

Seeing in 3D

what makes the world seem solid?

- we live in a 3D world
- but we only experience a single point of it
- our eyes, ears and brains have developed many methods to see and hear in 3D

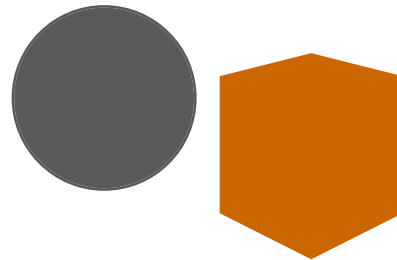
passive effects

some 3D effects don't depend on our eyes at all, just the external appearance of the world

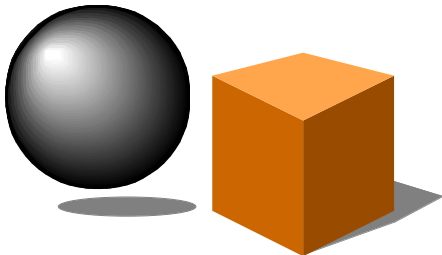
this is why things in ordinary photographs can look solid

the same effects are used in paintings

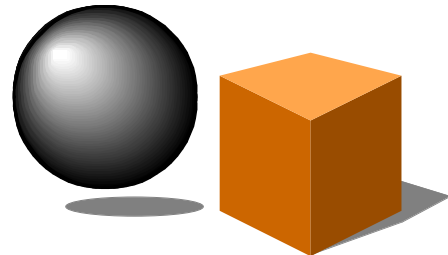
a flat world?



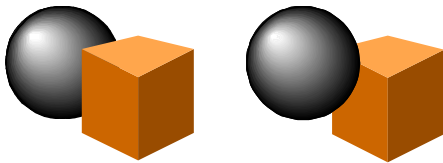
shadows and high lighting



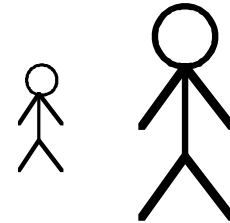
but which is closer?



occlusion



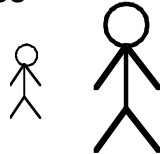
semantic cues



which is closer?

semantic cues

- same thing . . .
closer = bigger
- 'normal sizes' tell us distance
- or compare with known objects
- including own body

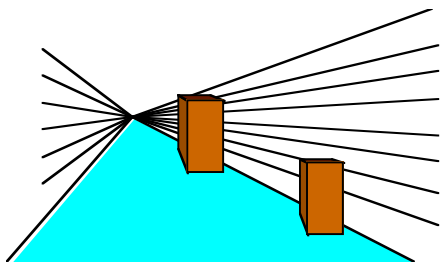


Blue hazing with distance

- look at a distant hill or building
 - fuzzy, less contrast, bluish tinge
- scattering effect of air
- brains get used to it:
 - blue objects seem further away
 - red ones closer
- use in visualisation and VR
(also used in garden design!)



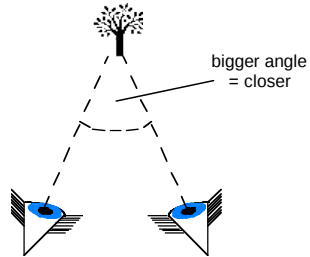
Perspective



static eye effects

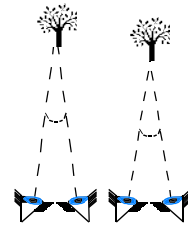
another set of 3D experiences arise because of the movement of the eyes and the way we have to look to see objects

binocular/stereo vision



stereo vision - at the limits

large distance
 $\Rightarrow$ angles get small
 angular distinction less too
 so harder to distinguish
 small differences



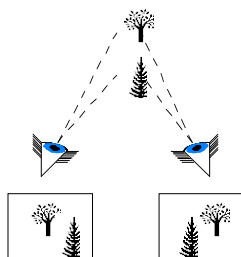
focus

- focus our eyes on object of attention
- closer and further objects are blurred
- some idea of absolute and relative distance

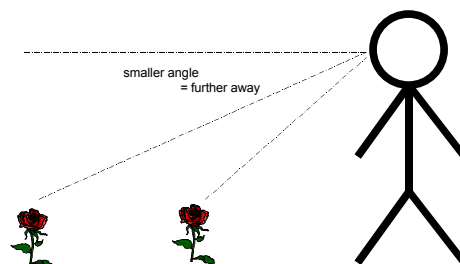
conflict!

- real life ...
 depth of focus = stereo distance
- VR headset
 twin images for stereo distance
 fixed focus on 'screens'
 $\Rightarrow$ confused brain

Parallax between eyes



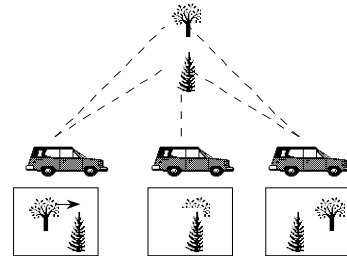
Height of head – looking down



dynamic effects

movement is also important especially for more distant objects where stereo vision and other eye effects are less precise

Parallax effects due to sideways movement



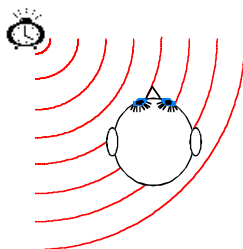
Rate of approach



- you approach some objects
- closer ones grow larger more quickly
- distant ones more slowly

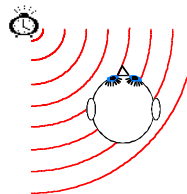
Hearing in 3D too?

binaural hearing - stereo sound



sound reaches one ear before the other
difference gives location
but only left-right
1D not 3D!

True 3D



sound distorted by head, pinnae and ear lobes
each ear gets different kind of sound
allows 3D positioning of sounds
only works for 'natural sounds'