Comp 388/441 - Human-Computer Interface Design

Week 2 - 22nd January 2015

Dr Nick Hayward

Colour & Vision - I

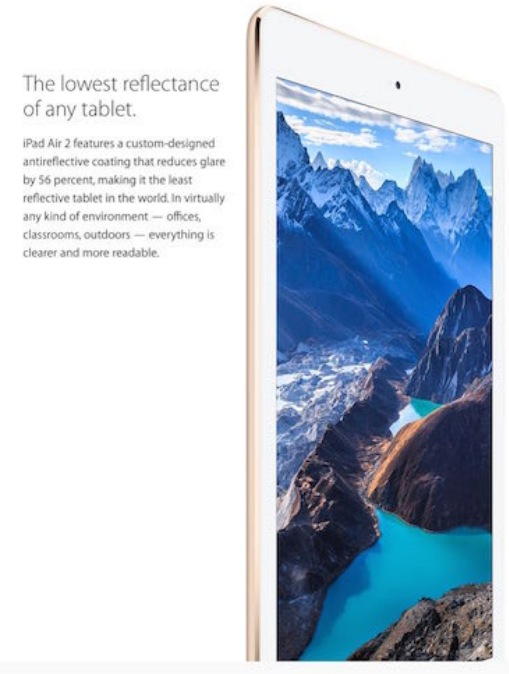
Perception

- colour perception in humans
  - *inherent strengths and weaknesses*
- a few limitations in everyday lives
- considerations as UI designers
  - *presentation of colours affects a user's ability to recognise and distinguish them*
  - *display influences a user's perception of colour*
  - *eg: their monitor, screen or other viewing device*
  - *user's vision optimal detecting contrasts, edges*
  - *not absolute brightness*
  - *some users will have some degree of colour-blindness*

Display performance - I

A comparison of glare (source: Amazon)

Display performance - 2



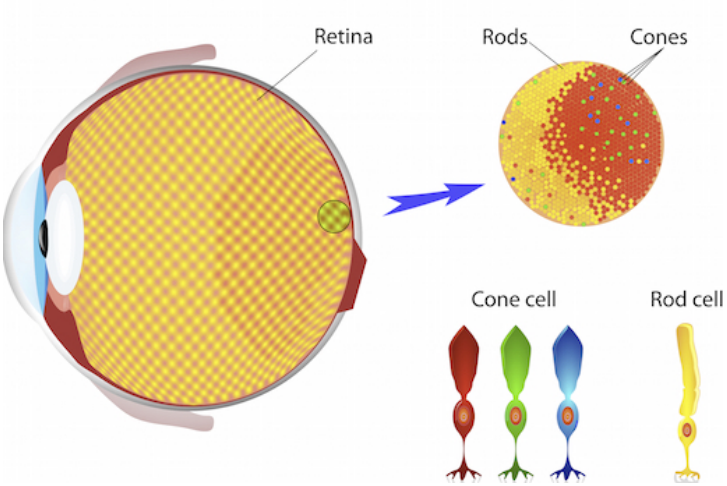
Reducing glare - Apple Ipad Air 2 (source: Apple)

Colour & Vision - 2

Rods and Cones

- retina at the back of the eye is used for focusing images
- retina has two types of light receptor cells
  - *known as rods and cones*
- *rods* detect light levels, but not colours
- *cones* detect colours
  - *three types sensitive to red, green, and blue light*
  - *often compared to video cameras, monitors...*

Colour & Vision - 3



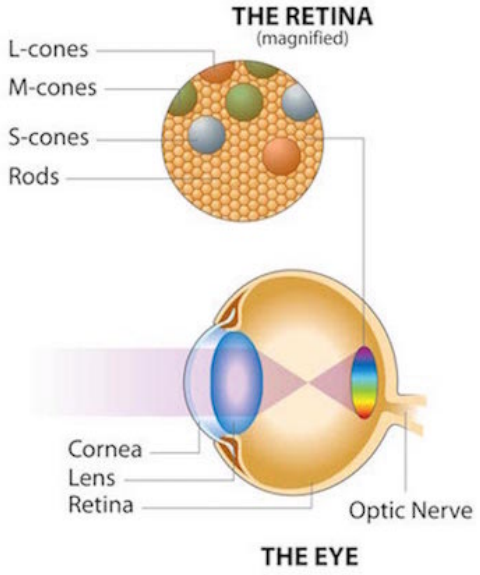
The Human Eye (source: DoveMed)

Colour & Vision - 4

Modern Environmental Influences

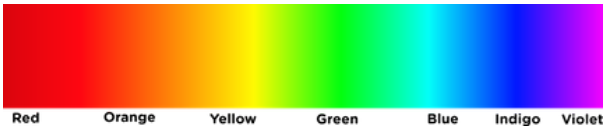
- we need to consider the effect of environmental conditions on human vision
  - *modern working and living spaces*
- rods are sensitive to the environment's overall brightness
- three types of cones sensitive to different frequencies of light
- bright artificial lights dramatically reduce the use of rods
  - *rods designed for low levels of light*
  - *navigating low-light environments*
- bright artificial lights max out our rods
  - *rods provide no real useful information*
- vision becomes reliant on input from cones

Colour & Vision - 5



The Human Eye (source: Verilux)

Colour & Vision - 6



Visible Light Spectrum (source: Wikimedia)

- S-cone = short-wavelength sensitivity
  - *sensitive to light over almost the entire range of visible light*
  - *most sensitive to the middle (yellow...) and low (red...) frequencies*
- M-cone = middle-wavelength sensitivity
  - *less sensitive than S-cones*
  - *sensitive to light ranging from high-frequency (blues...) through middle frequency (yellows & oranges...)*
- L-cone = long-wavelength sensitivity
  - *less sensitive than either S or M-cones*
  - *most sensitive to upper end of visible light spectrum (violets through blues...)*
  - *our eyes are less sensitive to violets through blues than other colours*

Colour & Vision - 7

Combinations in the brain

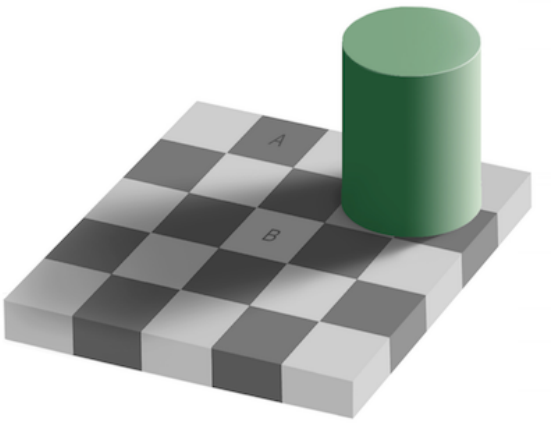
- our brain works on the principle of subtraction
- visual cortex at the back of our brain does the work
  - *neurons subtract signals coming along the optic nerves from S and M-cones*
  - *produces red-green difference signal channel*
  - *neurons subtract signals from L and S-cones*
  - *produces yellow-blue difference signal channel*
  - *third set of neurons as the signals from S and M-cones*
  - *produces an overall black-white, or luminance, channel*
- three channels known as *colour-opponent* channels

Vision & Contrast - 1

Sensitivity

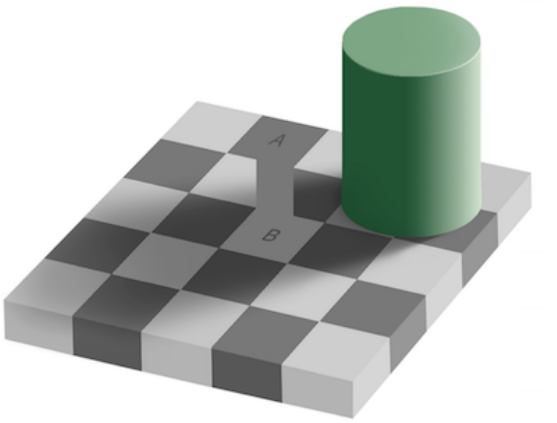
- our vision is now much more sensitive to differences in colour and brightness
  - *greater sensitivity to contrasting colours and edges*
  - *less sensitivity to absolute brightness levels*
- greater sensitivty to contrast is an advantage
  - *more easily discern objects in varied light*
- sensitivity to colour contrasts rather than absolute colours
  - *allows us to discern colour of an object in bright light or shade*

Vision & Contrast - 2



"Grey square optical illusion" - Edward H. Adelson (source: Wikipedia)

Vision & Contrast - 3

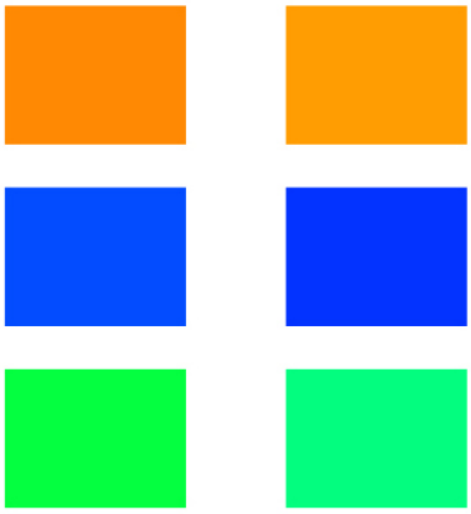


"Grey square optical illusion" - Edward H. Adelson (source: Wikipedia)

Vision & Contrast - 4

Grey Square Optical Illusion - Source: YouTube

Vision & Contrast - 5



Colour Presentation (source: National Geographic - Modified)

Vision & Contrast - 6

A few things to avoid in images & graphics

- try to avoid overly pale colours
- avoid pale colours juxtaposed
- avoid pale colours for smaller blocks or zones
- often simply be lost in the noise of larger zones and blocks
- carefully consider chosen colours for charts, graphs, infographics...

Vision Issues - I

Colour Blindness

- does not infer an inability to see colours
  - *a defect with one or more colour subtraction channel*
- makes it difficult to distinguish certain pairs of colours
- most common form of colour blindness is lack of red-green perception
- ~8% of men & ~0.5% of women suffer
  - *source: Wolfmaier, 1999.*

Vision Issues - 2

Key

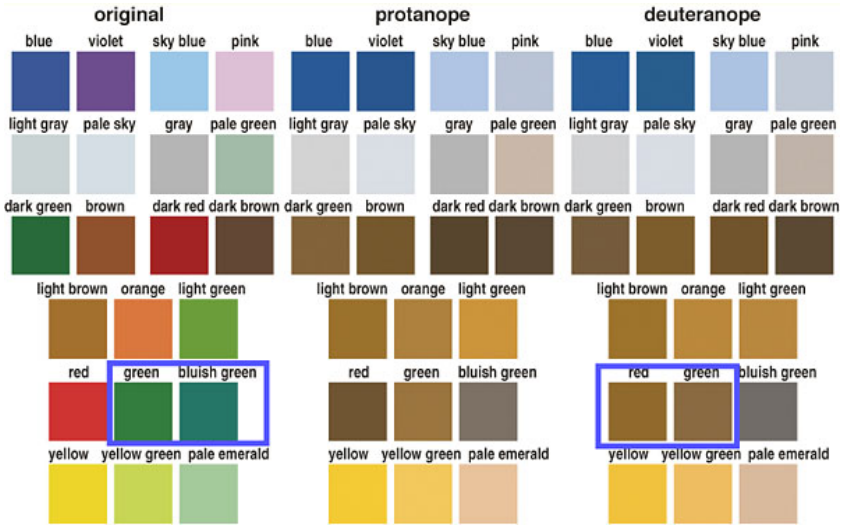
- left = normal human colour vision
- right = human Red-Green colour blindness

Colour Blindness - Red-Green (source: Ask a Mathematician / Ask a Physicist)

Vision Issues - 3

'No Such Thing as Color - what it's like to be color blind'
Source: YouTube

Vision Issues - 4



Colour perception (source: Okabe, M & Ito, K. 2008)

Vision Issues - 5

Other issues to consider...

- ambient lighting has a direct impact upon a user's display
  - *washed out, distored colours*
  - *light and dark areas may persist*
  - *mobile & wearable considerations*
- display viewing angle affects a user's interpretation of colour
  - *cheaper, non-IPS displays offer poor viewing angles and colour shifting*
- mono or greyscale displays directly influence design choices
- variation in colour across competing display technologies
  - *deeper blacks, richer colours, varied viewing angles*

The Bible with Sources Revealed - Source: Amazon

Colour Suggestions

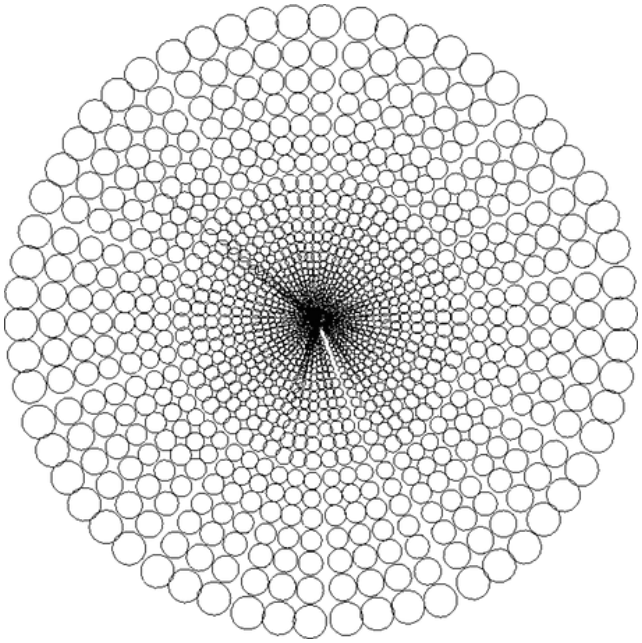
- subtle colour differences versus saturation, brightness, and hue
  - *test in monochrome to discern zones of coloured differences*
- distinctive colours aid a user's visual system in the combination of colours and visual recognition
  - *black, white, red, green, yellow, and blue*
- avoid colour pairs that colour blind people can't distinguish
  - *eg: dark red vs black, dark red vs dark green, blue vs purple, and light green vs white*
  - *try those colours against yellows and greens*
- try adding supporting recognition to colours within your interface
  - *eg: icons, keys, notes...*

Vision & Resolution I

Peripheral vision - consider spatial resolution in human vision.

- spatial resolution drops greatly from the centre to the periphery
- three know reasons for this phenomenon
  - *data compression*
  - *information compressed, associated data loss from visual periphery*
  - *pixel density*
  - *eye has ~ 6-7 million cone cells in the retina*
  - *cones densely packed in centre of vision, known as* ***fovea***
  - *processing*
  - *fovea is ~ 1% of the retina*
  - *brain's visual cortex uses ~ 50% of its area for input from the fovea*
  - *remaining area for other 99%*
- vision has much greater resolution in the centre than elsewhere
  - *Waloszek, G. 2005.*

Vision & Resolution - 2



Foveal Image (source: Illustrated Dictionary of Computer Vision)

Vision & Resolution - 3

Is peripheral vision any use?

Three primary functions for peripheral vision:

- better vision in the dark
- detects motion
- guides the fovea, our centre of vision

Vision & Interfaces - I

Application in User Interfaces

- one of the primary issues is a user's focal point relative to other interface elements
- error messages are an example of this issue
  - *user's focal point at button or clicked link...*
  - *messages often missed if presented within peripheral vision relative to link...*
  - *messages need to be obvious relative to focal point of fovea*
- other design considerations for peripheral vision
  - *standard design options*
  - *colour, font or icon size, relative positioning, opacity...*

Vision & Interfaces - 2

Make messages visible...

- use a user's focal point to our advantage as designers
  - *put the message at the focal point*
- user's tend to focus in a predictable manner with user interface interaction
- inherent predictability can be used to guide design
  - *western users tend to follow a pattern of movement for forms, panels etc*
  - *top left to bottom right*
  - *click a link and obtain focal point*
- mark an error prominently to help users
  - *normally place the message near the source of the error*
  - *or relocate to focal point if discrepancy in the user interface*

Vision & Interfaces - 3

Make messages visible...cont'd

- consider adding an error icon or symbol to the message output
  - *ensure icon or symbol is consistent throughout application, website...*
- reserve a single colour for error messages throughout the interface
  - *customarily red colour used for error and danger messages*
  - *consider red colour relative to company or brand image*
  - *red considered good luck, auspicious in Chinese culture*
    - often associated with death in Egypt...
  - *if necessary, change colour and add error icon etc to help reinforce different colour*

Vision & Interfaces - 4

Overt Interface Options

There are also more obvious options for attracting a user's attention.

- a message in an error dialog or modal box
  - *gets attention quickly and forces a user to interact before continuing*
  - *use with caution, can be very annoying if abused*
  - *carefully consider context before deploying modal options*
  - *traditional popups can be overridden in browser settings*
- use sound to reinforce an error message
  - *system beep or warning common tool for notifying users*
  - *notifies a user to check the interface for more information*
  - *consider as a support, reinforcement to visual messages*
  - *again, quickly becomes annoying if abused*
  - *environmental conditions important as well*
  - *vibrations an alternative for mobile apps...*

Vision & Interfaces - 5

Overt Interface Options...cont'd

- animated notifications work with our peripheral vision's motion tracking
  - *peripheral vision's ability to detect motion*
  - *detection causes reflexive eye movement towards the screen*
  - *animations often seen in interface menu selections*
  - *menu blinks or flashes to indicate selection of option*

Considerations

- these options should be used sparingly in a user interface design
- such visual options are often associated with annoying advertisements
- context is important
- consider advanced options to cancel or limit such interface options

Vision & Interfaces - 6

Positive Highlighting & Focus

- peripheral vision useful as a trigger for the fovea to focus
- moving, overt objects and triggers quickly draw the fovea's attention
- *searching* is another important role for our vision
  - *peripheral vision plays key role*
  - *dependent upon search target, style, colour, movement...*
- design can help our vision focus upon search target
  - *text decoration, highlighting, weight, emphasis...*
  - *bold that* ***pops***

Vision & Interfaces - 7

Test 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc et libero et mi porttitor scelerisque. Mauris gravida enim nec mi vulputate, quis aliquet dolor suscipit. Aenean rutrum sapien vitae lobortis bibendum. Donec vitae interdum diam. Maecenas dapibus facilisis elit vel imperdiet. Cras ultrices tempor dictum. Fusce ex eros, egestas at congue non, venenatis nec nisl. Donec fringilla pulvinar augue eu vulputate. Etiam metus est, aliquam quis sem et, ultricies tincidunt arcu. Integer eu sem nisi. Proin gravida odio urna, vitae scelerisque enim ornare et. Integer placerat massa viverra, aliquam arcu et, porta augue. Aliquam erat volutpat.

Vision & Interfaces - 8

Test 2

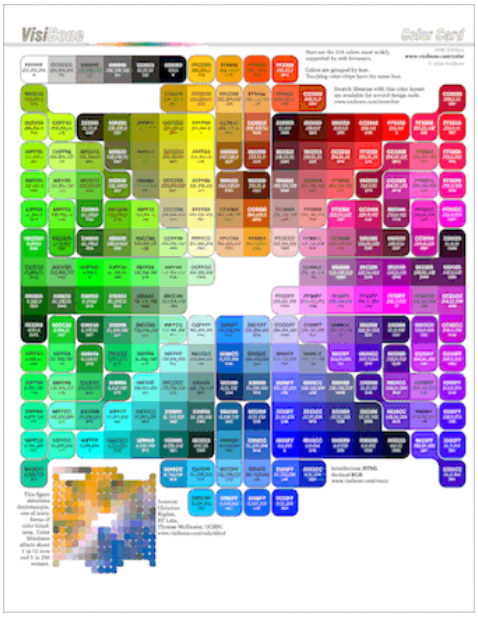
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc et libero et mi porttitor scelerisque. Mauris gra**v**ida enim nec mi **v**ulputate, quis aliquet dolor suscipit. Aenean rutrum sapien **v**itae lobortis bibendum. Donec **v**itae interdum diam. Maecenas dapibus facilisis elit **v**el imperdiet. Cras ultrices tempor dictum. Fusce ex eros, egestas at congue non, **v**enenatis nec nisl. Donec fringilla pul**v**inar augue eu **v**ulputate. Etiam metus est, aliquam quis sem et, ultricies tincidunt arcu. Integer eu sem nisi. Proin gra**v**ida odio urna, **v**itae scelerisque enim ornare et. Integer placerat massa **v**i**v**erra, aliquam arcu et, porta augue. Aliquam erat **v**olutpat.

Vision & Interfaces - 9

Test 3

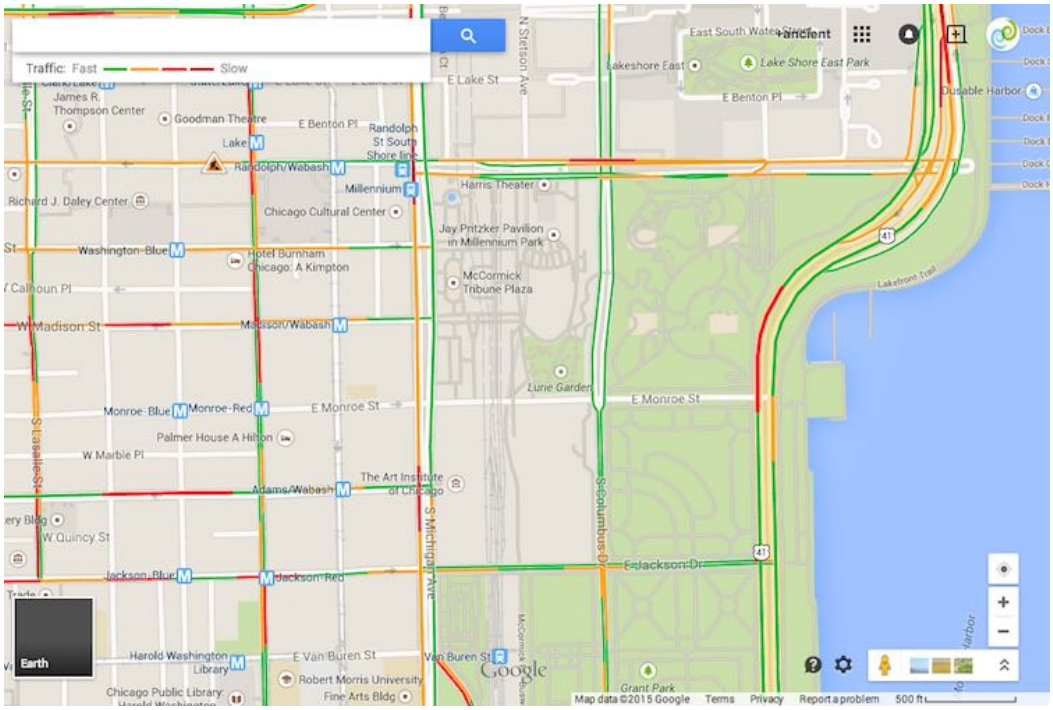
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc et libero et mi porttitor scelerisque. Mauris gravida enim nec mi vulputate, quis aliquet dolor suscipit. Aenean rutrum sapien vitae lobortis bibendum. Donec vitae interdum diam. Maecenas dapibus facilisis elit vel imperdiet. Cras ultrices tempor dictum. Fusce ex eros, egestas at congue non, venenatis nec nisl. Donec fringilla pulvinar augue eu vulputate. Etiam metus est, aliquam quis sem et, ultricies tincidunt arcu. Integer eu sem nisi. Proin gravida odio urna, vitae scelerisque enim ornare et. Integer placerat massa viverra, aliquam arcu et, porta augue. Aliquam erat volutpat.

Vision & Interfaces - 10



Browser colours & colour blindness (source: VisiBone)

Vision & Interfaces - 11



Traffic with Google Maps (source: Google Maps - Downtown Chicago)

Vision & Interfaces - 12

Email Survey - (source: Art Institute Chicago)

References

- Okabe, M. & Ito, K. *Color Universal Design (CUD) - How to make figures and presentations that are friendly to Colorblind people.* J*Fly. 2008. http://jfly.iam.u-tokyo.ac.jp/color/.
- Waloszek, G. *Vision and visual disabilities: An introduction.* SAP Design Guild. 2005. http://www.sapdesignguild.org/editions/highlight_articles_01/vision_physiology.asp
- Wolfmaier T. *Designing for the color-challenged: A challenge.* ITG Publication. 1999.