VRDC
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A Game Designer's Overview of the Neuroscience of VR

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NEUROSCIENCE AND VR

- Why Neuroscience Matters
- Motion
- Immersion
- Emotion
- Future of VR/Neuroscience in Entertainment and Health Applications

Three Levels of Truthiness

- Fact
- Inference
- Speculation

Mountain Pass into Unknown Territory

Mountain Pass into Unknown Territory

- Easy to get stuck
- Use Neuroscience to suggest the right path
- Compass to find our way out of dead ends
- This has worked in the past, with quest for better images, animation over millennia

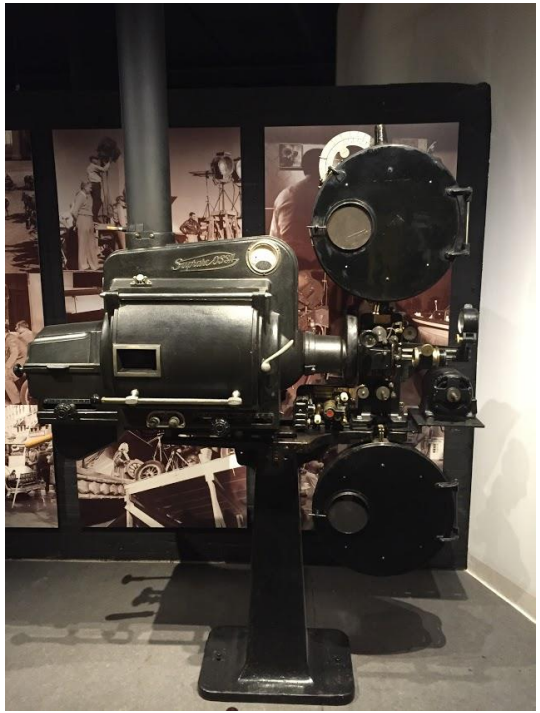
Long History of Images

- Cave paintings
- Camera Obscura
- Shadow Plays

Long History of Images

- Technology advanced with Magic Lanterns
- Bright light – originally flame, later electric
- Sort of early slide projector
- First public only, then rich private owners, then cheaper mass market

Long History of Images



- Then late in 19th century, first movie cameras invented
- Slow but steady advance through 20th century
- Same public, wealthy private, mass market progress

Long History of VR

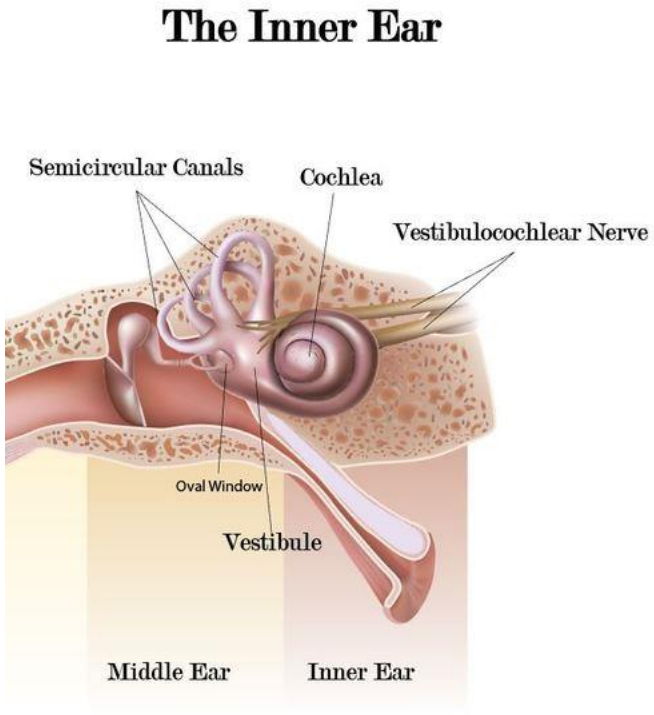
- VR has its own deep roots
- Stereoscopic Viewers
- Military HUD
- Data Glove and VPL
- Virtual Boy

Common thread?

- Everything comes through our brains and sensorimotor systems
- Our eyes and brains function with shortcuts
- Understanding that gives us our maps for exploring

Motion

Vestibular System



- Semicircular canals measure pitch, roll, yaw
- Your brain tries to match to visual input (more on this)
- Mismatch = trouble
- Evolutionary sign of possible poisoning

Minimizing VR Sickness

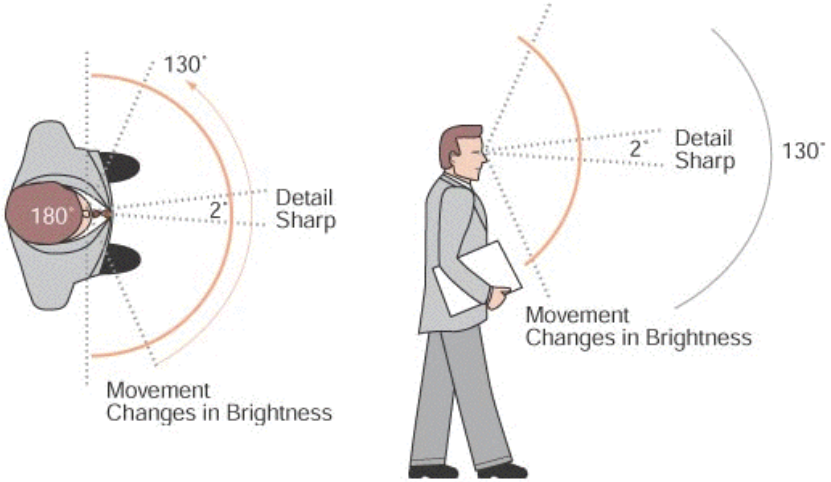
- Fast frame rate (90+ best)
- Minimize lag when head moves (20ms or less)
- Get all visual cues right
- Minimize acceleration
- Creative solutions based on how our visual field and vestibular system interact

Avoid Acceleration (or all movement!)

- Constant speed
- Instant changes
- If curves, show them ahead of time, show tracks, slow
- Teleportation – but show landmarks, let player control

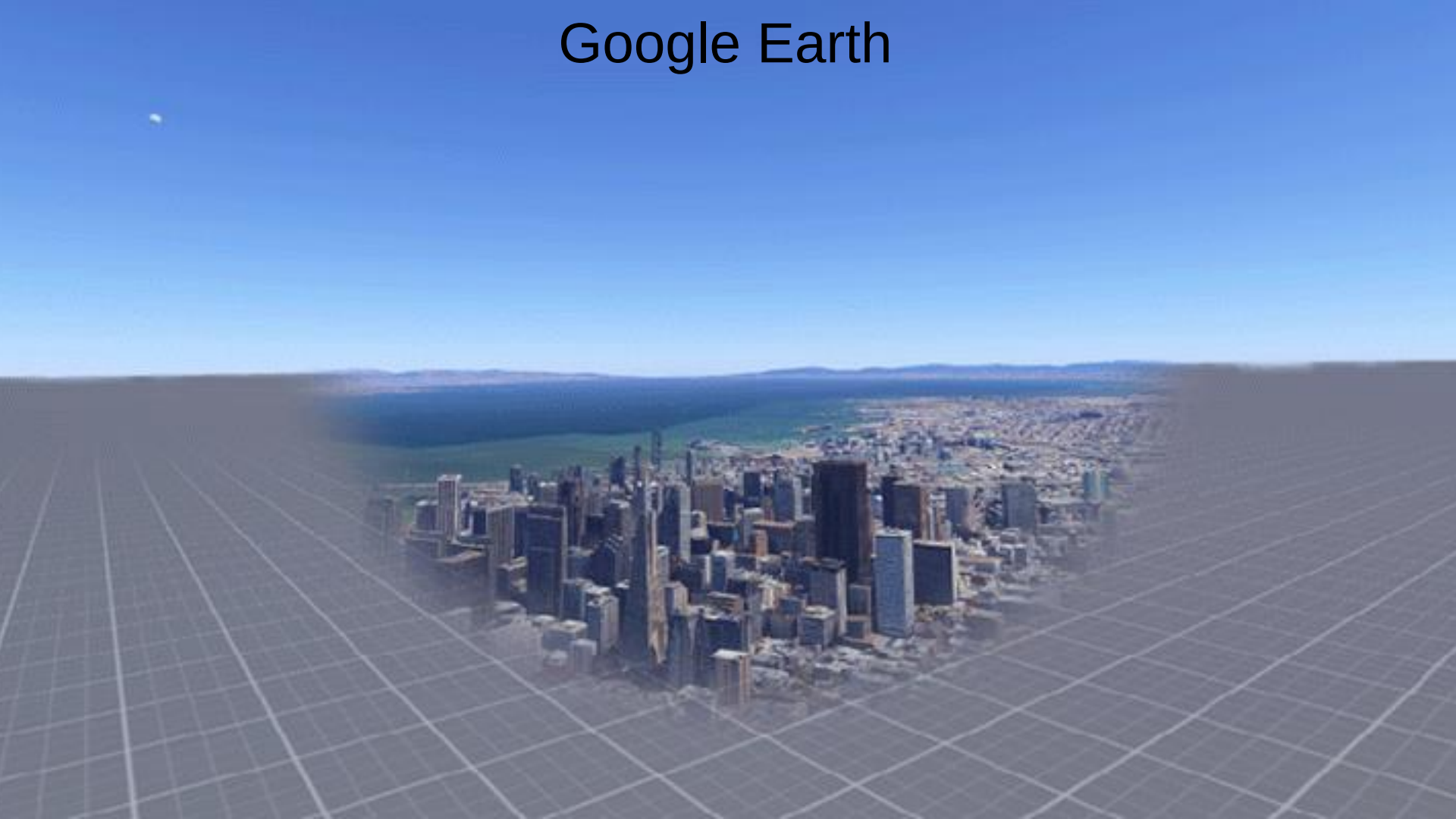
Movie Precedents

Minimizing VR Sickness

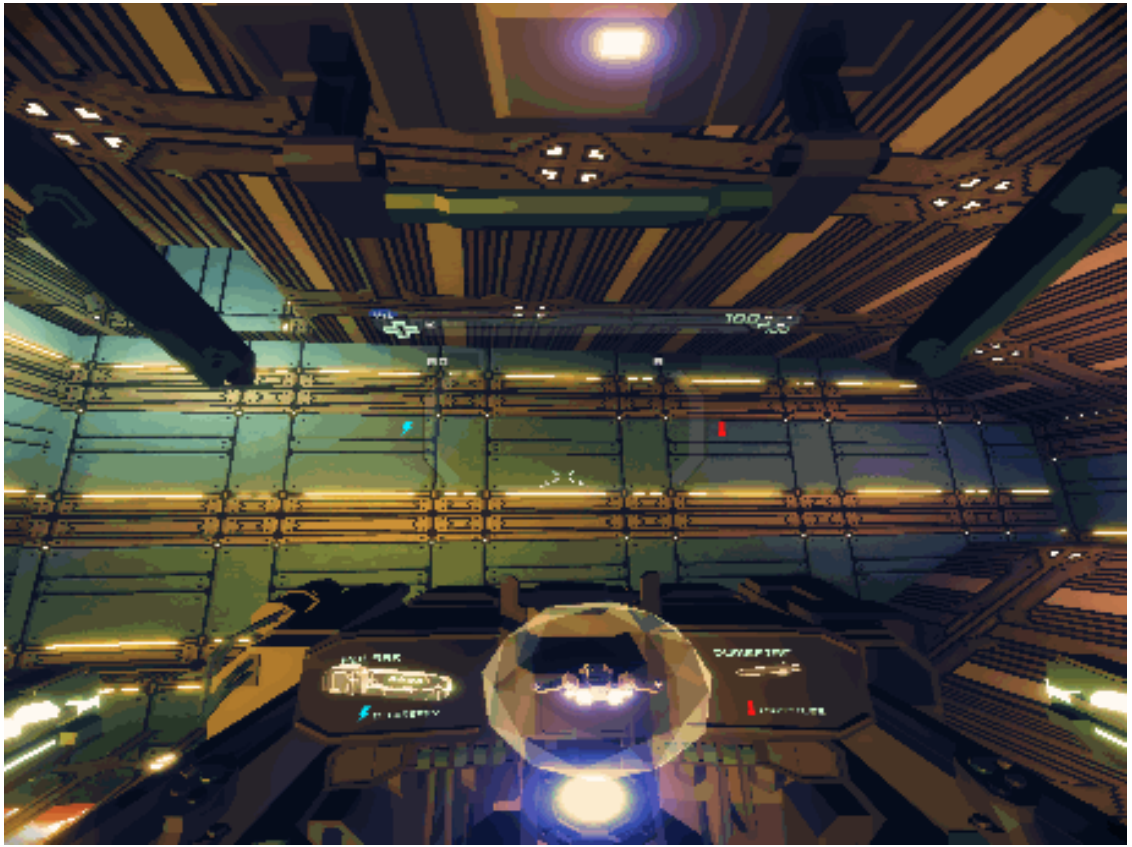


- Foveal Vision –the center 2 degrees of visual field
- Peripheral vision key to motion
- Blur or eliminate peripheral vision in fast movement
- Why Star Wars OK – but IMAX sometimes is not

Google Earth



Sublevel Zero



Neuroscience and Motion

- Eye Tracking makes foveated rendering possible
- Coming to VR as well as eventually to mobile
- Key is learning how our visual system/brain interact, what is minimum needed?

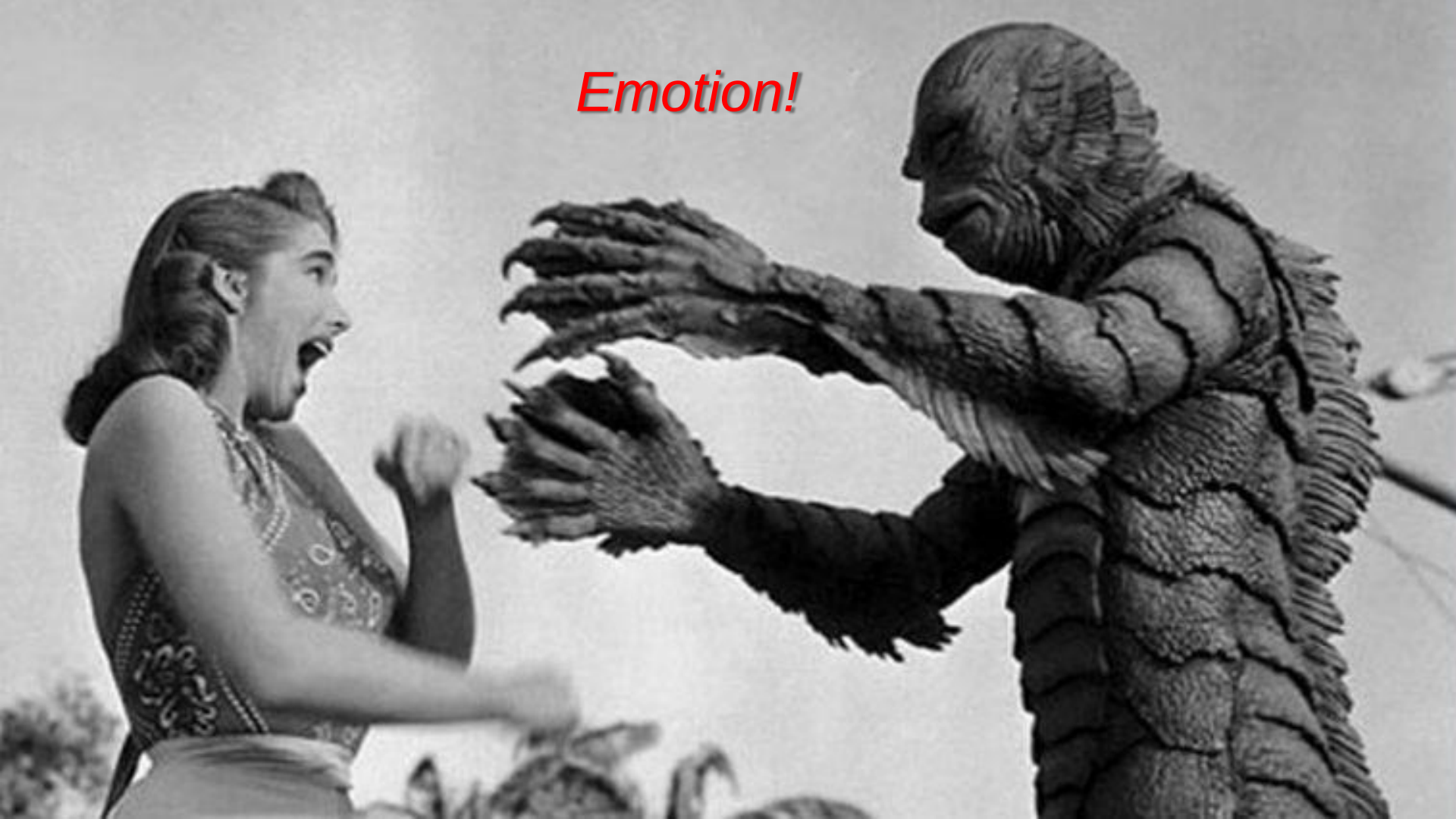
Immersion

VR needs to get MANY visual cues right

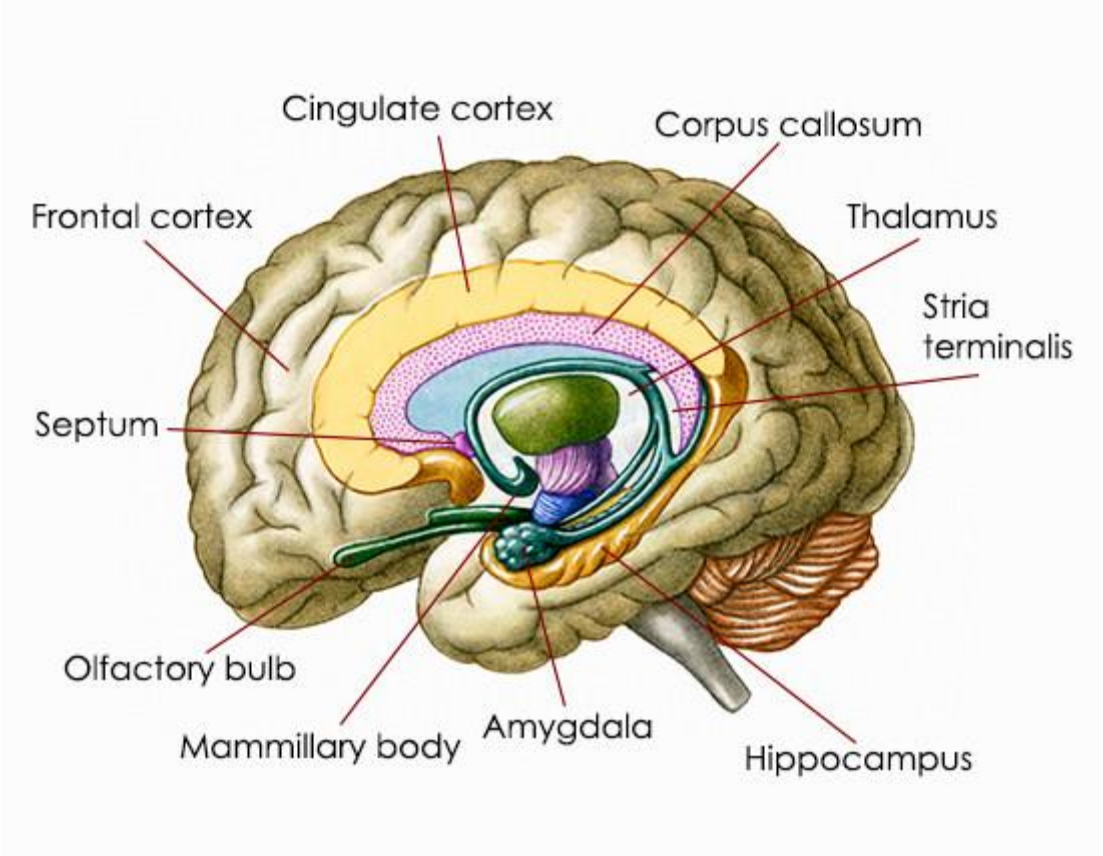
- Frame rate
- Head tracking
- Field of View
- Vergence
- 3D Rendering
- Perspective
- Parallax
- Distance Fog
- Textures
- Size
- Occlusion
- …and more

Breaking Immersion

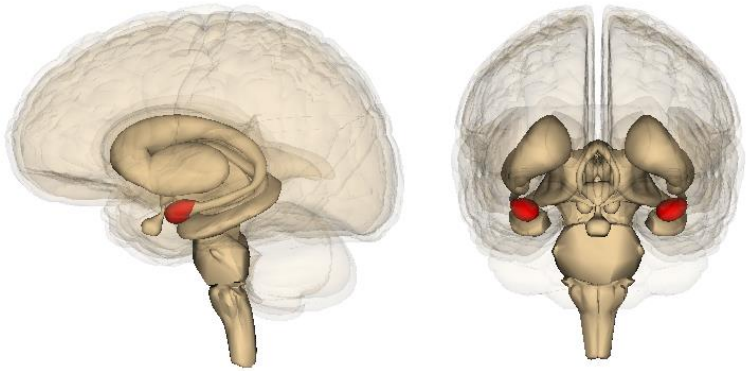
- Beware of violating a sense of presence with floating icons, interface
- Put interface in the 3D world – Digetic Interface
- Study our visual system
- Less is more – keep framerate high, realism not necessary


Emotion!

Good Servant/Bad Master

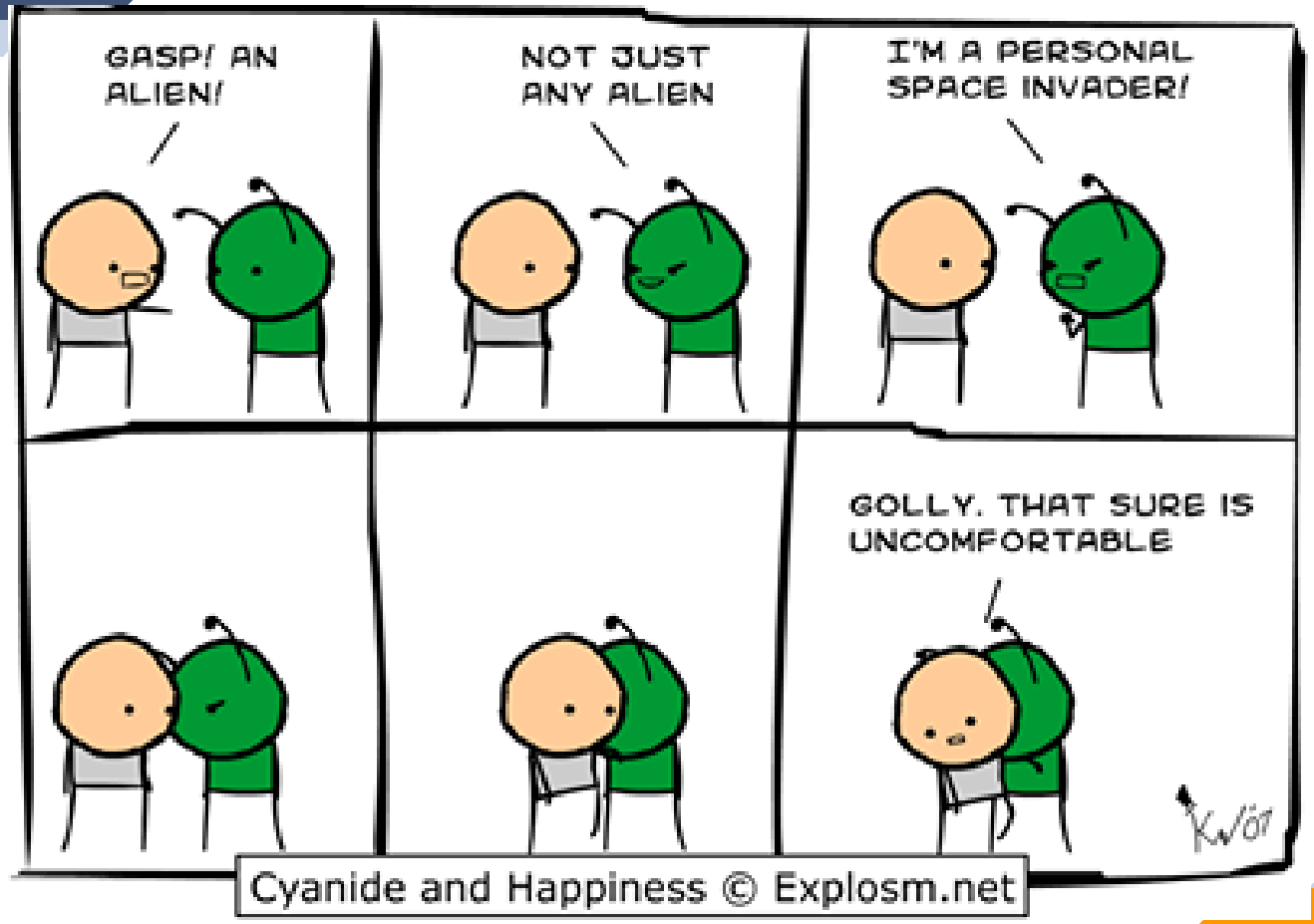

Cingulate cortex
Corpus callosum
Frontal cortex
Thalamus
Stria terminalis
Septum
Olfactory bulb
Mammillary body
Amygdala
Hippocampus

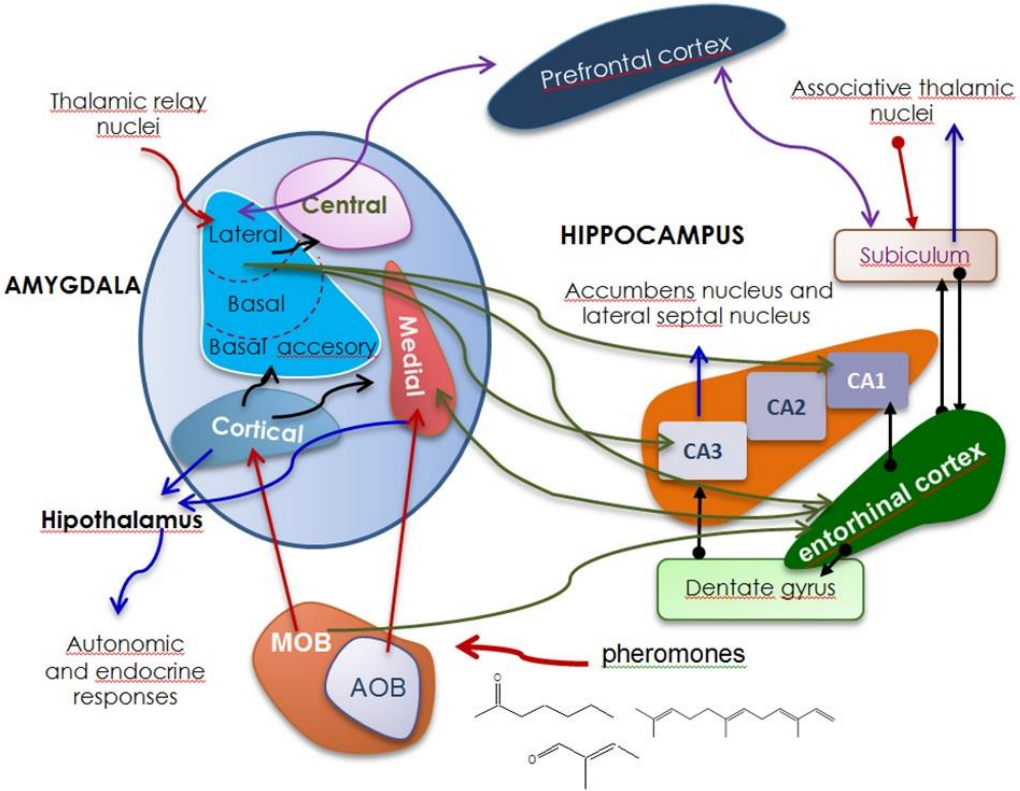
Amygdala Functions



- Fear
- Anger/Aggression (fight or flight)
- Arousal/Intimacy


AFFECTION!


GASP! AN ALIEN!
NOT JUST ANY ALIEN
I'M A PERSONAL SPACE INVADER!
GOLLY. THAT SURE IS UNCOMFORTABLE
Cyanide and Happiness © Explosm.net


Prefrontal cortex
Thalamic relay nuclei
Associative thalamic nuclei
Central
Lateral
Basal
Basal accesory
Medial
Cortical
AMYGDALA
HIPPOCAMPUS
Subiculum
Accumbens nucleus and lateral septal nucleus
CA1
CA2
CA3
entorhinal cortex
Dentate gyrus
Hipothalamus
Autonomic and endocrine responses
MOB
AOB
pheromones

Mary Pickford - Silent Film Actress


henry
Oculus Rift

Care and Feeding of Your Amygdala

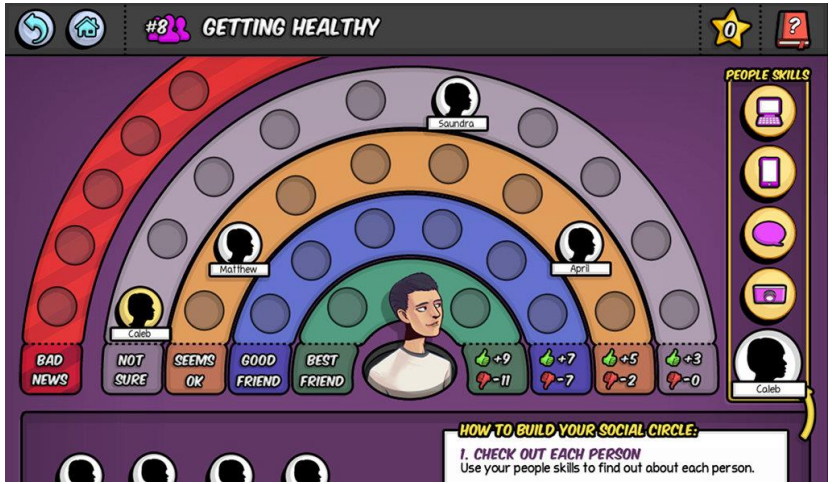
- Don’t dial up fear and aggression to 11!
- Room for emotion, empathy, maybe even romance in games, VR films
- VR builds on very old biology - use proximity and gaze to explore truly new approaches


Possible Futures

VR Movie Possibilities

- Spotlight Stories Lessons
- 180 degree, seated
- Easier to shoot, light
- Interactive through gaze
- Shared or “Single Player”
- Strong replay value, Easter Eggs
- Ads, product placement

Games as Medicine (not VR yet!)



- Pear Therapeutics – FDA approves app to treat substance addiction
- Play2Prevent – prevent risky teen sexual behavior
- Neuroracer – roll 70 year old brains back to 30


EVO
CHALLENGE
00000
Collect ONLY
these specimens
Ignore the others.
READY?
OK

VR as Medicine

- Phobias
- PTSD
- Acute Pain Remediation
- Training Doctors, Caregivers
- Mirror therapy post-stroke
- Asperger’s, emotion training
- Depression, Parkinson's, Alzheimer's


Future is in YOUR hands

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Thank you!

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