Visualizing Color

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by Bob Chung
R•I•T, Rochester, New York

Introduction

- Color is a visual sensation. It involves light, objects, and human vision. Teaching and learning color become a lot easier *and fun* if the visual sensation is engaged in the learning process.
- This document was originally developed by the author for the Education Committee workshop at the 1994 ISCC (Inter-Society for Color Council) annual meeting in Troy, MI.
- Ten color myths are listed. Demystifiers for each myth are given. These are followed by a color demonstration that supports the demystifier. The fundamentals behind light, how light is modified by objects, and how color is seen, are explained and clarified.

Continue

Acknowledgments

- The author wishes to thank Franz Sigg, Milt Pearson, and Glenn Miller for their counsel and encouragement in the initial project and its revision. A special thank-you goes to his graduate student, AnnMarie Scamacca, for her graphics arrangements using many desktop publishing tools.

- Also to Graduate Student Mark Witkowski for his work on repurposing this document and making it interactive.

- Please direct comments and suggestions to the attention of

Professor Bob Chung
RIT/SPMS
69 Lomb Memorial Drive
Rochester, New York 14623-5603
telephone: 716 .475.2722
e-mail: rycppr@rit.edu

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Myth Selection

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Choose the myth that you would like to explore!

1 Rainbow

2 RGB Light

3 Additives

4 Primaries

5 Reflectance

6 Perception

7 Red & Blue

8 Mixing

9 Rendering

10 Matching

Question #1

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Blue, cyan, green, yellow, and magenta are seen in the rainbow?

True

False

CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Blue, cyan, green, yellow, and magenta are NOT seen in the rainbow

The spectrum does not include magenta; cyan is a mixture of blue and green light; yellow is a mixture of green and red light.

The long wavelength (red) and the short wavelength (blue) do not overlap in the rainbow. If they did, we would see magenta in the rainbow.

Myth: Blue, cyan , green, yellow, red, and magenta are seen in the rainbow.

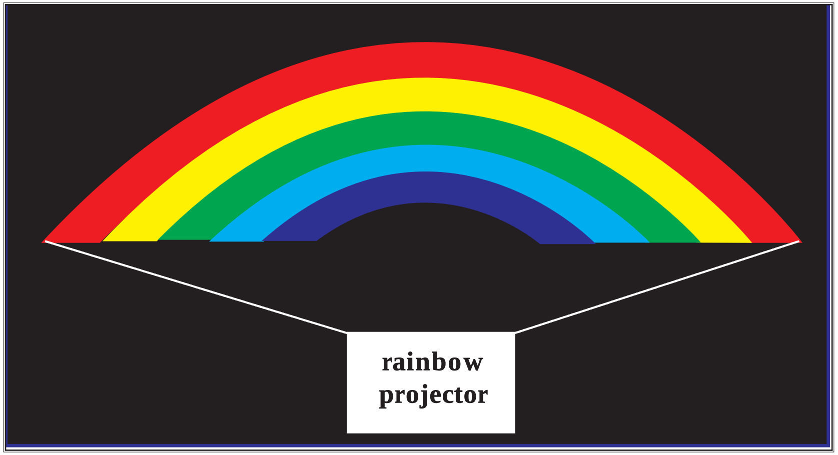
Demystifier: a. The spectrum does not include magenta; cyan is a mixture of blue and green light; yellow is a mixture of green and red light.

b. The long wavelength (red) and the short wavelength (blue) do not overlap in the rainbow. If they did, we would see magenta in the rainbow.

Demonstration of myth #1

Demonstration: Rainbow projector.

a. Light is a form of energy, the visible spectrum.
b. The long wavelengths (600-700nm) portion of the spectrum elicits the sensation of red; the medium wavelength portion (500-600nm) elicits the sensation of green; the short wavelength portion (400-500nm) elicits the sensation of blue.
c. Place color patches in the spectrum and observe selective absorption or reflection of each patch.



* The rainbow projector is available from Edmund Scientific, telephone: (609) 573-6250.

Question #2

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Whenever we mix red and green, we get a dark brown color?

True

False

Quit

CONGRATULATIONS

YOU ANSWERED CORRECTLY!

When we mix red light and green light, we see the color yellow.

When we mix red paint and green paint, we see the color dark brown or dark gray.

Note: The statement, “Yellow and blue make green seal,” by the Glad-Lock Zipper bag is a misnomer.

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Myth #2

Myth: Whenever we mix red and green, we get a dark **brown** color.

Demystifier: a. We need to differentiate colored *light* from colored *objects*.

b. When we mix red light and green light, we see the color yellow.

c. When we mix red paint and green paint, we see the color dark brown or dark gray.

Note: The statement, "Yellow and blue make green seal," by the Glad-Lock Zipper bag is a misnomer.

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Demonstration of myth #2

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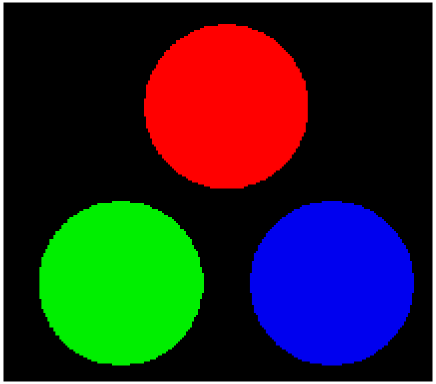
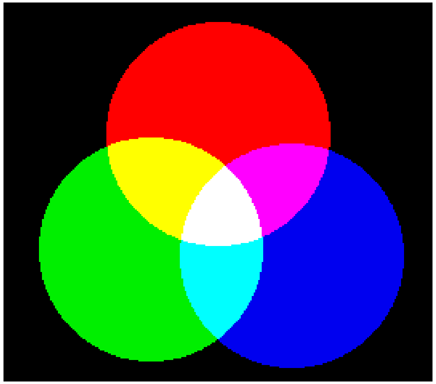
Demonstration: Three projectors with red, green, and blue filters in circled slides.

a. There is no color sensation except black when the projectors are off.
b. We see only the color of the filter when projectors are on and not overlapped.
c. We see additional colors as the lights are overlapped (cyan, magenta, yellow, or white).
d. Note that yellow is seen when red light is mixed with green light.
e. White light results when red, green, and blue light are overlapped (energy is added).





Question #3

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Printers are adding inks in the printing process. Thus, printed colors are mixed additively?

True

False

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CONGRATULATIONS

YOU ANSWERED CORRECTLY!

The term additive or subtractive, describes the production of physical stimuli to the eye.

When the visual stimulus increases, such as when colored lights (energy) are added in a dark room, the color mixing is termed *additive*..

When the visual stimulus decreases, such as when printing inks are added on white paper, the color mixing is termed *subtractive*.

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Myth #3

Myth: Printers are adding inks to their printing presses; painters are adding colors to their canvases. Thus, printed and painted colors are mixed additively.

Demystifier:

a. The term additive or subtractive, describes the production of physical stimuli to the eye.

b. When the visual stimulus increases, such as when colored lights (energy) are added in a dark room, the color mixing is termed *additive*..

c. When the visual stimulus decreases, such as when printing inks are added on white paper, the color mixing is termed *subtractive*.

Demonstration of myth #3

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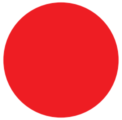
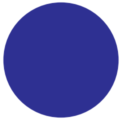
Demonstration:

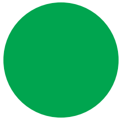
a. Three projectors with RGB filters to demonstrate additive color mixing.



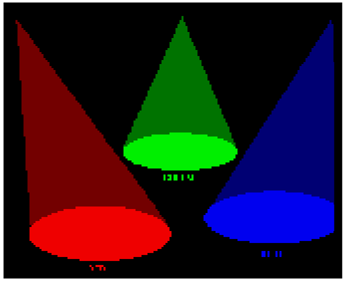
Red light



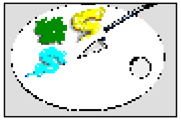
Blue light



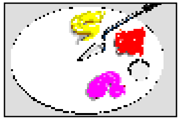
Green light



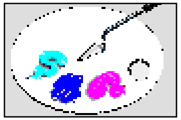
b. A transparency viewer and CMY color keys to demonstrate subtractive color mixing.



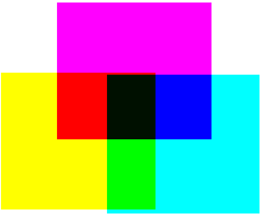
Cyan and yellow ink make green ink.



Magenta and yellow ink make red ink.



Magenta and Cyan ink make blue ink.



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Question #4

Yellow, red, and blue are the primary colors from which all other colors are mixed?

True

False

CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Blue, green, and red lights are the normal additive primaries which in combinations can form all hues.

Yellow, magenta and cyan are the normal subtractive primaries which in combinations can form all hues.

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Myth #4

Myth: Yellow, red, and blue are the primary colors from which all other colors are mixed.

Demystifier:

a. Many children books make the mistake of stating that yellow, red, and blue are primary colors.

b. Blue, green, and red lights are the normal additive primaries which in combinations can form all hues.

c. Yellow, magenta and cyan are the normal subtractive primaries which in combinations can form all hues.

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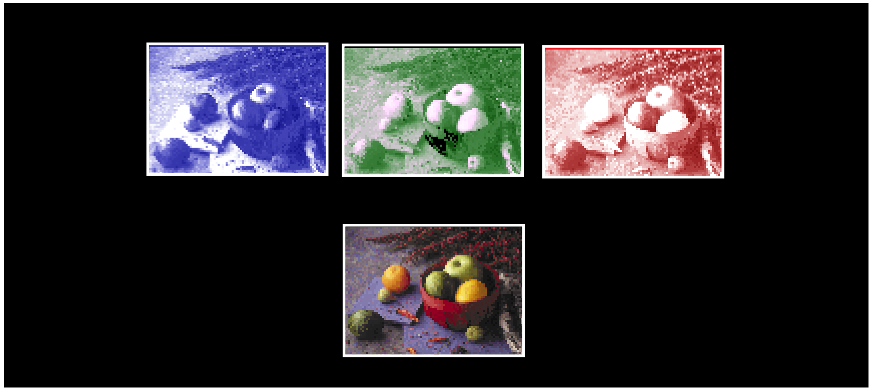
Demonstration of myth #4

Demonstration:

a. Three projectors with three separation positives.



b. Color separation records (CMYK) and their composites.

Question #5

The major difference between magenta and red is in their green reflectance values?

True

False

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CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Magenta and red colorant *reflect* long wavelengths (red) energy and *absorb* medium wavelength (green) energy.

Magenta colorant reflects more short wavelength (blue) energy than red colorant does.

Because of spectral fusion, the eye cannot see individual wavelength of light. Both color theory and instrumentation can help demystify the difference.

Myth #5

Myth: The major difference between magenta and **red** is in their green reflectance values.

Demystifier:

a. Magenta and red colorant reflect long wavelengths (red) energy and absorb medium wavelength (green energy).

b. Magenta colorant reflects more short wavelength (blue) energy than red colorant does.

c. Because of spectral fusion, the eye cannot see individual wavelength of light. Both color theory and instrumentation can help demystify the difference.

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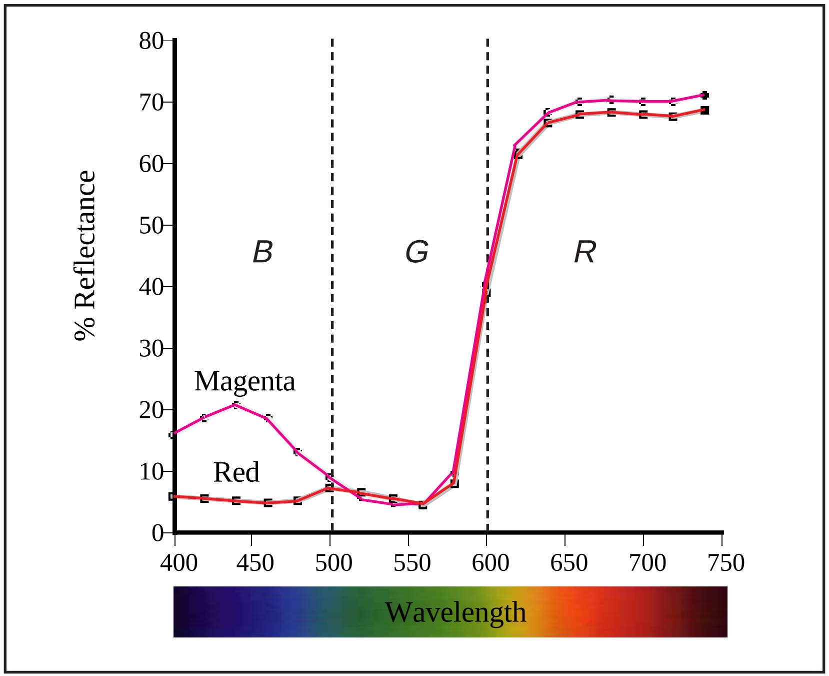
Demonstration of myth #5

Demonstration:

a. Show spectral differences of a red and magenta filter through a diffraction grating.

b. Spectrophotometric curves of a magenta and red ink patch.



Question #6

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People have the same ability to perceive color?

True

False

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CONGRATULATIONS

YOU ANSWERED CORRECTLY!

“If one says 'red' (the name of a color) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be sure that all these reds will be very different. ”
— Josef Albers, *Interaction of Color*.

While the majority of people's vision are color normal, some are color deficient.

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Myth: People have the same ability to perceive color.

Demystifier: a. “If one says 'red' (the name of a color) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be sure that all these reds will be very different. ”

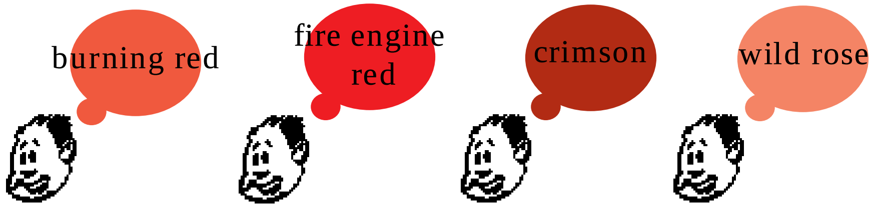
— Josef Albers, *Interaction of Color*.

b. While the majority of people's vision are color normal, some are color deficient.

Demonstration of myth #6

Demonstration: Ishihara test for color blindness.

a. Different people do not think of the colors exactly the same way. The color red may be thought of as:



b. People do not see color exactly the same due to color vision differences.

Plate Number	Normal Vision	Red-Green Deficiencies	Total Color Blindness
1	12	12	12
8	6	x	x
14	x	5	x

Note: ‘X’ means no number.

Plate 1

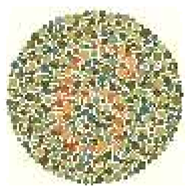


Plate 8

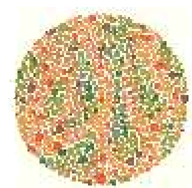


Plate 14

Note: These are illustrations of the original Ishihara plates. They may not elicit the original visual effect.

Question #7

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A red object, when illuminated by a blue light, appears reddish blue?

True

False

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Myth #7

Myth: A red object, when illuminated by a **blue** light, appears reddish **blue**.

Demystifier: a. A red apple appears reddish in daylight.

b. When the short wavelength portion of the spectrum (blue) is the source of illumination, its energy will be absorbed by a red object, thus rendering the red color black.

CONGRATULATIONS

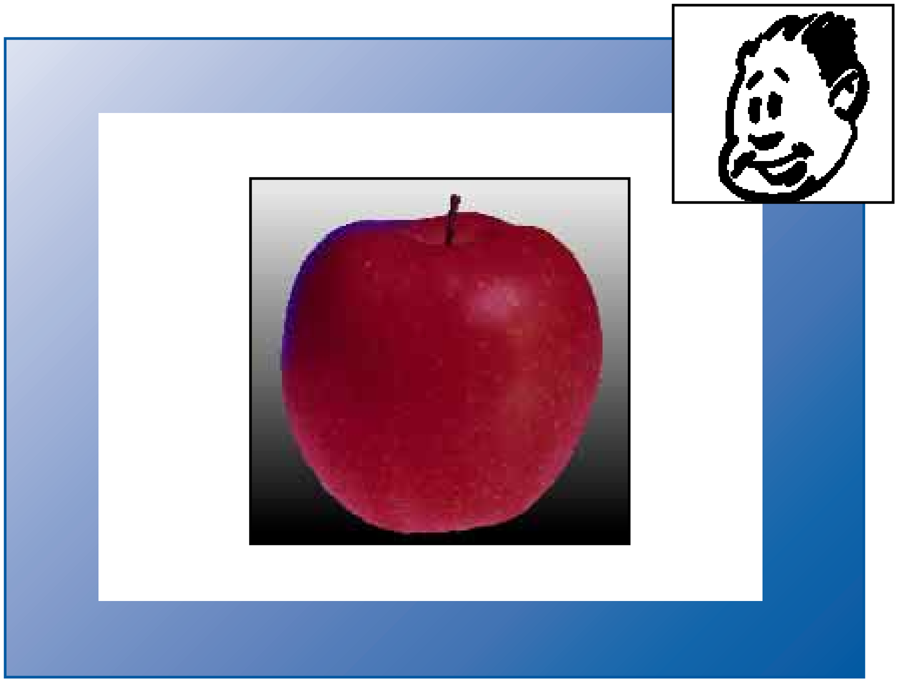
YOU ANSWERED CORRECTLY!

A red apple appears reddish in daylight.

When the short wavelength portion of the spectrum (blue) is the source of illumination, its energy will be absorbed by a red object, thus rendering the red color black.

Demonstration of myth #7

Demonstration: Use colored (blue) light illuminating an apple. The visual effect is most pronounced when a 450 nm interference is used in front of a projector.



Question #8

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Colors seen by spinning discs are examples of subtractive color mixing?

True

False

Quit

CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Temporal fusion is one of the mechanisms of color vision.

Colorants, when temporarily being overlapped, produce visual stimuli additively.

Myth #8

Myth: Colors seen by spinning discs are examples of subtractive color mixing.

Demystifier: a. Temporal fusion is one of the mechanisms of color vision.

b. Colorants, when temporarily being overlapped, produce visual stimuli additively.

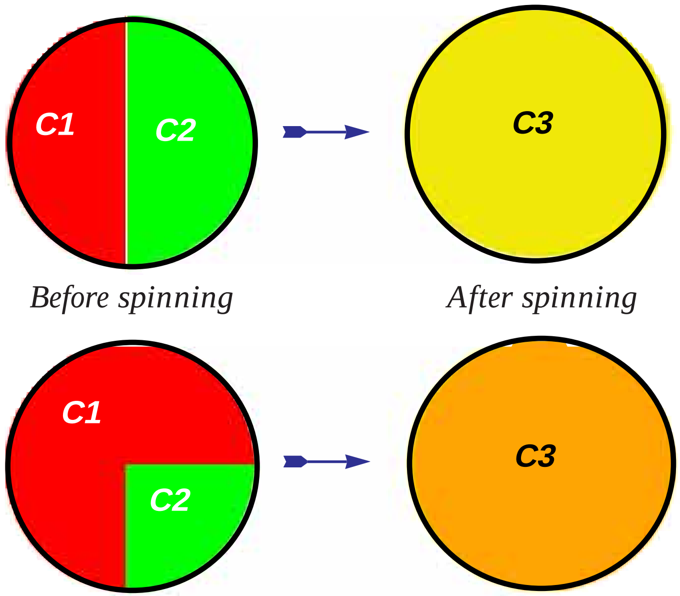
Demonstration of myth #8

Demonstration: Spinning wheels.

a. The perceived color of a rotating disk is the result of *temporal fusion*, the same effect as motion pictures.

b. Notice that a disc, made of a red and a green color, when spun, produces a yellowish hue. The yellow hue is further intensified if fluorescent red and green dyes are used.

c. This demonstrates that a rotating disk follows the additive color mixing principle.



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Question #9

When two white lights look the same, they have the same ability to render colored objects?

True

False

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CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Light sources have different color rendering indices.

White lights, made of narrow-band energies, have poor color rendering abilities.

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Myth #9

Myth: When two white lights look the same, they have the same ability to render an object the same color.

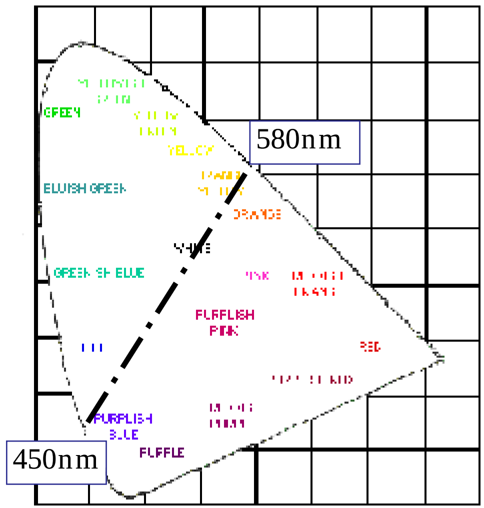
Demystifier: a. Light sources have different color rendering indices.

b. White lights, made of narrow-band energies, have poor color rendering abilities.

Demonstration of myth #9

Demonstration: Three projectors—By overlapping two projectors with narrow-band filters (yellow and blue), a white light is seen. A third projector with CC (color compensating) filters and a polarizing filter can match the white light, but with continuous spectral energy distribution.

a. The narrow-band yellow filter is a glass interference filter, 10nm band path, transmittance peaked at 580nm. Its complementary filter, as predicted by the 1931 CIE Chromaticity diagram, is peaked at 450nm.



b. Interference filters are available from Corion Corp. Tel: (508) 429-5065.

Question #10

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Two colors that look the same will always look the same?

True

False

Quit

CONGRATULATIONS

YOU ANSWERED CORRECTLY!

Two colors that look the same can be viewed differently due to differences in their surrounds. This is also known as *simultaneous color contrast*.

“A color has many faces, and one color can be made to appear as two different colors.”

—Josef Albers, *Interaction of Color.*

Myth #10

Myth: Two colors that look the same will always look the same.

Demystifier: a. Two colors that look the same can be viewed differently due to differences in their surrounds. This is also known as *simultaneous color contrast.*

b. "A color has many faces, and one color can be made to appear as two different colors."
—Josef Albers, *Interaction of Color.*

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Demonstration of myth #10

Demonstration: Josef Albers Color Plate.

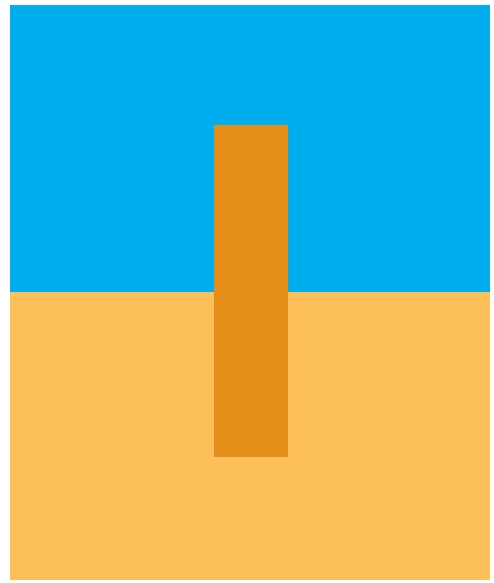
Horizontal blue and yellow stripes placed on top of a vertical stripe of OCHER makes the OCHER:

a. appear to be different, yet

b. it is the same color at the top as at the bottom of the page.

a

b



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Conclusion

- You have successfully navigated your way through this document. We hope that it has raised your awareness of color and its attributes.

- If you wish to order *Visualizing Color* for classroom use, the cost is $4 per copy. If the quantity is ten or more, the cost is $3 per copy. A check made payable to RIT/School of Printing Management and Sciences should be included with the request. If you would like to order or have any questions, comments or concerns, feel free to contact the author.

Professor Bob Chung
RIT/SPMS
69 Lomb Memorial Drive
Rochester, New York 14623-5603
telephone: 716 .475.2722
e-mail: rycppr@rit.edu

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