

Comp 341/441 - HCI

Spring Semester 2018 - Week 2

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Perception

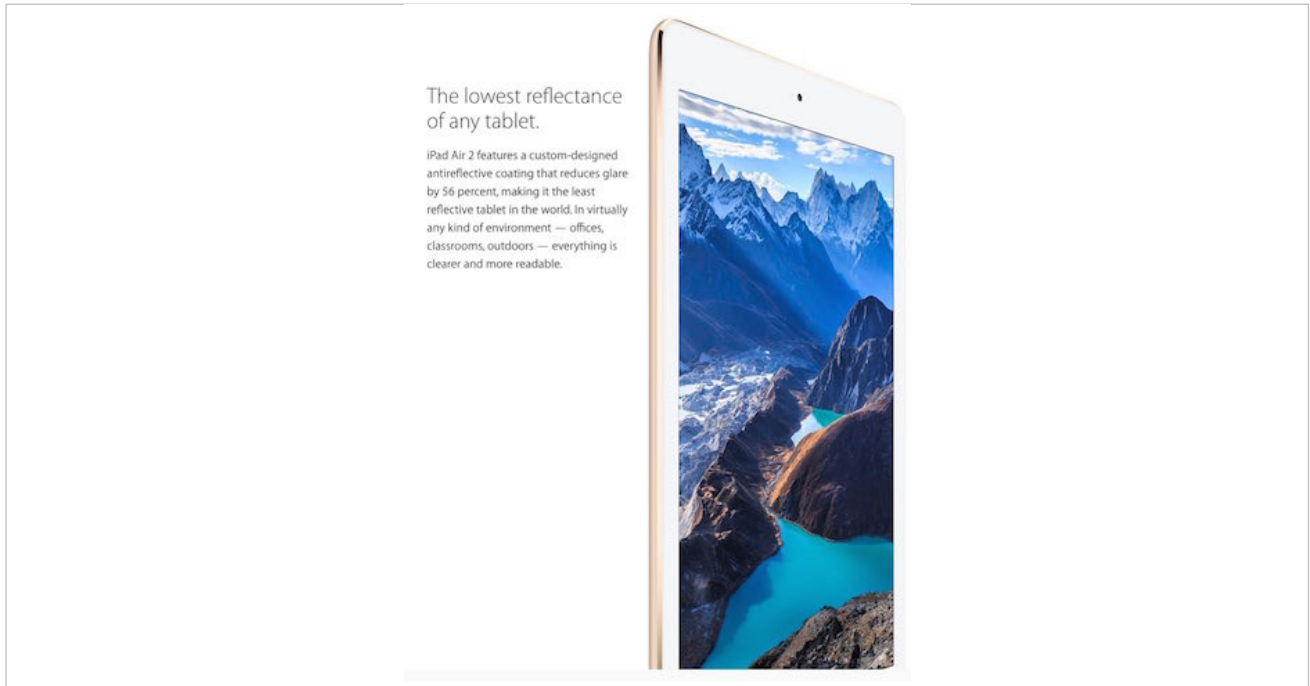
- colour perception in humans
 - *inherent strengths and weaknesses*
- a few limitations in everyday lives
- considerations as UI designers
 - *presentation of colours affects a user's ability to recognise and distinguish them*
 - *display influences a user's perception of colour*
 - eg: their monitor,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

Image - Display performance - I



A comparison of glare (source: Amazon)

Image - Display performance - 2

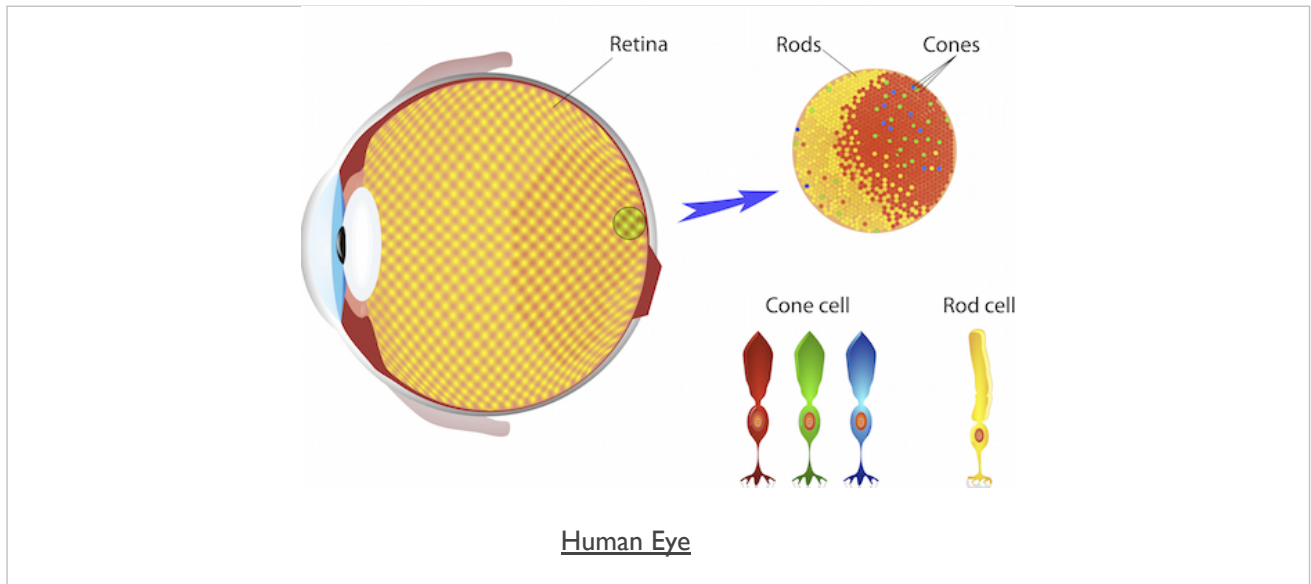


Reducing glare - Apple iPad Air 2 (source: Apple)

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...*

Image - Colour & Vision - 3

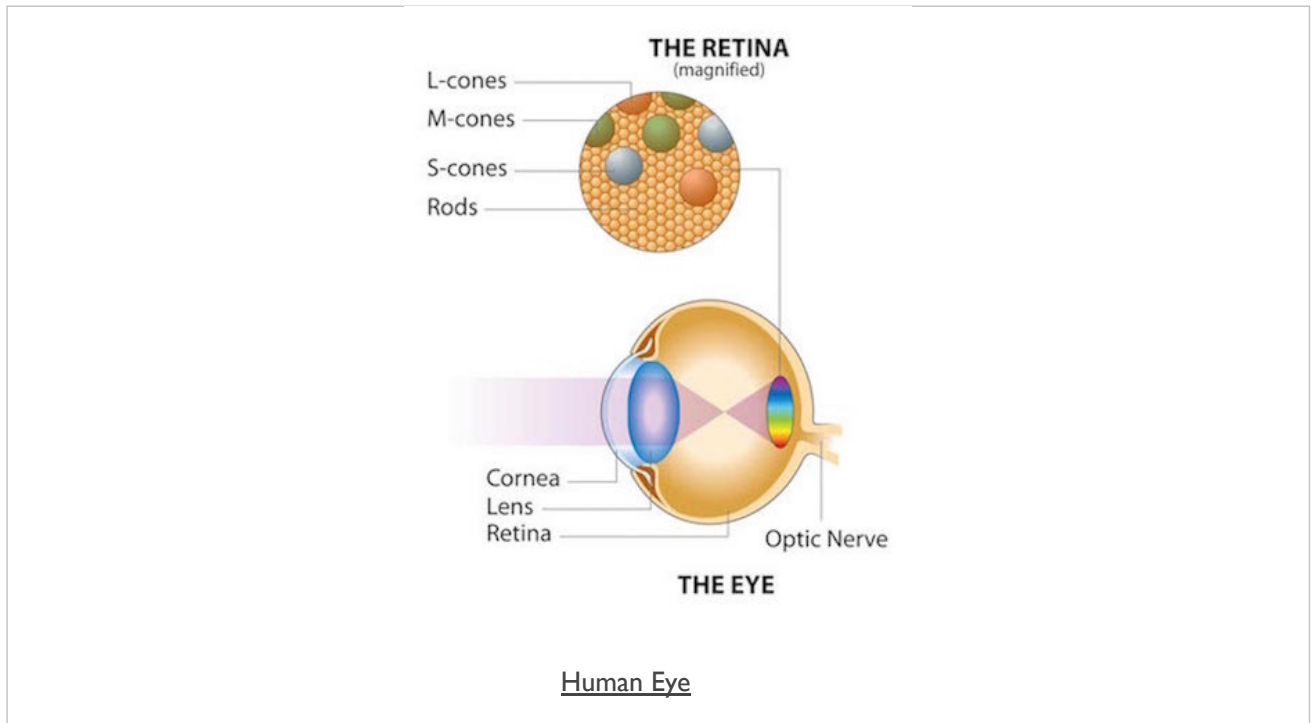


The Human Eye (source: DoveMed)

Modern Environmental Influences

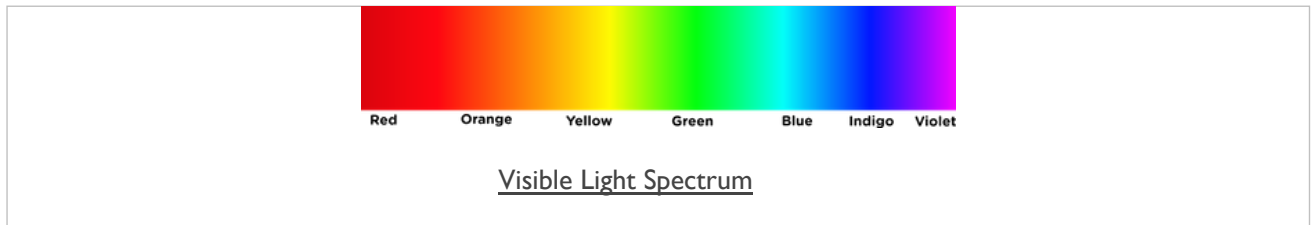
- we need to consider the effect of environmental conditions on human vision
 - *modern working and living spaces*
- rods are sensitive to the environment's overall brightness
- three types of cones sensitive to different frequencies of light
- bright artificial lights dramatically reduce the use of 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

Image - Colour & Vision - 5



The Human Eye (source: Verilux)

Image - 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*

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

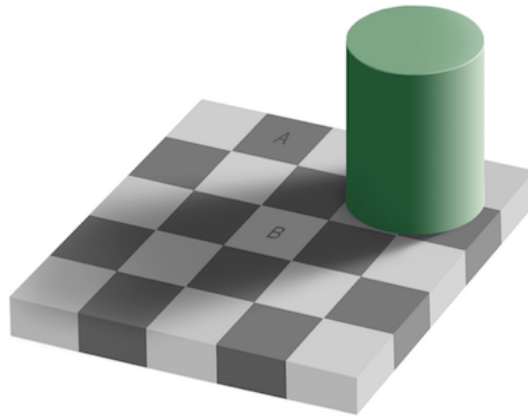
Vision & Contrast - I

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 sensitivity 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*

Image - Vision & Contrast

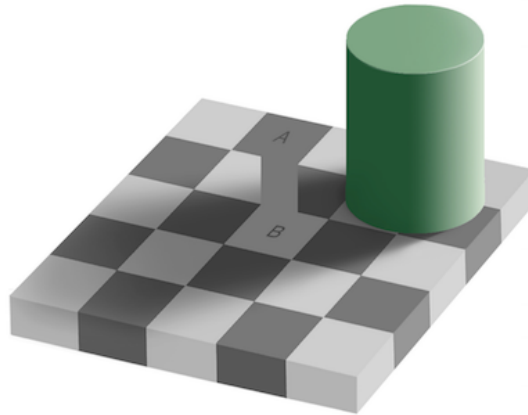
Optical Illusions



Grey Square Illusion

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

Image - Vision & Contrast - 3



Grey Square Illusion

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

Video - Vision & Contrast - 4

Incredible Shade Illusion!



Grey Square Optical Illusion - Source: YouTube

Vision & Contrast - 5

Shade and Shadow

- on the 2D plane
 - *we often struggle to understand why the two colours are the same*
- importance and effect of shade
 - *its effect on the brain's perception of colour*
- our brain is compensating
 - *for the shadow &*
 - *adjusting the colour of square B*
- our eyes see the squares as the same grey colour
- our brain adapts perception
 - *to match what we think is actually the real representation*
 - *i.e. real representation of colours and square B*

Image - Vision & Contrast - 6

Chiaroscuro

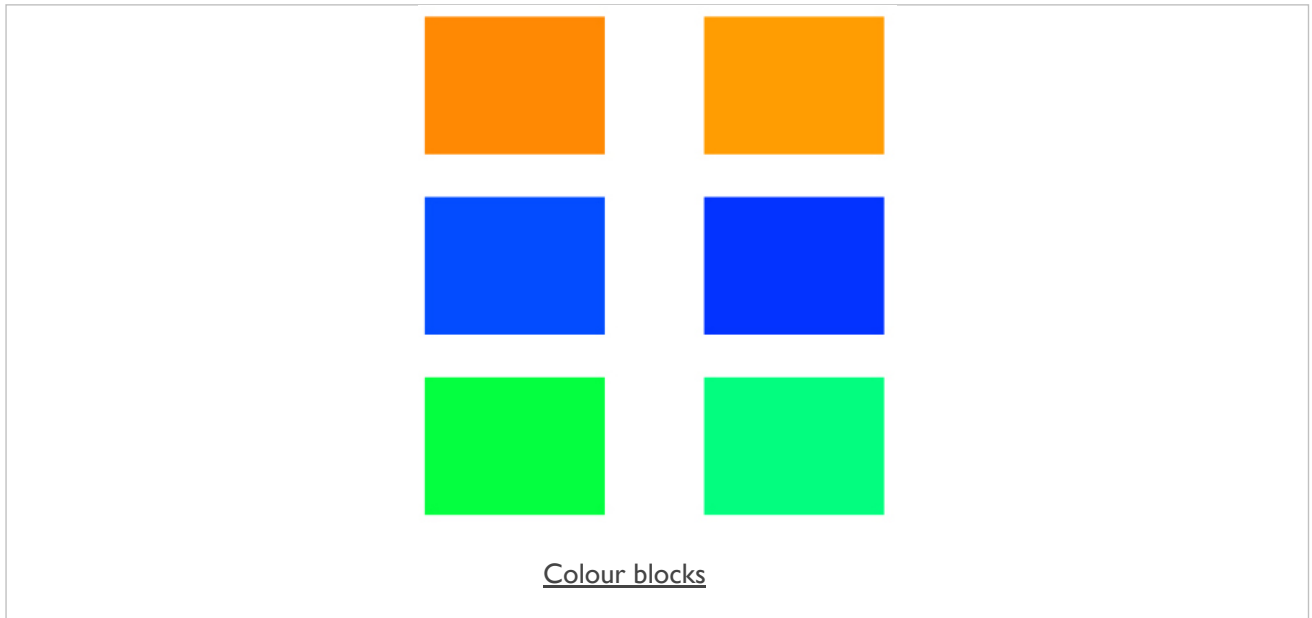


Supper at Emmaus, Caravaggio

Supper at Emmaus, Caravaggio. Further details

Image - Vision & Contrast - 7

Colour presentation



Colour Presentation (source: National Geographic - Modified)

Vision & Contrast - 8

Presentation factors

■ colour patch size

- *harder to discern colour as objects get smaller or thinner*
- *text is a good example of thin rendering*
- *text colour is often hard to discern - e.g. black and navy...*

■ paleness

- *as colours become more pale, it's harder to differentiate similar tones*

■ separation

- *as colour blocks become more separated*
- *harder to determine their colours*
- *particularly true with eye motion from one colour block to another*

a few suggestions

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 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*

Image - Vision issues - 2

human colour perception

Key

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



Colour Blindness

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

Video - Vision issues - 3

Colour blind

No Such Thing As Color - what it's like to be color blind



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

Source: [YouTube](#)

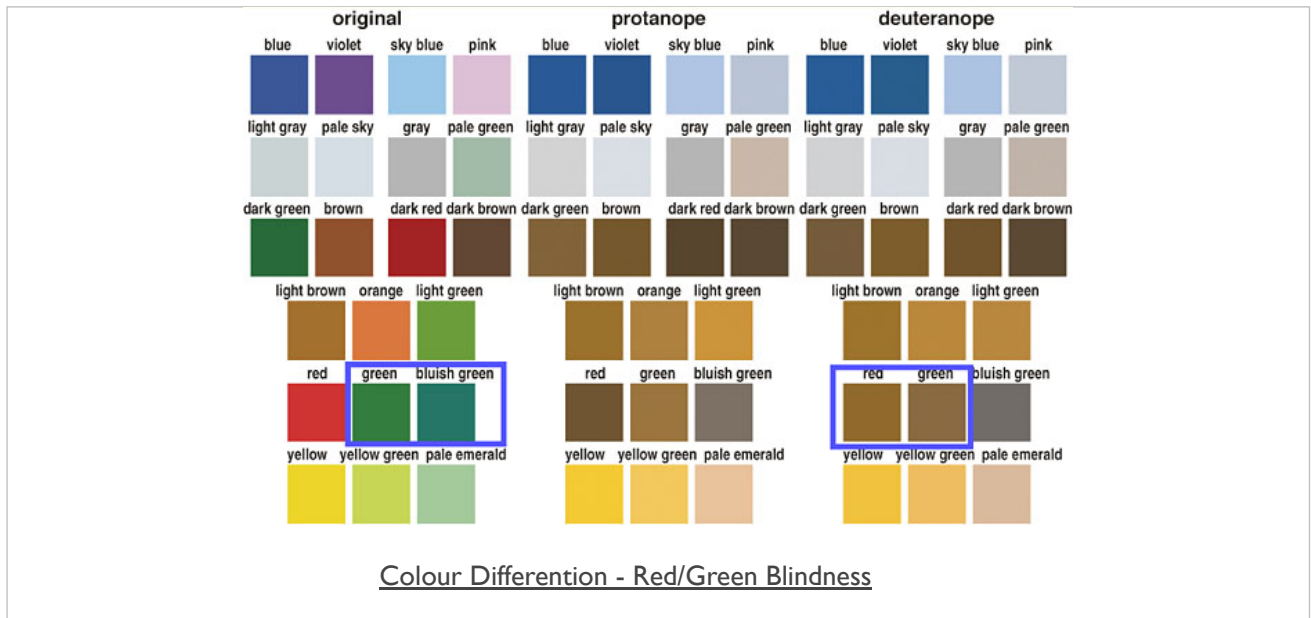
Vision issues - 4

colour differentiation & impact

- consider data visualisation
 - *we may use colour to differentiate quantity, scale, percentages...*
- for a person with red-green colour blindness
 - *impacts their ability to discern such data differentiation solely based upon colour*
- we may rectify this issue in at least two respects
 - *modify our colours to match those perceived by red-green colour blindness*
 - *offer supporting data and explanation for the visualisation*
- not always possible to create a full data visualisation for colour blindness
 - *e.g. one that easily differentiates such quantities and values*
 - *due to limited palette for red-green colour blindness*

Image - Vision issues - 5

colour differentiation



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

other issues to consider...

Other issues to consider...

- ambient lighting has a direct impact upon a user's display
 - *washed out, distorted 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*
- try to 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

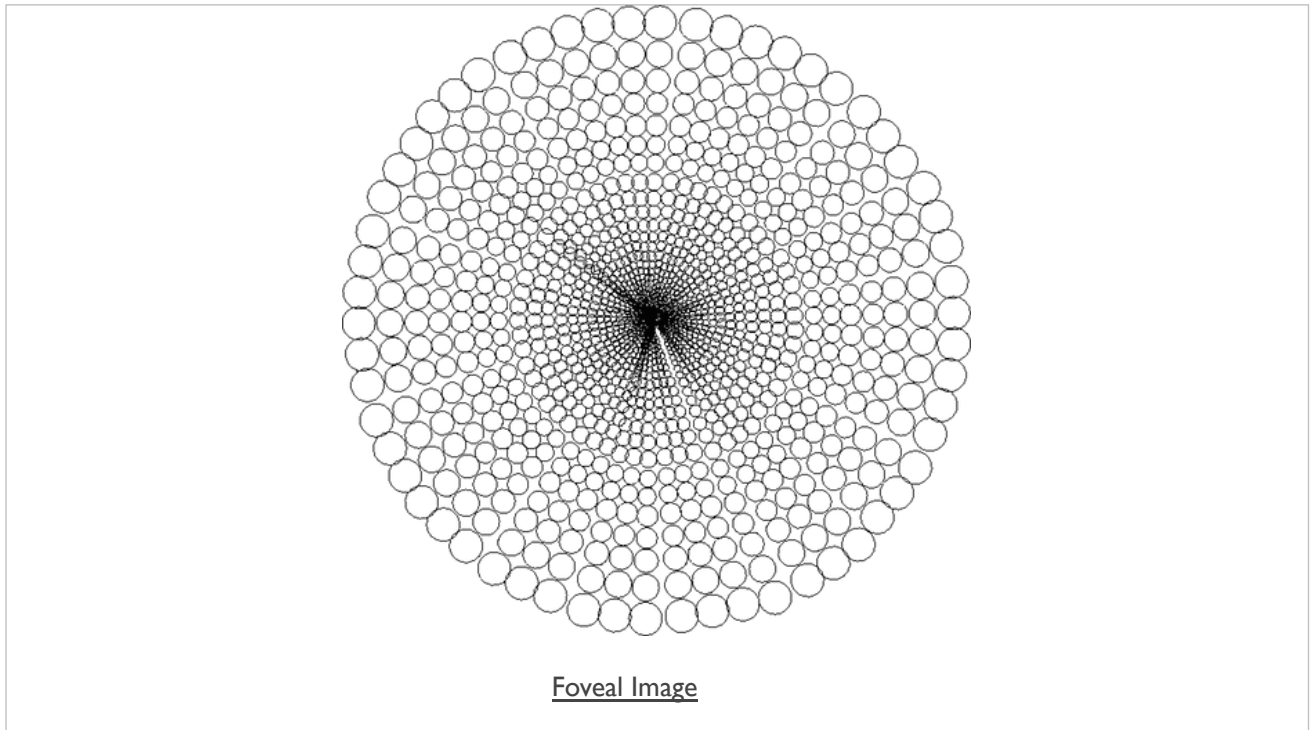
Peripheral vision

Peripheral vision - consider spatial resolution in human vision

- spatial resolution drops greatly from the centre to the periphery
- three known 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

Image - Vision & Resolution - 2

foveal resolution



Foveal Image (source: Illustrated Dictionary of Computer Vision)

Vision & Resolution - 3

is peripheral vision any use?

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

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

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 &c.*
 - *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

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 &c. to help reinforce different colour*

Vision & Interfaces

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

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

References

- Laing, R.D., Phillipson, H. & Russell Lee, A. *Interpersonal perception: a theory and a method of research* Tavistock Publications. 1966.
- 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.