How to do colorimetry

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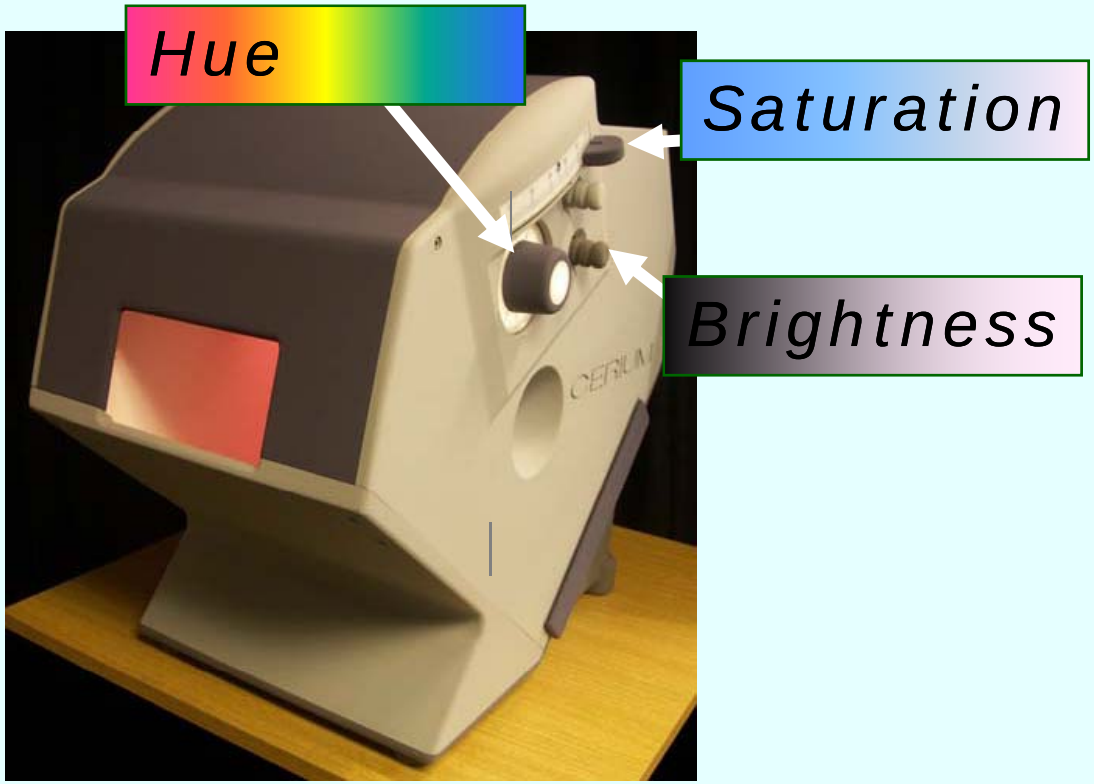
University of Essex

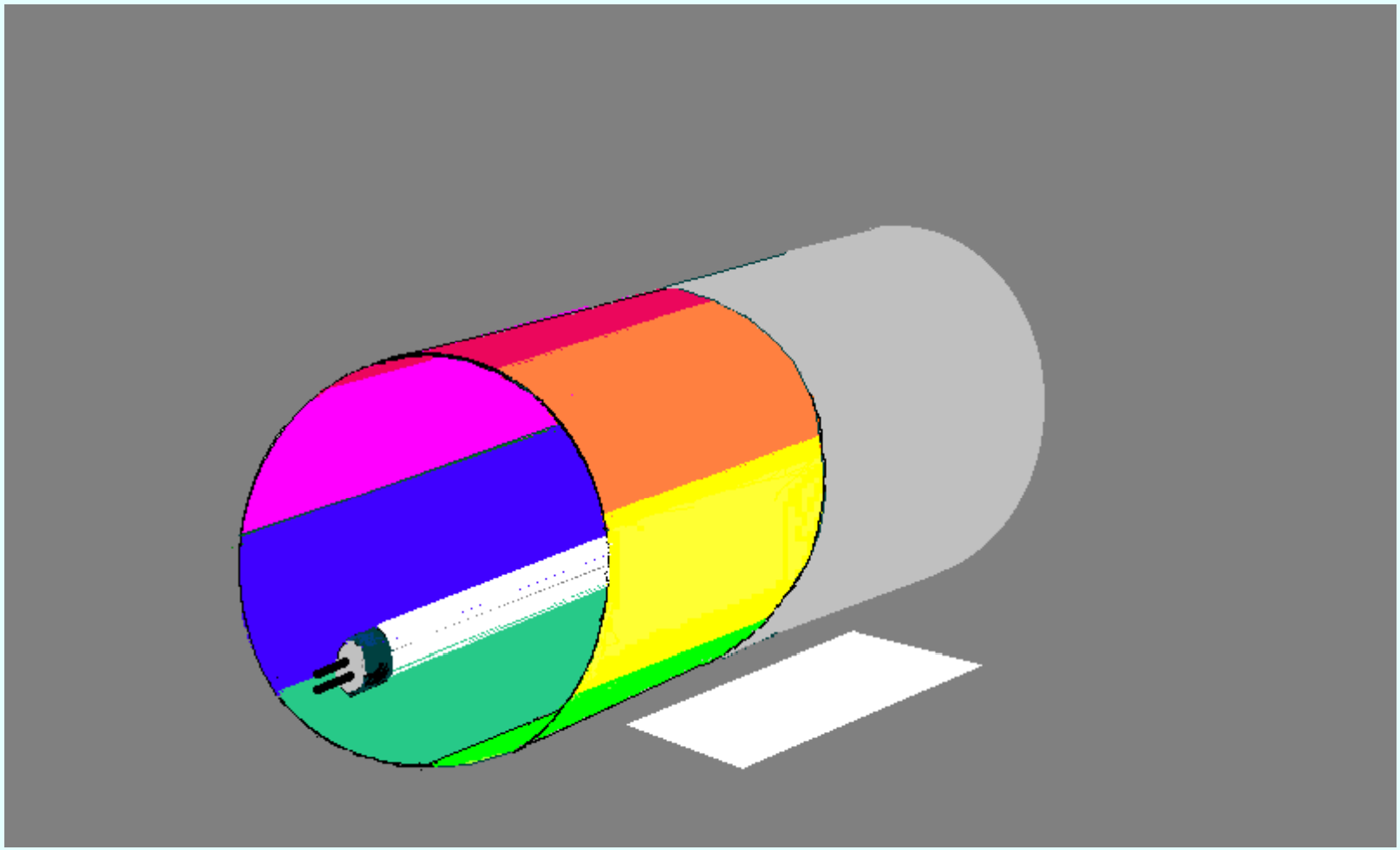
Intuitive Colorimeter



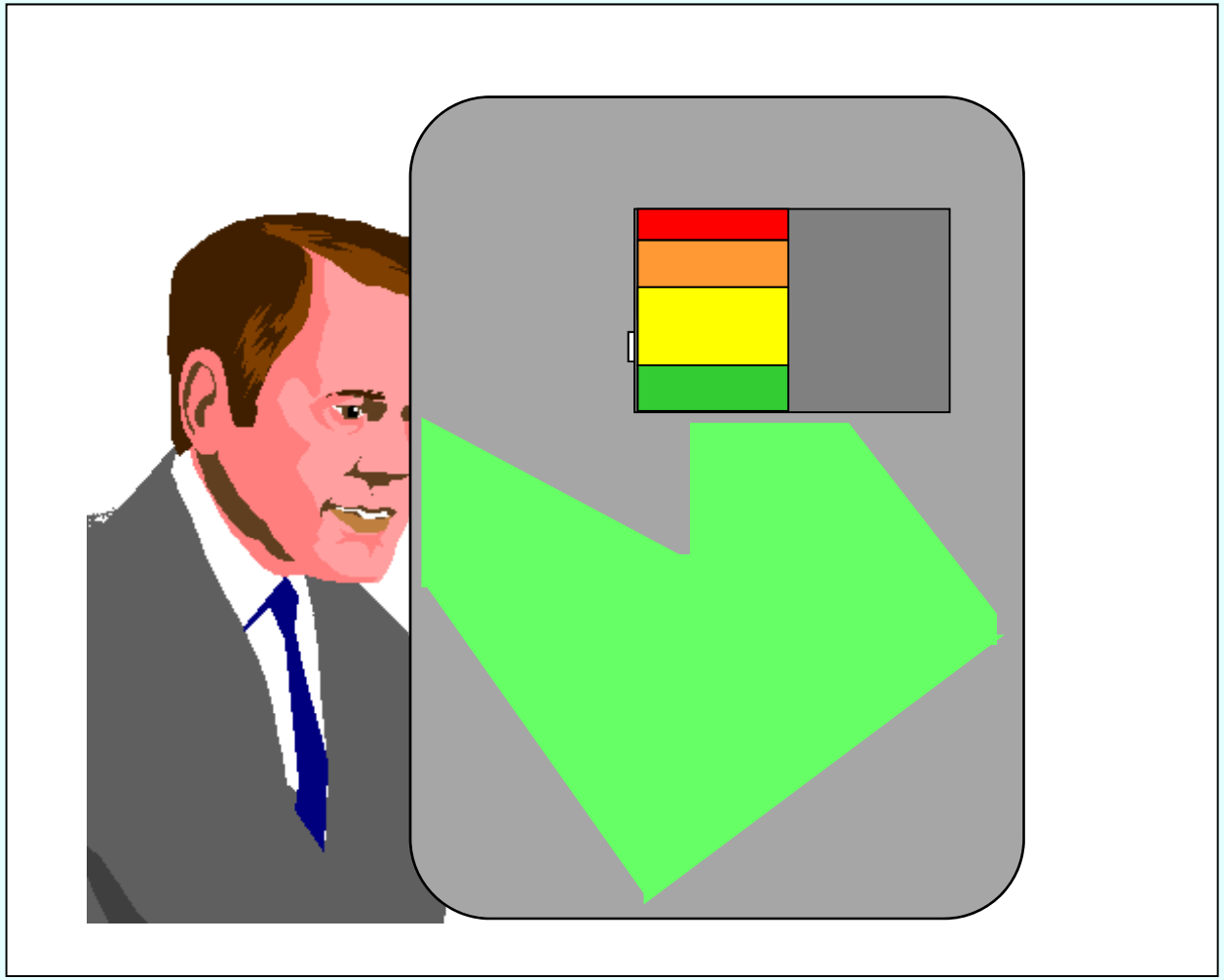
Shines coloured light on text

Wilkins, A.J., Milroy, R., Nimmo-Smith,I.,Wright, A., Tyrrell, R., Holland, K., Martin, J., Bald, J., Yale, S., Miles, T., Noakes,T. (1992) Preliminary observations concerning treatment of visual discomfort and associated perceptual distortion. *Ophthalmic and Physiological Optics*, 12, 257-263.

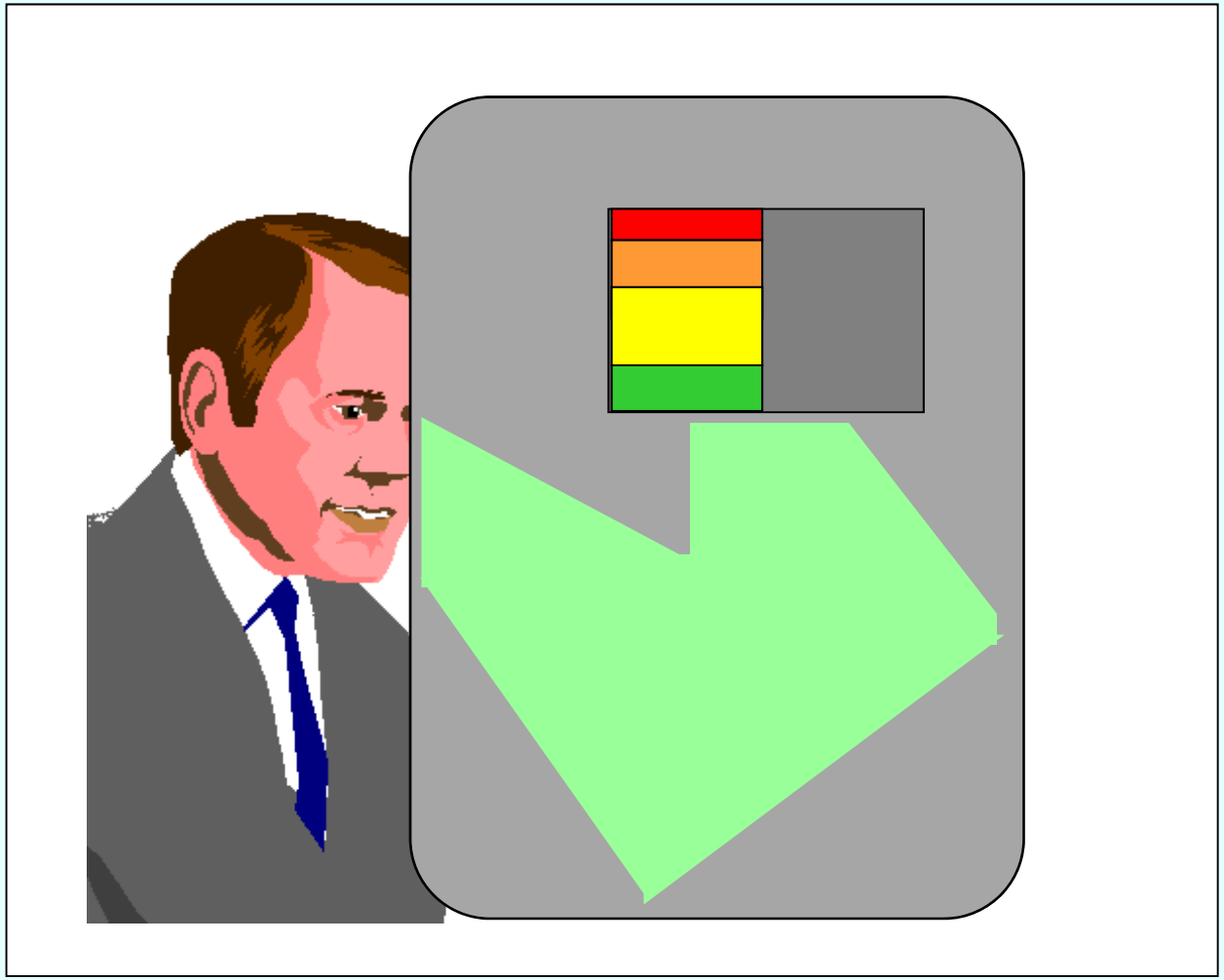
Filters with lamp and aperture



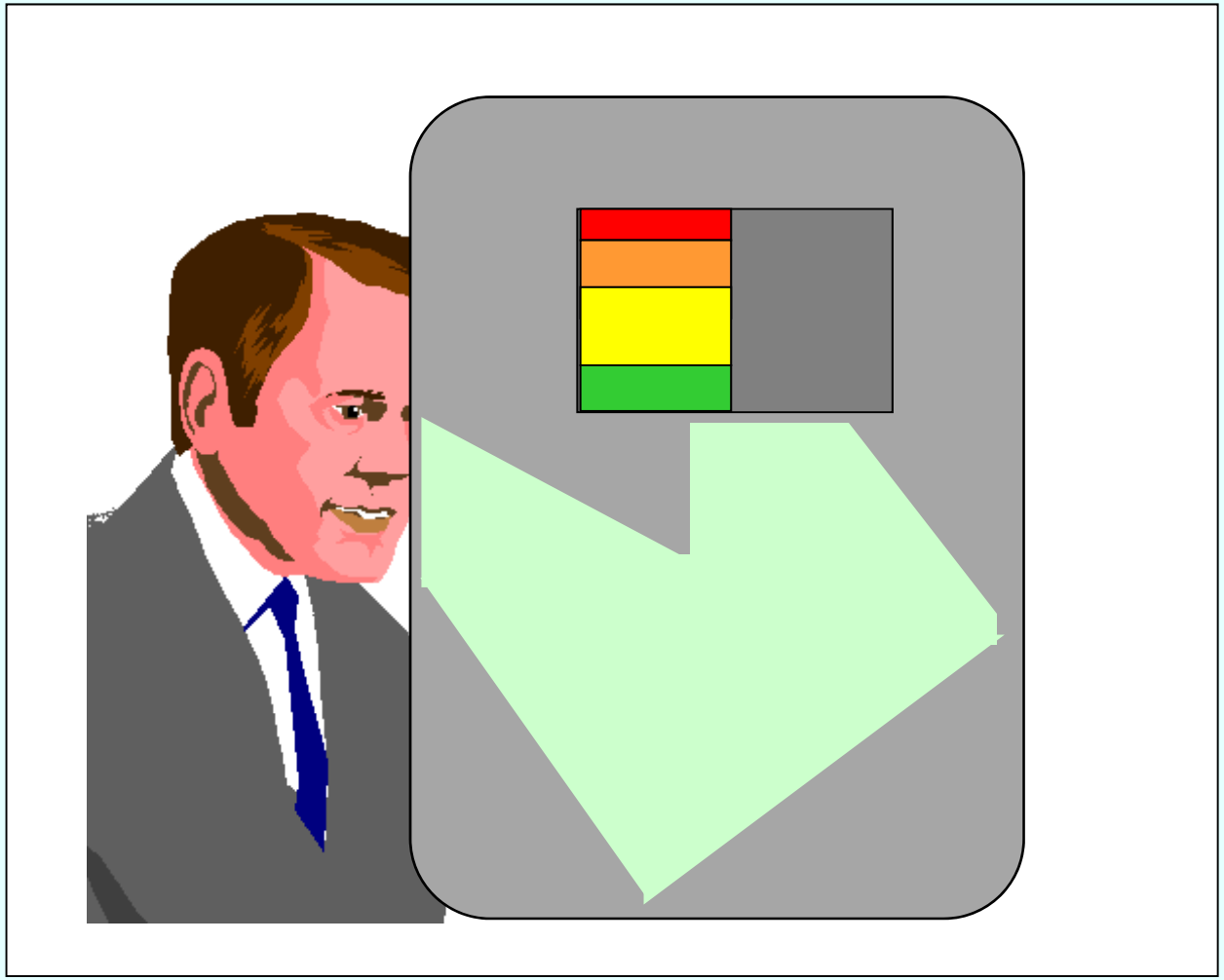
Cross section



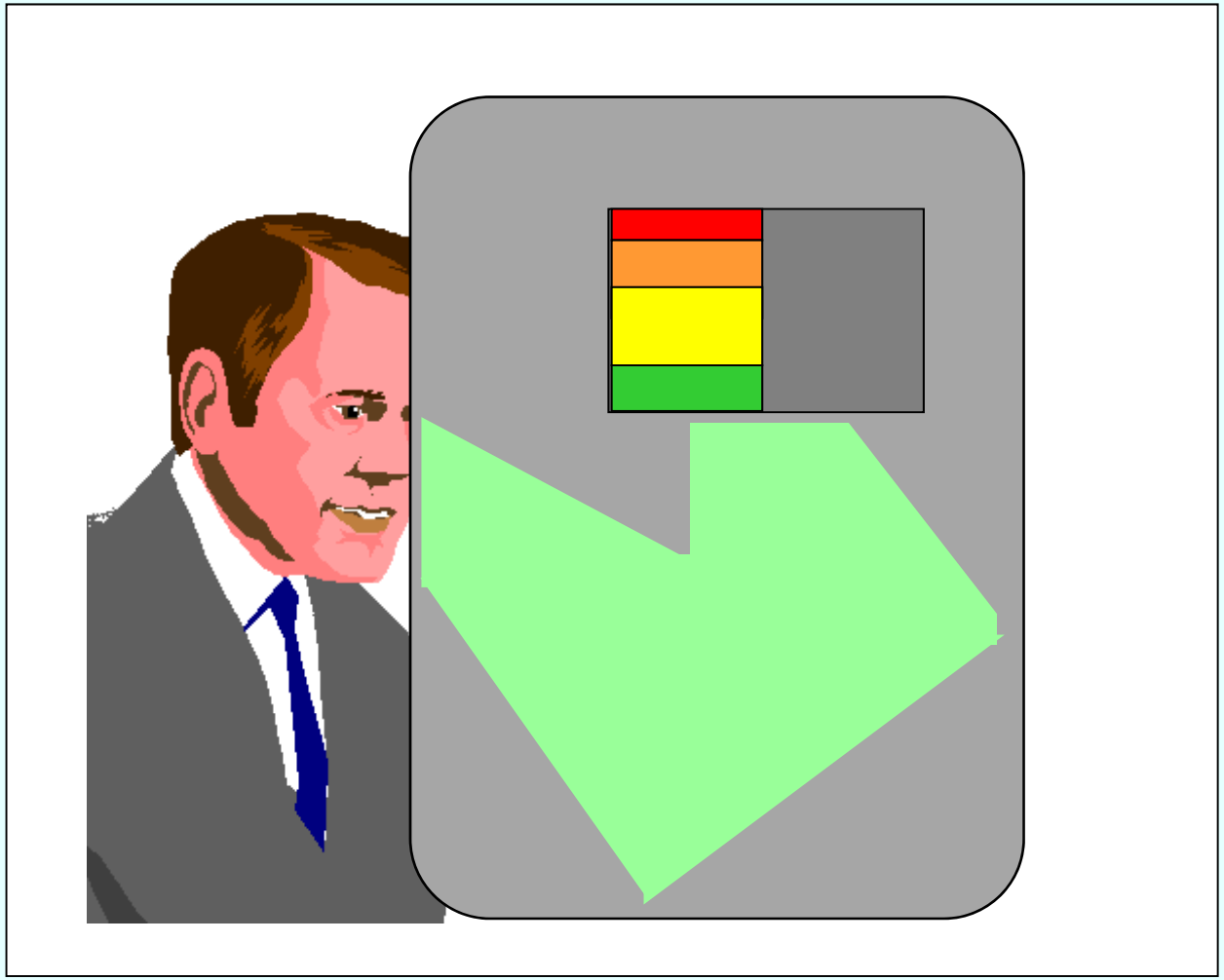
Cross section



Cross section



Cross section



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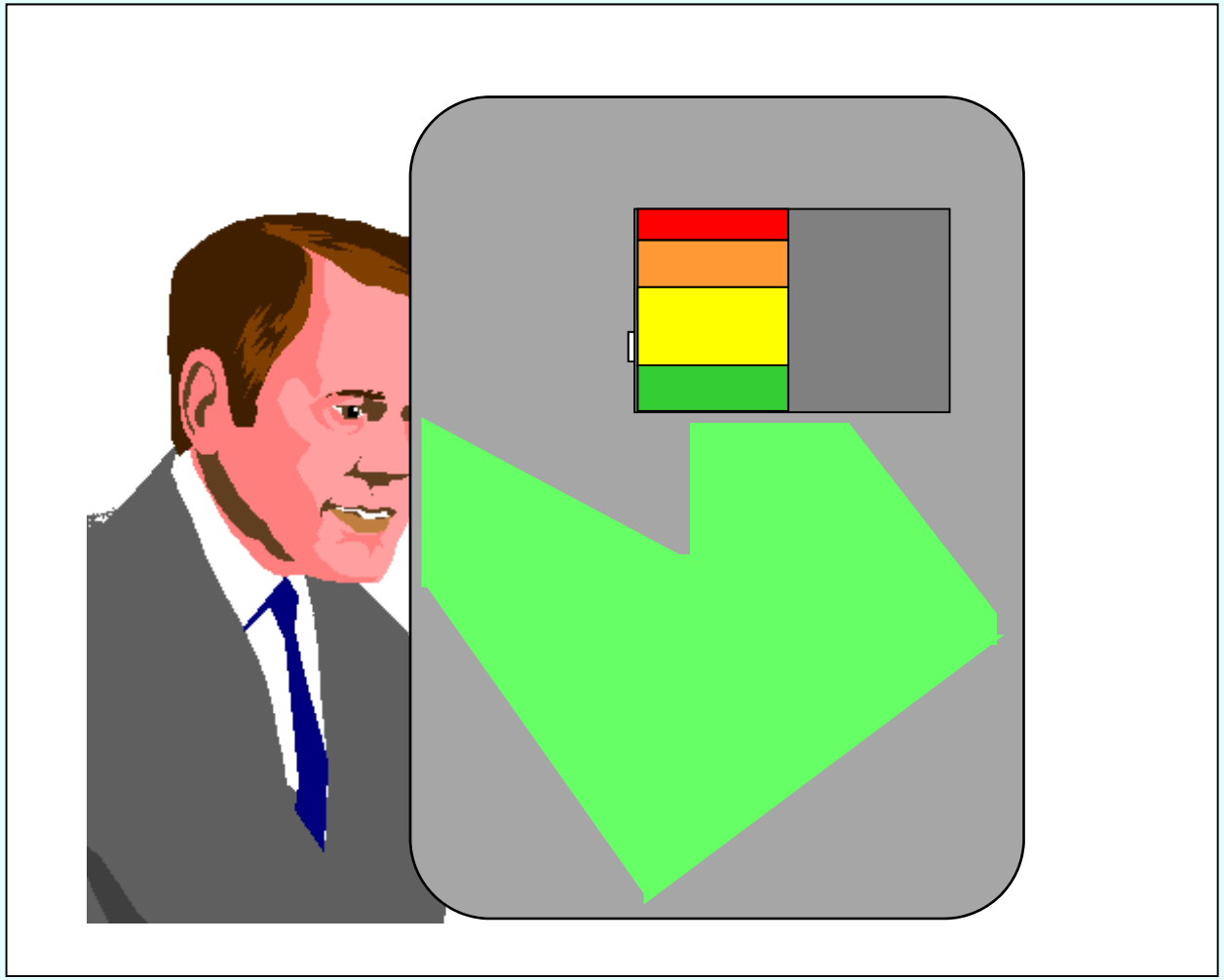
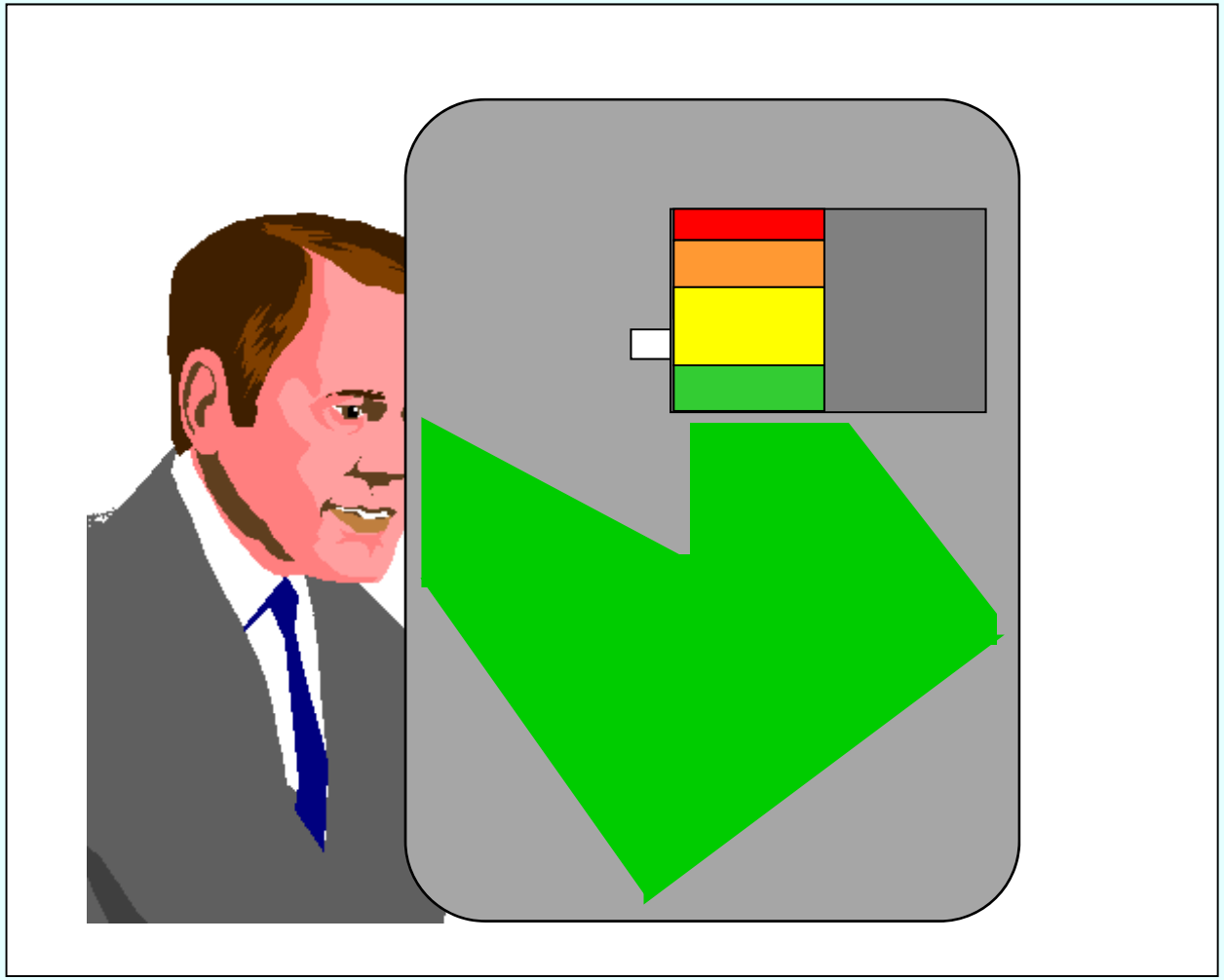
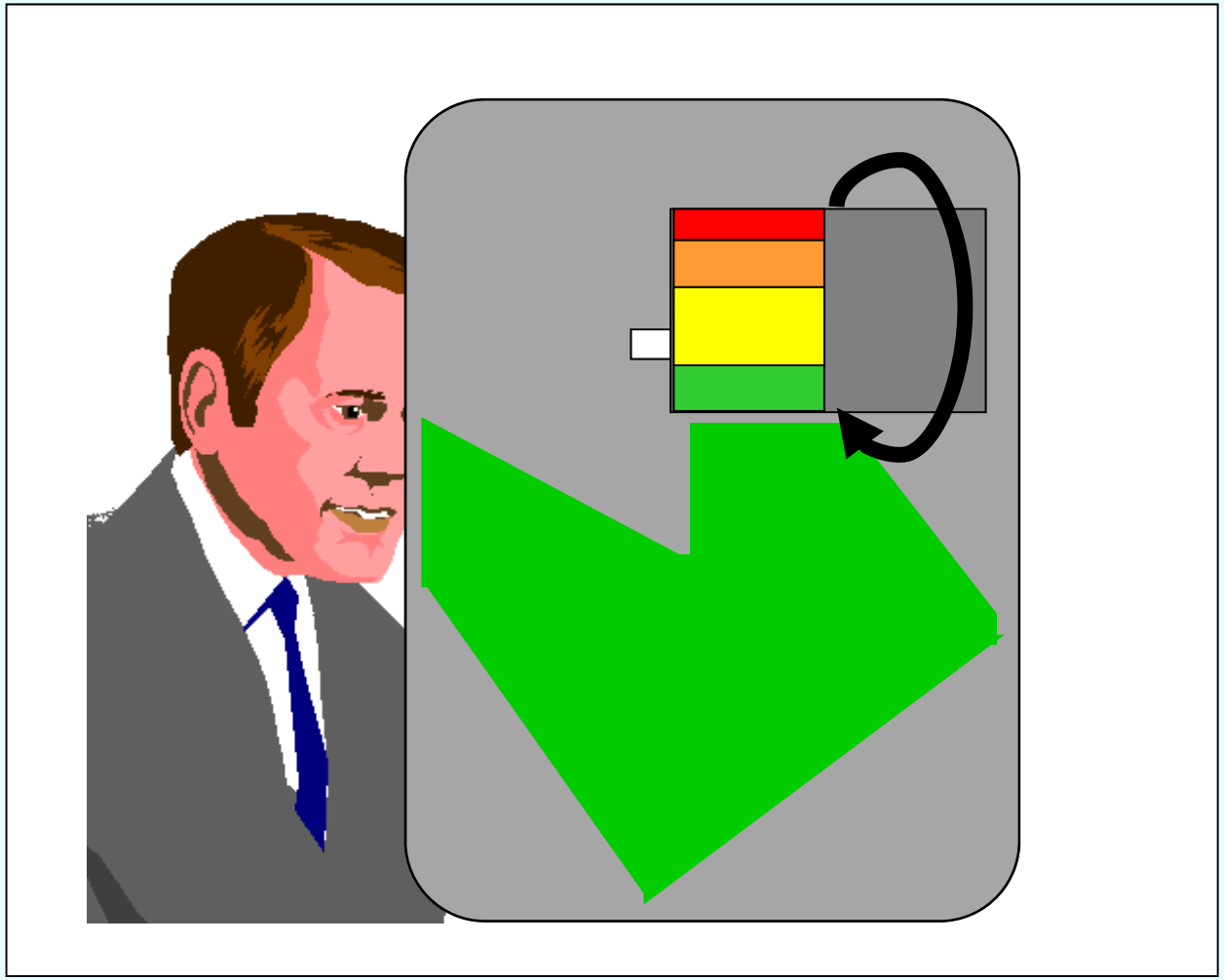


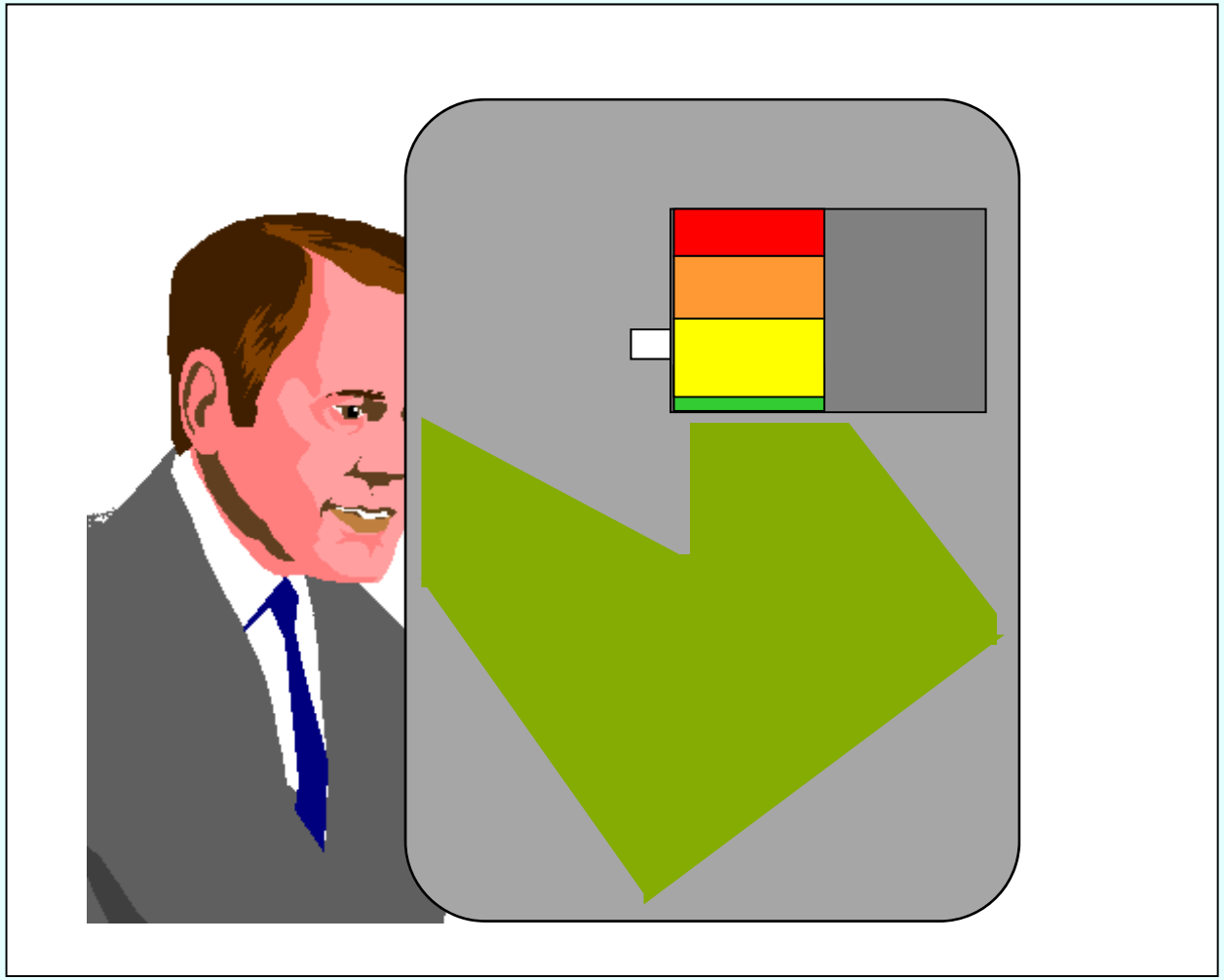
Cross section



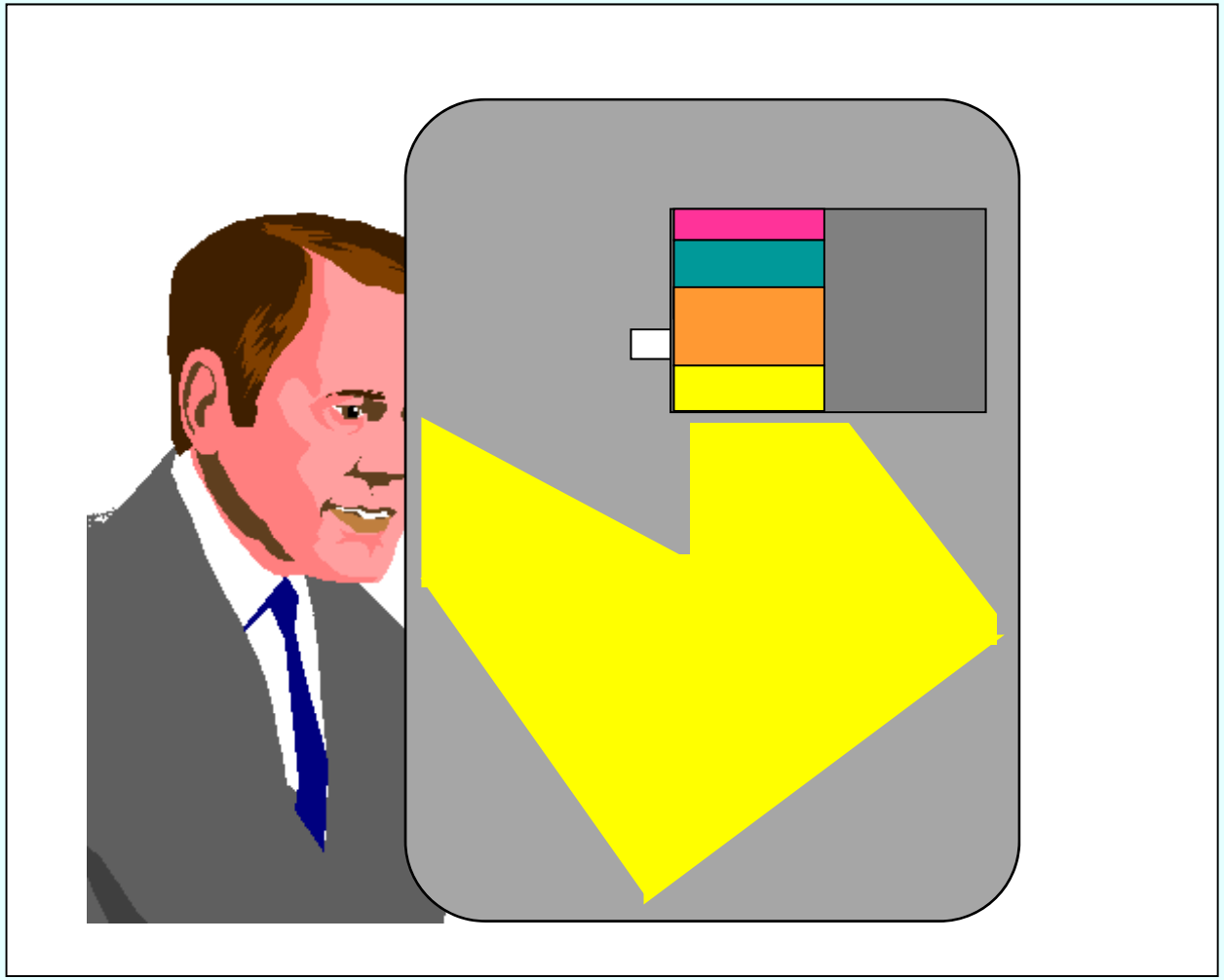
Cross section



Cross section



Cross section



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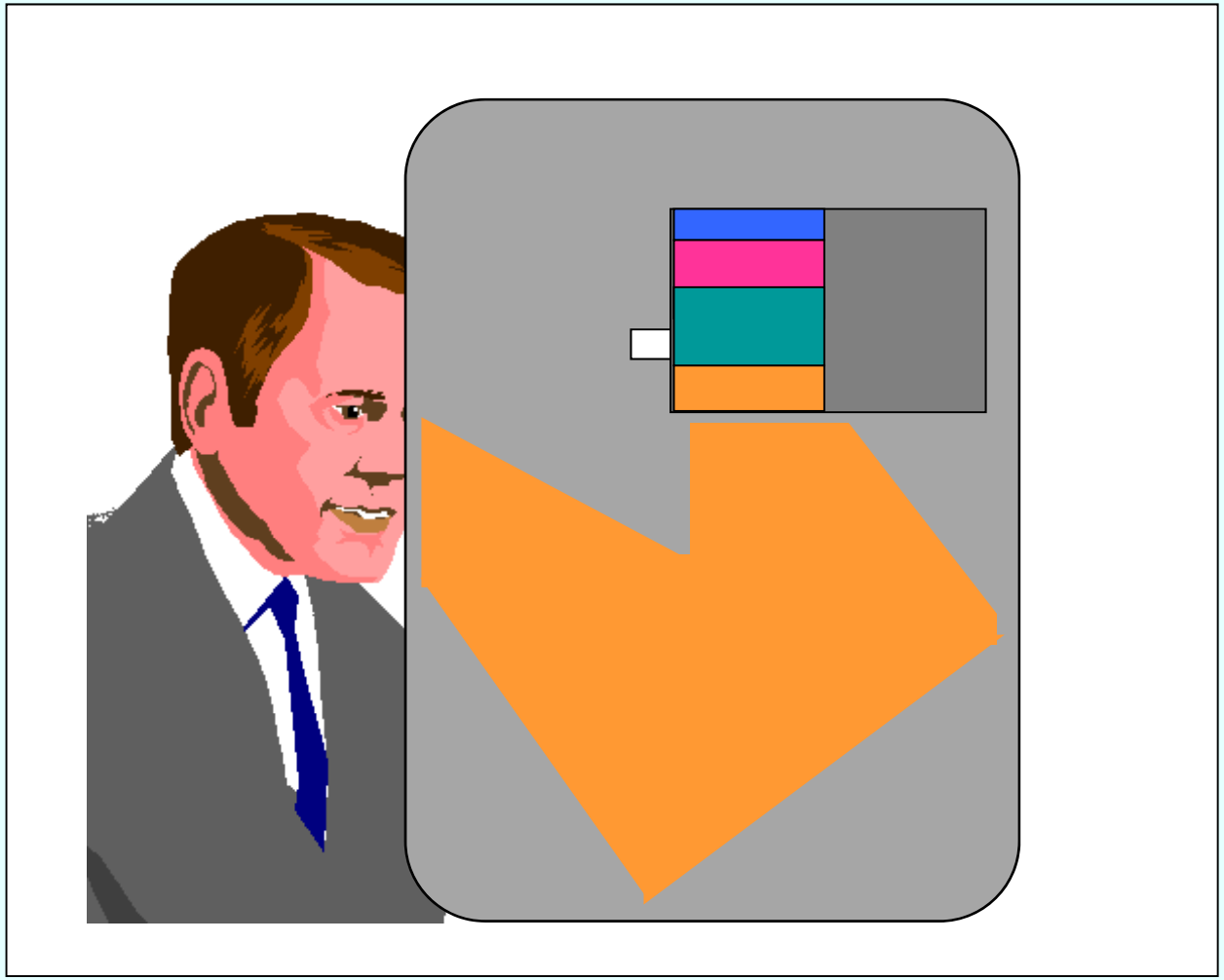
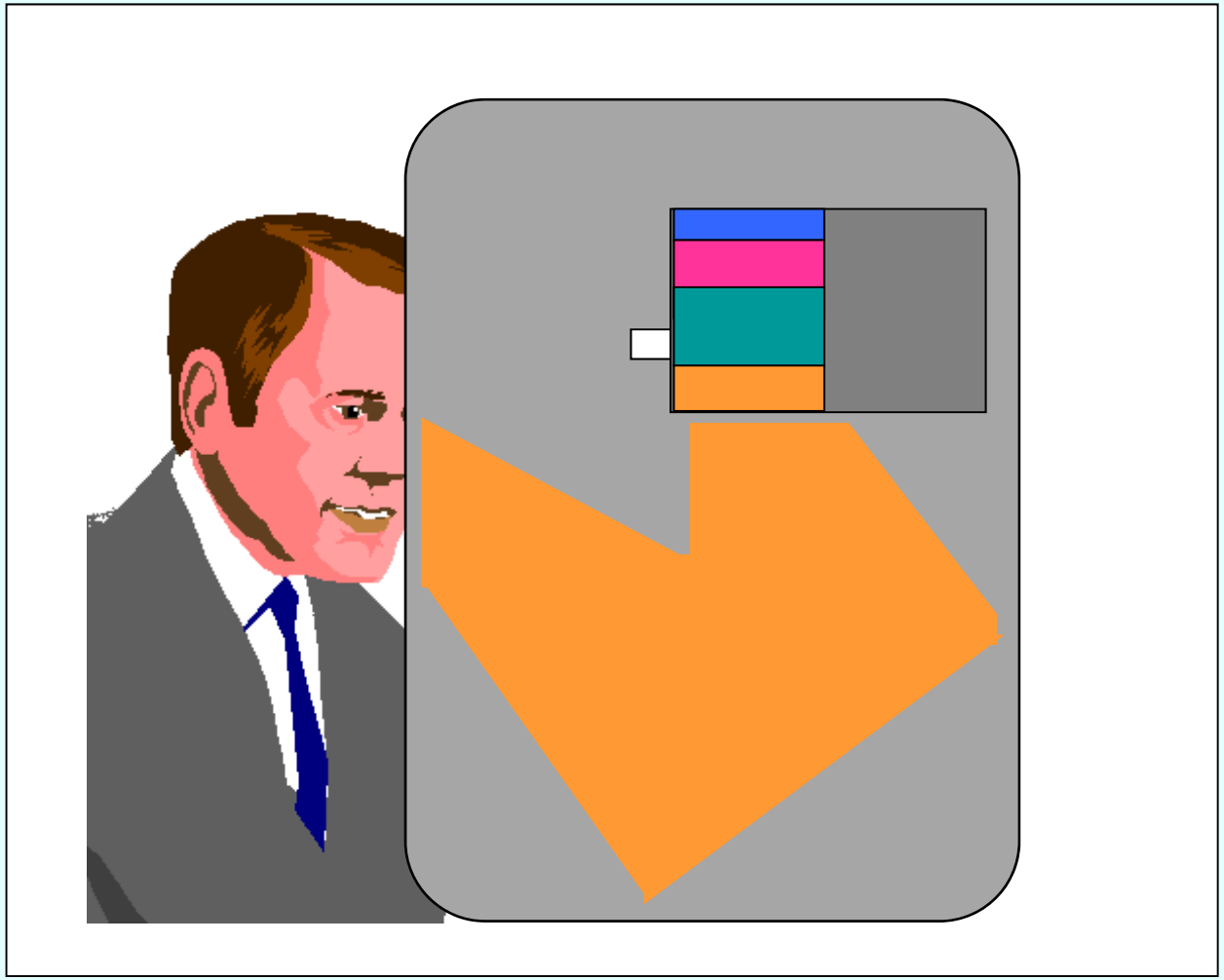
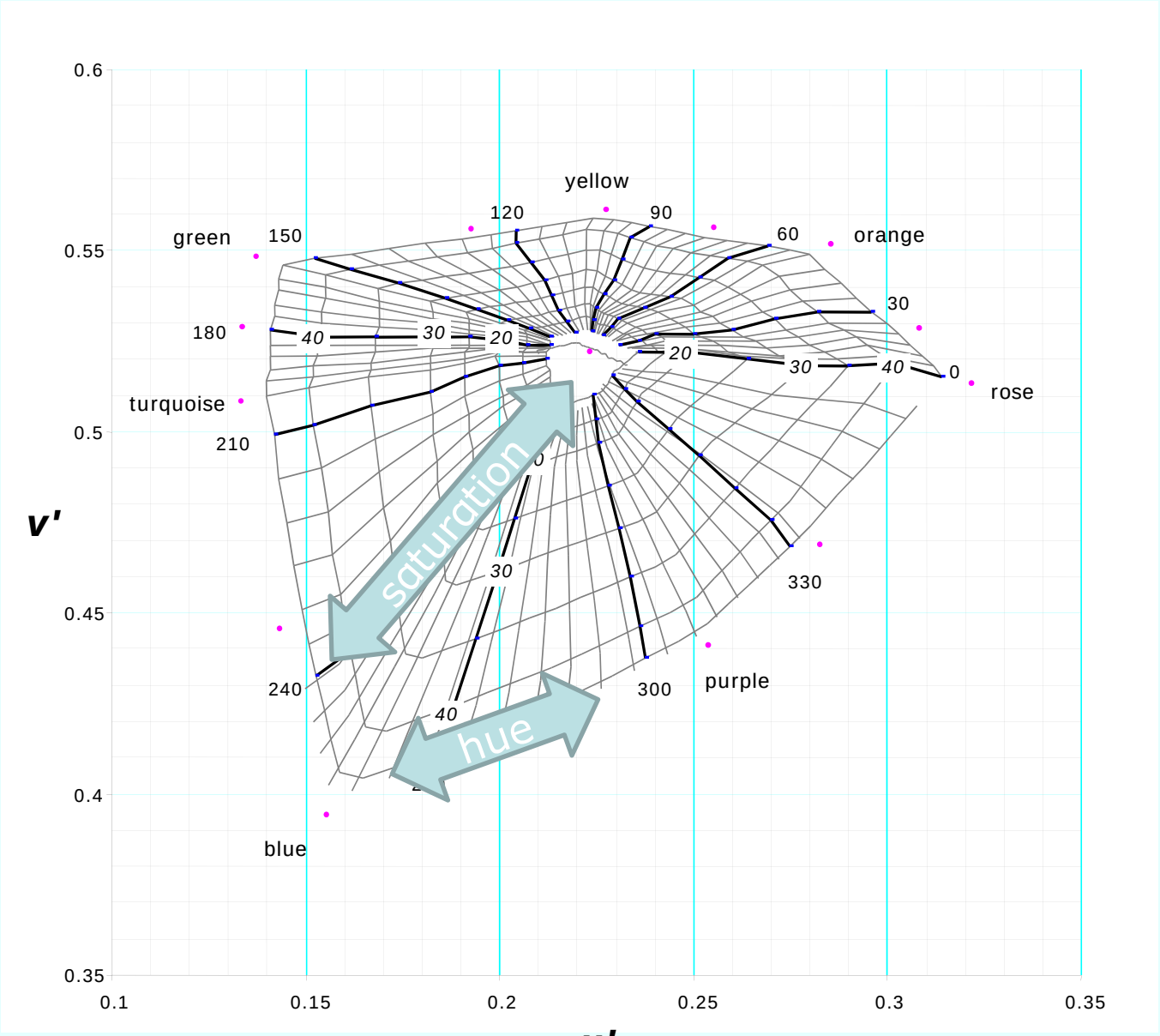
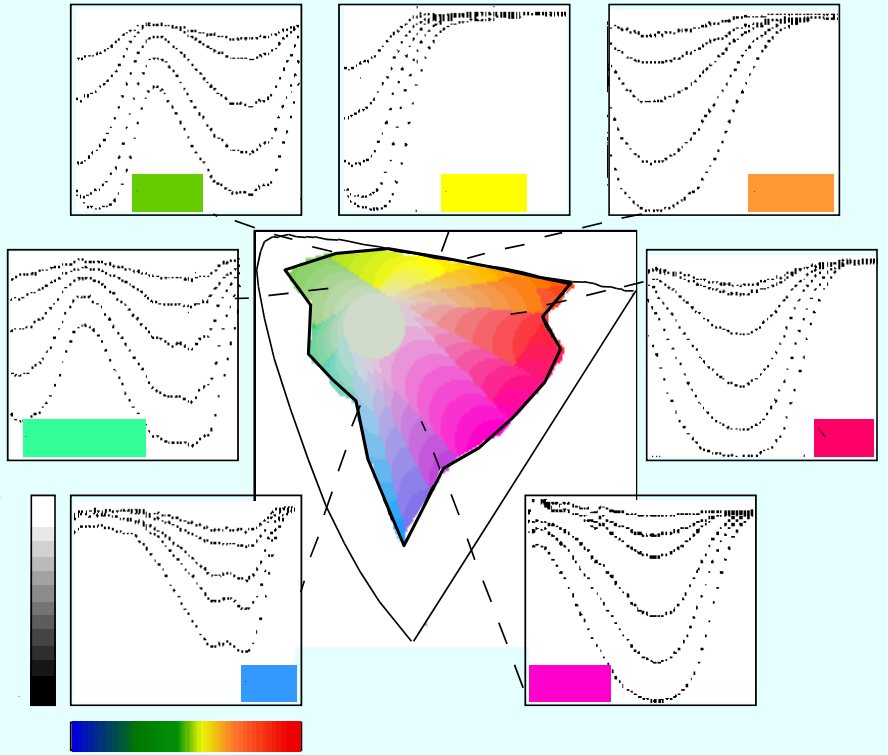


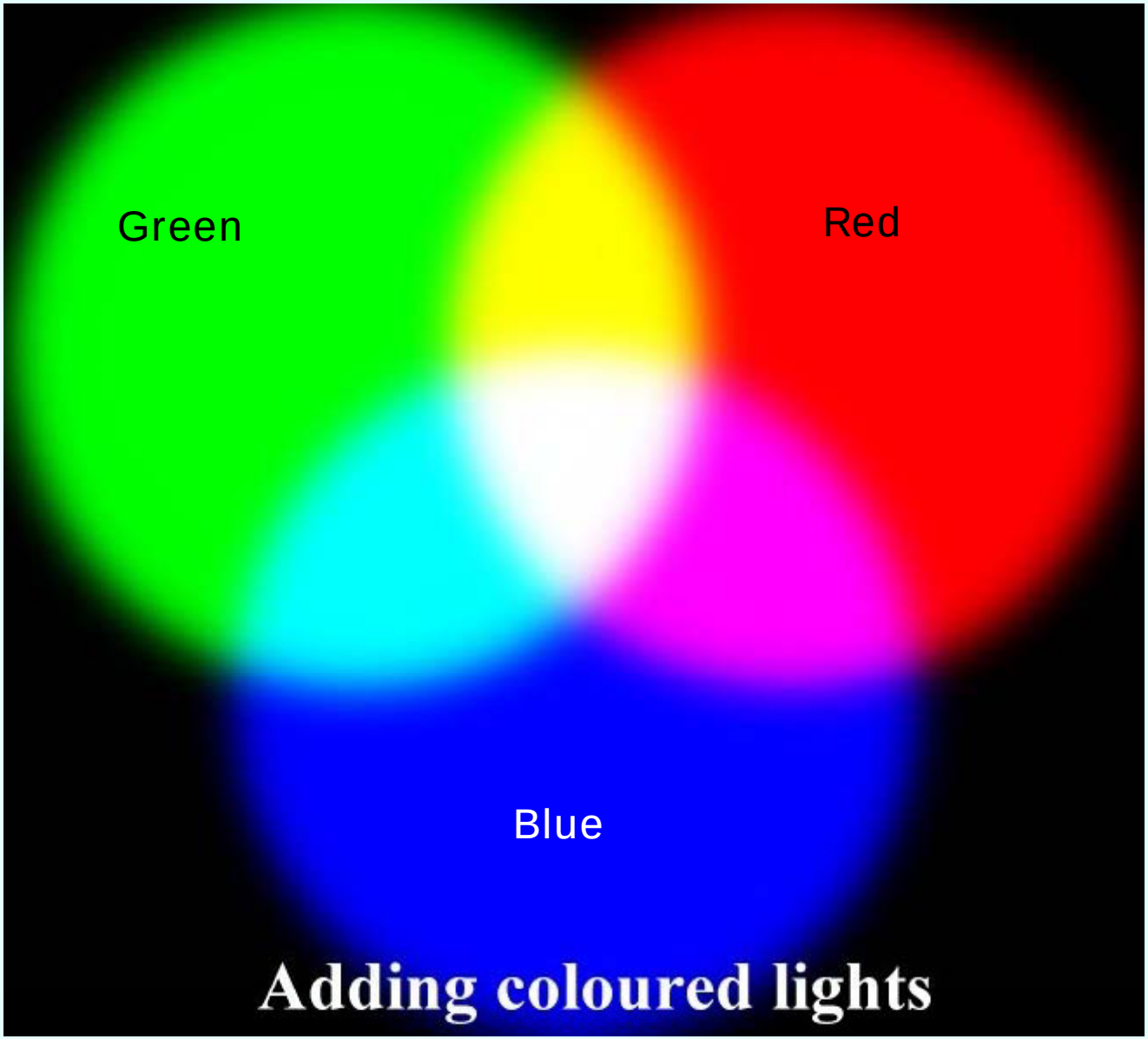
Cross section




0.6
0.55
0.5
0.45
0.4
0.35
v'
0.1
0.15
0.2
0.25
0.3
0.35
u'
yellow
120
90
green
150
60
orange
30
180
40
30
20
20
30
40
0
turquoise
rose
210
saturation
30
330
240
300
purple
40
hue
blue

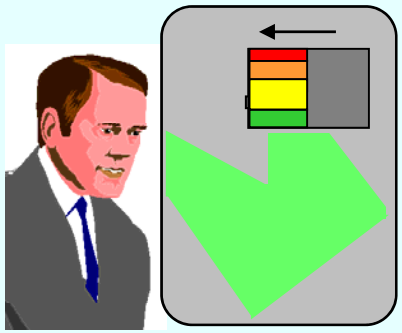
Trial lenses

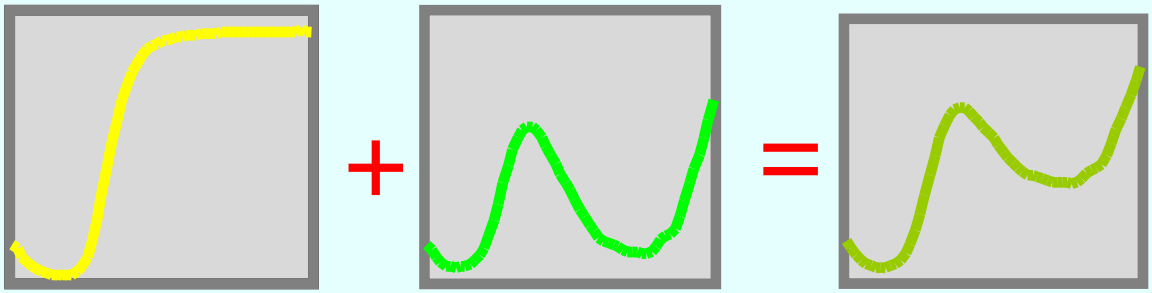


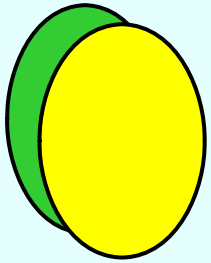

Green
Red
Blue
Adding coloured lights

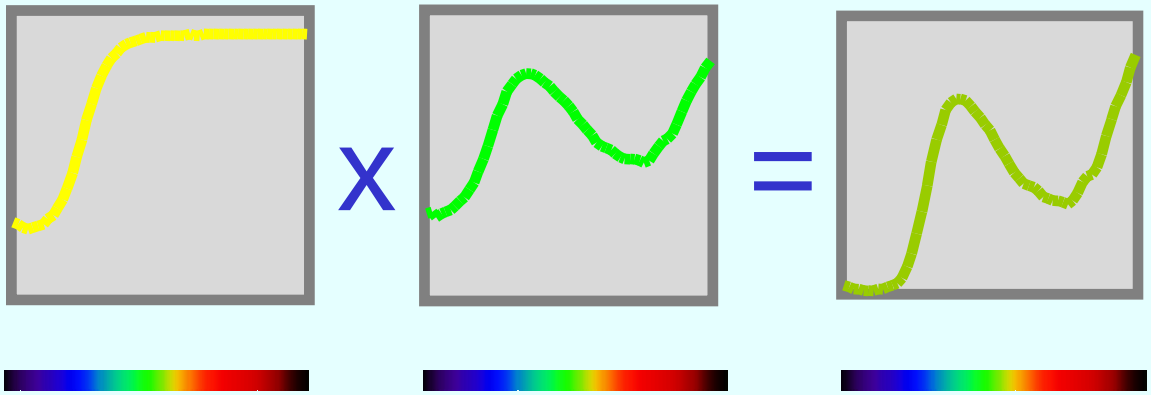
Adding pigments

Adding vs. multiplying



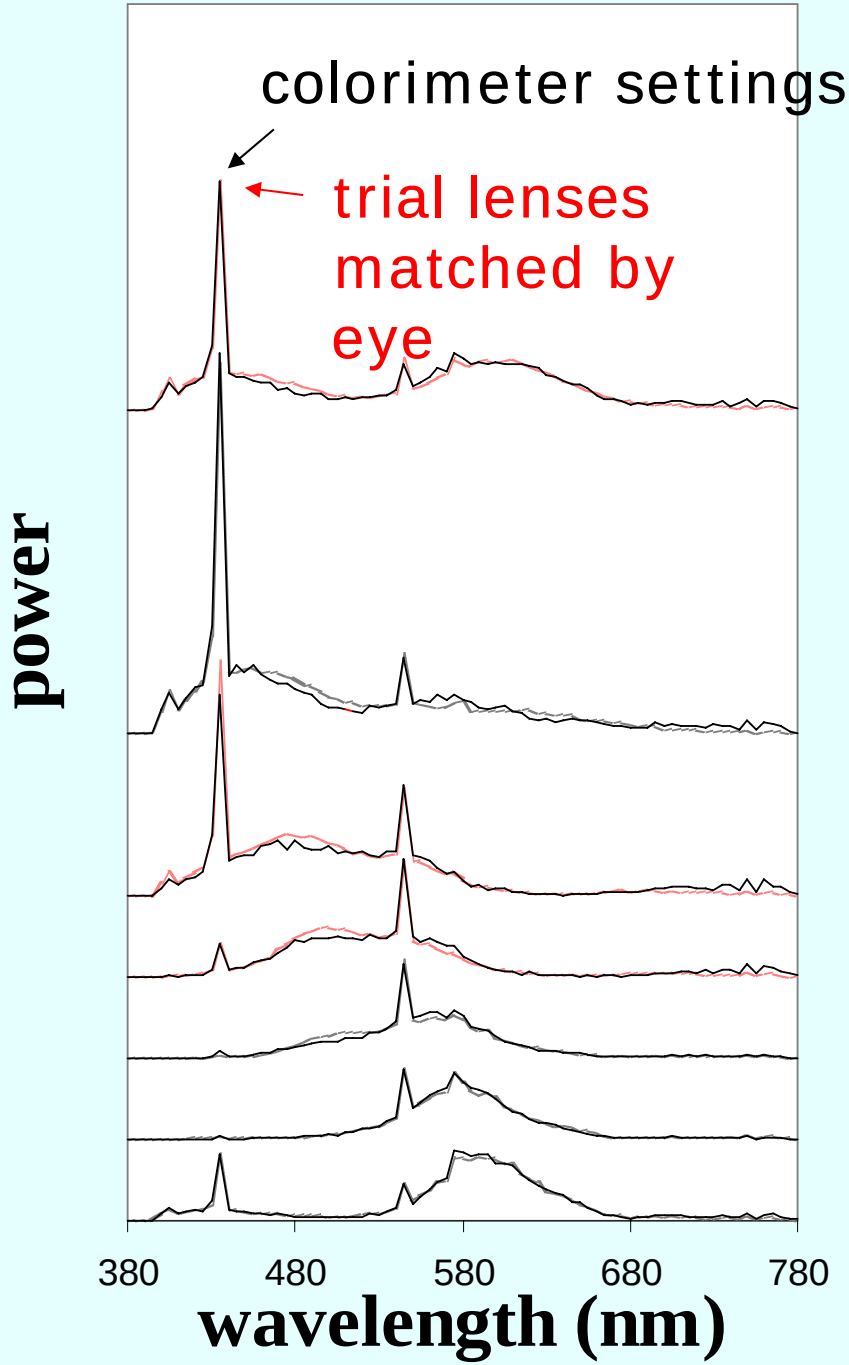






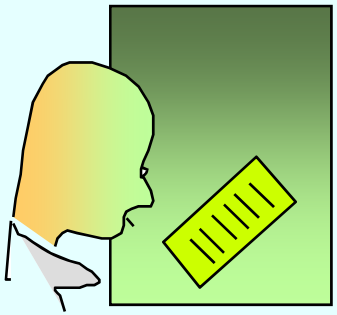
Lens spectral power distribution matches Colorimeter

Use in patients with anomalous colour vision



Colorimetry Procedure

1



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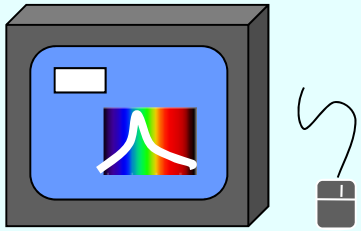

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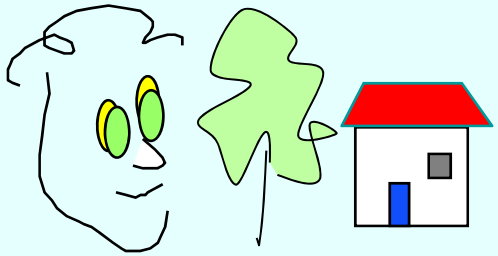

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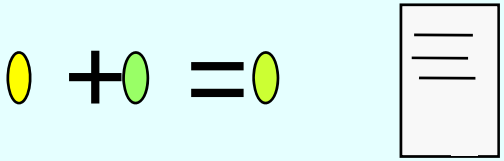

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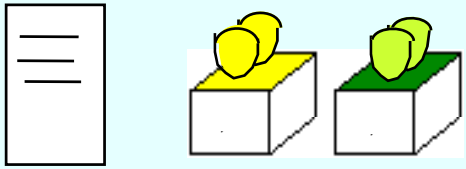

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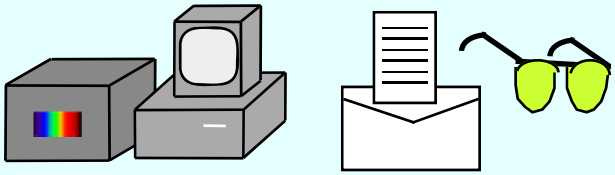
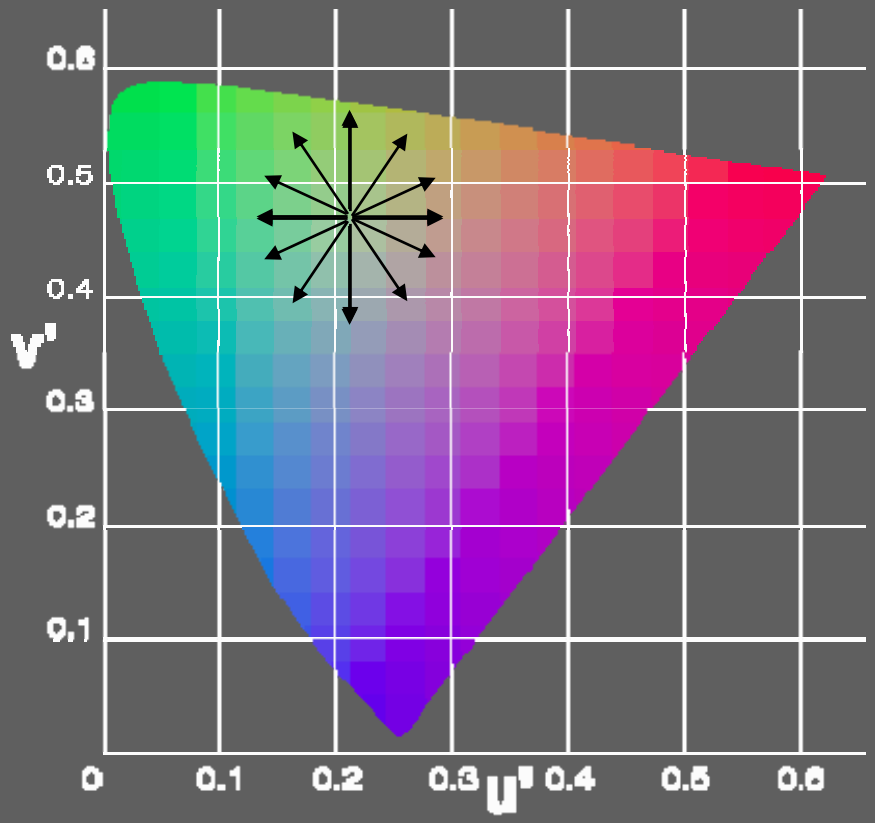


Wilkins, A.J. (1997). A system for precision ophthalmic tinting and its role in the treatment of visual stress. In *John Dalton's Colour Vision Legacy*. Dickinson, C., Murray, I., and Carden, D. (eds) Taylor and Francis: London.

Colorimetry Procedure

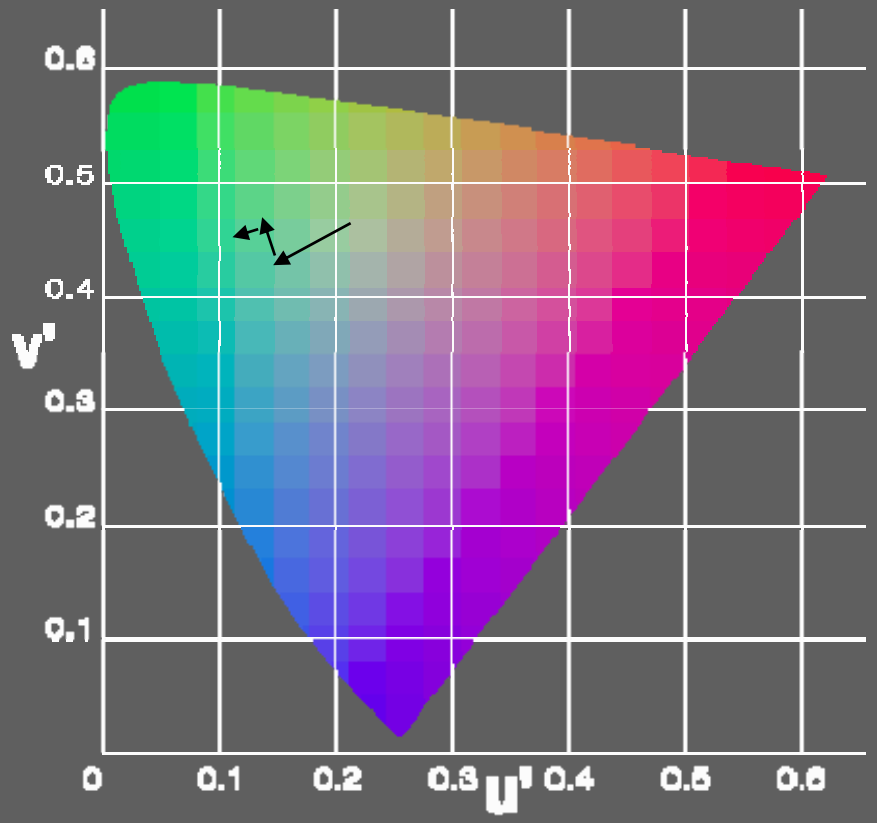
1. Find best hues

Before adaptation to Colour



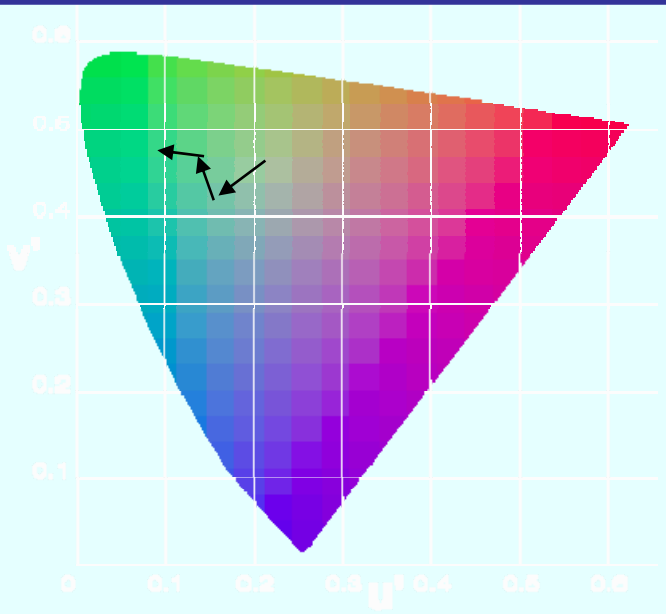
2. Optimize hue/saturation

After adaptation to Colour



Re-optimise hue
at revised saturation

Reoptimise saturation
at revised hue

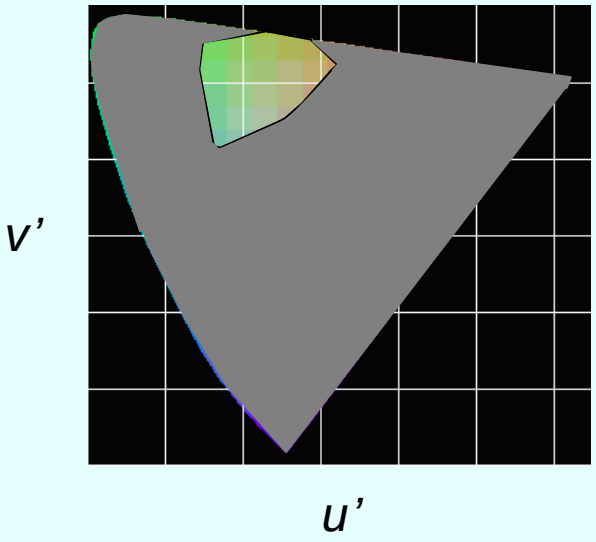


Issues

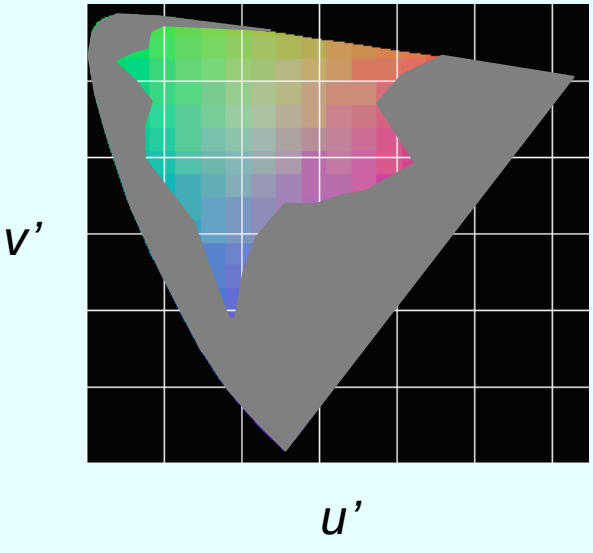
- Is the IC gamut too small?
- Is a system based on fluorescent lighting adequate?
  - Can it emulate any lighting?

Gamut

Colorimeter Mark II



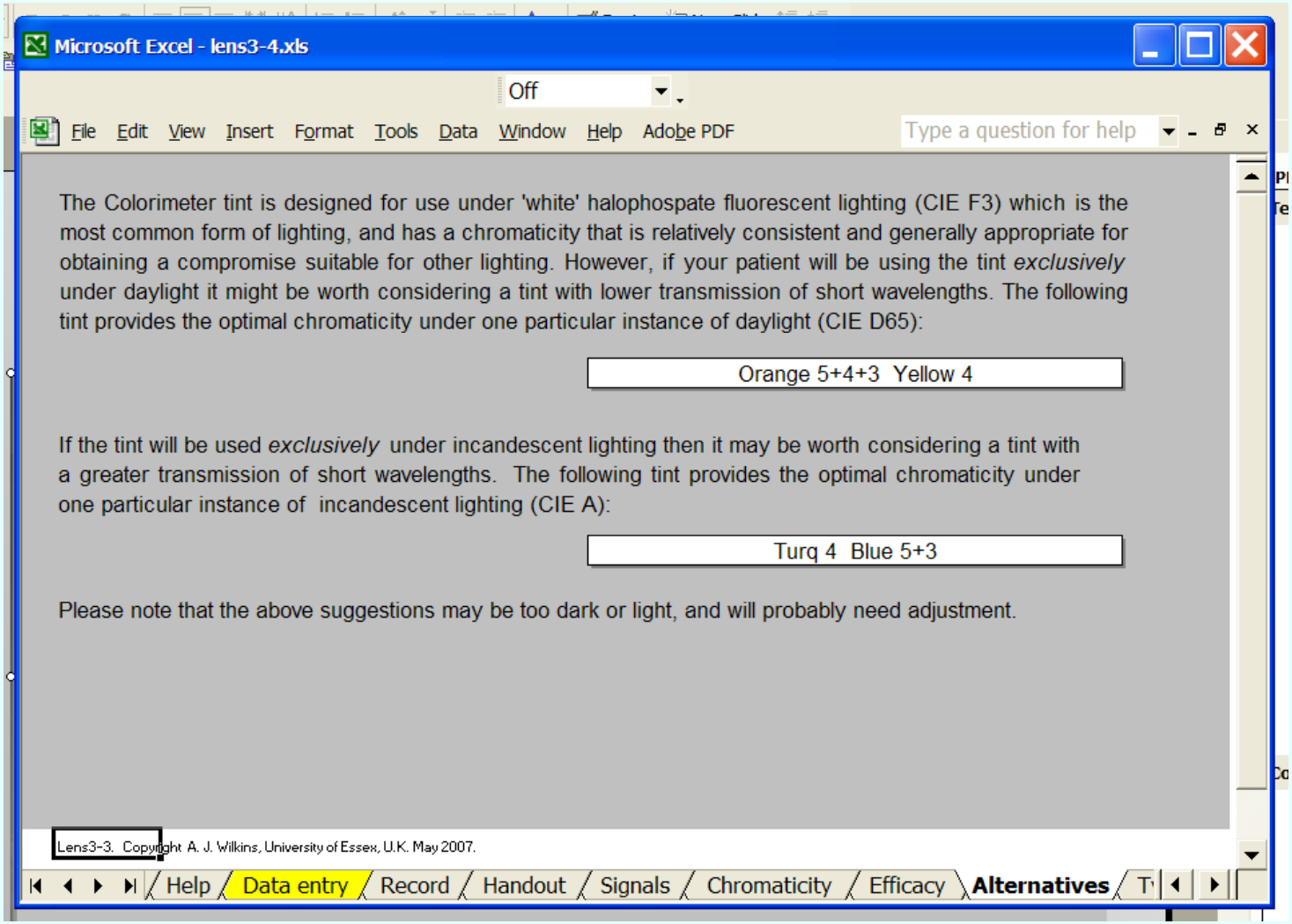
Lenses



Emulate any lighting?

- Is a system based on fluorescent lighting adequate?
  - constant chromaticity
  - spectral power distribution irrelevant if no coloured surfaces are visible (ignoring lens fluorescence)
  - enables us to find a chromaticity
  - the tint necessary to give that chromaticity varies with lighting

Lens5-22.xls


Microsoft Excel - lens3-4.xls
Off
File Edit View Insert Format Tools Data Window Help Adobe PDF
Type a question for help
The Colorimeter tint is designed for use under 'white' halophospate fluorescent lighting (CIE F3) which is the most common form of lighting, and has a chromaticity that is relatively consistent and generally appropriate for obtaining a compromise suitable for other lighting. However, if your patient will be using the tint *exclusively* under daylight it might be worth considering a tint with lower transmission of short wavelengths. The following tint provides the optimal chromaticity under one particular instance of daylight (CIE D65):
Orange 5+4+3 Yellow 4
If the tint will be used *exclusively* under incandescent lighting then it may be worth considering a tint with a greater transmission of short wavelengths. The following tint provides the optimal chromaticity under one particular instance of incandescent lighting (CIE A):
Turq 4 Blue 5+3
Please note that the above suggestions may be too dark or light, and will probably need adjustment.
Lens3-3. Copyright A. J. Wilkins, University of Essex, U.K. May 2007.
Help Data entry Record Handout Signals Chromaticity Efficacy Alternatives

Preparation - 1

- Attenuators in
- Supply ON
- Saturation to 0

Preparation - 2

- Room lights dim
- Text on viewing platform (vary to suit patient)

Sit on right of patient

Symptoms

With saturation=0:

“Are the letters and words clear or difficult to see?

“Do they stay still, or do they move?

“Does the text hurt your eyes?

Note patient’s description and use it subsequently

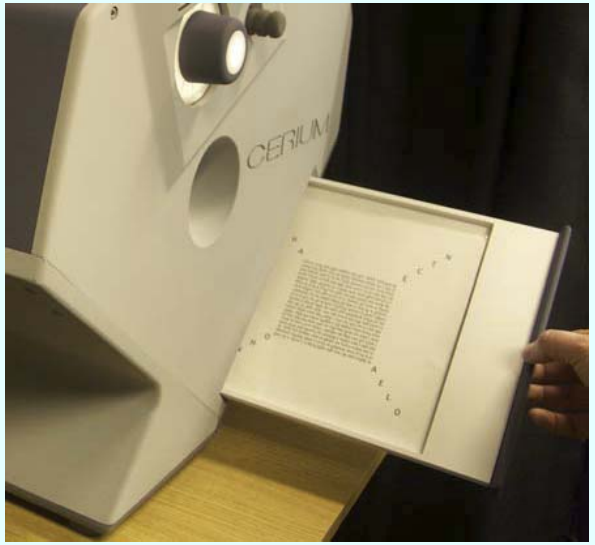
Symptoms should be sufficient but not excessive

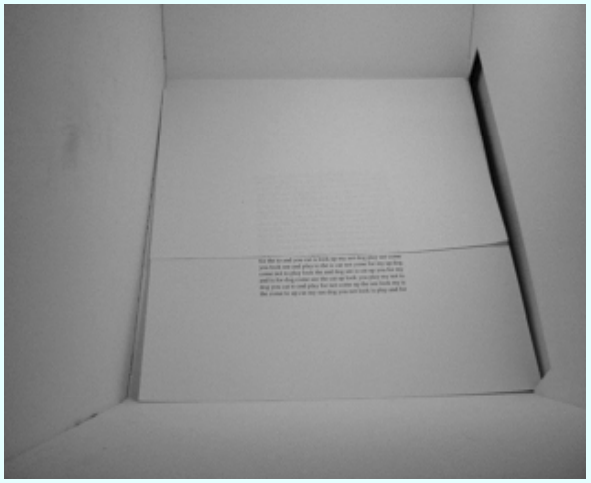
If discomfort is extreme

cover some of the text

Use text that suits patient

e.g. RRT with appropriate font





Explain procedure

“I will shine coloured light on the text

“Colour may make the text

- easier or more comfortable to see
- more difficult to see
- or it may have no effect

“If colour makes text worse, close your eyes!”

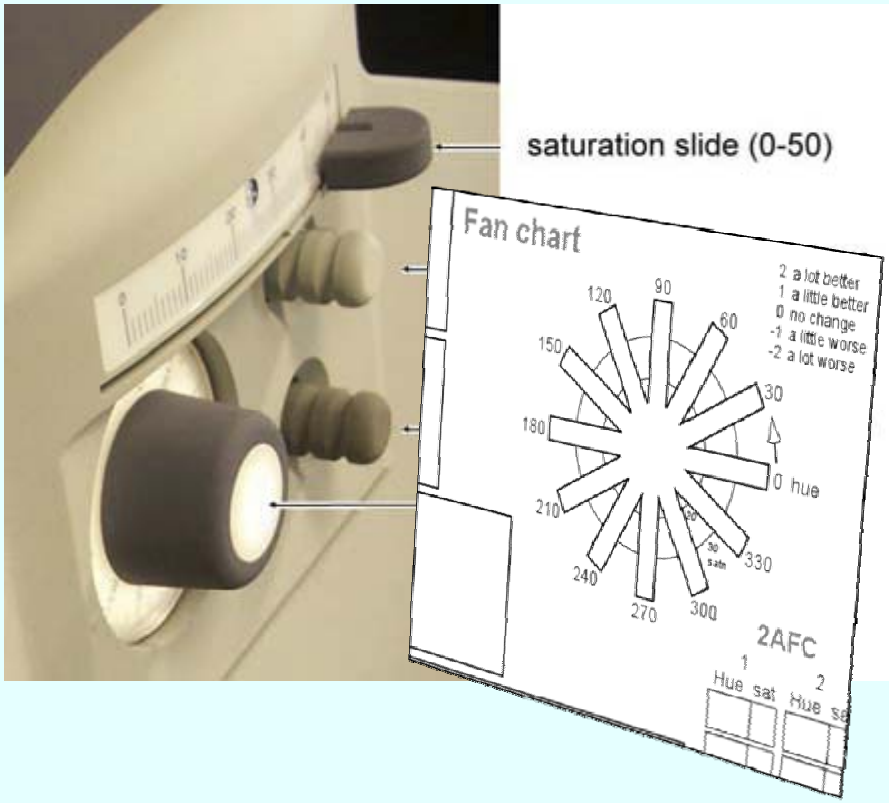
It may be useful to use the patients own description of the perceptual distortions when assessing their response to a colour

Obtain best hues

Start with hue=0, saturation=0

repeat

- Increase saturation to 30
- Wait 5s
- Decrease saturation to 0
- What was effect of colour?
  - easier to see
  - more difficult to see
  - no effect
- Annotate Fan Chart
- Increase hue by 30 degrees

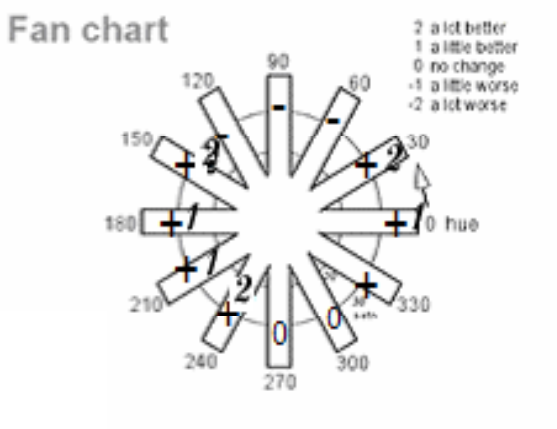


Purpose of limiting saturation to 30

- To prevent exposure to strong uncomfortable colours
- This usually works, but use common sense…
- If there are strong indications that coloured filters are likely to be helpful and no preference is forthcoming – use stronger colours

Annotate fan chart

For each of the 12 hues



easier to see +1

more difficult to see -1

no difference 0

a lot easier: +2

a lot more difficult: -2

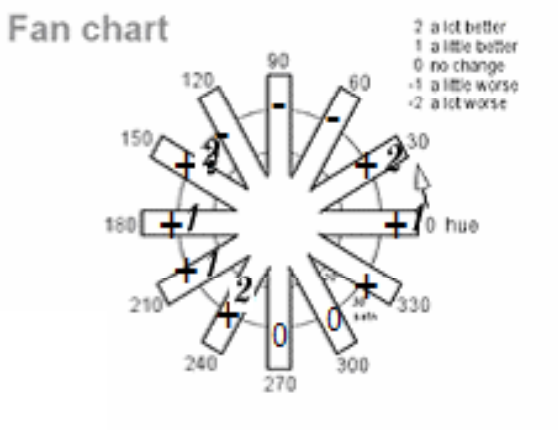
Repeat any you are unsure of to check for consistency

Permit maximum saturation

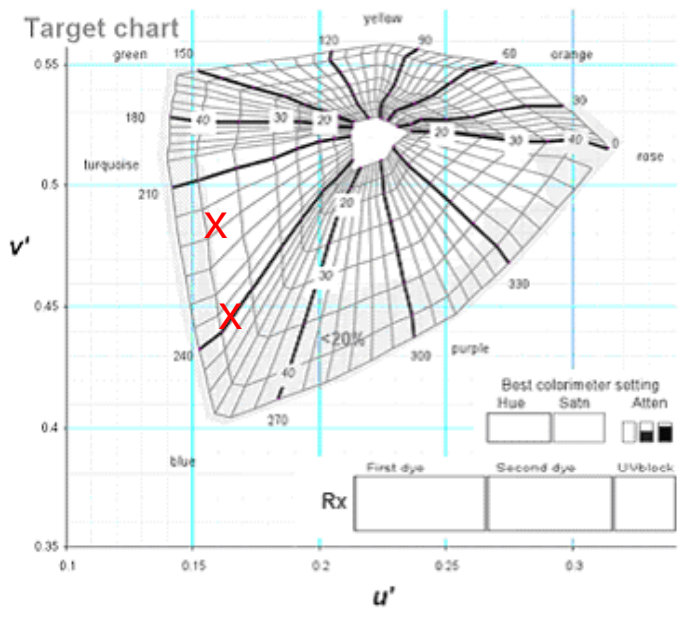
Optimise saturation at best hues

Examiner **or patient** adjusts saturation "as if tuning a radio" to get best perception of text.

In this example, best hues are 30º, 150º and 240º



At best settings: compare neighbouring hues



For example, at 240º :

“This is number 1;

“Close your eyes”

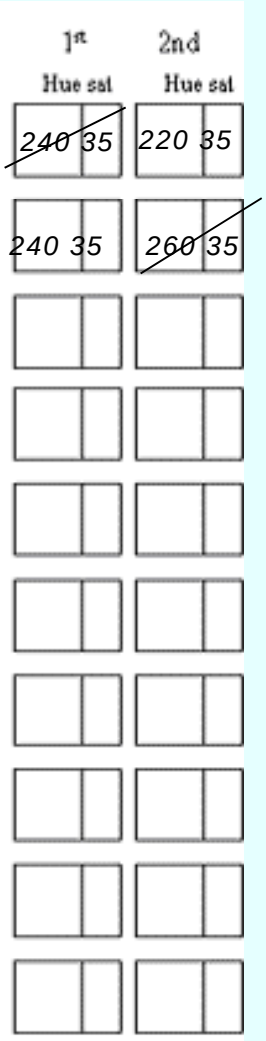
Decrease hue by 20º to 220º

“Open your eyes;

“This is number 2;

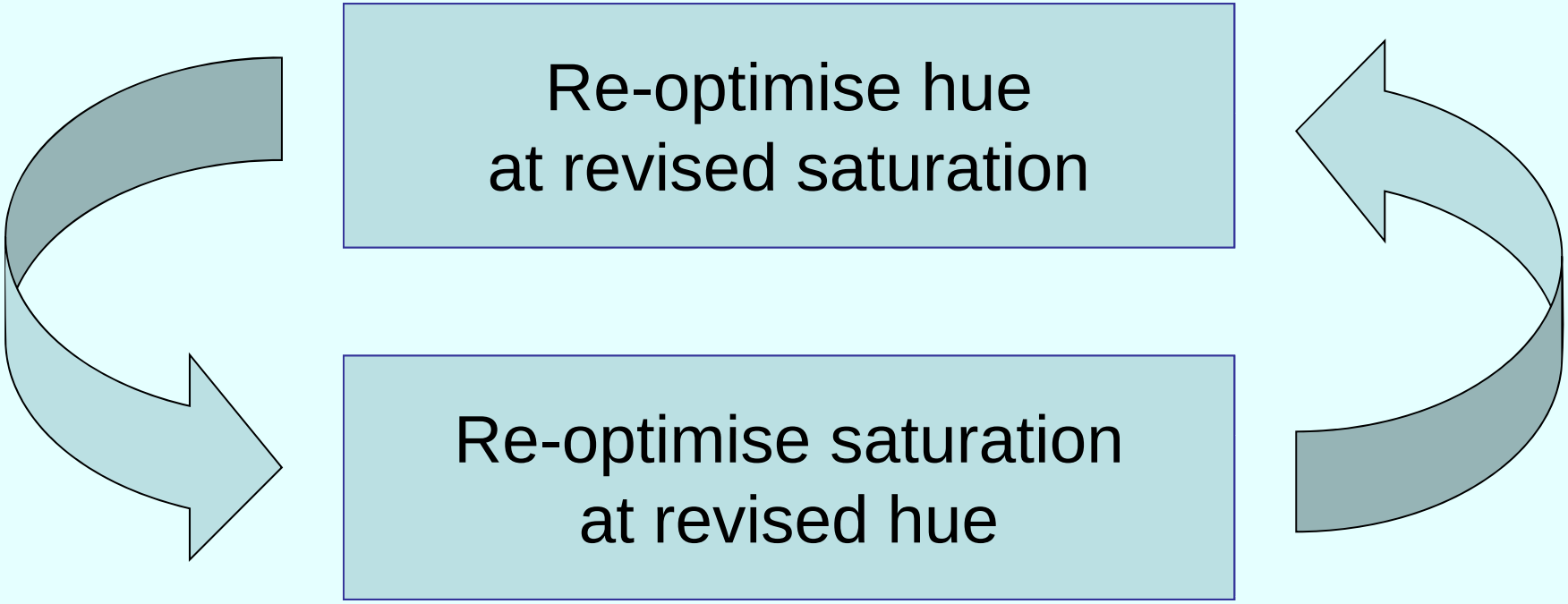
“Which is better, 1 or 2?”

Similarly for an increase in hue by 20º to 260º



Use smaller hue differences if necessary.

Shortlist the settings and search for a consistent optimum



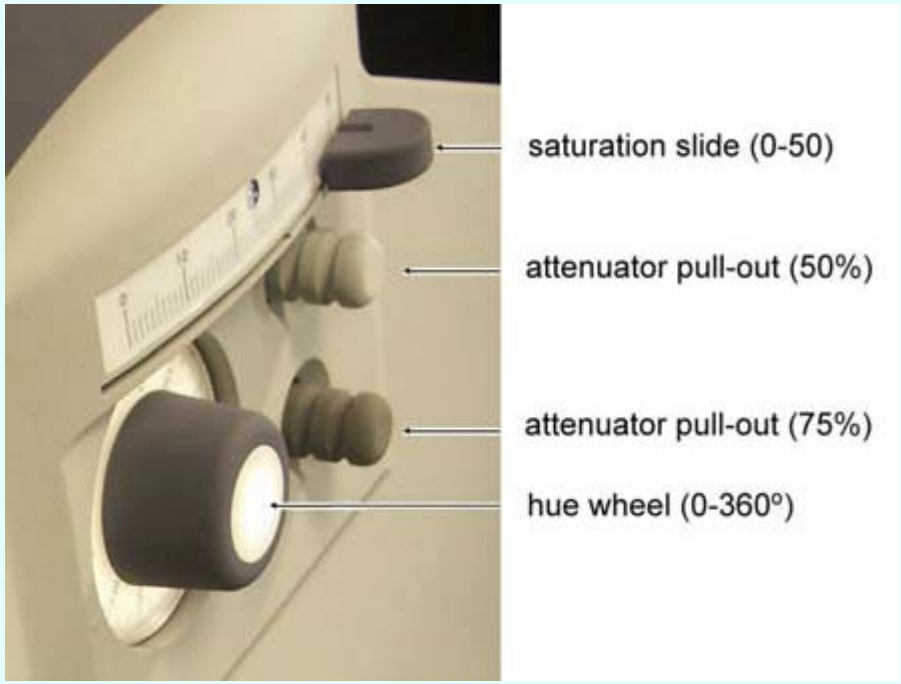
Minimise saturation

At the best setting ask the patient to reduce the saturation as much as possible without reducing the benefit.

(We want the weakest tint that suffices.)

Attenuator test - purpose

The attenuators do NOT indicate the need for grey tints.



They indicate:

- whether there is residual glare;
- whether the tinted glasses will be too dark.

Attenuator test - procedure

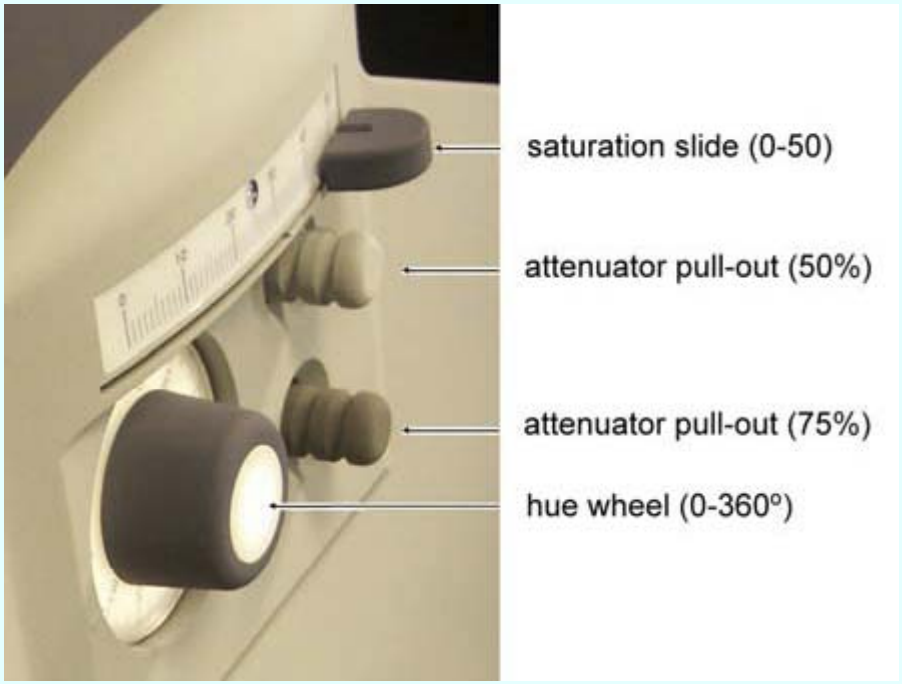
At best hue and saturation -

"Is it better when it is dark like this?"

Pull out 50% attenuator

"...or light like this?"

Push in 50% attenuator



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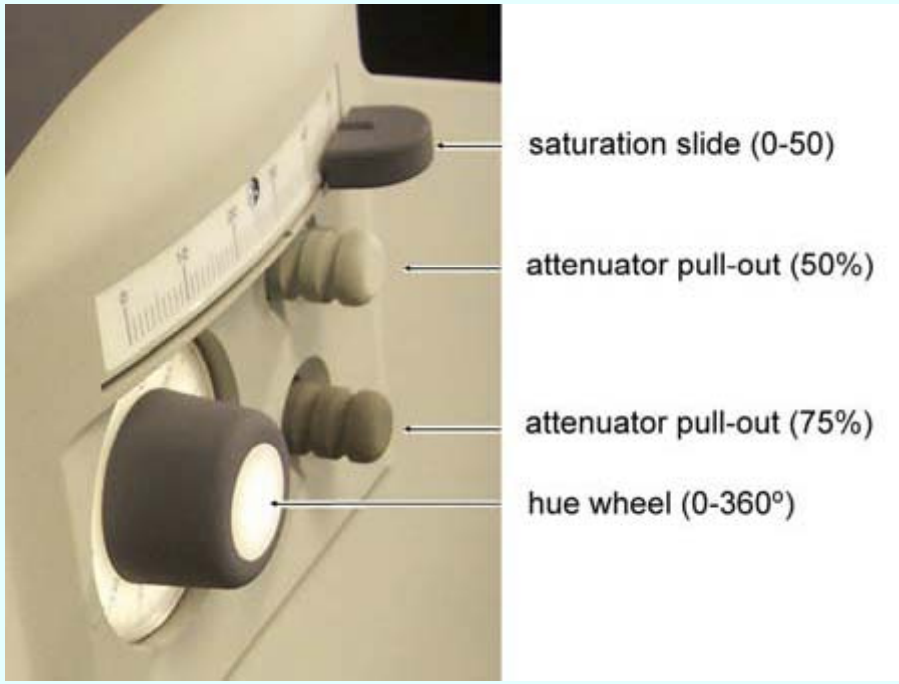


Residual glare

Preference for 50% attenuator may indicate residual glare -

Check by increasing saturation slightly, and repeating attenuator test.

If patient no longer prefers 50% attenuator keep the stronger saturation.

Darkness of lenses

Strong colours usually come in dark lenses.

Preference for **no attenuator** may indicate intolerance for dark lenses.

Will lenses of the chosen colour be dark? ...

Enter hue

and saturation

in spreadsheet

Darkness of lens is indicated here

	Entry	Check
Hue	220	220
Satn	35	35

		Check
Dye 1		N/A
Dye 2		N/A
Neutral		

Calculation based on hue and satn entered above

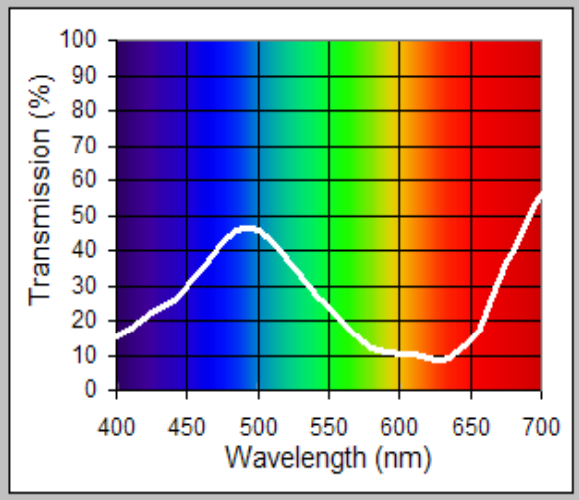
Transmission of spectacles	To obtain luminance as with spectacles
27%	No attenutator

No. trial lenses: 4 lenses

Consider UV blocker

Turq 2 Blue 5+4+3

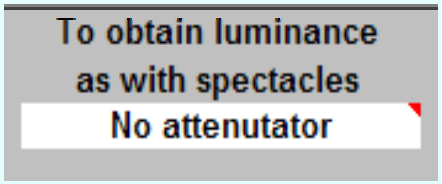
Purple	A6	B5	C4	D3	E2	F1
Blue	A5 **1**	B4 **1**	C3 **1**	D2	E1	Neutral C1
Turq	A5	B4	C3	D2 **1**	E1	
Green	A5	B4	C3	D2	E1	Neutral B2
Yellow	A5	B4	C3	D2	E1	Neutral A3
Orange	A5	B4	C3	D2	E1	
Rose	A6	B5	C4	D3	E2	F1



The above table shows the lenses used as they appear in the box

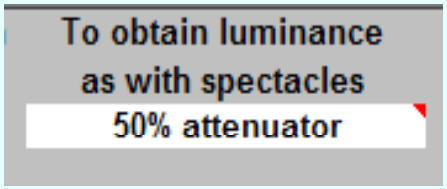
No problem if…

- patient prefers no attenuator and spreadsheet indicates



OR

- patient prefers 50% attenuator and spreadsheet indicates

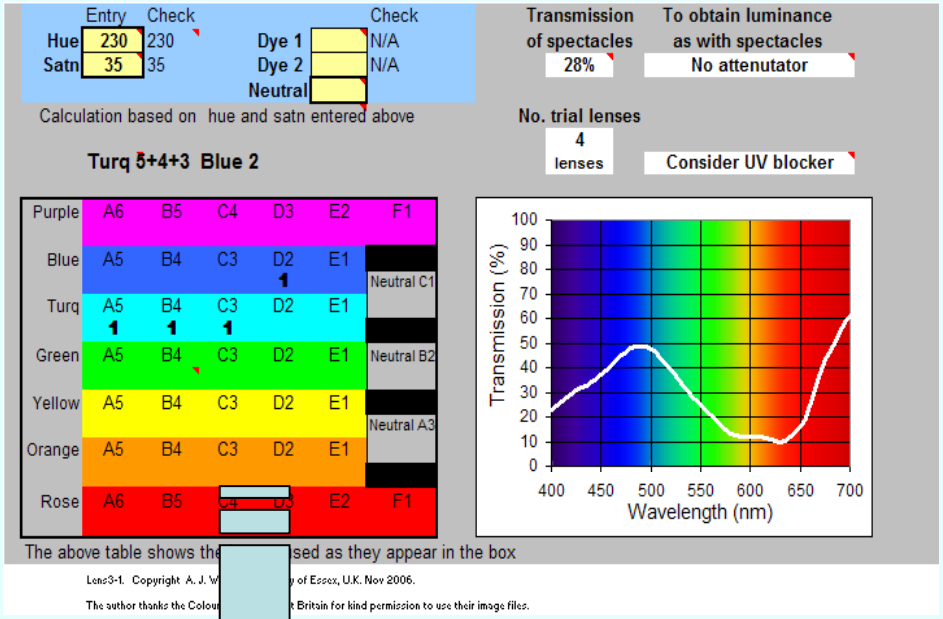


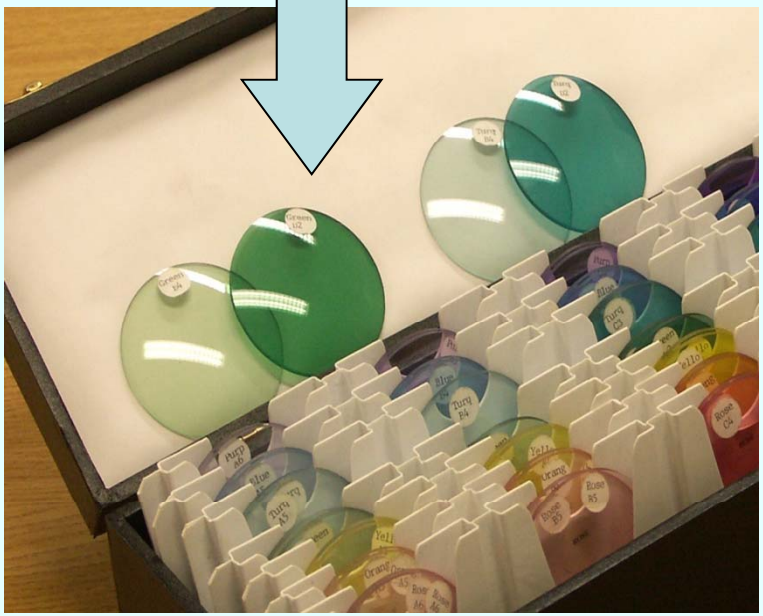
Otherwise...

Consider trade-off between saturation and luminance when trial lenses are offered.

Trial lenses

Select the lenses specified by spreadsheet





Check for a visible match

Close patient's viewing aperture.

Hold the lenses over the white port.

Adjust the lenses for a visible match if necessary.

(Allow for the difference in brightness.)

Select bright white

Try out lenses using standard light

"Are the lenses as good as it was in the box just now?"

Adjust saturation if lenses are too dark.

This can be done under the guidance of the spreadsheet by entering a number for saturation that is 5 less than the current number

Try out lenses using variety of lights

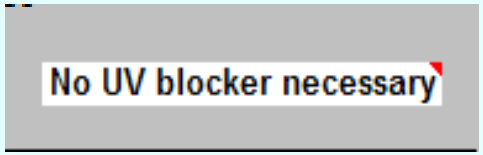
Judge effect of lenses under typical lighting

and typical tasks.

Adjust if necessary.

UV blocker?

- All lenses block UV below 380nm.
- The addition of a UV blocking dye can block UV below 400nm.
- With some prescriptions the dye already absorbs below 400nm.
  - The spreadsheet indicates:



- Other prescriptions permit sufficient short wavelength light for it to be worth considering a UV blocker.
  - The spreadsheet indicates:

Consider UV blocker

If indicated, add the UV blocking lenses to the patients prescription and see if the colour change is tolerated.

- If so, add the UV blocker to the prescription.
- If not, counsel patient regarding the inadvisability of using the lenses out of doors at midday.

Order the lenses

- The prescription is specified by the selected trial lenses.
  - Identify the required lenses using both their letters and their numbers
  - E.g. Turquoise D2 Blue A5+B4+C3 with UV blocker

Suitable frames

- Remember that the frames should be large enough to prevent stray light in the periphery, particularly if the tint is dark.

Advantages of the colorimeter

- Light source is controlled
- Light source is suitable compromise
- No coloured surfaces visible (colour constancy discounts illuminant)
- Continuous variation of hue/saturation
- Luminance constant
- Rapid
- Efficient

Disadvantages of the colorimeter

- Restricted gamut
- Restricted viewing
  - Near vision only
  - Locomotion and balance not observable
- No glare source (other than pattern glare)
- No radiation at the extremes of the visible spectrum (fluorescence?)

Assessment with lenses

- Slower
- Less precise
- More realistic provided lighting is appropriate
  - Sunlight/daylight not always available
- Enables glare sources to be assessed
- Enables patient's balance and locomotion to be assessed
- Essential for ultraviolet blocker

Assessment with lenses

Indicated when:

- Saturation is maximum (dark lens)
- Patient dislikes change in colour from use of Ultraviolet blocker (blue/purple/rose lenses)
- Patient complaints of sensitivity to bright or flickering light (photosensitive epilepsy)
- Balance and locomotion are affected
- Different colour in the two eyes is necessary

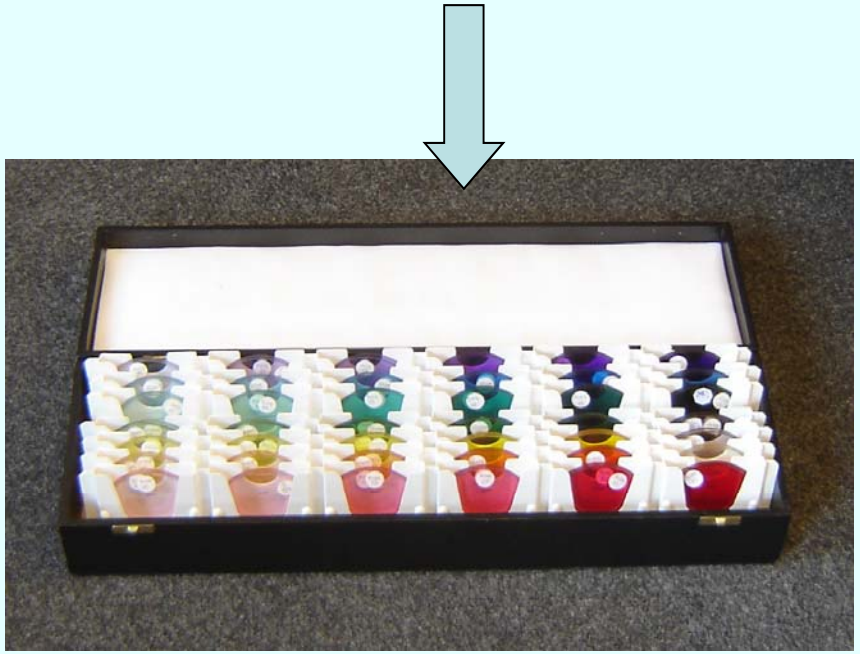
Assessment with lenses

- Ensure lighting is appropriate (typical or stressful)
- Engage patient in an appropriate task
  - Reading
  - Observation of text
  - Observation of glare source (e.g. fluorescent lighting)

Assessment with lenses

- Start by using **Lens D** binocularly
- Try each colour in turn

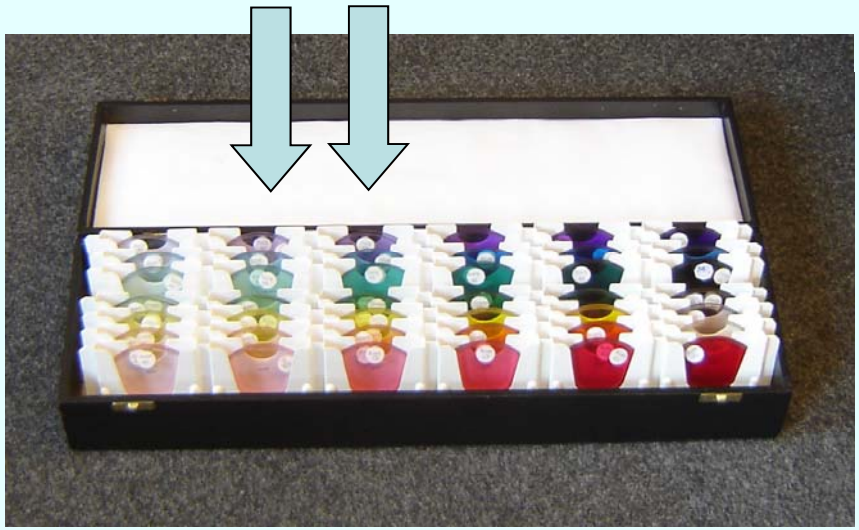
  (transmit 50-60%)



Assessment with lenses

- Shortlist the good lenses
- Try stronger and weaker versions of the good lenses and select the best

- Try adding **B or C lenses** of *neighbouring* colour



Different colour in the two eyes?



Invasive – careful assessment of any effects of the tint on bincular function is essential.

Different colour in two eyes?

Indications (in principle)

Anything that might suggest differences of function, between the two eyes, e.g.:-

- Large interocular differences in acuity, correctable or otherwise
- Ocular pathology, especially if lateralised
- Neurological conditions that can give monocular impairment (e.g. MS) ?Afferent pupillary defect
- Interocular differences in colour appreciation
  - "Do colours appear the same when you look through one eye and then the other?"

How to test

One way of doing it

(likely to minimise tint differences:- cosmesis)

- Find binocular optimum
- Offer it as lenses
  - Use spreadsheet to find lens combinations for 15/30 degrees increased/decreased hue angle
- Increase/decrease hue angle in one eye then other eye.

Summary

- Find best hues
- Optimise saturation
- Readjust hue if necessary
- Minimise saturation
- Check luminance
  - residual glare? –increase saturation
  - lens too dark? – try lens in typical lighting
- Consider UV blocker
- Dichoptic tint?
- Suitable frames