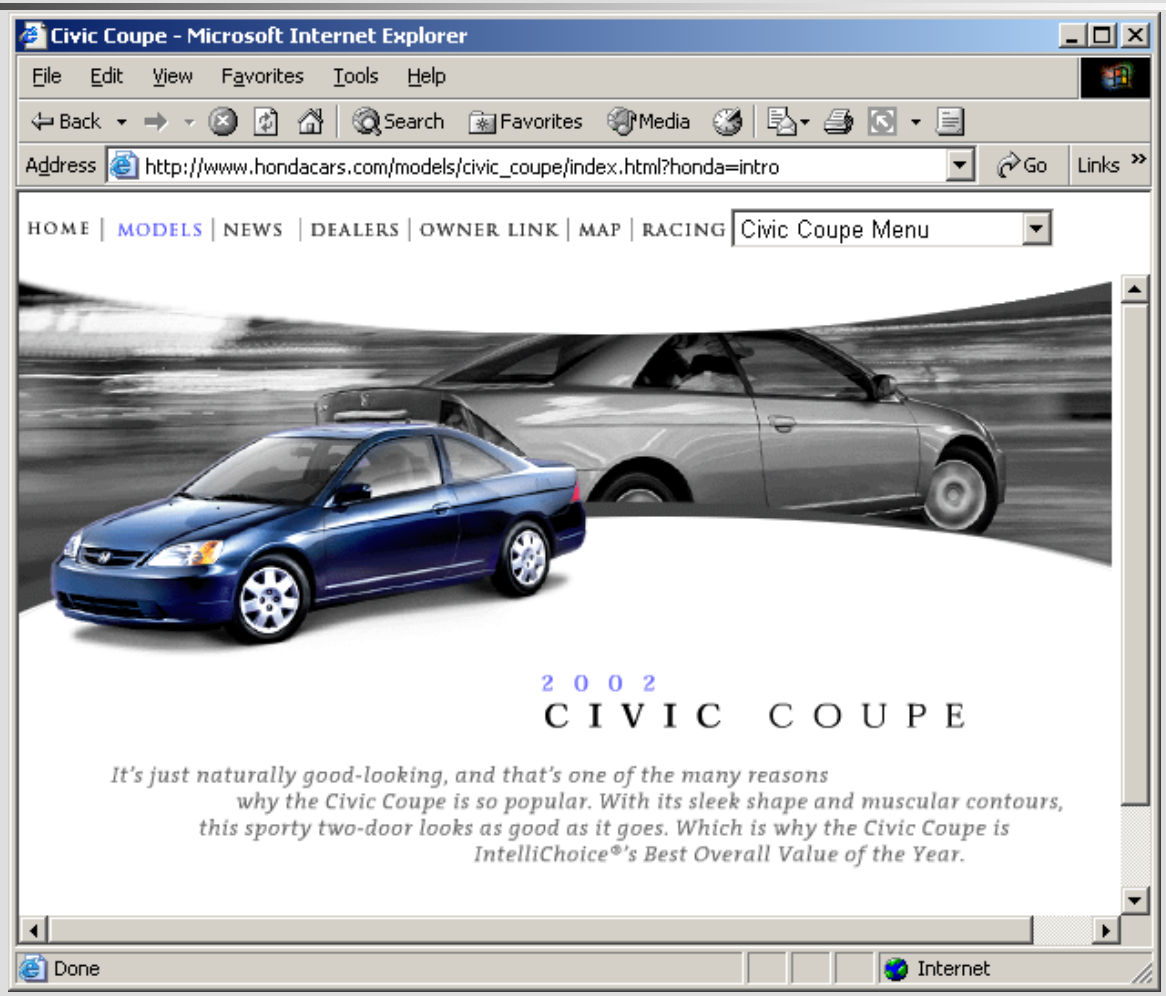
All orange

Monochromatic example: orange, with variation in brightness and saturation

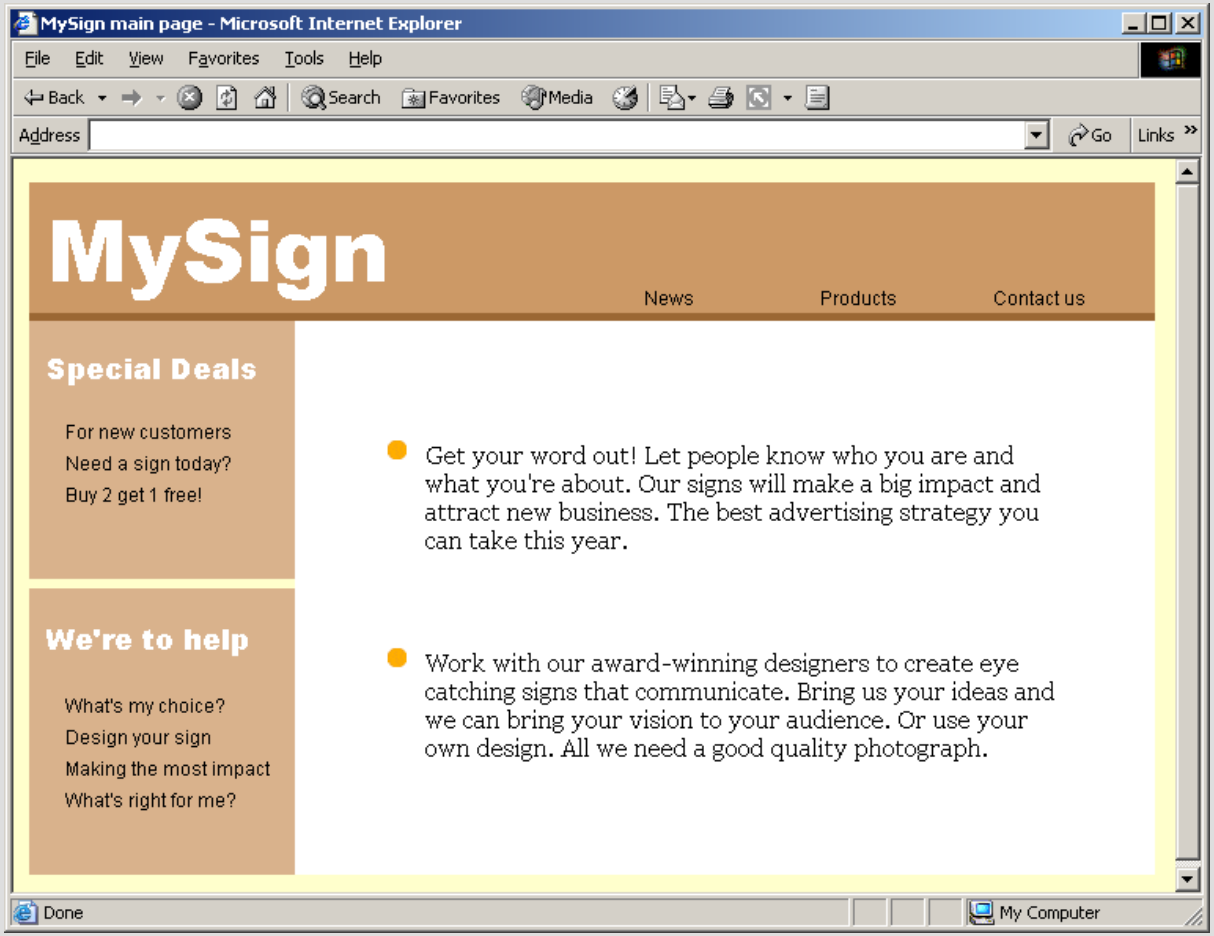


Complementary: red and green

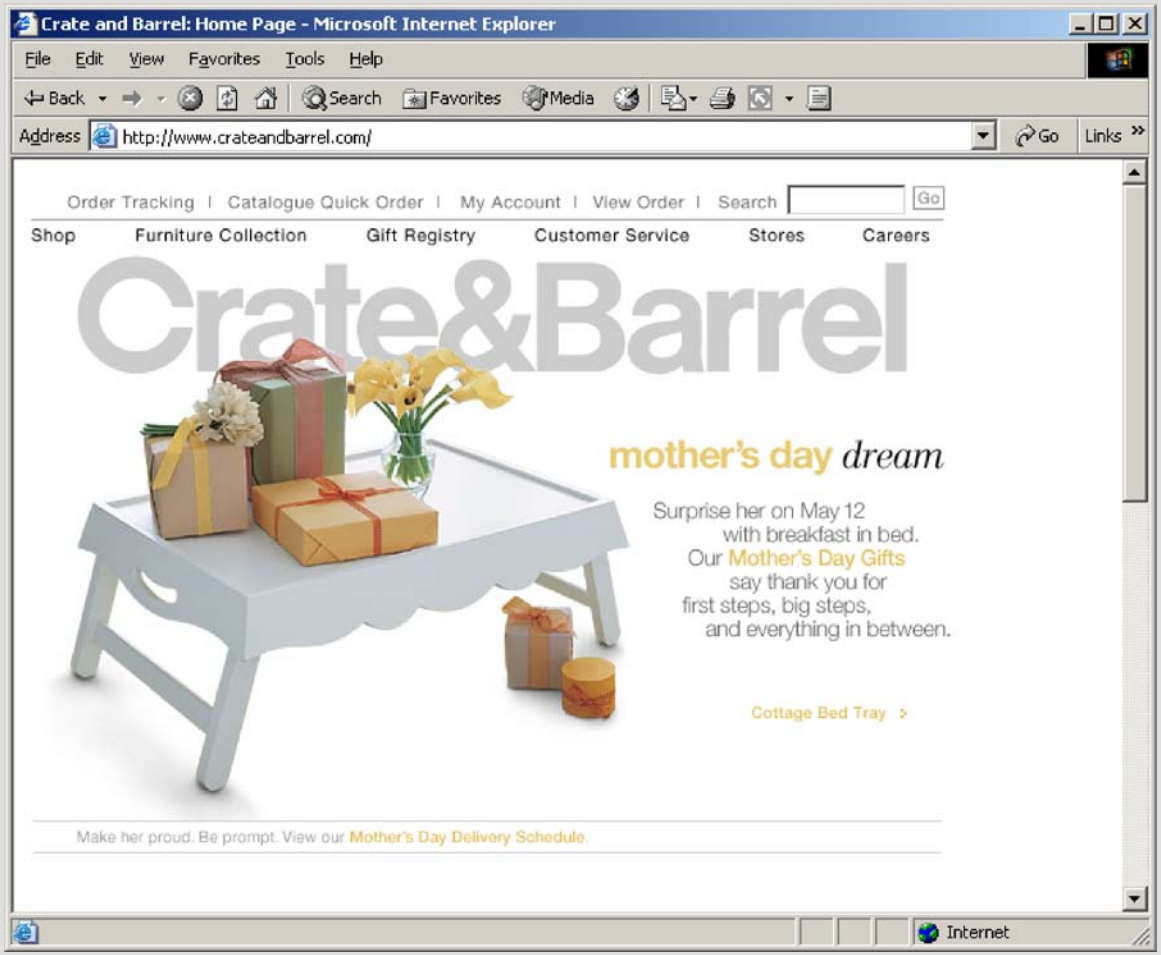
Complementary: various blues, with red-orange highlights



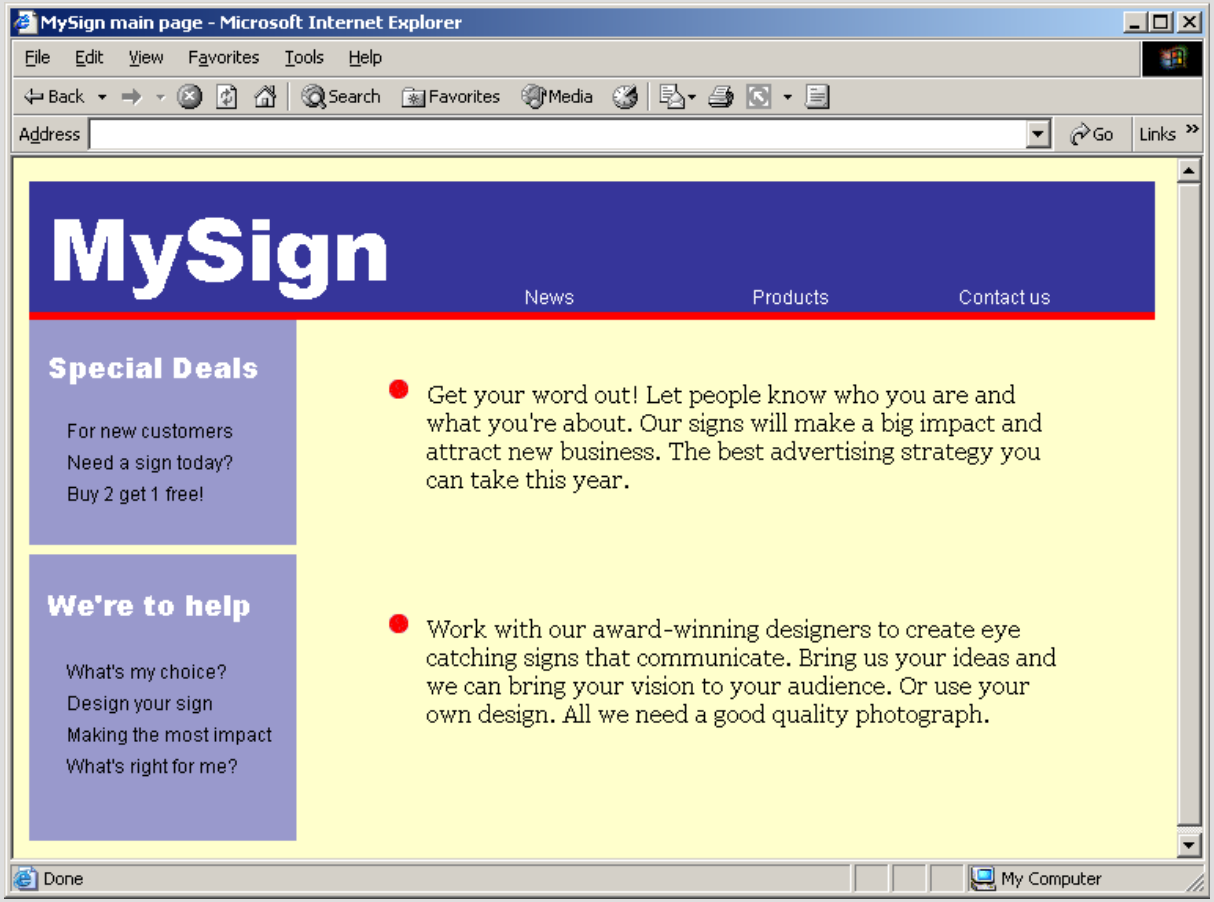
Analogous: bright orange, darker yellow-orange, light yellow



Analogous: red-orange through yellow-green

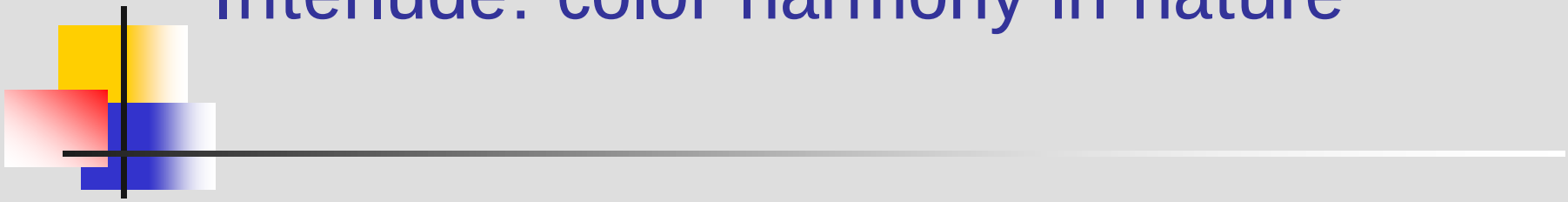


Triadic: red, yellow, blue



Triadic: red, yellow, blue

Interlude: color harmony in nature



- Ten pictures of flowers, taken at the Heather Garden, in northern Manhattan, New York City, June and July, 2003
- One picture taken at sunrise in Arizona, of frost on glass

Analogous greens and blue-greens

Unsaturated blues

Fully-saturated orange, against its complement, green

A dark color can be highly saturated

Nearly saturated yellow-orange against a background of unsaturated blues and greens

Low-saturation colors can be beautiful

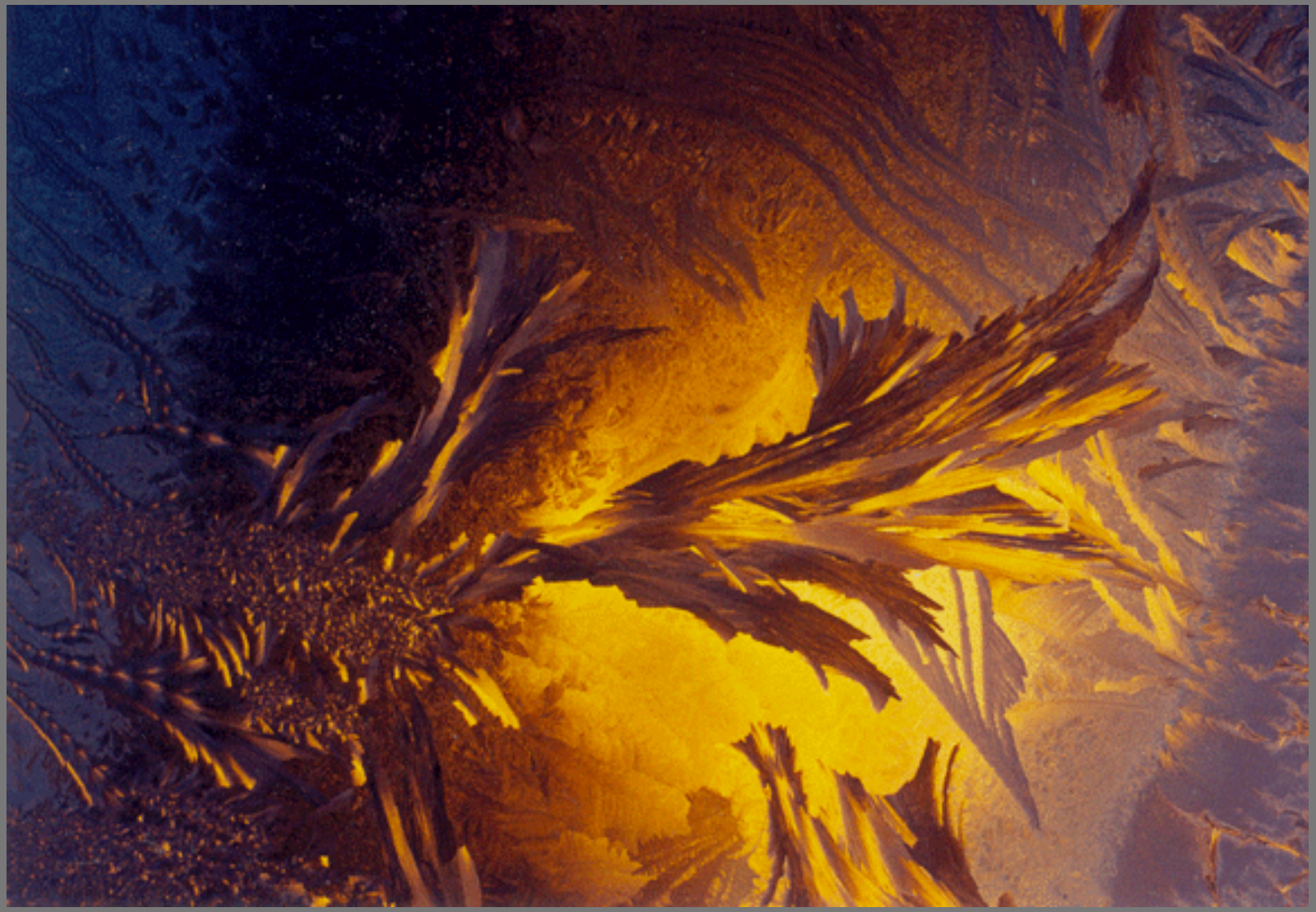
Medium-high saturation magenta; low saturation greens

High saturation orange; medium saturation complementary greens

A riot of warm analogous colors

Complementary colors

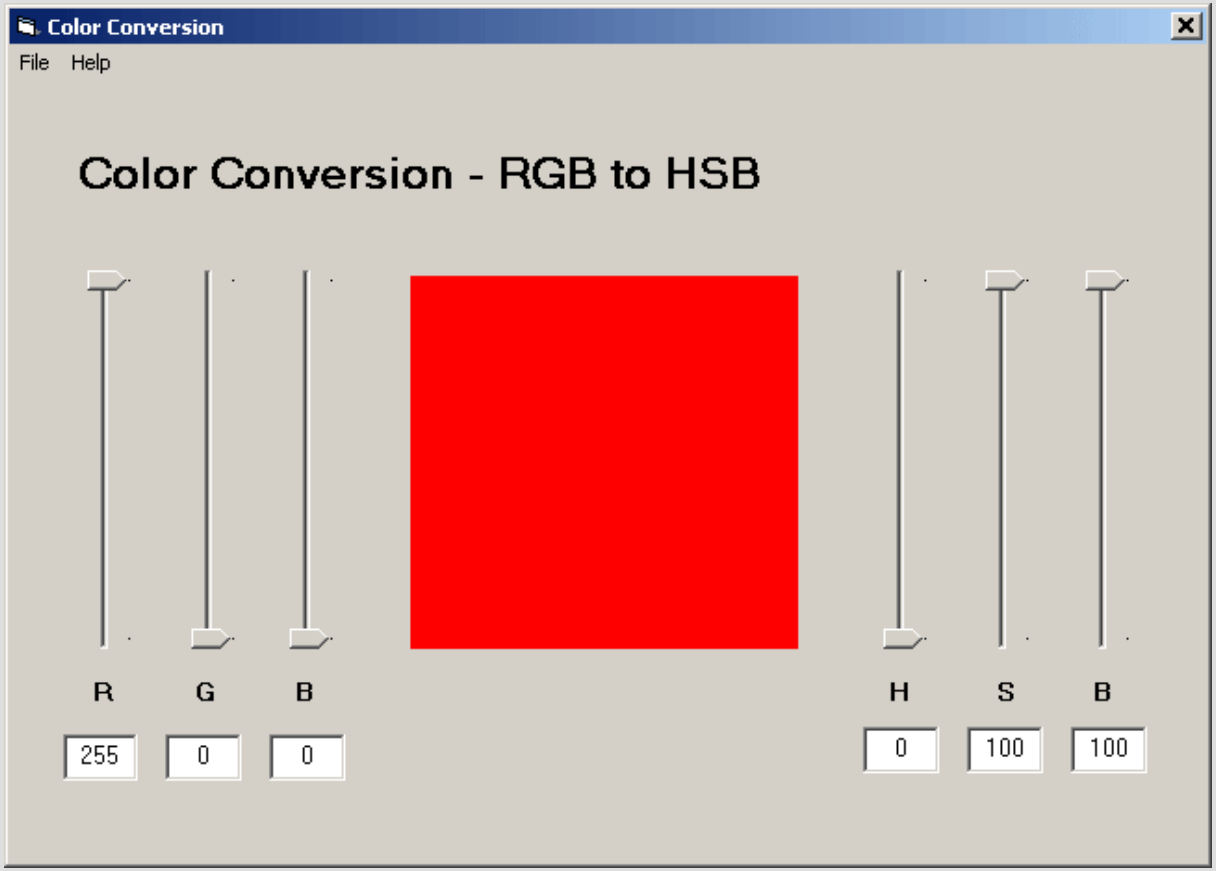
Complements: ice crystals at sunrise



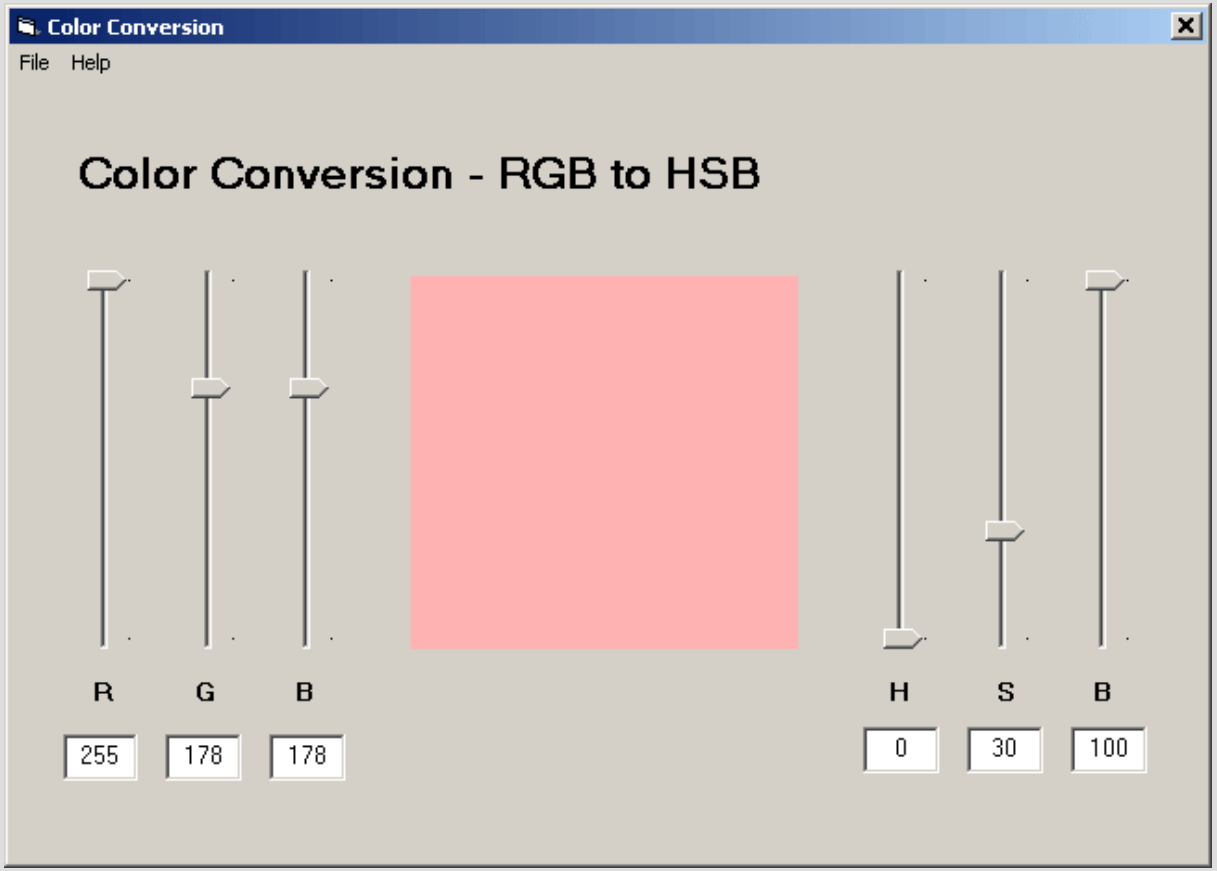
The color software at the companion Web site is a great way to learn

- Permits simple experimentation with the concepts, e.g.:
  - What is pink? (Desaturated red)
  - Can a dark color be saturated? (Yes)
  - Does adding red and green really give yellow? (Yes)
  - Is gray ever saturated? (No)
  - What does saturation mean at low brightness levels? (Not much)
  - In RGB, how do you “add white” to red? (Increase the amounts of green and blue)
  - **http://www.prenhall.com/mccracken/**

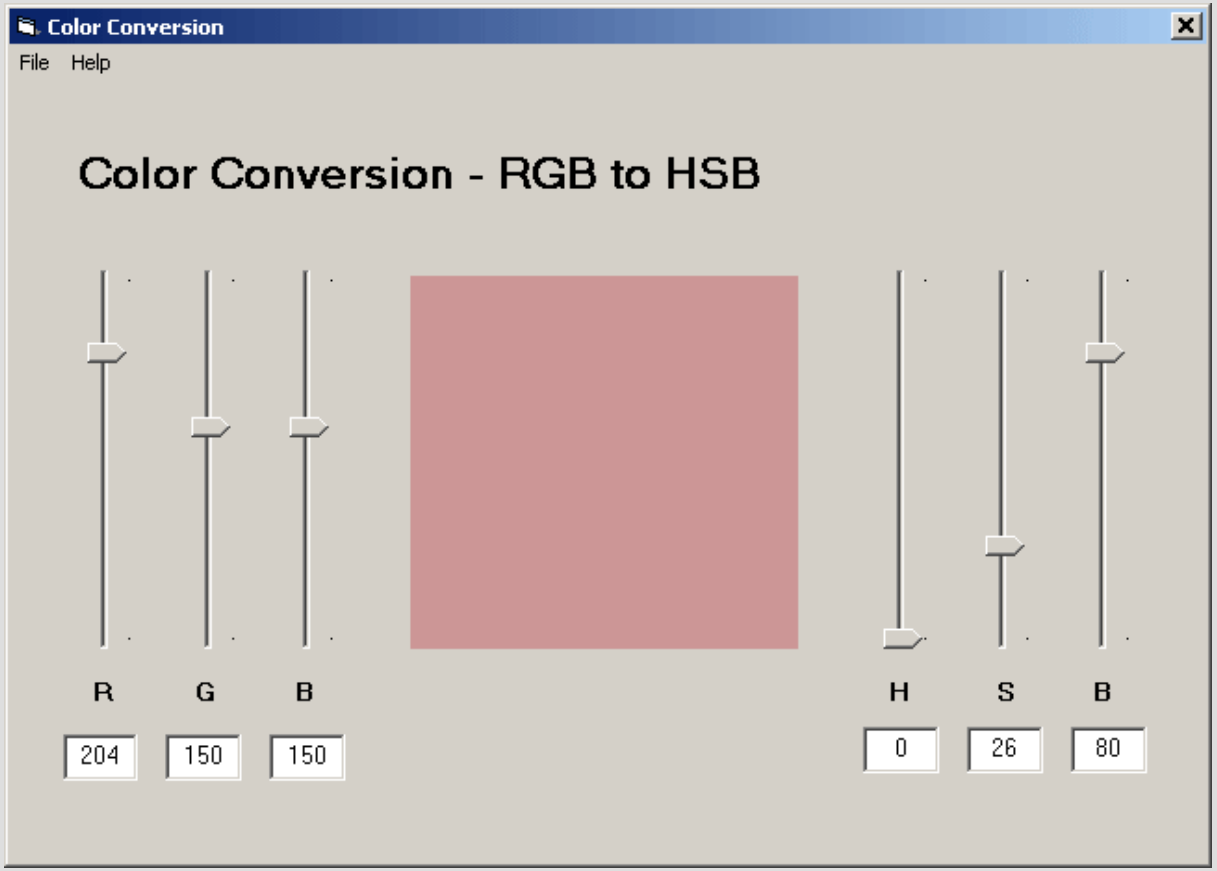
Here is pure red; what would we have to do to make pink?



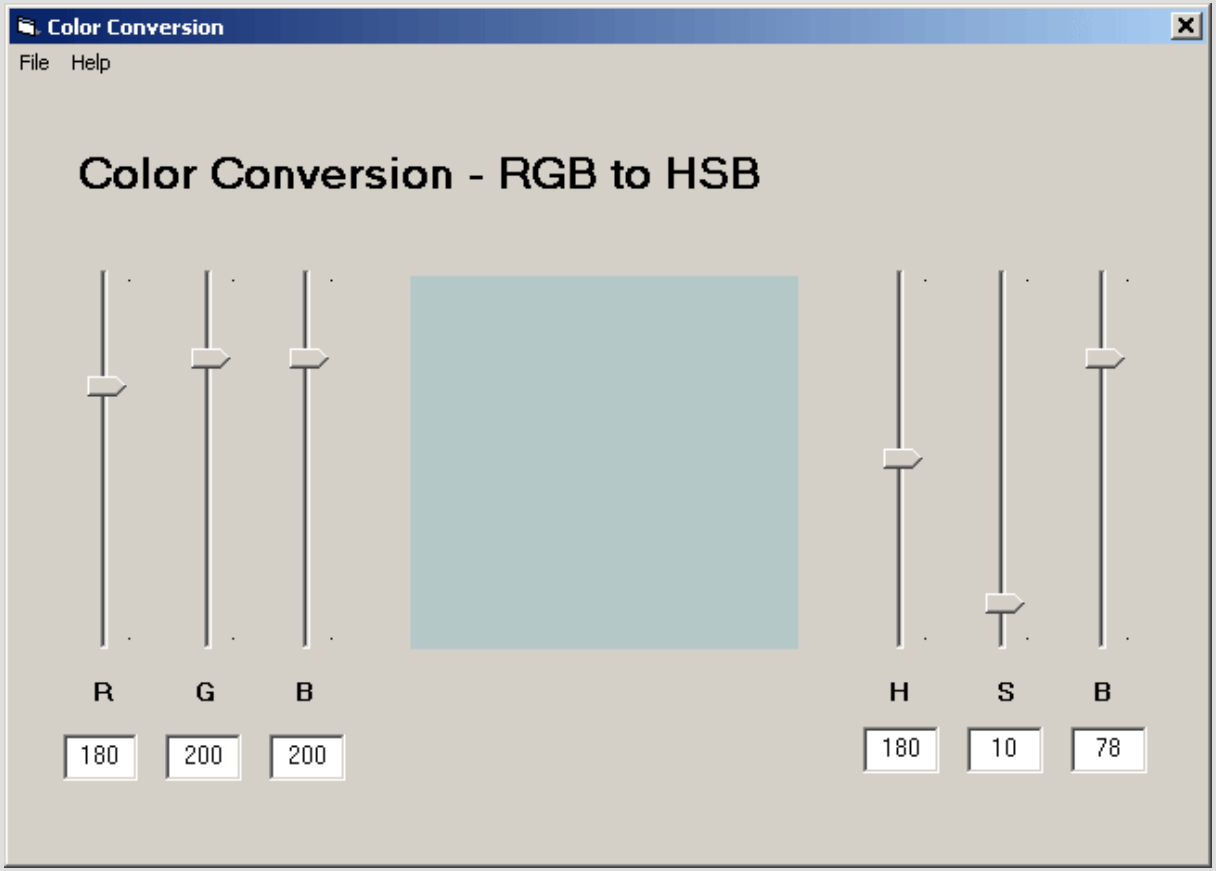
Answer: add green and blue



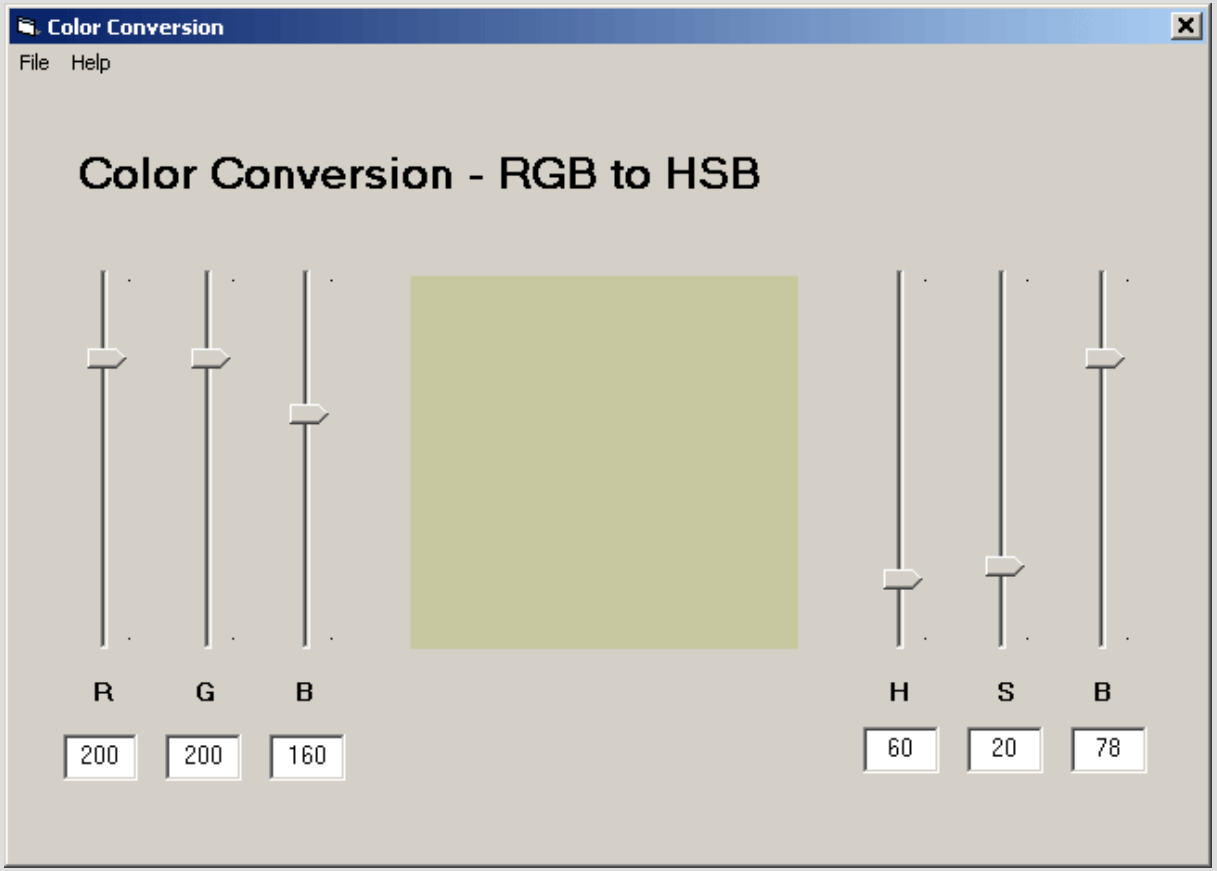
Lower all three, to get “dusty red,” maybe, although we don’t often use the language of fashion or interior decoration



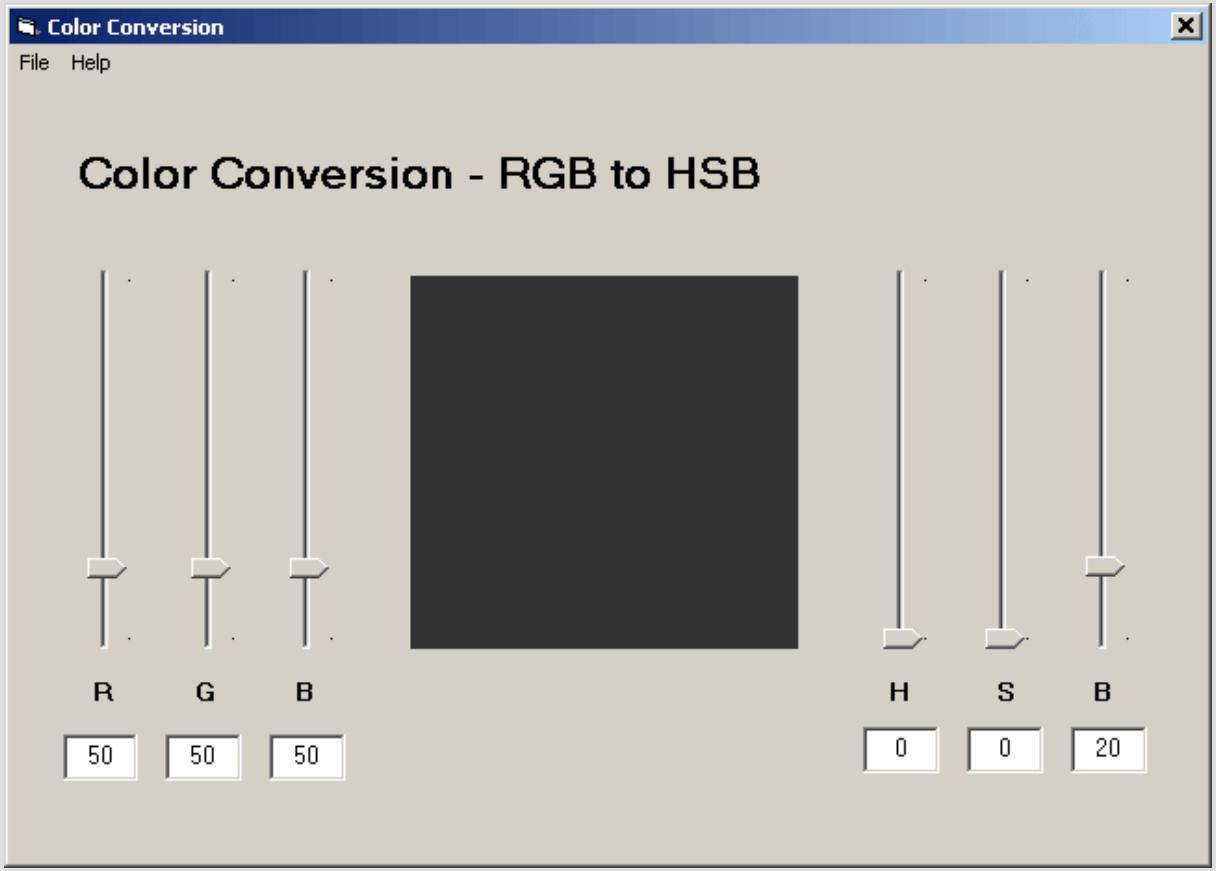
This is a cool gray: less red than green and blue



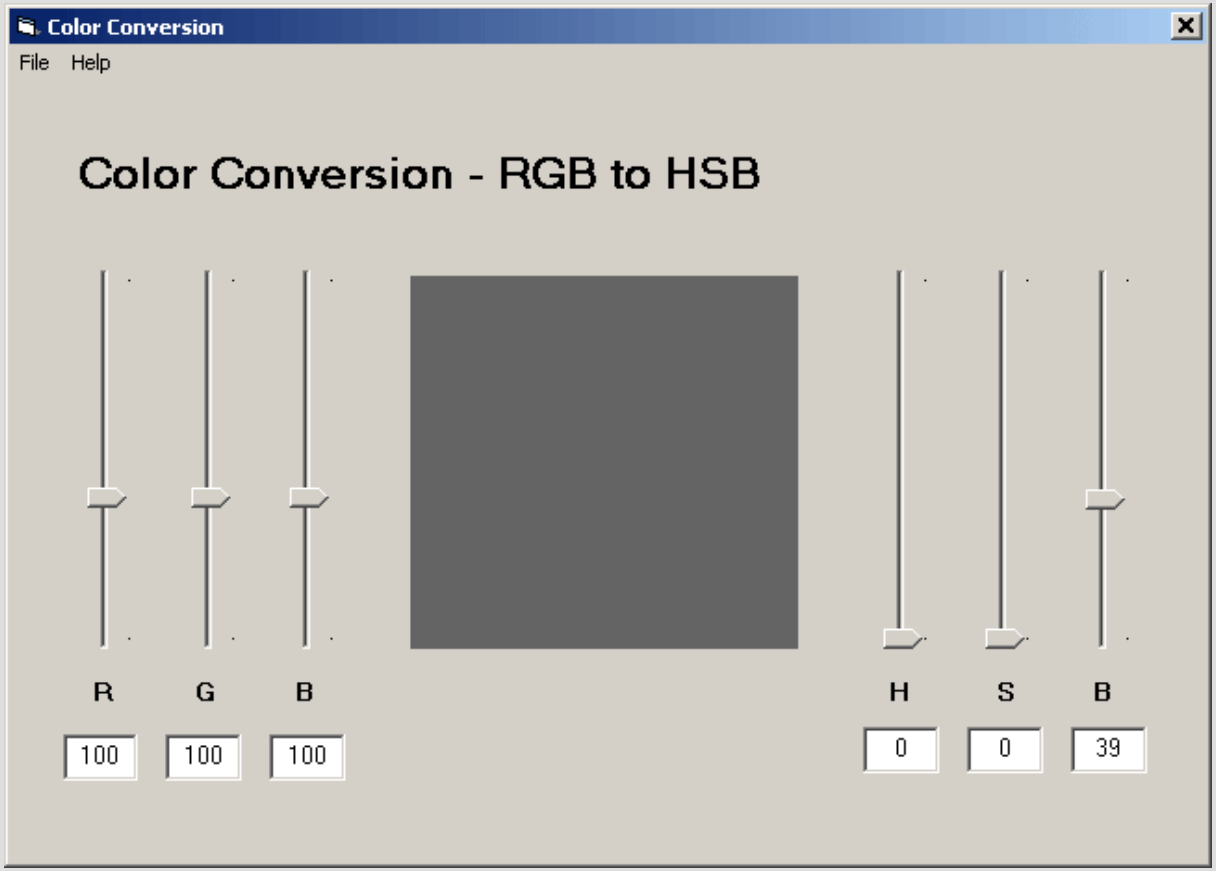
This is a warm gray: less blue than red and green



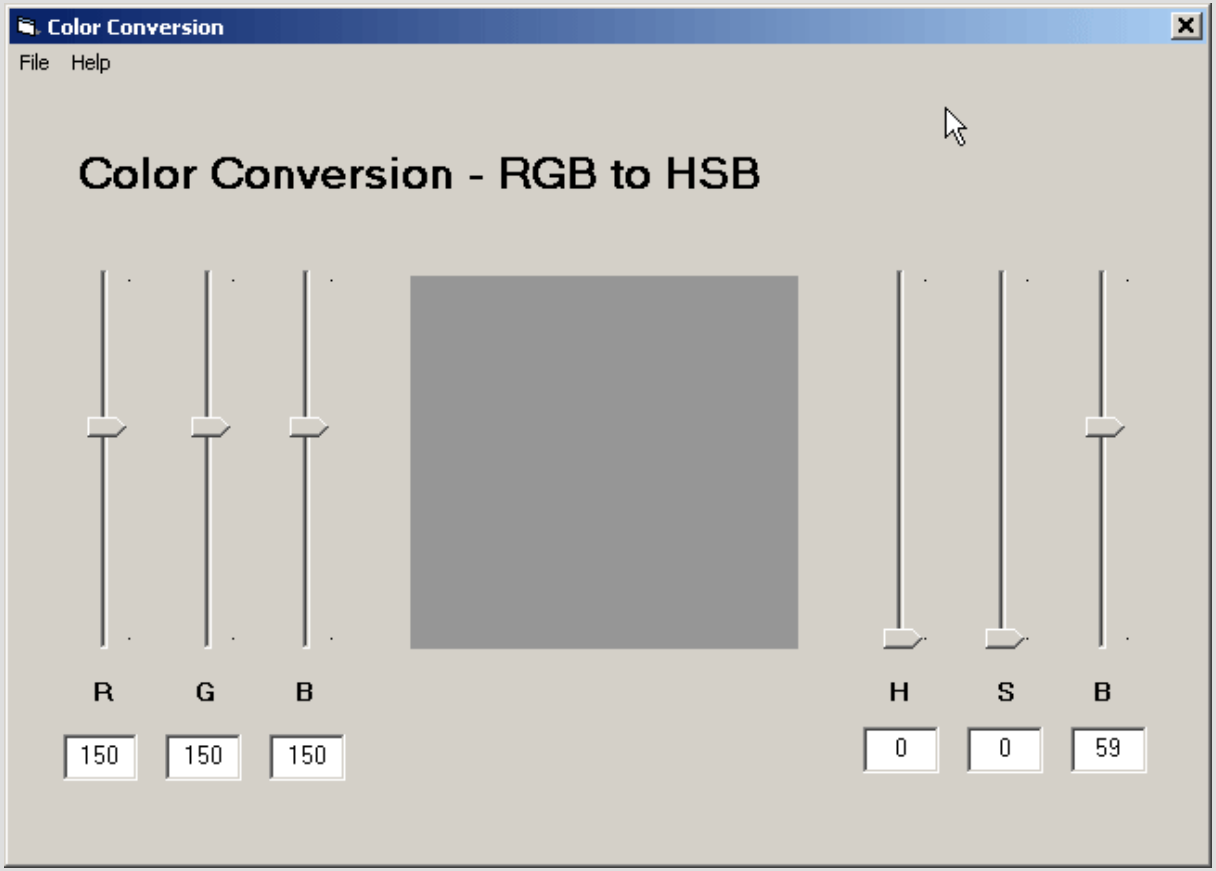
Is gray ever saturated? Let's try: this is so dark as to be almost black, depending on room lighting; zero saturation



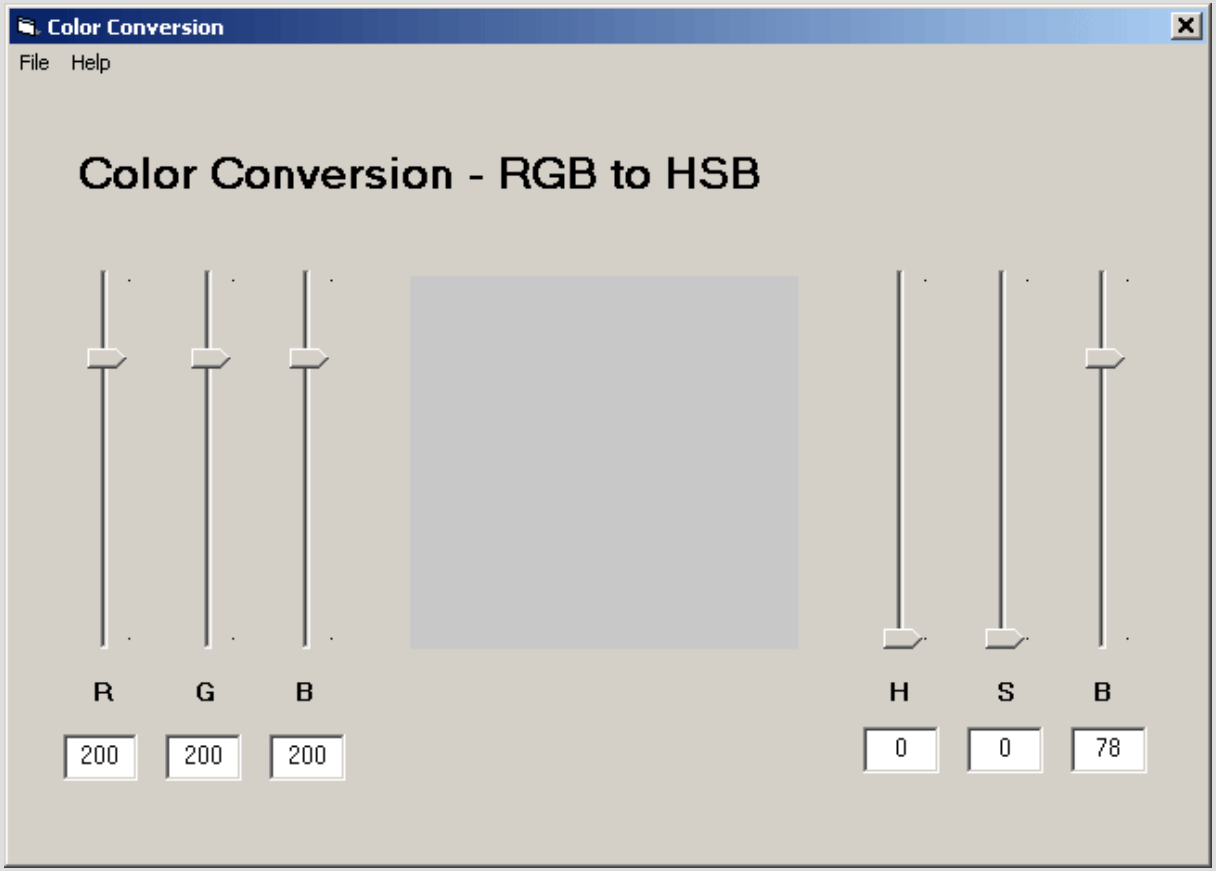
Another gray (same amount of R, G, and B); saturation still zero, brightness up



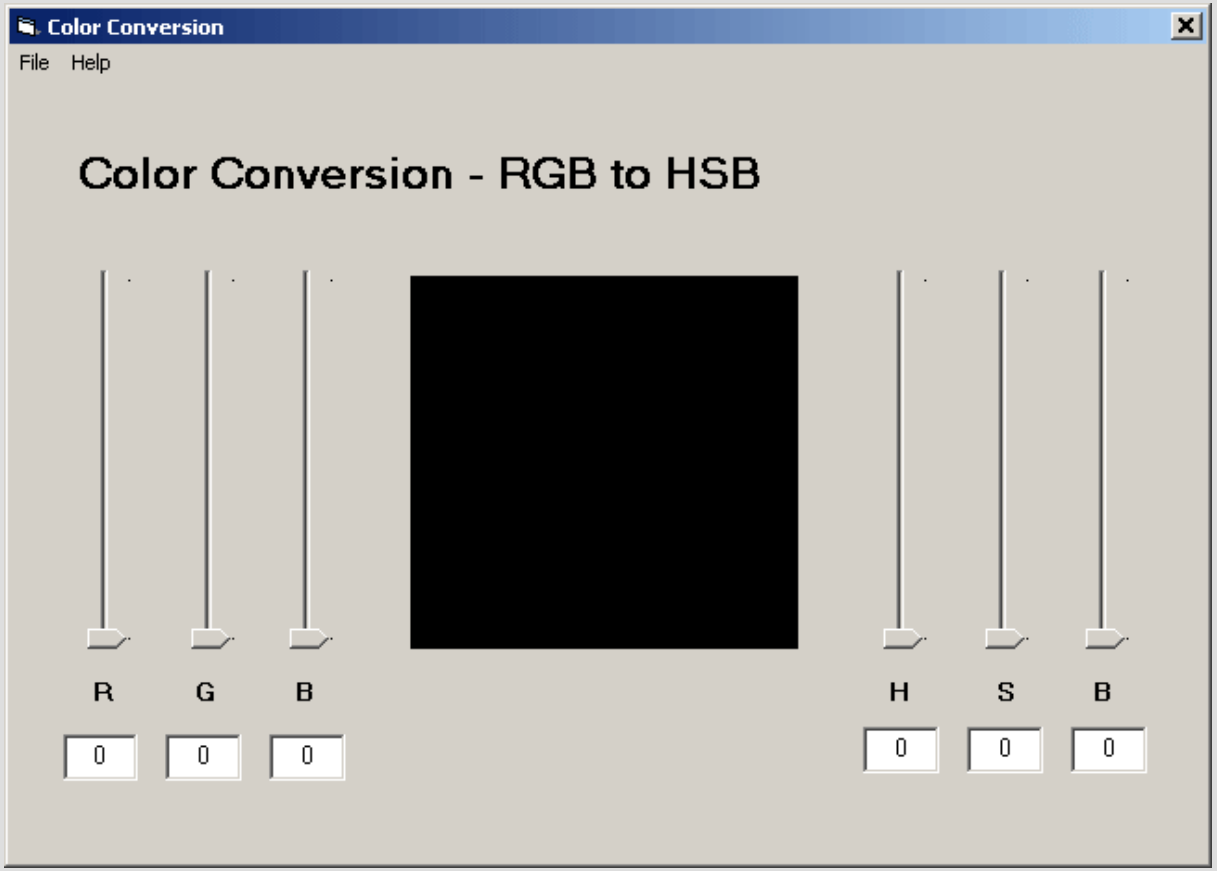
A lighter gray



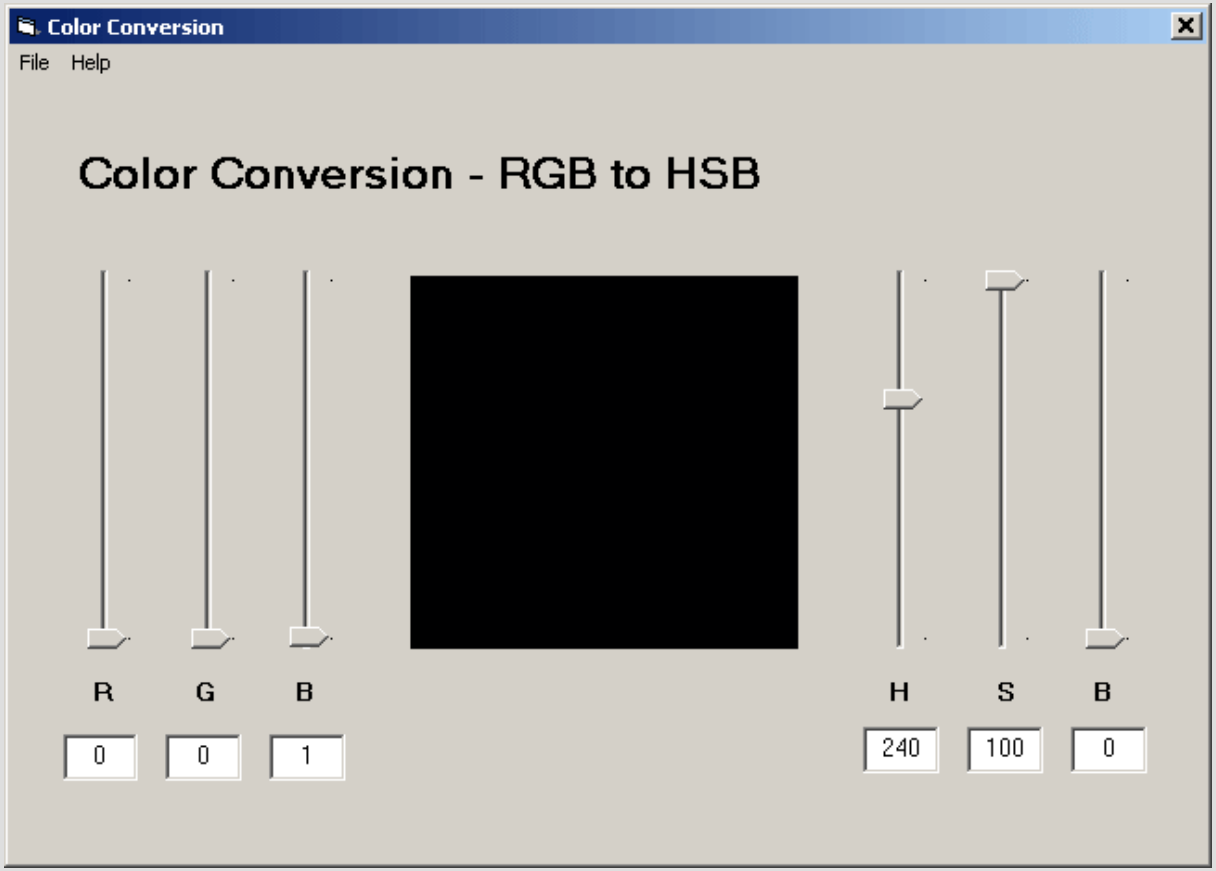
Gray getting toward white; still zero saturation



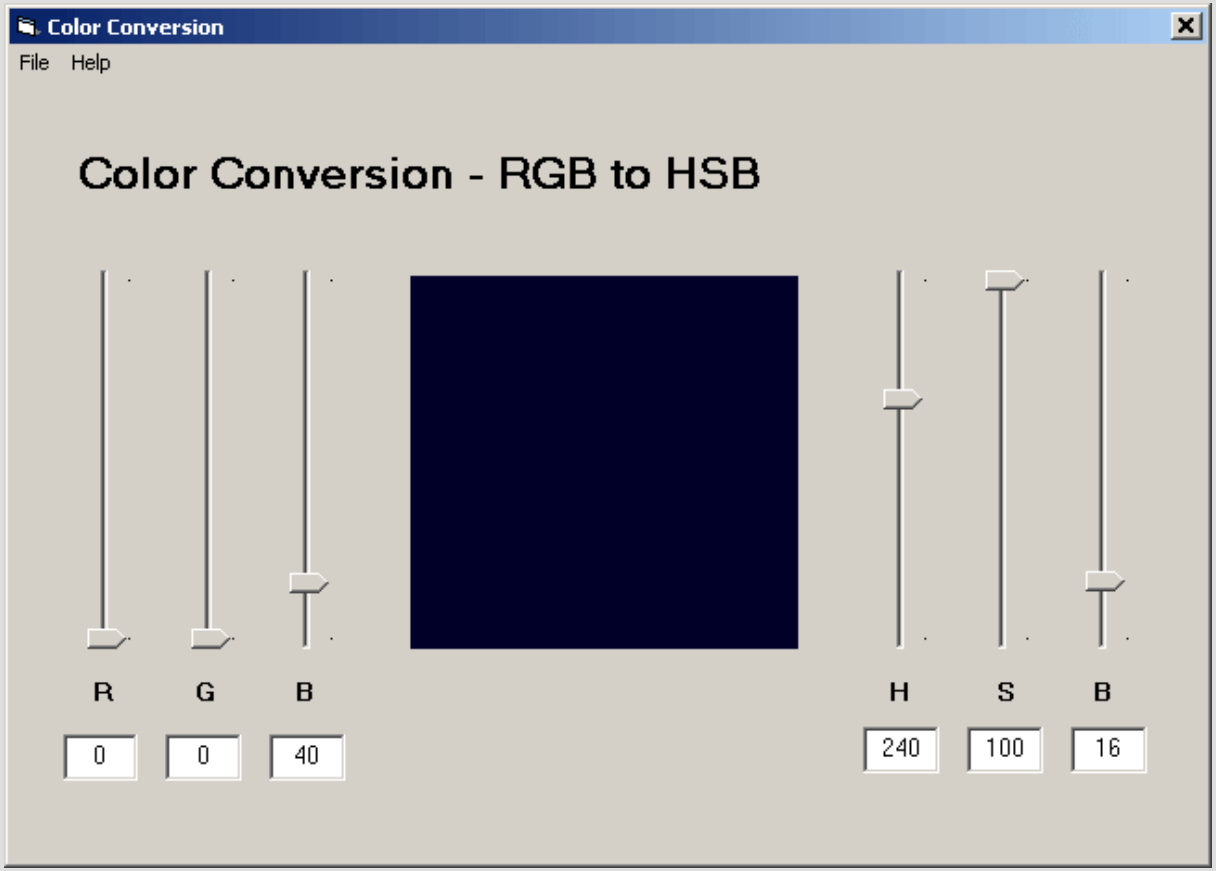
Black is completely unsaturated, right? Right.



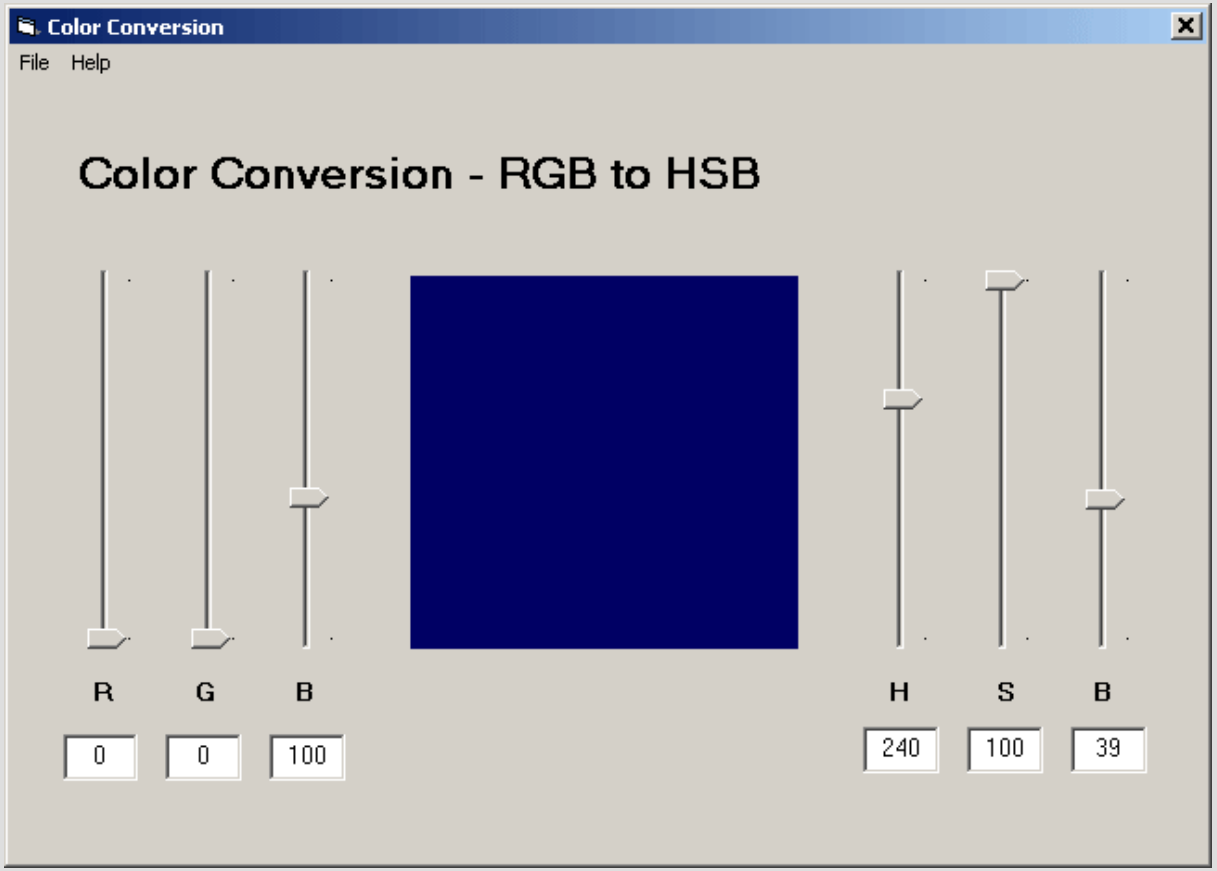
Change the amount of blue from zero to one: now 100% saturated (same result in Adobe and Microsoft software)



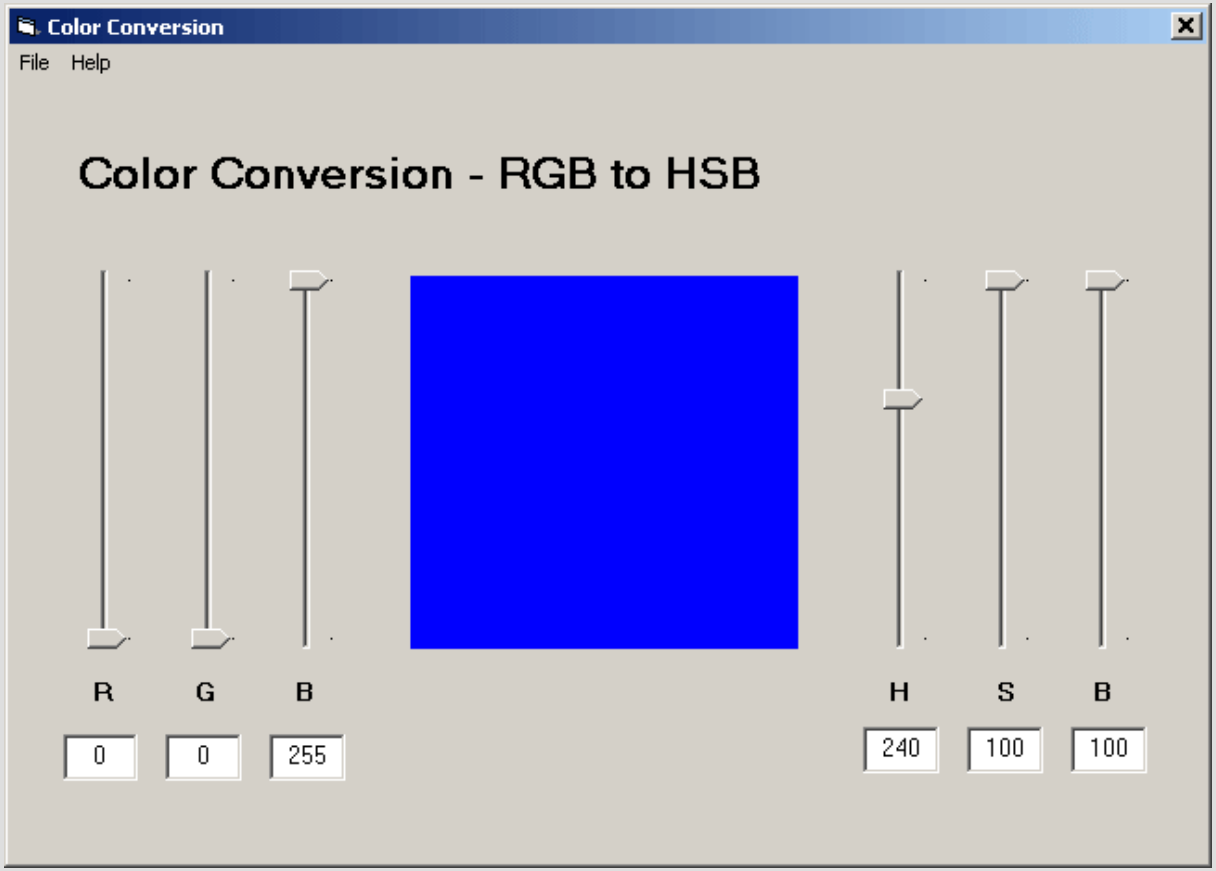
Now B = 40; can you distinguish from black? (Still 100% saturated)

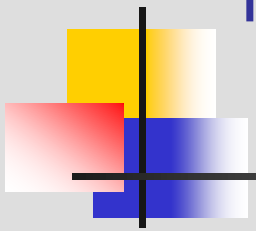


Now B = 100, and we have something like midnight blue; still 100% saturated—but now that begins to make sense



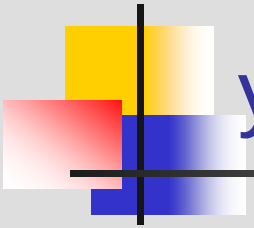
Pure blue; fully saturated by any definition





Moral

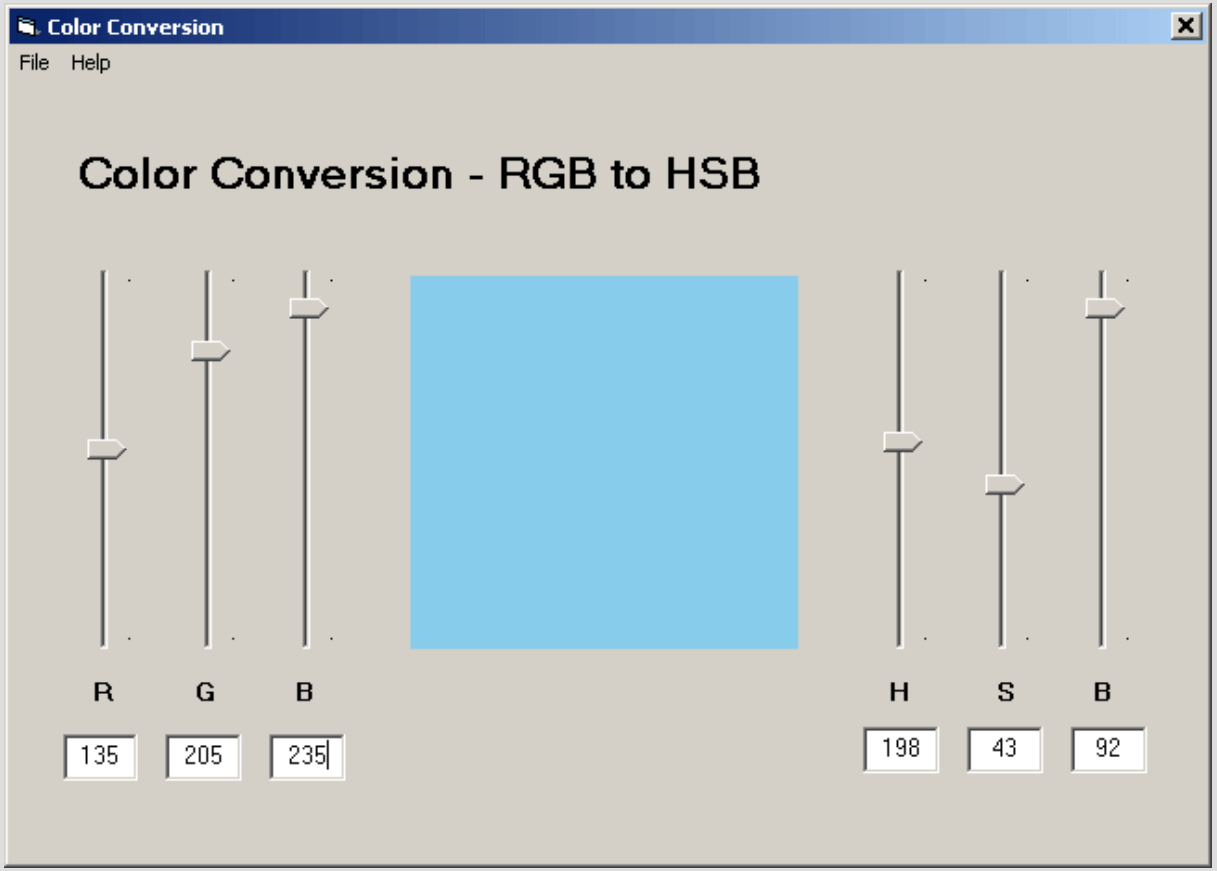
- The axis of the color cone (Slide 20) runs from black at the bottom, through the grays, to white at the top
- All points on the axis are unsaturated
- Near the bottom of the color cone there is very little space between the axis and the pure colors
- And the pure colors at the bottom of the cone are dark
- Hence: saturation is not a helpful term for low-brightness colors



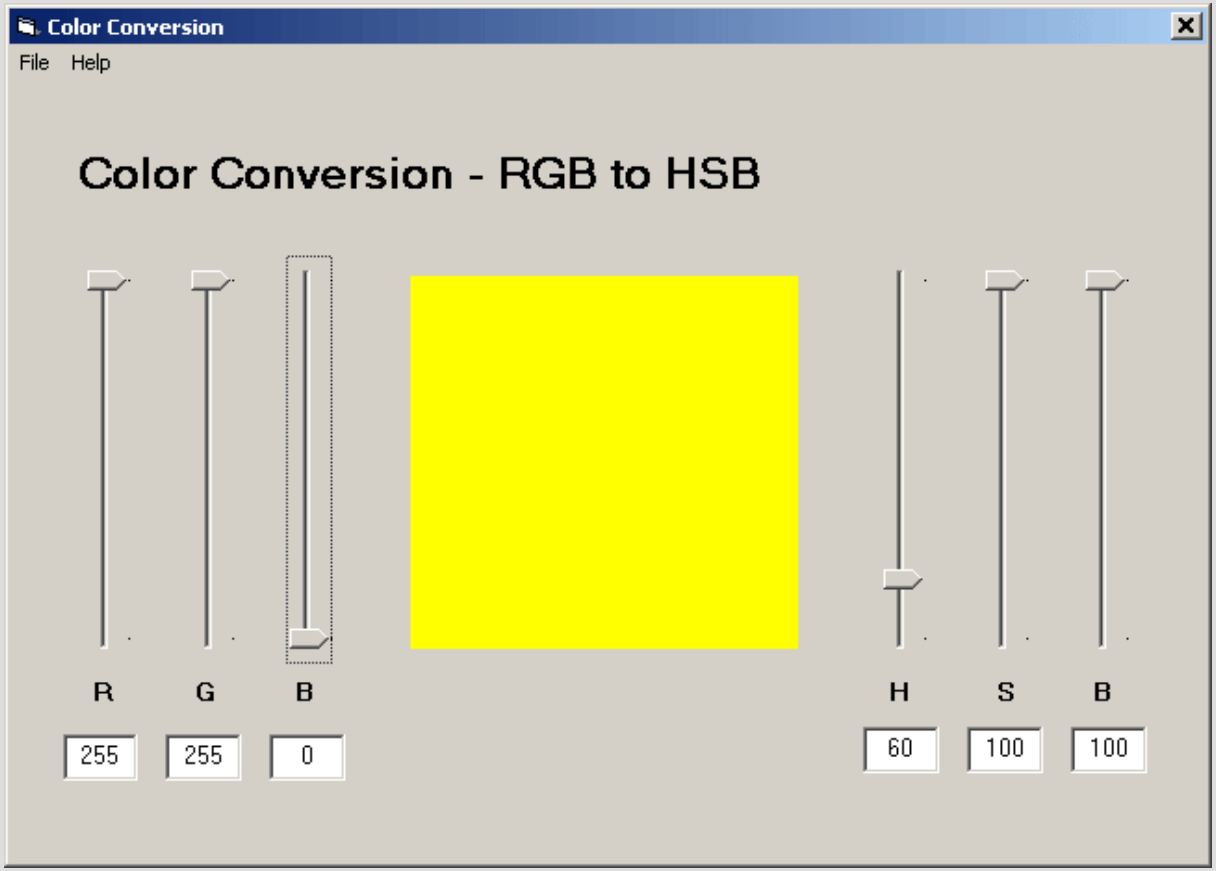
“I’d like the house painted a sky-blue yellow”

- That was the description once given to a husband: “I want a yellow, but not a bright yellow; like sky blue isn’t exactly blue.”
- The husband didn’t understand, but negotiation found the color
- Now he understands: desaturate pure yellow, as in the following slides

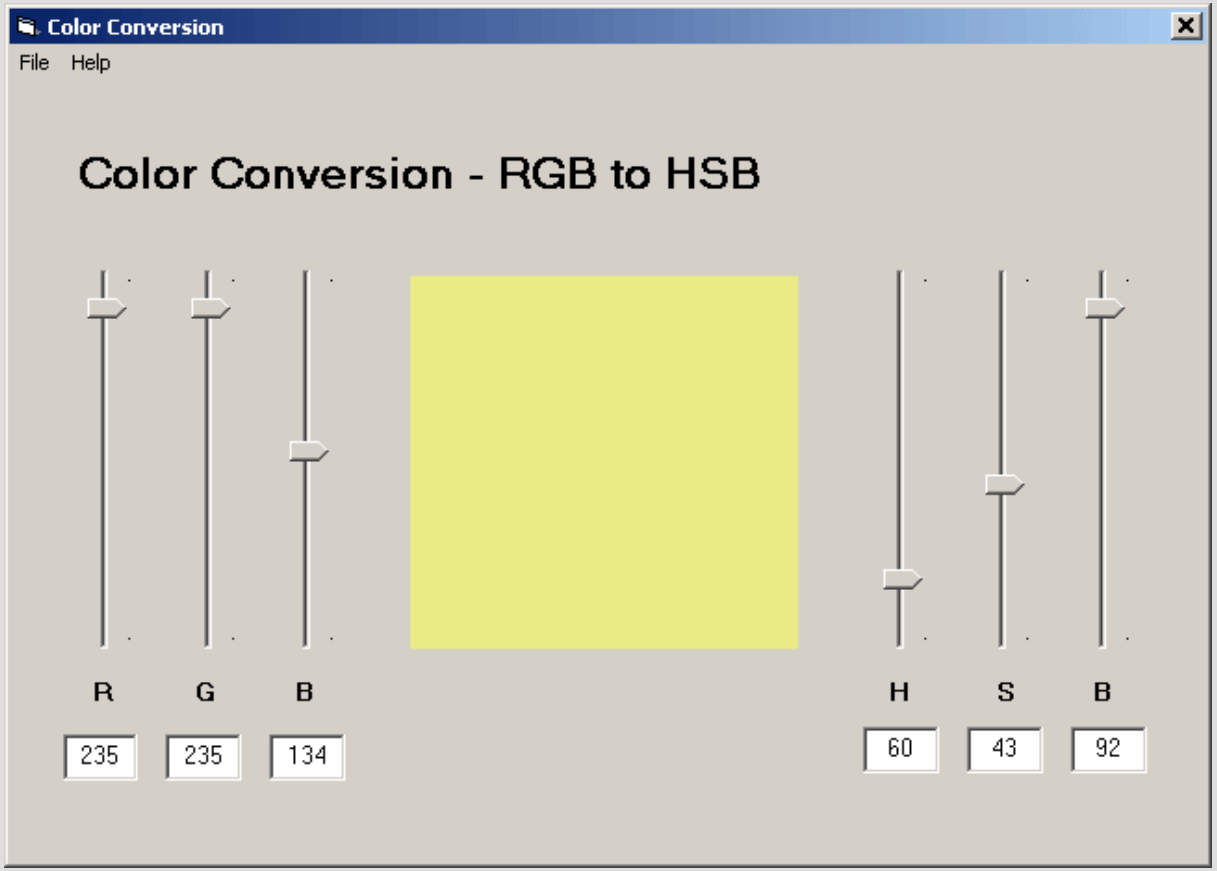
Starting point: what is sky blue? Find a sample somewhere; note its saturation and brightness

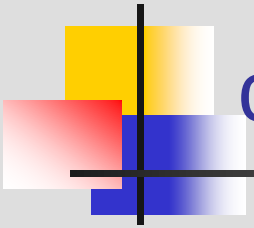


Now make a pure yellow, which is maximum red and green



Now change the saturation and brightness to what we had for sky blue. Voilá! Sky-blue yellow.

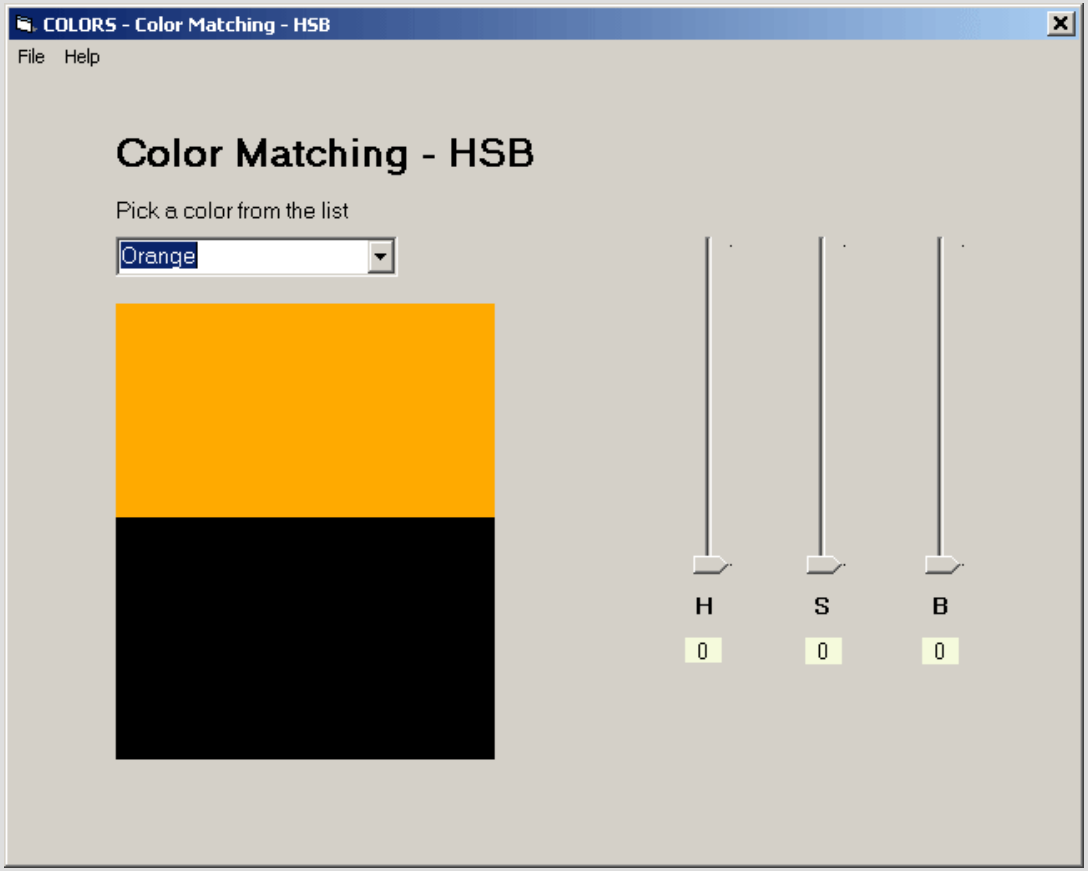




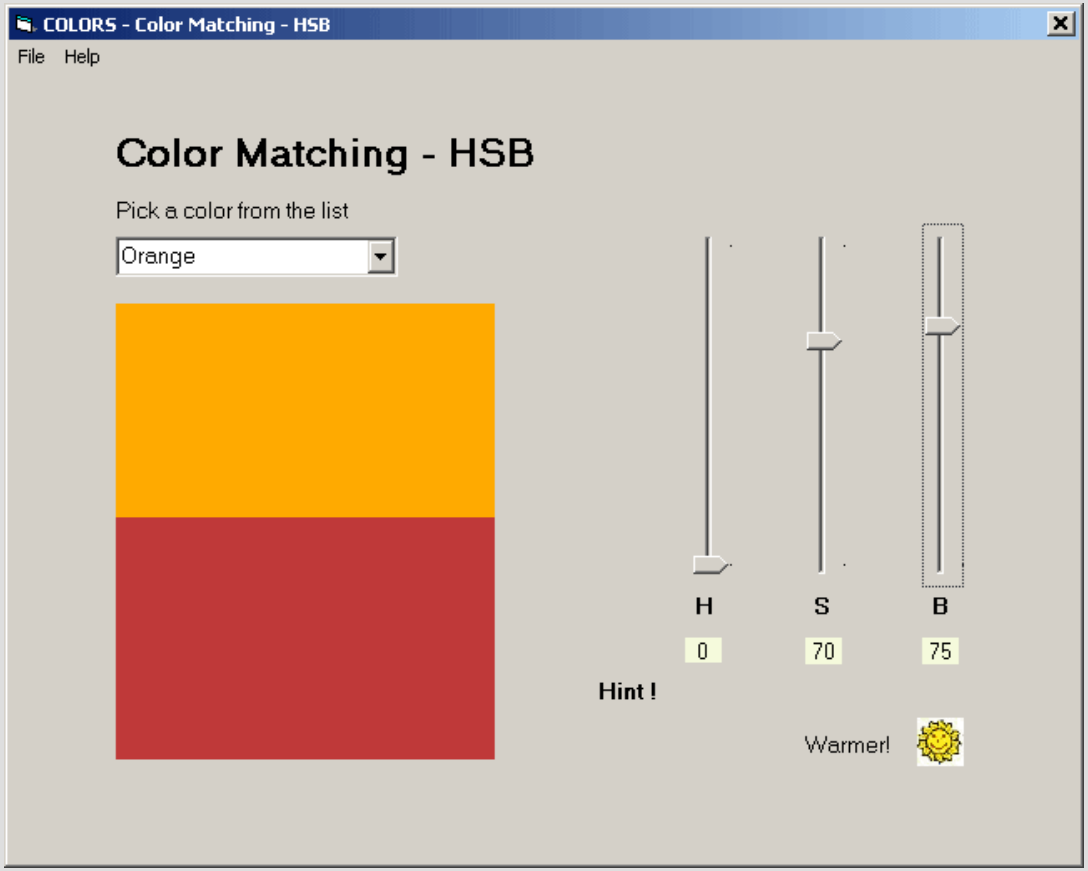
The color matching tool from the companion website

- Two versions: match using RGB or HSB model
- Start with any of the hundreds of named colors available
- That color appears in a top rectangle; bottom rectangle is black
- Move sliders to match colors
- Hints given; “warmer” means “your last change got you closer”
- When you get a match, the number of adjustments taken is reported

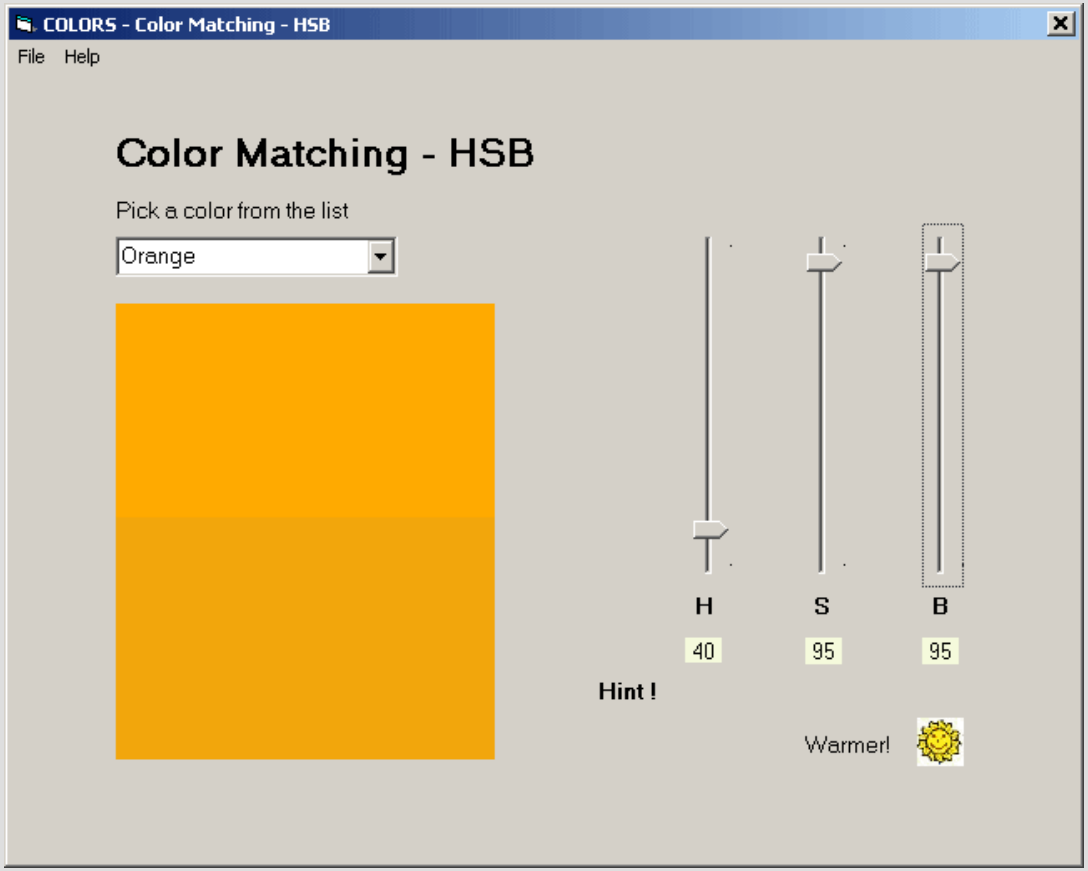
Let’s match orange, in the HSB model



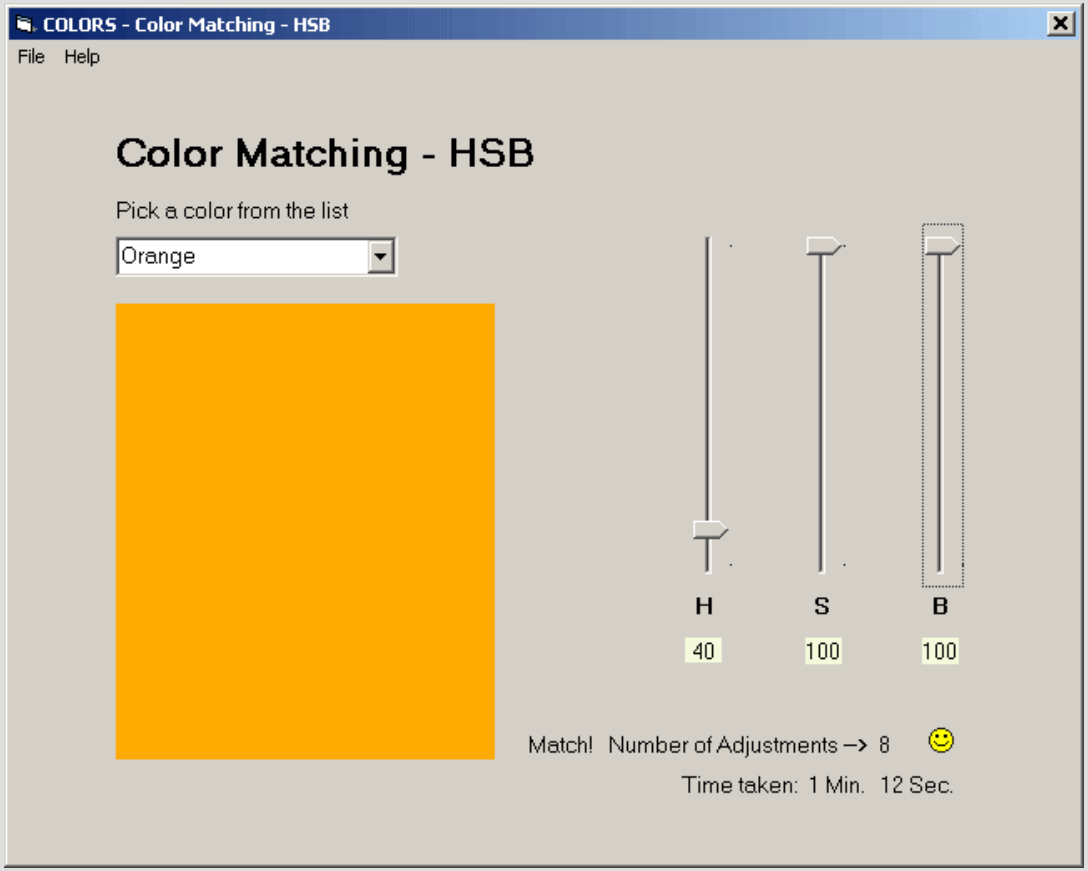
Increase saturation and brightness, so we can see where we are



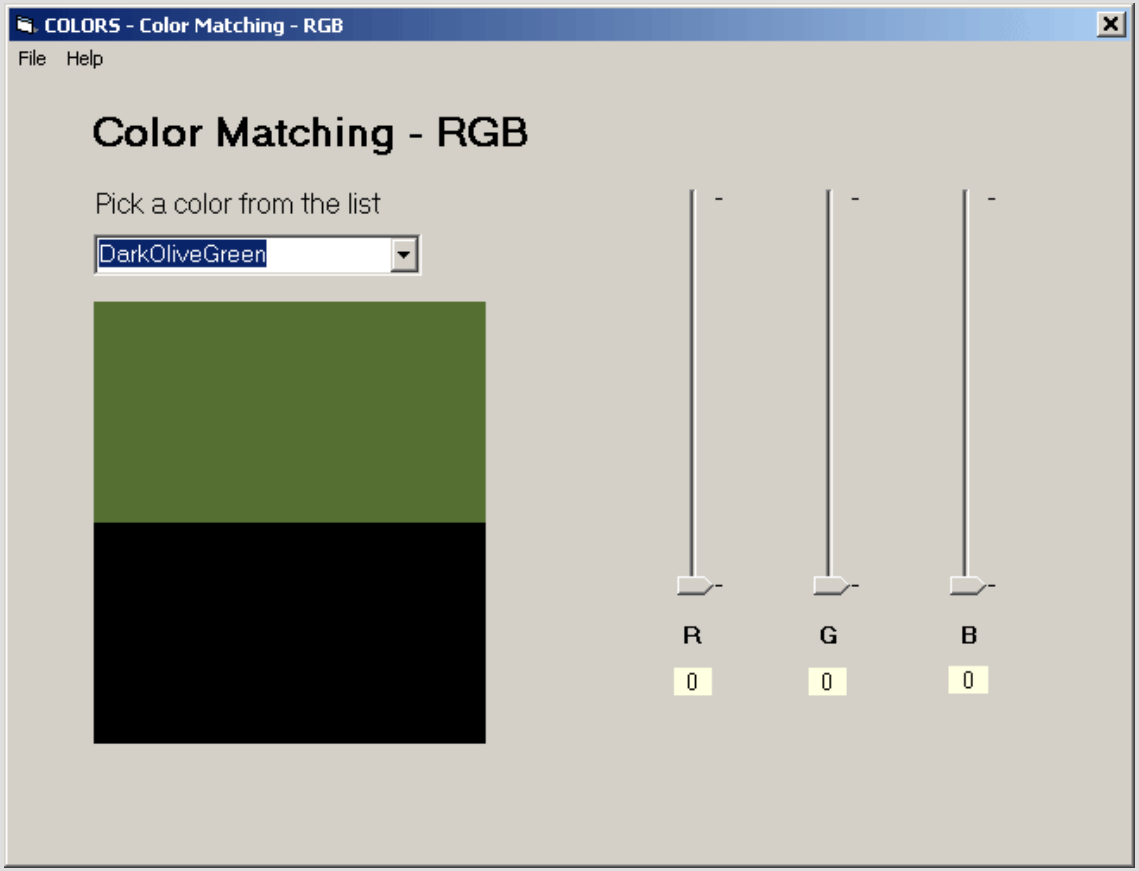
Need to increase saturation and brightness, and adjust hue



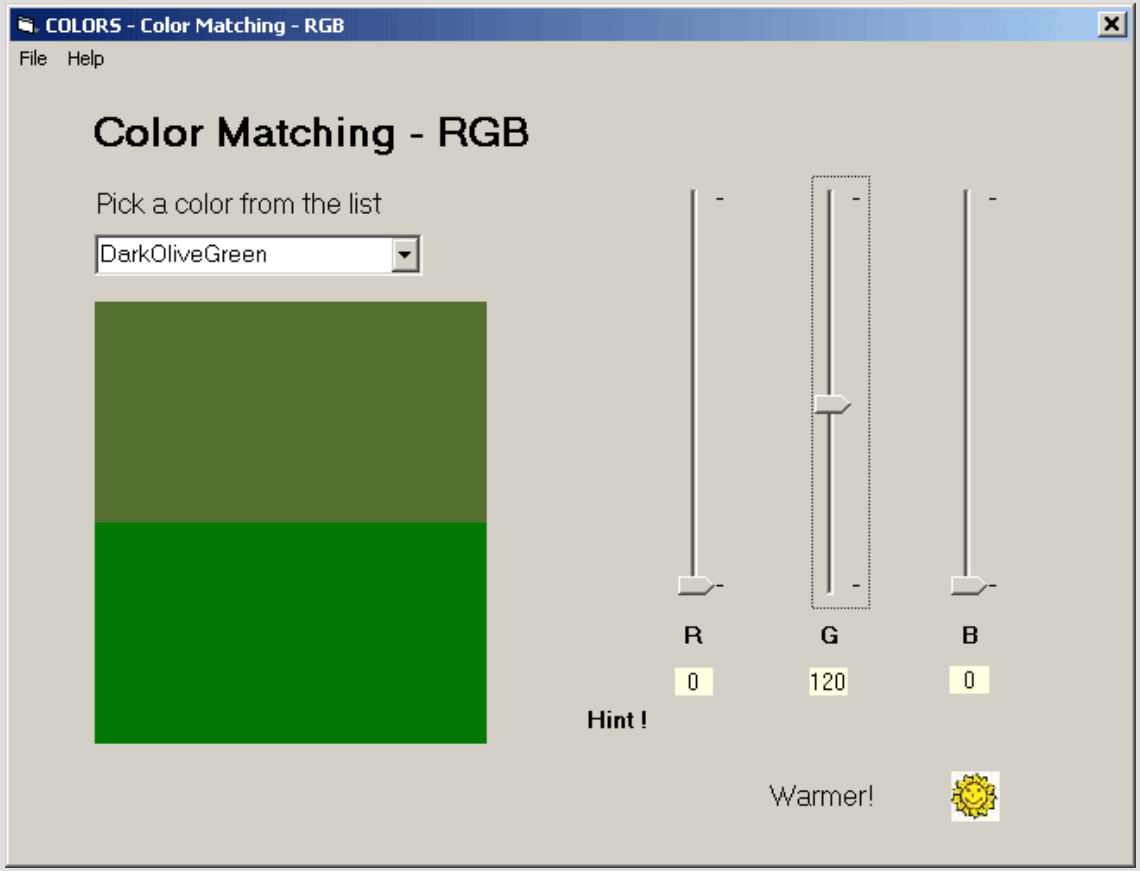
Success! (Not all adjustments were shown, obviously.)



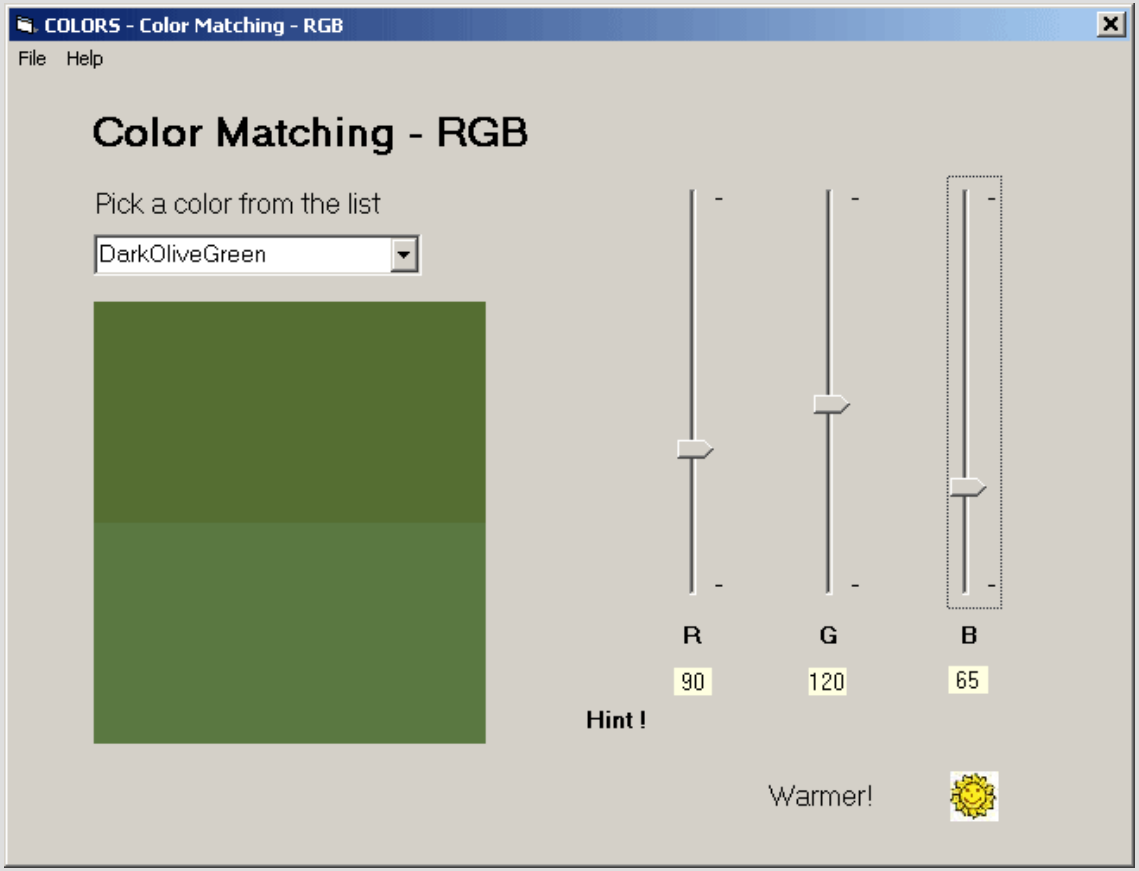
Let's try a cool color, using the RGB model



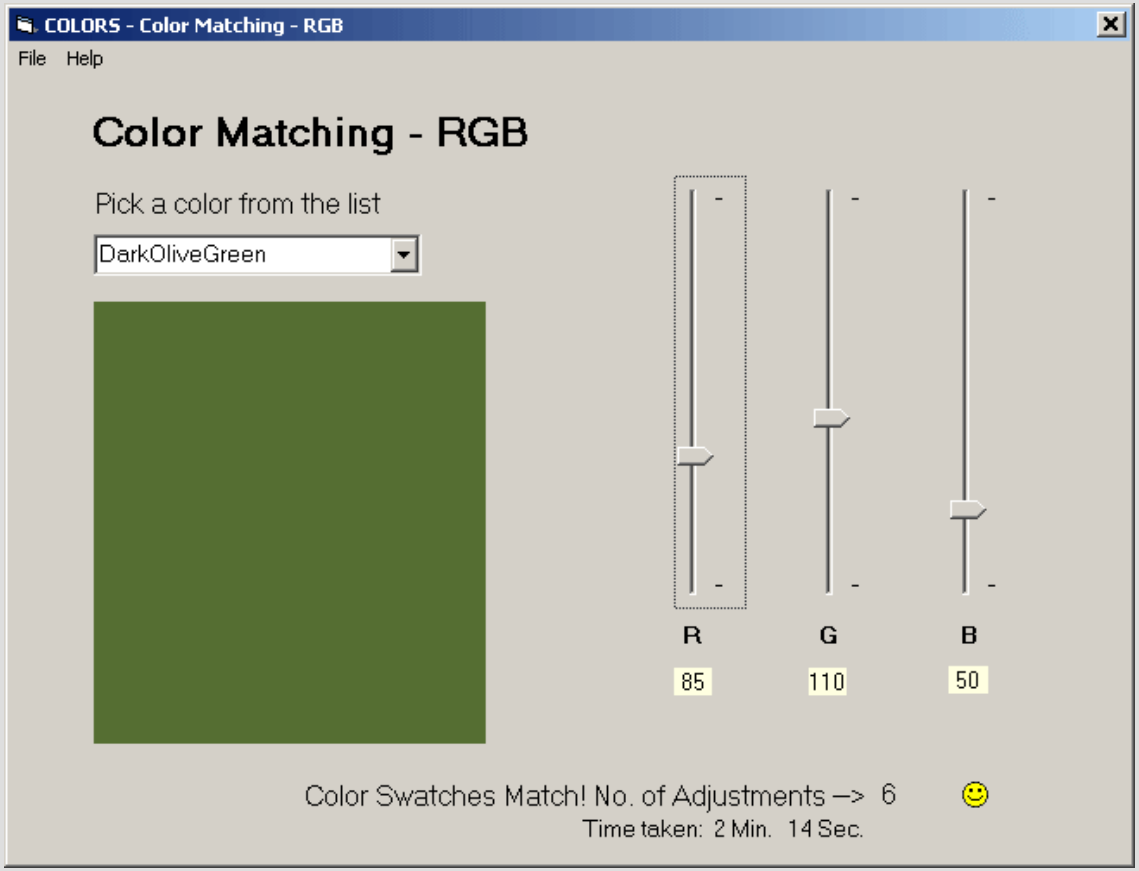
Dark olive green is green, but obviously not fully saturated

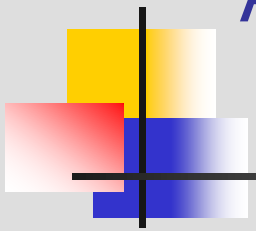


So add some red and blue to desaturate



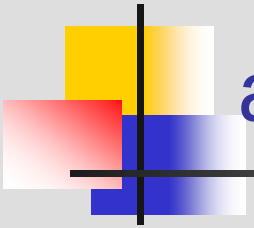
Success again—and again not all adjustments were shown





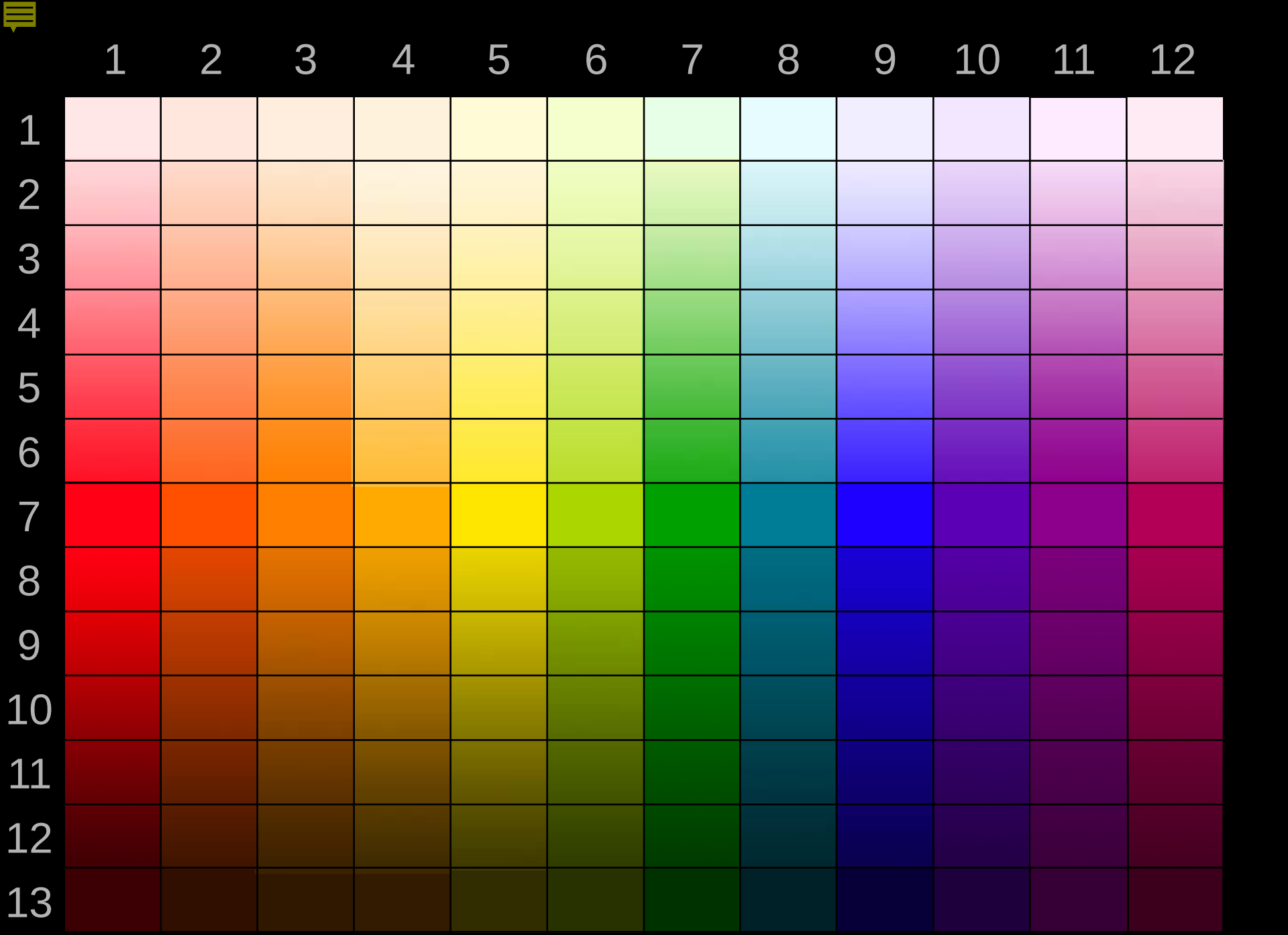
A little more on color harmony

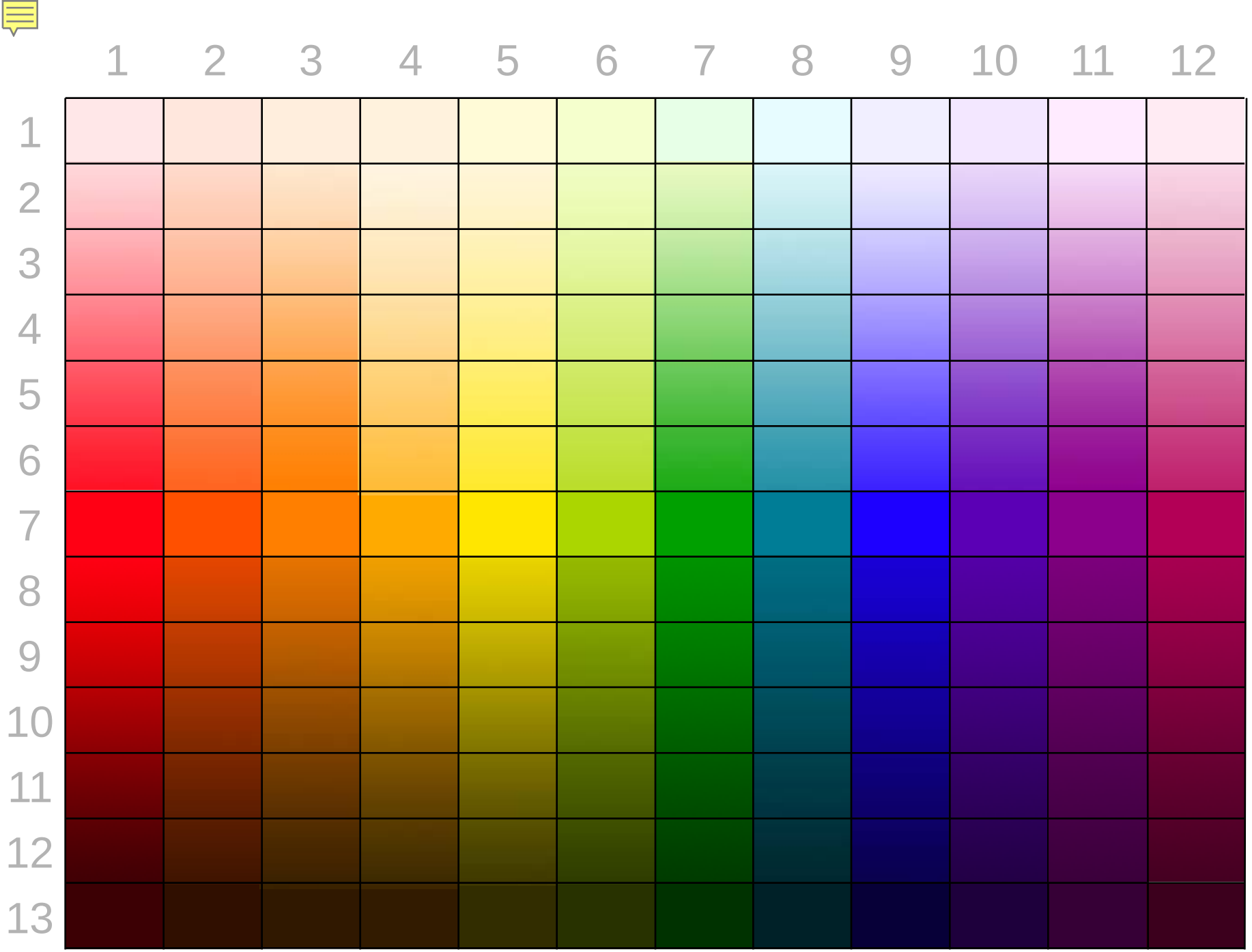
- In the text we were limited in the number of color pages we could use, so the examples of color harmony were necessarily restricted. With the luxury of more space here, we can add some additional material.
- In printing color in the book there is also the problem of *gamut*: many colors we can produce on the screen cannot be printed on a CMYK printer. Examples: red, green, and blue.



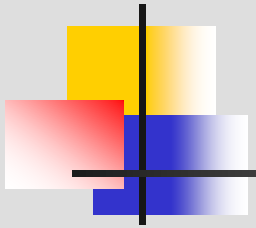
The colors, laid out linearly instead of around a circle

- On the next two slides we have the 12 colors of Slide 12, but shown in vertical bands
- In each band the colors range from quite light to quite dark
- Light colors may appear almost white—but that perception depends in part on background
- Dark colors may appear almost black—same comment
- So we show with a black background and then with a white background



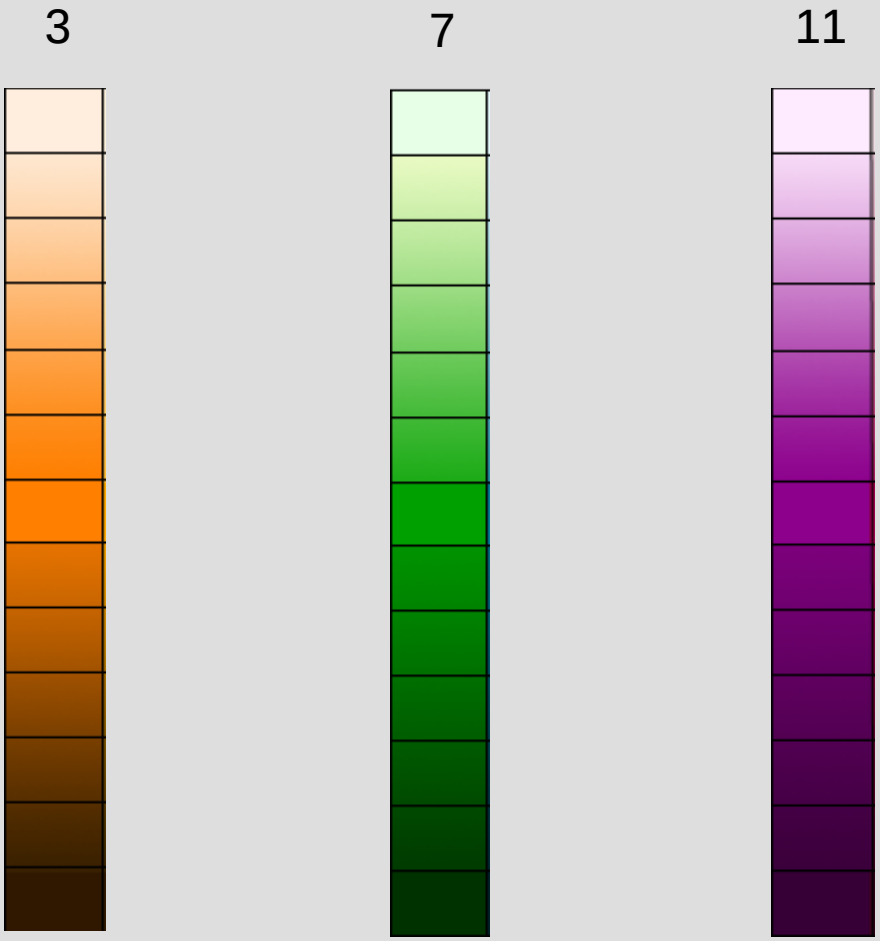


The four color-harmony schemes



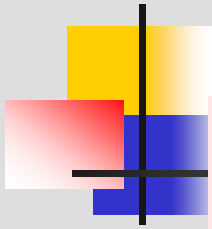
- Monochromatic: colors from one column
- Complementary: any two colors whose column numbers differ by 6
- Analogous: several colors from adjacent columns, with 12 considered next to 1
- Triadic: colors from columns:
  - 1, 5, and 9, or
  - 2, 6, and 10, or
  - 3, 7, and 11, or
  - 4, 8, and 12

Three columns for picking monochromatic schemes; these three make a triadic



Monochromatic: Column 8, rows 2, 7, 12

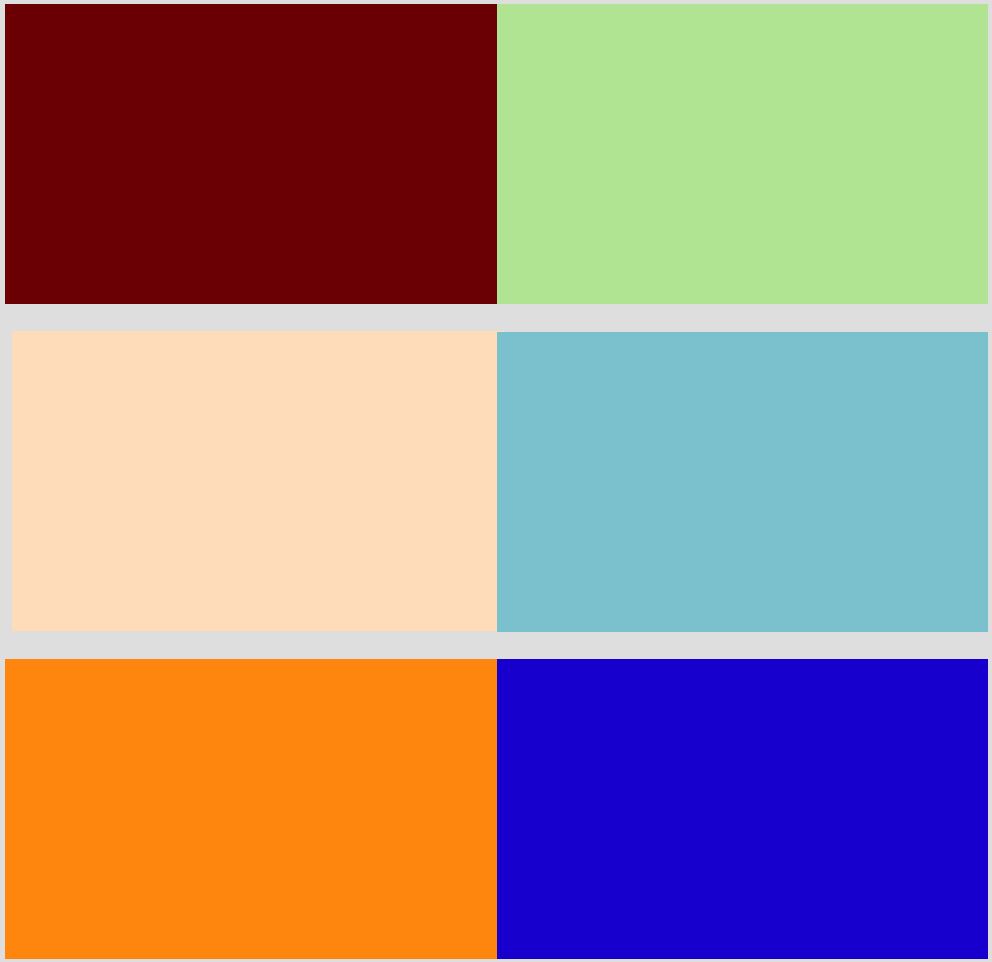
Monochromatic: Column 1, rows 1, 4, 10



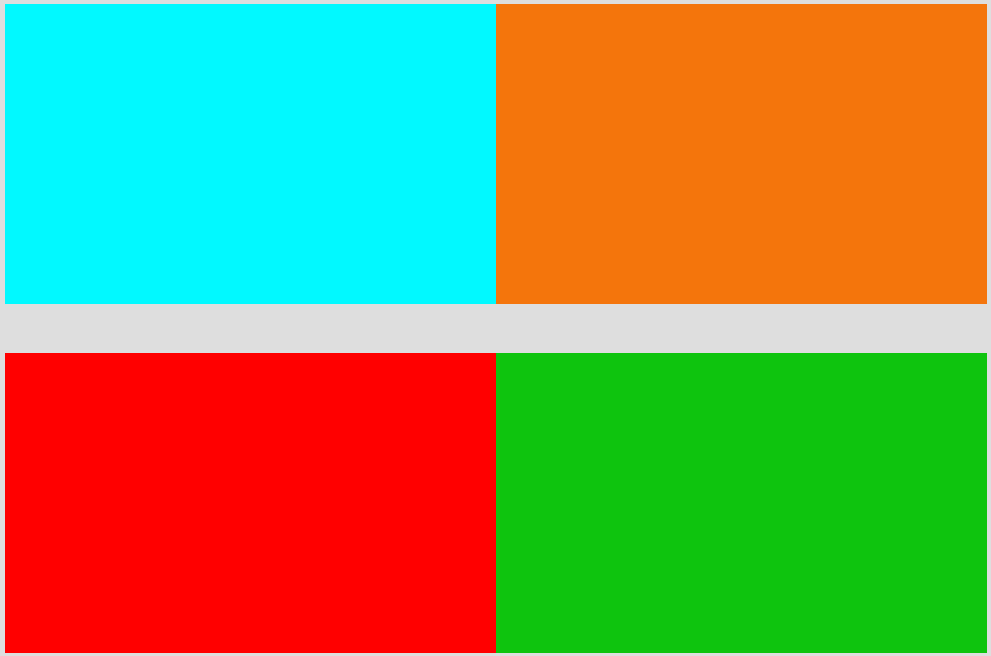
Words, words, words . . .

Show Me!

Three pairs of complementary colors (complements don’t have to scream)



But they *can* scream, if you wish (It's called a *clash*—gets people's attention)



But don't do this casually—the clash can be almost painful; you need to have a reason to do it

A triadic can shout . . .

. . . or whisper . . .

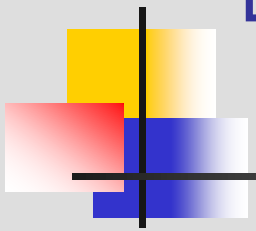
. . . or speak conversationally . . .

. . . or let others talk . . .

Big Important Words

Nice words, but not headline-type words. Text. The story, now that I have your attention.

End interlude



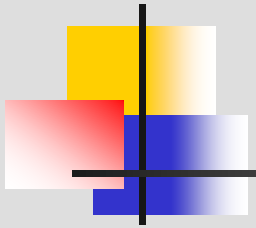
End of Interlude

And that is what we have time for, in exploring another way of looking at color harmony. Try it! Think about the color combinations that work, and experiment with variations of them.

Further reading on color harmony

- Anon. *The New Munsell Student Color Set.* Fairchild Publications, 1994.
- Faber Birren. *Principles of Color.* Schiffer Publishing, 1987.
- Cailin Boyle. *Color Harmony for the Web.* Rockport Publishers, 2001.
- Hideaki Chijiiwa. Color Harmony: *A Guide to Creative Color Combinations.* Rockport Publishers, 1987
- Bride Whelan and Lesa Sawahata. *Color Harmony Workbook.* Rockport Publishers, 2001.

Text and background colors for legibility

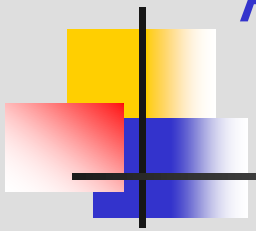


- Rule #1: Provide adequate contrast
- Rule #2: But not too much, and for extended use, black on white is too much contrast
- Rule #3: Dark on light is better than light on dark, for text
- Rule #4: There are no other rules
  - Complements work
  - So does a dark color on a background of the same hue but much lighter
  - Light on dark is occasionally OK for headings

Text in a dark color on its complement in a light color works nicely

Color is one of the pleasurable aspects of eyesight and is an integral part of Web pages. Properly used, color makes a page both attractive and usable. It can provide cues that indicate a button's function or state. It can distinguish between navigational aids and content, unobtrusively guiding the user through a page. This chapter presents some color basics and design tips to enhance both the effectiveness and appeal of a Web site.

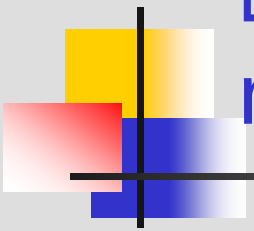
A great many combinations are possible



In this chapter you will do the following:

- understand physical and perceptual aspects of color
- become aware of several color models and learn the advantages of each
- learn to apply four different color harmony schemes
- explore how color can make Web pages pleasing and easy to read

Even a little color in the background makes text easier to read



It is rare that the color choices for Web pages are left entirely in the hands of a developer or designer. In most cases, the client will already have some colors in mind, based on a corporate logo, a school insignia or personal preference. Color harmonies provide options for choosing colors that are compatible with the client's wishes. Applying guidelines for text and background color will foster readability. Finally, using color to organize text and focus attention will result in easier navigation.

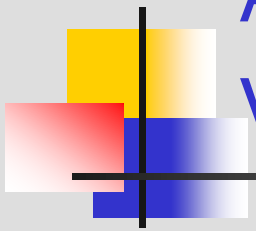
Now, for comparison, here is what black on white looks like

There is quite a bit of overlap in the response curves. The peak sensitivities for the first and second types are actually in the yellow range. There is a big disparity in the height of the three curves. This is due to the fact that human eyes are most sensitive in the green range of the spectrum and are dramatically less sensitive in the blue range.

Black on white may not look too bad here. But suppose you sat at a monitor six hours a day. Wouldn't you prefer a pastel background? And text that is dark but not black?

But do provide adequate contrast

Offer expires 07/31/03. Offer available to new High Speed Internet subscribers only. May not be used in conjunction with any other offer. Service is not available in all areas. Certain taxes and fees may apply. DSL: Offer requires a 12 month subscription. First six months will be billed at $29.95 per month, 49.95 thereafter. Early termination fees apply. Includes Standard DSL Installation Kit. Does not include shipping and handling charges. Additional equipment may be required.



Always remember how we perceive blue vs. red and green

Below is the same text as on the previous slide, except pure blue instead of pure yellow. According to Adobe they both have 100% brightness, and according to Microsoft they both have luminance of 128. But that it not how we perceive them.

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Don’t use red on blue or vice-versa

Blue has the shortest wavelength of visible light and red the longest. Blue is refracted more strongly than red in our lenses. (Compare with what a prism does to white light.) Result: our eyes can’t focus on red and blue at the same time, and the boundary seems to vibrate. It gets painful. Camera lenses deal with this by using lens components with different indexes of refraction, to produce an *achromatic* lens, so that red and blue both focus at the focal plane. Our eyes don’t work that way. This hurts.

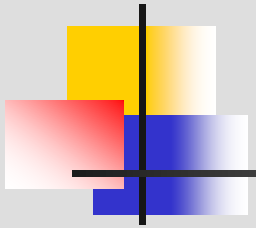
Never use bright red on bright green or vice-versa

Red on green also hurts the eyes. I refuse to show any more of it!

But change brightness and/or saturation . . .

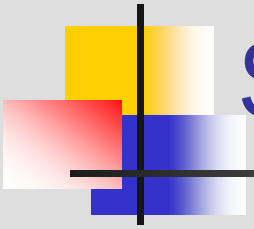
But: same hues, except a very light green background and a very dark red text—different story. In fact, this is rather nice, so I'll show some more of it.

One reason this works is that there is adequate contrast between the text and the background. As noted, our low sensitivity to blue makes it hard to give rules on what the difference in brightness should be. Use judgment and common sense. And maybe do some user testing. ☺



That's It For Text/Background

You have seen combinations that work and combinations that don't work. Be bold! Experiment! Just maintain adequate contrast.



Summary

In this chapter you learned about:

- The color spectrum; our eyes' sensitivity to red, green, and blue
- Additive (RGB) and subtractive (CMYK) color models
- The hue, saturation, and brightness (HSB) color model
- Four color-harmony schemes: monochromatic, complementary, analogous, and triadic
- Text and background color combinations that are legible and easy on the eyes