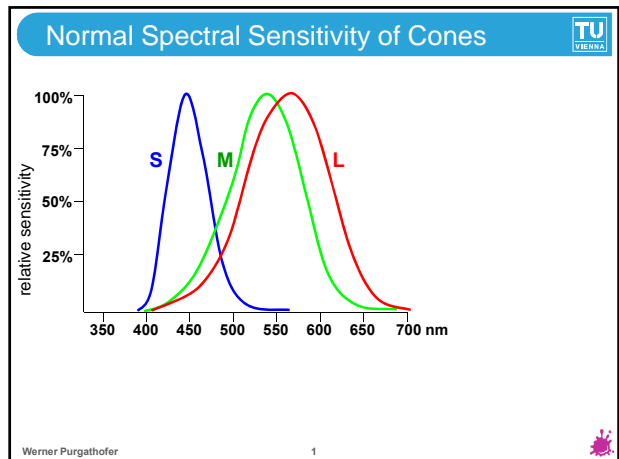


Einführung in die Farbwissenschaft

Color Blindness



Color Blindness

- recessive trait, located on X-chromosome
- much more likely to occur in males
 - ◆ 8%-13% males have deficiencies
 - ◆ <1% females have deficiencies
- cause: some cones missing or defect
- several types of color blindness exist
 - ◆ depends on which cones are missing

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Color Blindness Forms

- **red-green blindness** (~5% of people)
 - ◆ *Daltonism*, after its discoverer (1798)
 - ◆ *deuteranopia* (missing „green“ pigments)
 - ◆ *protanopia* (missing „red“ pigments)
- **blue-yellow blindness** (~0.02% of people)
 - ◆ *tritanopia* (missing „blue“ pigments)
 - ◆ equally distributed across males and females
- **complete color blindness** (~0.001%)
 - ◆ *achromatopsia*
 - ◆ no spectrally selective pigments at all

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Normal Color Vision

- tri-chromatic vision
- fovea: mainly red- and green-cones, no rods
- outside fovea: mainly rods, some blue cones

retina

fovea

...cones

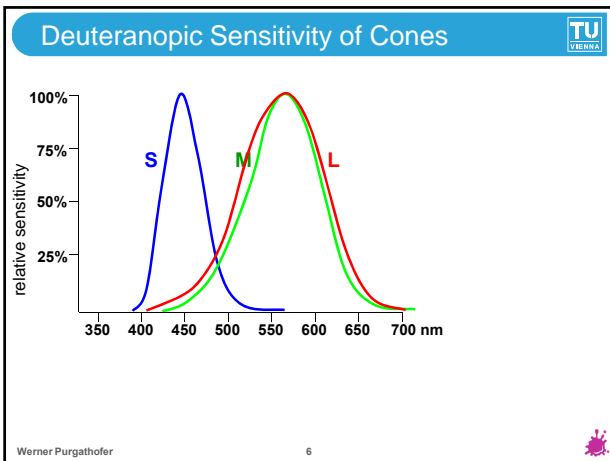
...rods

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Deuteranopia [Deuteranopie]

- **deuteranopia** = green blindness
- green-cones act as red-cones
- people have only di-chromatic vision
- blue = normal, green + red → orange-yellow
- neutral point (grey!) = 498 nm

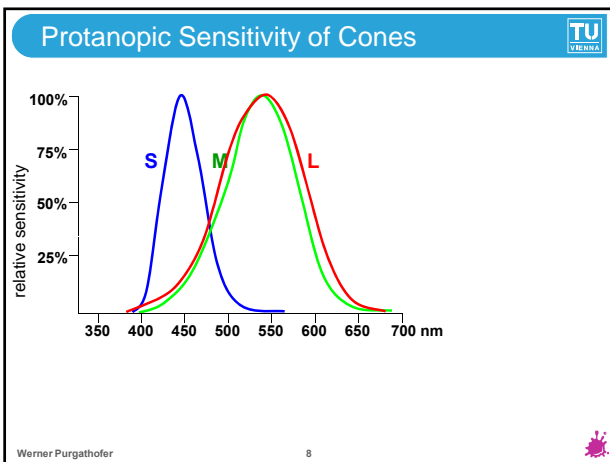
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Protanopia [Protanopie]

- **protanopia** = red blindness
- red-cones act as green-cones
- people have only di-chromatic vision
- blue = normal, green + red → greyish yellow
- neutral point (grey!) = 492 nm

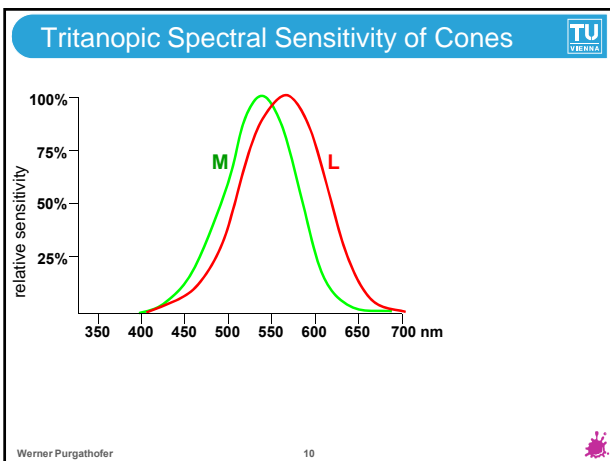
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Tritanopia [Tritanopie]

- **tritanopia** = blue blindness
- blue-cones are missing (very rare)
- people have only di-chromatic vision, but blue is the least important color (# cones)
- blue → grey, green + red = normal

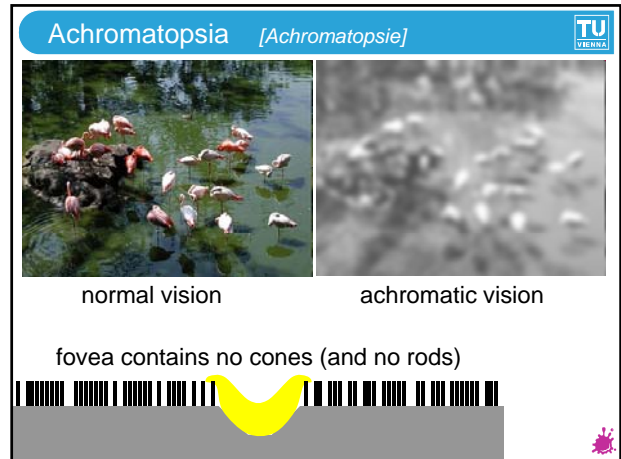
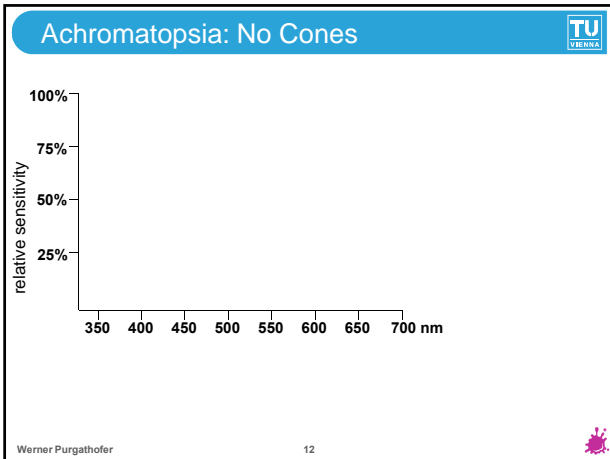
TU VIENNA



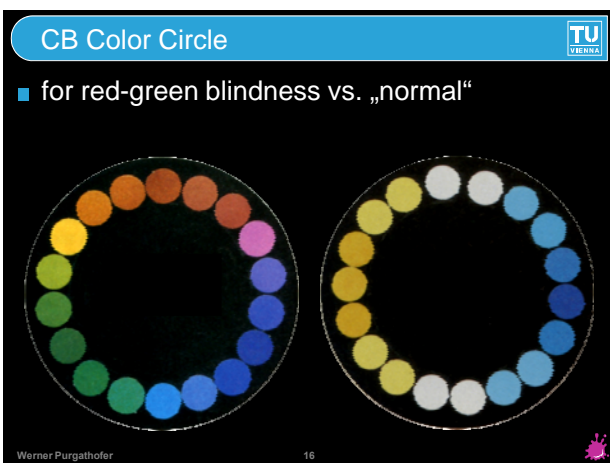
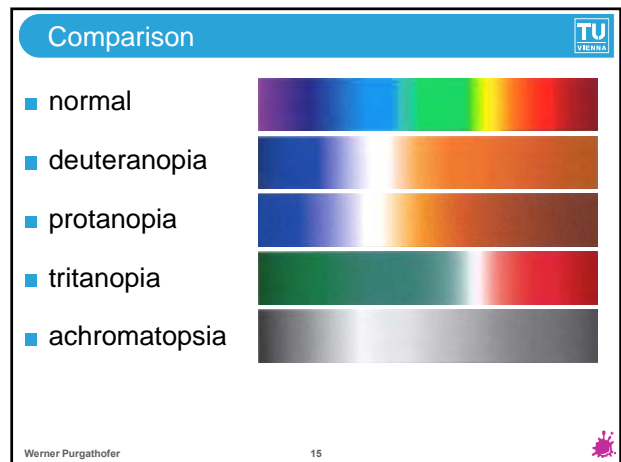
Achromatopsia [Achromasie]

- **achromatopsia** = total color blindness
- all cones are missing (very rare: 1/100.000)
- all colors → grey
- blind fovea → no sharp images (poor acuity)
- extremely sensitive to bright light

TU VIENNA



- ### Weaker Color Deficiencies
- normal: sensitivity of pigments is varying
 - **deuteranomaly**: green-weakness
 - **protanomaly**: red-weakness
 - **tritanomaly**: blue-weakness
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Comparison

■ normal / deuteranopia / protanopia / tritanopia

Comparison

< normal
deuteranopia >
protanopia >
< tritanopia

Comparison

KURIER Widgets
IMMER AKTUELL
iGoogle

^ normal
deuteranopia ^
v tritanopia
protanopia v

Finding Raspberries

normal
deuteranopia
protanopia
tritanopia

Color Deficiency Examples

normal
protanopia
deuteranopia
tritanopia

source: www.graphics.cornell.edu

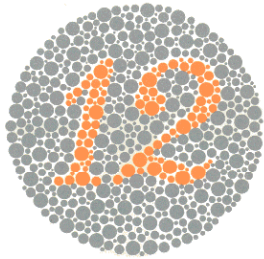
Color Deficiency/Blindness Tests

■ Ishihara Color Blindness Test (1917)

■ 4 kinds of test plates

- ◆ transformation plates
 - anomalous observers give different responses
- ◆ disappearing digit (vanishing) plates
 - only normal observers recognize a pattern
- ◆ hidden digit plates
 - only anomalous observers see a pattern
- ◆ qualitative plates
 - to classify protan from deutan and mild from severe anomalous color perception

Ishihara: Plate #1



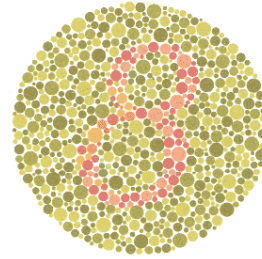
solution: both normal and those with all color vision deficiencies should read the number 12.

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Ishihara: Plate #2



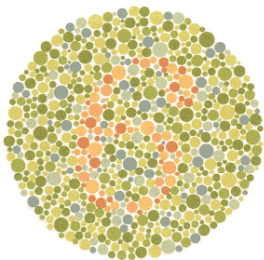
solution: normal color vision : 8
red-green deficiencies : 3
total color blindness : nothing

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Ishihara: Plate #8



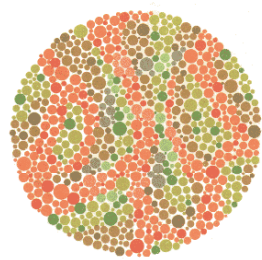
solution: normal color vision : 6
any deficiency : nothing or something else

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Ishihara: Plate #14



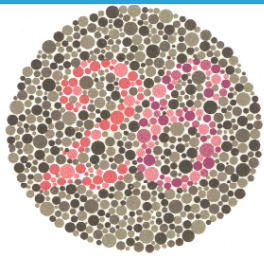
solution: normal color vision : nothing
red-green deficiencies : 5
total color blindness : nothing

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Ishihara: Plate #16



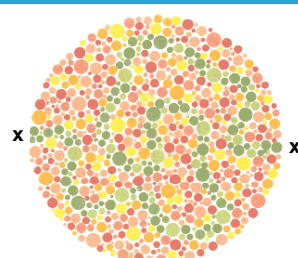
solution: normal color vision : 26
protanopia or strong protanomalopia : 6
mild protanomalopia : 26, but 6 is clearer than 2
deutanopia or strong deutanomalopia: 2
mild deutanomalopia: 26, but 2 is clearer than 6

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Ishihara: Plate #20



solution: normal color vision : line from x to x
any deficiency : no line or wrong line

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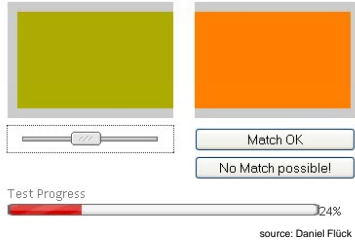
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Color Blindness Tests



- apart from color test charts, **anomaloscopes** are used to test for the various forms of CB



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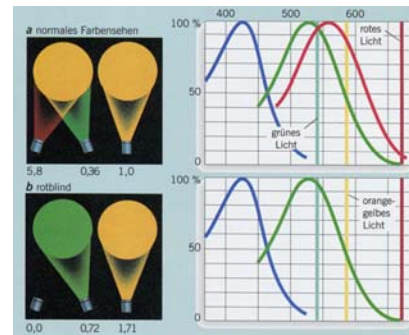
30



Anomaloscope



- mini color matching experiment
- subject has to mix red and green to match a given monochrome light



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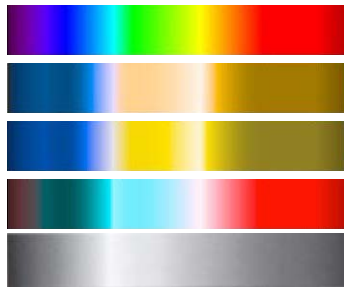
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Comparison #2 (Different Source)



- normal
- deuteranopia
- protanopia
- tritanopia
- achromatopsia



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