Our Colour Vision is Limited

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- Like the previous notes most of the stuff that you will see here is based heavily on this book
- Designing with the mind in mind by Jeff Johnson

Our Colour Vision is Limited

- Human colour perception has strengths and weaknesses
  - Relevant to user interface design
  - Vision optimised to detect contrast, not brightness
  - Ability to distinguish colours dpends on how they are presented
  - Some people are colour blind
  - Users display and viewing conditions affect colour perception

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- Eyes contain two types of receptors
  - Rods for detecting light levels
  - Cones for detecting colours
    - It was initially though that we had red green and blue cones that combined colours to generate all the colours we see
    - Each sensitive to one kind of light
    - Not strictly true

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- In reality they are low, medium and high frequency light receptors
  - Low frequency is sensitive to all light but particularly red and yellow
  - Medium frequency is sensitive to blue green yellow and orange
  - High frequency receptors are sensitive to violets and blues with weak response to green

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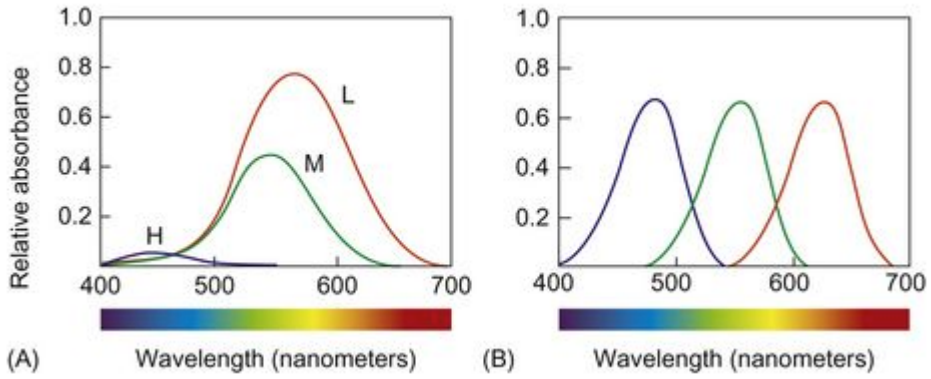
- Diagram on the left is the sensitivity of cones to different wavelengths of light
  - Diagram on the right is what you would get in a camera
  - But how does the brain combine these together



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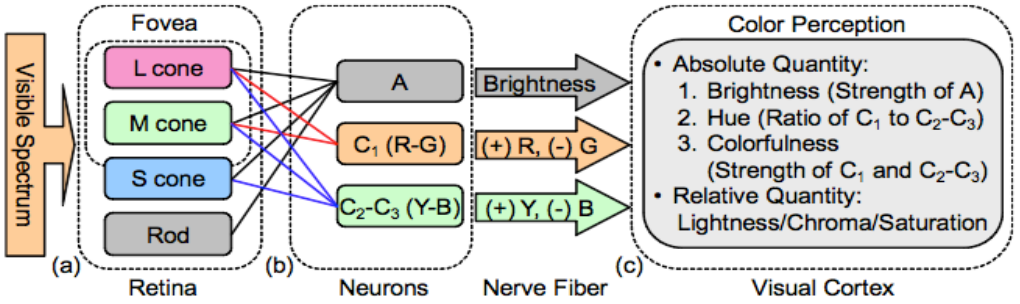
- The answer is by subtraction
  - By subtracting the low frequency from the medium freqeuncy we get the red green channel (red +ive green -ive)
  - By combining the medium and low and subtracting that from the high we get a yellow blue channel (yellow +ive blue -ive)
  - Brightness is a combination of all four



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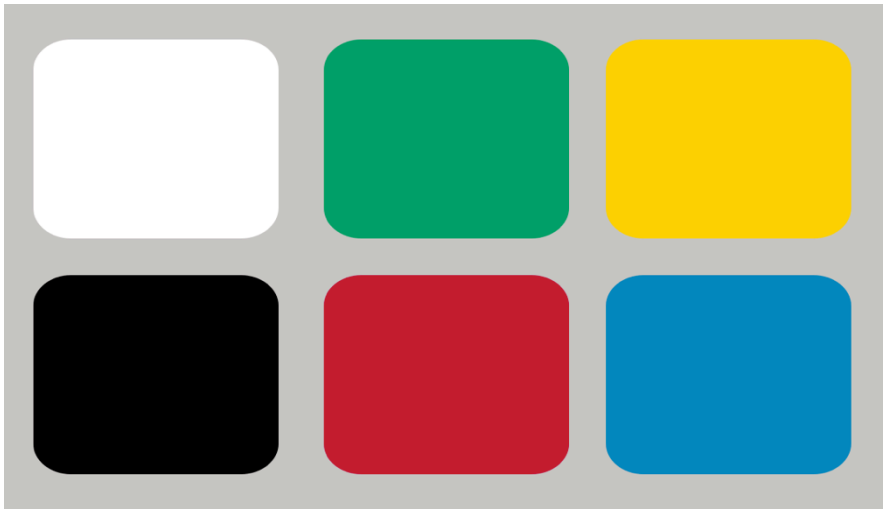
- Produces opponent colour channels
  - These are the three channels that a human will see
  - What this does is make us more sensitive to differences in colour instead of overall brightness



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- The green circle in the middle is the exact same colour however the different background makes us percieve colour differently
  - Check for yourself with a colour picker
  - Sensitivity to contrast was an evolutionary advantage helped to spot predators
  - With us to this day

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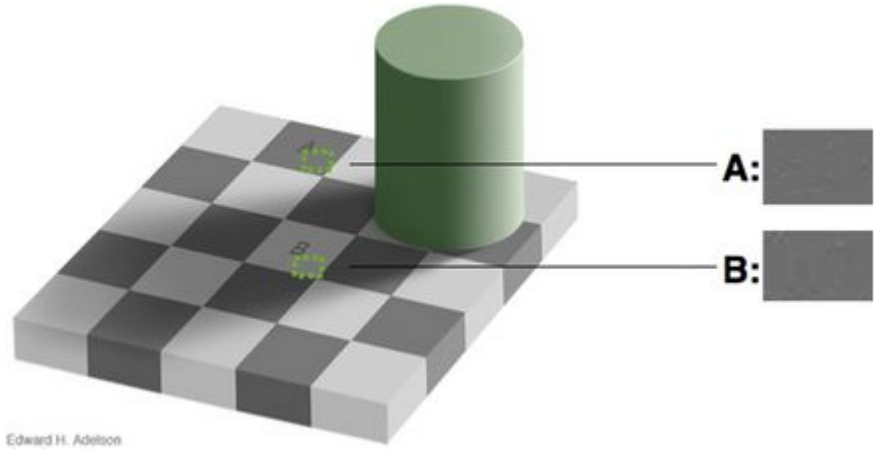
- Areas A and B have the same colour
  - We only see B as white because it is shaded by the green cylinder



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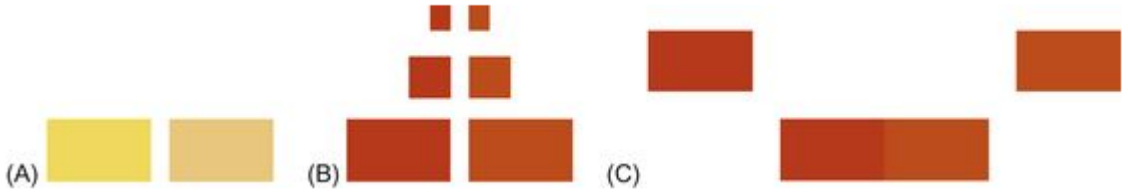
- How we discriminate colours depends on how they are presented
  - Paleness: the paler two colours are the more difficult it is to distinguish them
  - Colour patch size: the smaller or thinner objects are the harder it is to distinguish colours
  - Separation: The more separated colour patches are the more difficult to distinguish their colour.



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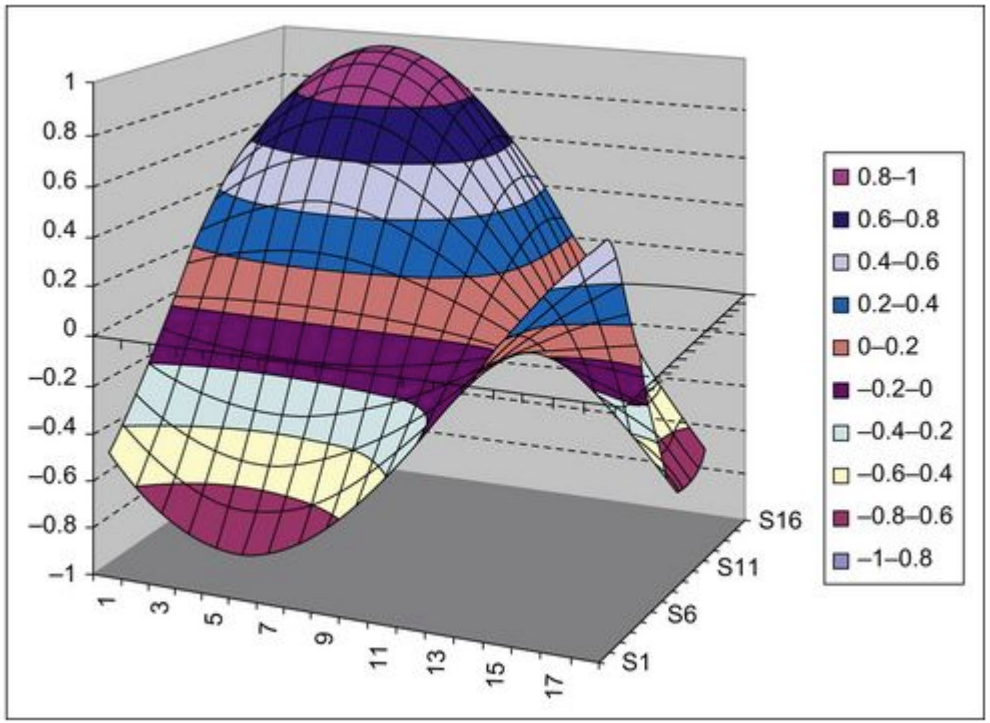
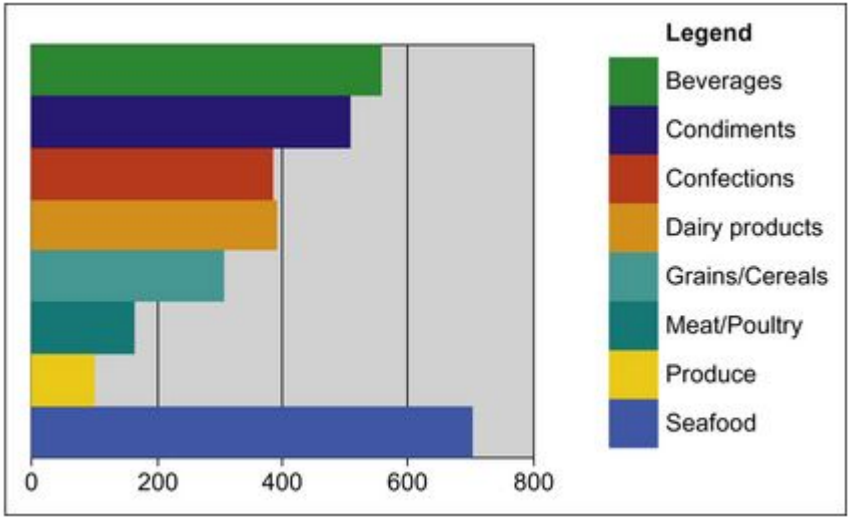
- Size of patches are a problem with legends in figures





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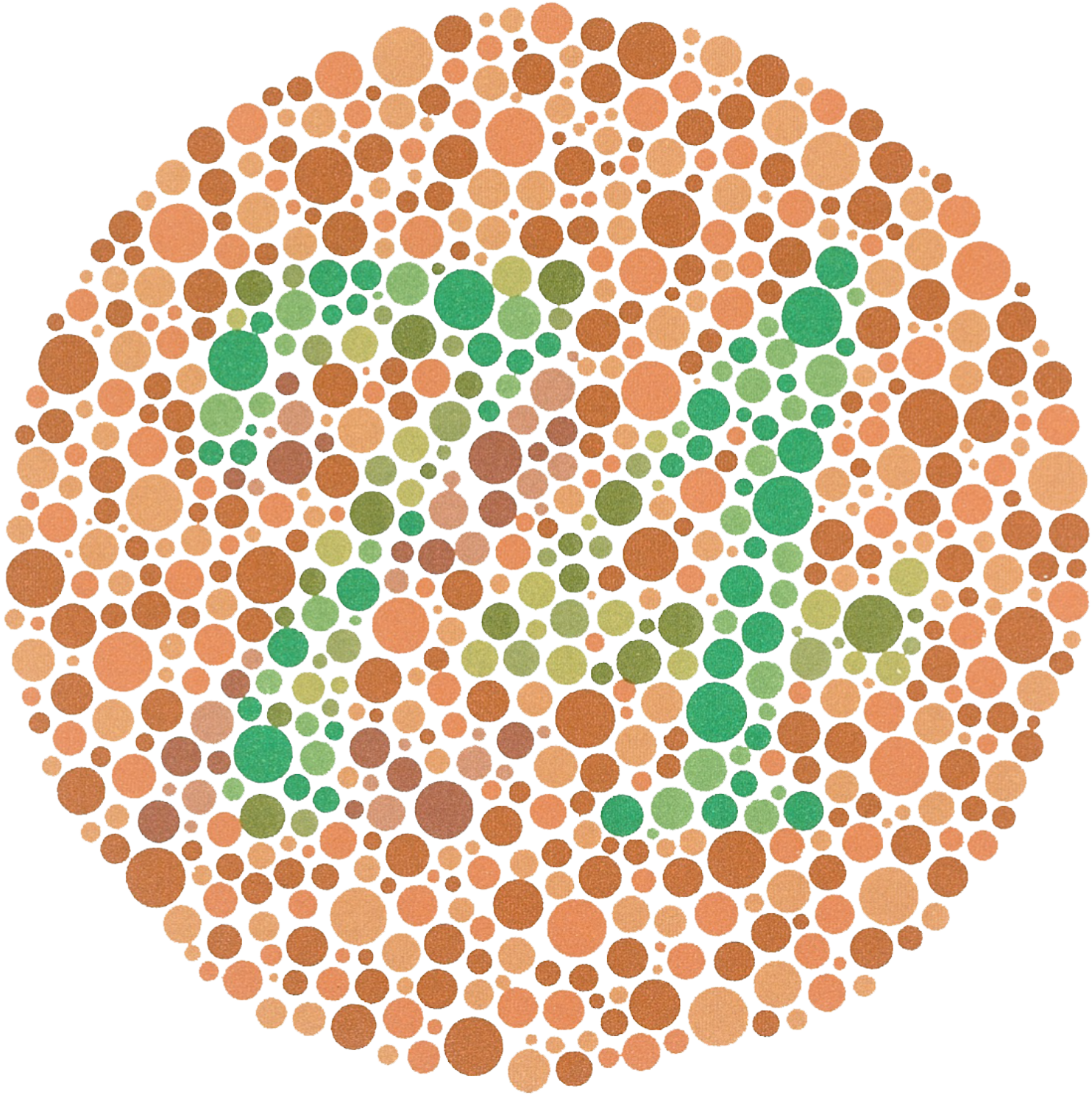
- Another factor in colour presentation is colour blindness.
  - Colour blindness is due to one of the opponent channels not functioning normally
  - Meaning it is difficult to distingush certian pairs of colours
  - Red green colour blindness is most common
    - 8% of men 2% of women approximately
    - Others are rarer



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- Colour pairs that red green blindness will have difficulty seeing

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- External factors can influence the ability to distinguish colour
  - Variation among colour displays
  - All displays show colour differently
  - Colour settings
  - Display technology
  - Drivers
  - etc

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- Display Angle
  - Some displays work much better when viewed straight on than at an angle.
  - Lcd screens being the main culprit
- Ambient light can affect colour perception
  - Brighter environment makes colours appear darker
  - Darker environment makes colours appear brigher

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- These factors are out of your control
  - If the environment needs to be accounted for then you will need to simulate it
    - Ambient and display
  - So colours are percieved properly
  - There are general guidelines however as to how to use colour in applications

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- Distinguish colour by saturation and brightness as well as hue
  - Avoid subtle colour differences
  - Make sure the contrast is high
    - To test this render all colours in greyscale
    - If you cant distinguish them as greyscale then you won't distinguish them in colour

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- Use Distinctive Colours
  - The colours that people percieve easiest are those that cause a strong signal on one colour opponent channel
  - But are neutral on the other compoent channels
    - Black, white, red, green, blue, yellow
  - All other colours cause signals on multiple channels and are not as easy to distinguish

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- Avoid Colour pairs that colour blind people cannot distinguish
  - See the examples on the earlier slides
  - Will make your application impossible for these users

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- Use colour redundantly with other cues
  - Dont rely on colour alone, use other markings as well
  - Different shape, symbol, position etc
  - e.g. a traffic light uses colour but position matters as well top is stop middle is prepare to stop and bottom is go.

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- Separate strong opponent colours.
  - Placing these next to or ontop of each other can cause issues

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- If at all possible try and use colours that are visible to everyone regardless of colour blindness
  - This example uses white and all shades of green, works in greyscale too