COMP210: Interfaces & Interaction

2: Session title here

Immersion

Immersion is the objective degree to which a VR system and application projects stimuli onto the sensory receptors. We discuss immersion in terms of:

- Extensiven - Range of sensory modalities targeted
- Matching - Stimuli vs reality
- Surrounding - Extent of environment (panoramic) and tracking
- Vividness - The quality of simulation
- Intractability - The quality of the input and outputs
- Plot - How compelling the narrative is

Figure: The Lawnmower Man - 1992

Immersion vs. Presence

`Presence is the psychological state of subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience.'

International Society for Presence Research, 2000

(ISPR Website)

Next Week

We will cover presence through the psychological state of subjective perception and illusions that help facilitate VR sytems.

Perceptual Modalities

"A perceptual modality can be defined as the means through which information is extracted from the environment" (James and Galbraith, 1985)

Immersion is created by surrounding the user of the VR system in images, sound or other stimuli that provide an engrossing total environment.

In order to achieve an illusion of immersion a reality system must consider the perceptual modalities: **Sight**, **hearing**, touch, proprioception, **balance/motion**, smell and taste.

A Journey Through the Human Eye: How We See

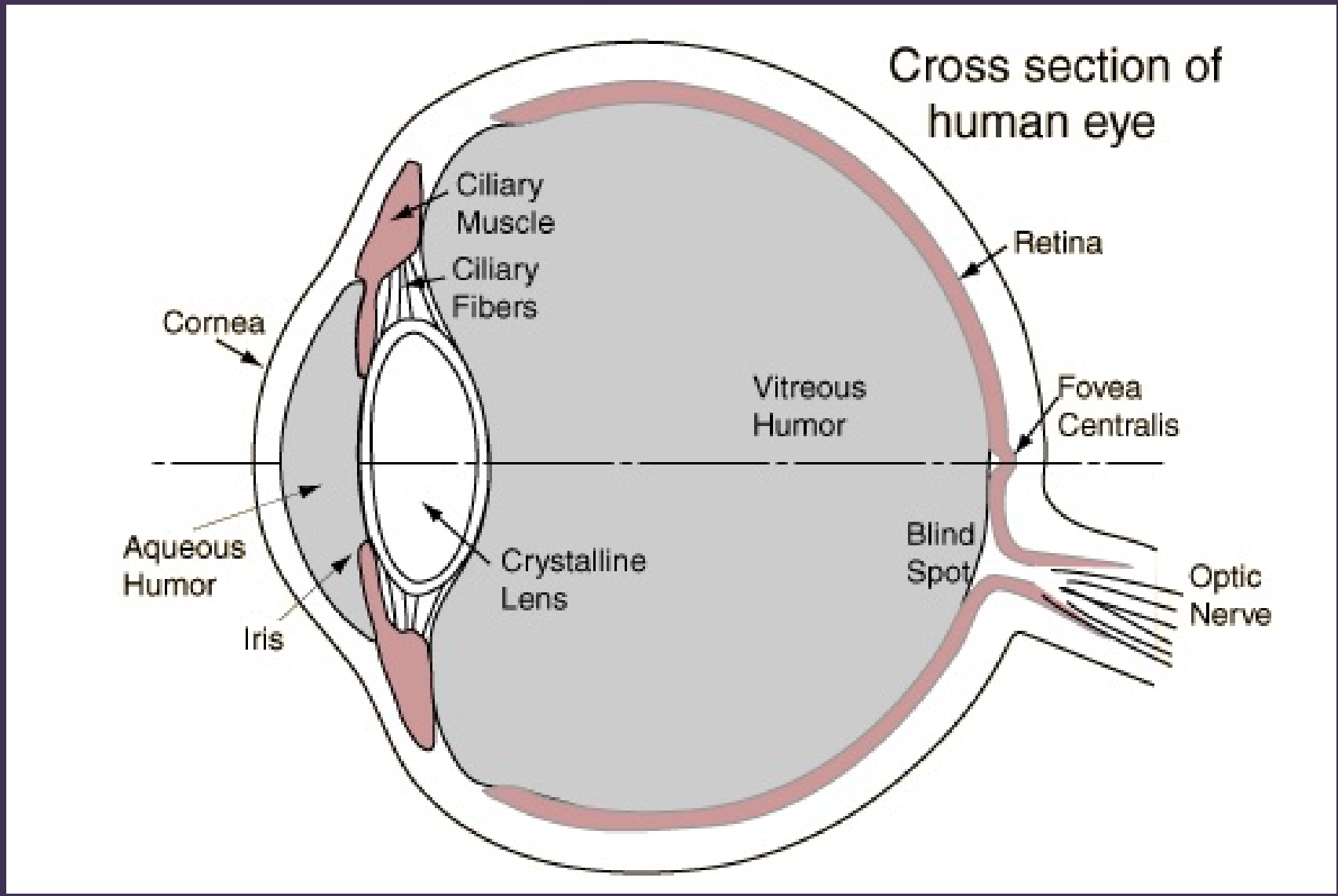

Cross section of human eye
Ciliary Muscle
Ciliary Fibers
Retina
Cornea
Vitreous Humor
Fovea Centralis
Aqueous Humor
Crystalline Lens
Blind Spot
Optic Nerve
Iris

Figure:

Cones and Rods

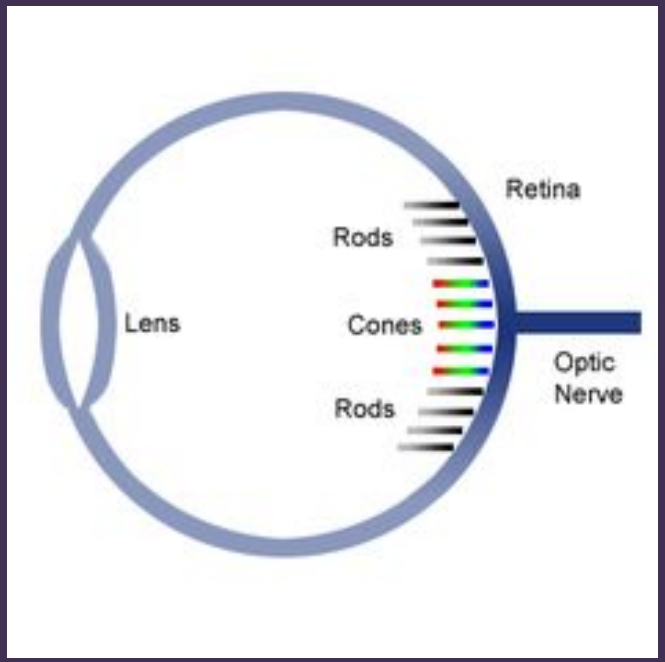


Figure: The retina is covered in two types of photoreceptors, cones and rods. Cones are responsible for vision in ideal conditions and rods are responsible for low light levels and non-ideal conditions.

Central vs. Peripheral Vision

Central

- has high visual acuity,
- optimised for bright daytime conditions, and
- is color sensitive.

Peripheral Vision

- is color insensitive,
- is more sensitive to light than central vision in dark conditions,
- is less sensitive to longer wavelengths (i.e., red),
- has faster response and has more sensitive to fast motion and flicker, and
- is less sensitive to slow motions.

Field of View and Field of Regard

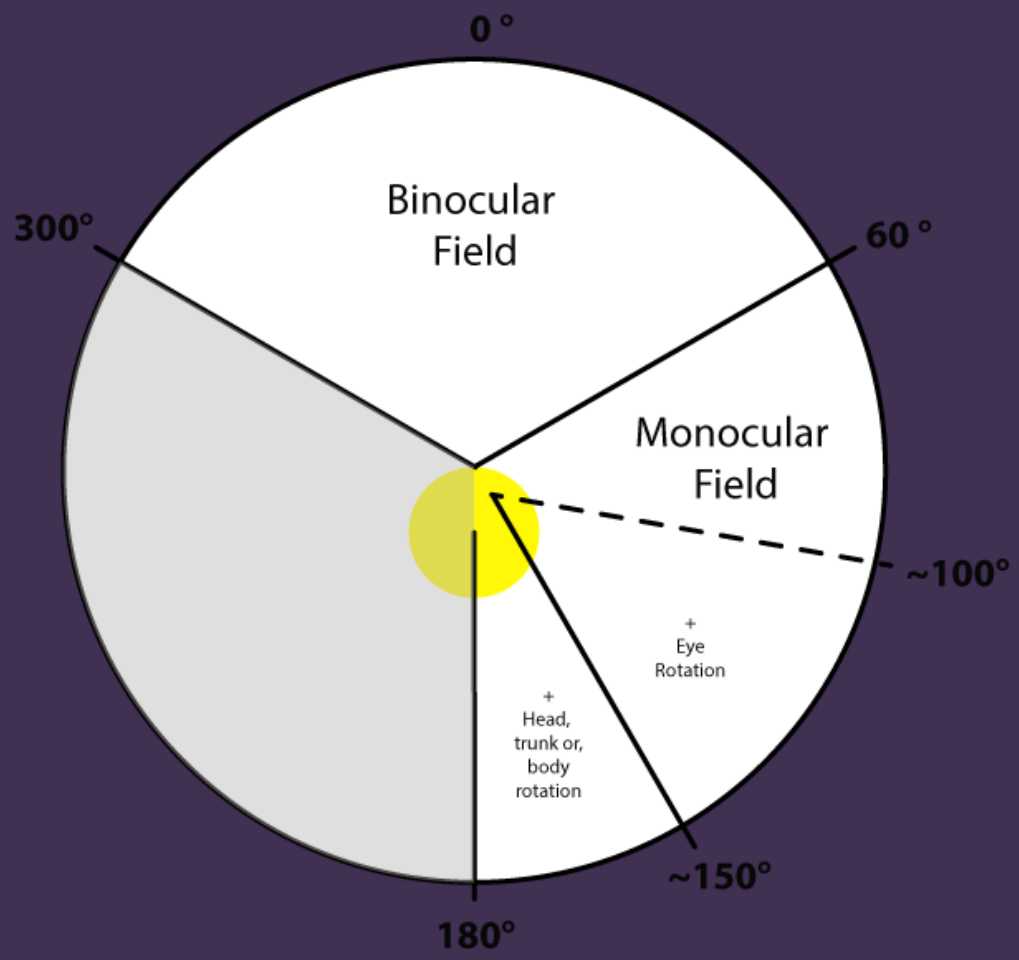
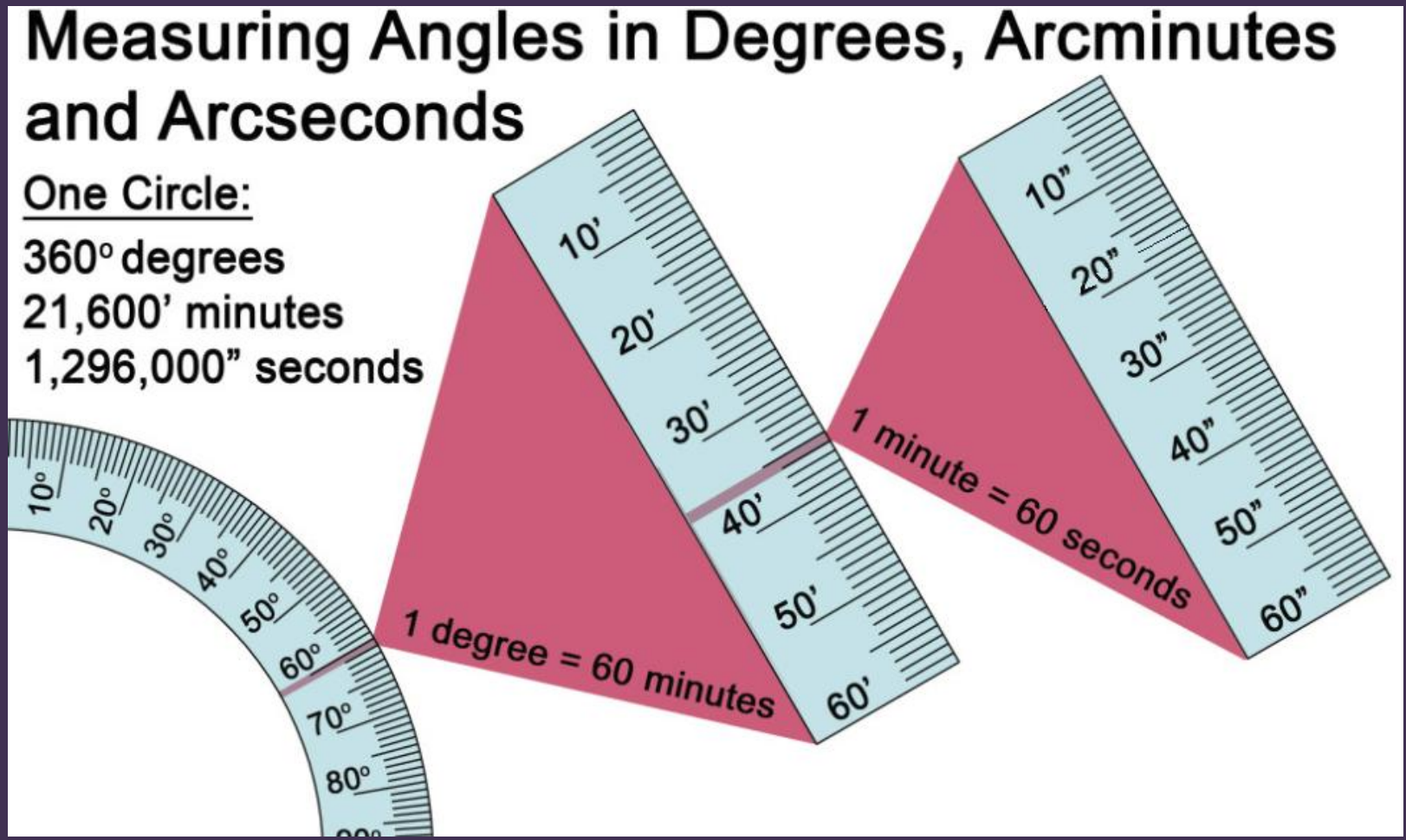


Figure: Horizontal field of view of the right eye with straight ahead fixation (looking towards the top of the diagram)

Arc Seconds & Minutes

Arc Seconds & Minutes



Acuity

Visual Acuity is the ability to resolve details and often measured in visual angle.

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A fifty pence coin held up at 81 meters away has an angle of acuity of one arc min(1/60th of a degree).

In perfect conditions a human can see a line as thin as 0.5 are sec(1/7200th of a degree).

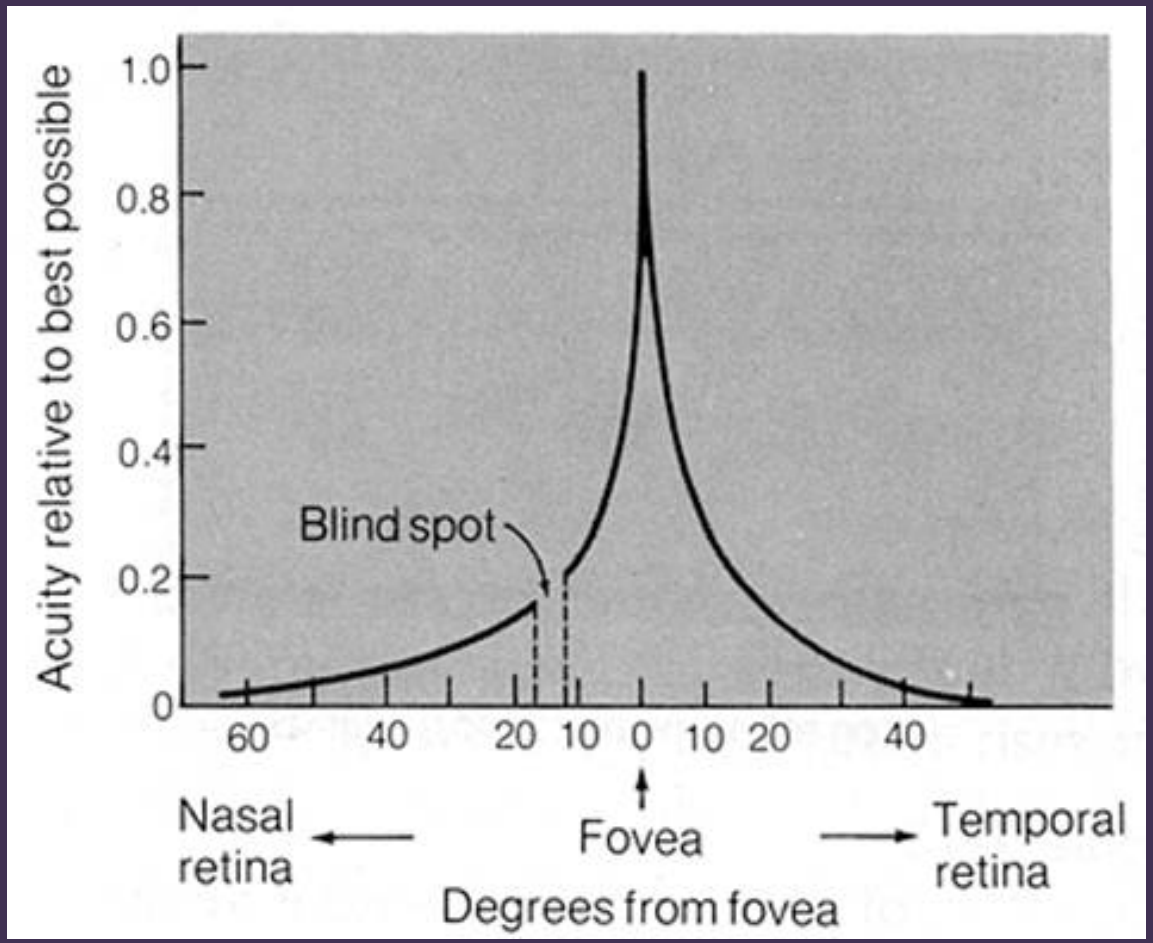


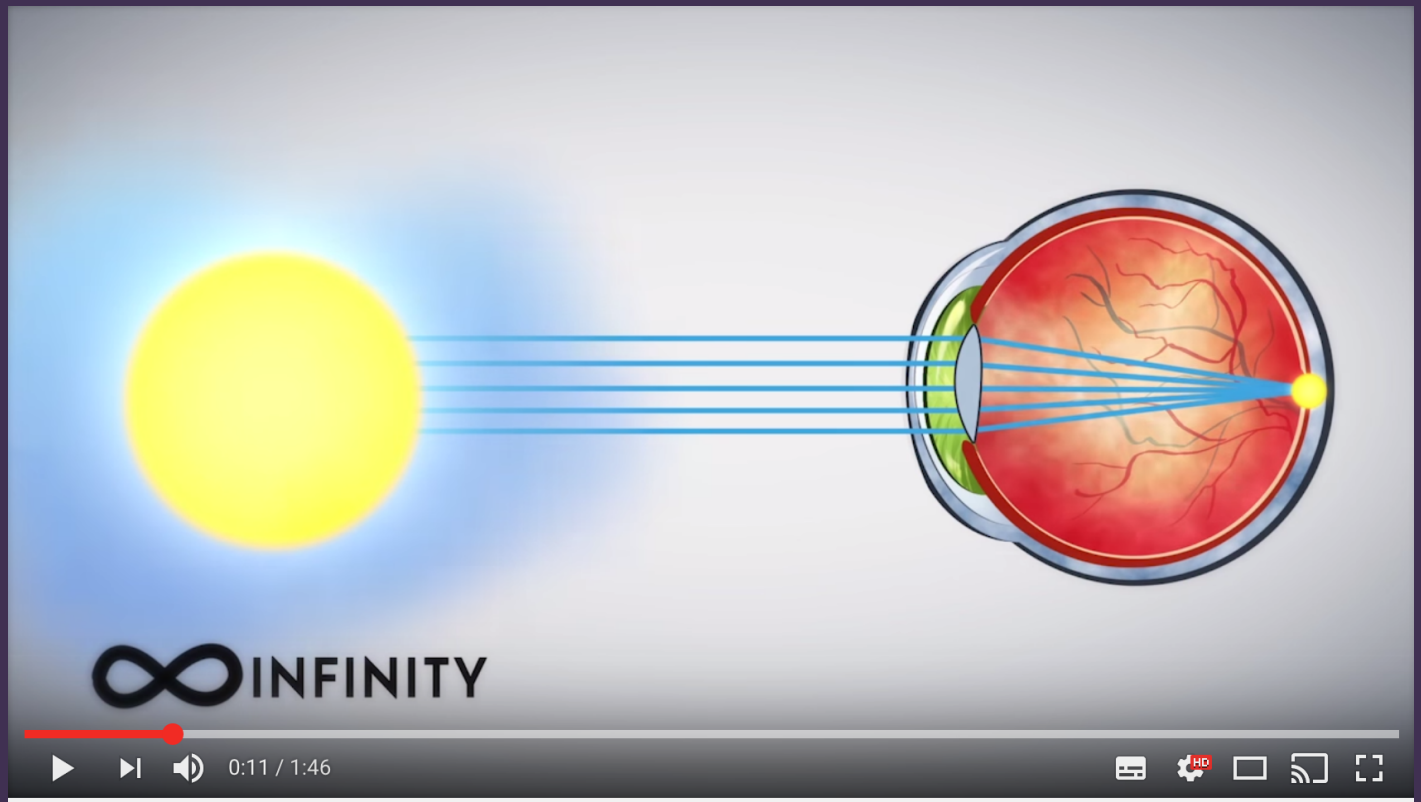
Figure: Visual acuity is much better at the fovea.

The evidence suggests that given stereoscopic vision with each eye able to see 210°(including rotation) a display would need horizontal vision of 378,000 pixels for each eye to match what we see in reality.

$$210 * 60 * (60/2) = 378,000$$

Obviously, this is an extreme analysis and there are ways that we can work around these limitations.

VR Lenses


INFINITY
0:11 / 1:46
How Lenses for Virtual Reality Headsets Work
VR Cover
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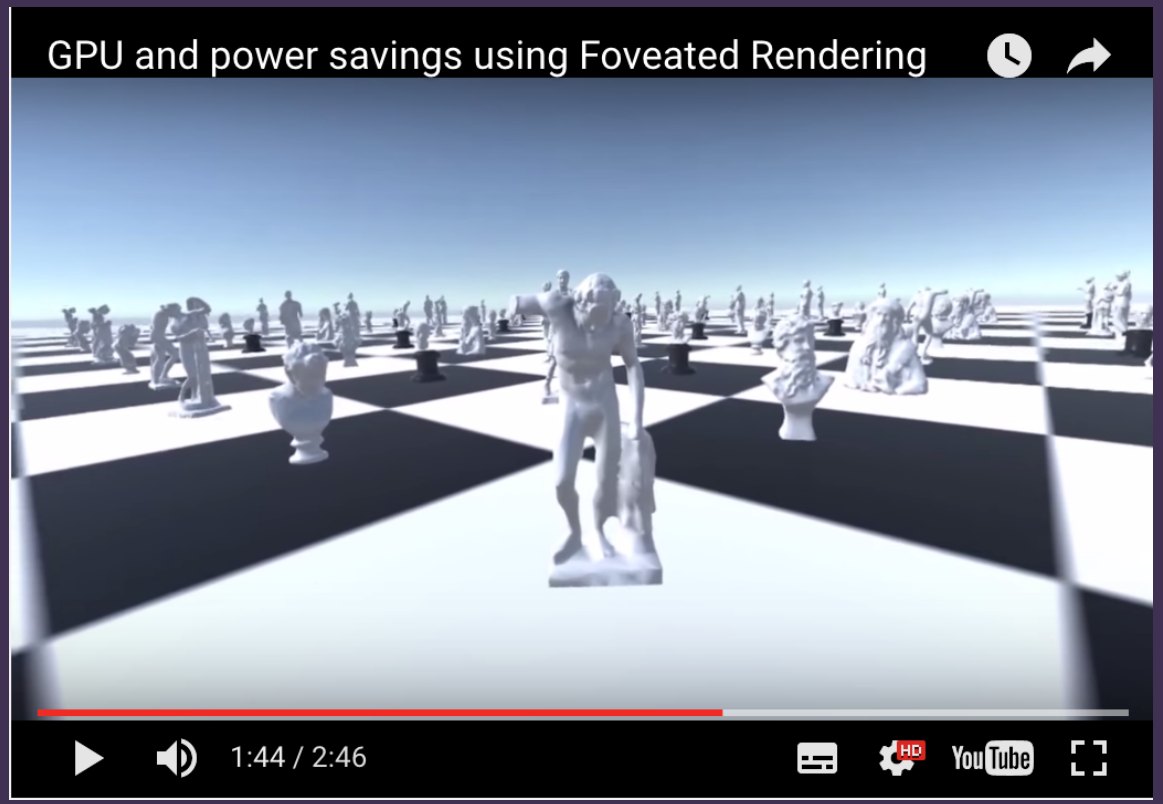
Foveated Rendering



Chromatic Aberration

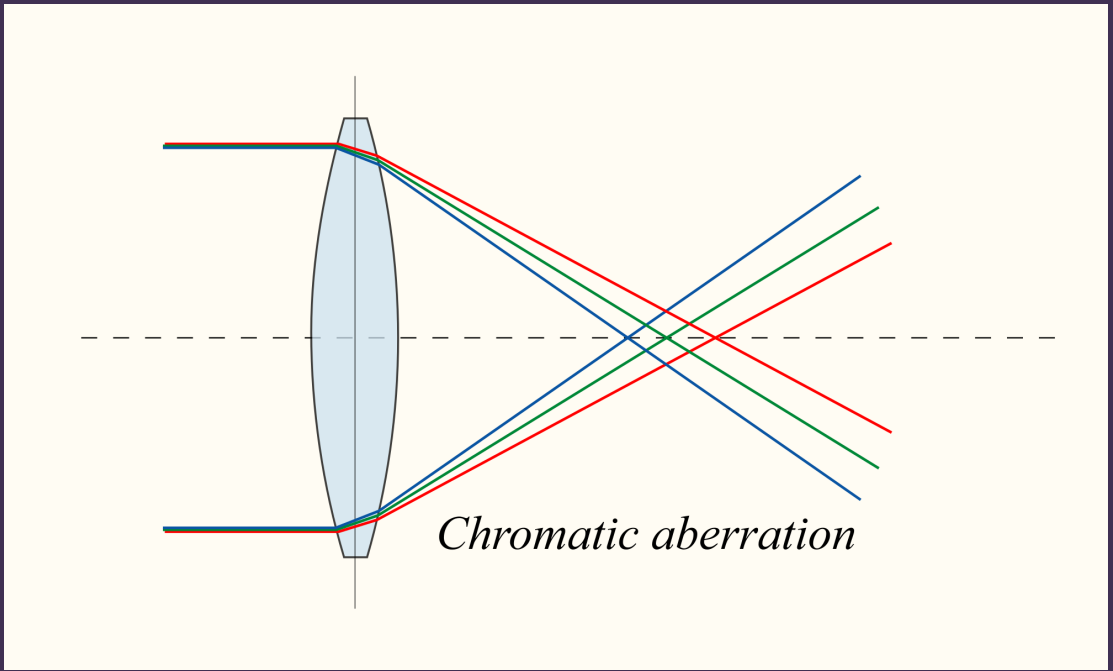


Figure: When different wavelengths of light refract at different angles. Movement of the eye can amplify the aberration.
aberration:a departure from what is normal

Vergence-Accommodation Conflict

Vergence - How your eyes track an object coming towards you.

Accommodation - When you pupils adjust to the objects light field.

The two actions are hardwired to work in sync as they are both trying aid the same process of tracking an object. They can be decoupled but it is not a comfortable experience for the user.

`After long session, I still have an hangover time though, as if I was on drugs the whole time and I need to readjust to reality.'

(link to further discussion)

and more

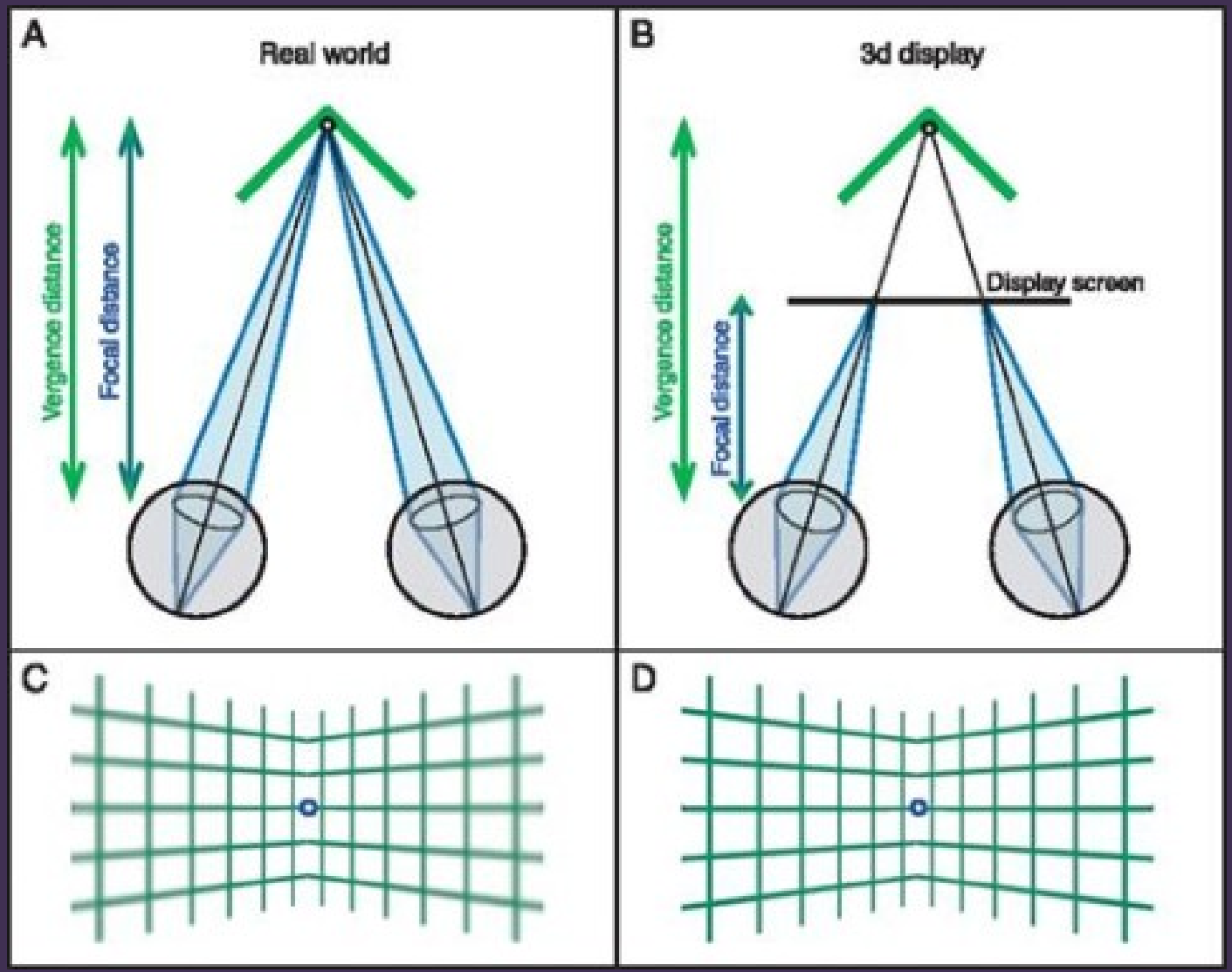


Figure: Vergence-Accommodation Conflict

Possible Solution

Motion to Photon Latency

- **Motion** - refers to the users movements in the physical space.
- **Photons** - The photons emitted from the HMD that are absorbed by photoreceptors (cones & rods) on the retina.
- **Latency** - delay between the two.

Put simply, motion to photon latency is the time it takes for the users movements in physical space to be visualised on the head-mounted display(HMD).

Side Effects

The <20ms motion-to-photon latency gold standard.

When the motion to photon latency is greater than 20ms or anytime there is inconsistent stimuli between the players physical body motions and the visuals displayed in the head-mounted display (HMD) then there is a good chance that motion sickness/simulator sickness will occur.

According to the Oculus Rift docs, other factors that can contribute to simulator sickness are:

- Acceleration - minimize the size and frequency of accelerations
- Degree of control - don't take control away from the user
- Duration of simulator use - allow and encourage users to take breaks
- Altitude - avoid filling the field of view with the ground
- Binocular disparity - some find viewing stereoscopic images uncomfortable
- Field-of-View - reducing the amount of visual field covered by the virtual environment may also reduce comfort
- ... (the list goes on)

- Latency - minimize it; lags/dropped frames are uncomfortable in VR
- Distortion correction - use Oculus VR?s distortion shaders
- Flicker - do not display flashing images or fine repeating textures
- Experience - experience with VR makes you resistant to simulator sickness (which makes developers inappropriate test subjects)

Oculus Rift Health & Safety Guide

Health and Safety

* These health & safety warnings are periodically updated for accuracy and completeness. Check *www.oculus.com/warnings* for the latest version.

⚠ WARNING **HEALTH & SAFETY WARNINGS: TO REDUCE THE RISK OF PERSONAL INJURY, DISCOMFORT OR PROPERTY DAMAGE, PLEASE ENSURE THAT ALL USERS OF THE HEADSET READ THE WARNINGS BELOW CAREFULLY BEFORE USING THE HEADSET.**

⚠ WARNING Before Using the Headset:

- Read and follow all setup and operating instructions provided with the headset.
- Review the hardware and software recommendations for use of the headset. Risk of discomfort may increase if recommended hardware and software are not used.
- Your headset and software are not designed for use with any unauthorized device, accessory and/or software. Use of an unauthorized device, accessory and/or software may result in injury to you or others, may cause performance issues or damage to your system and related services.
- To reduce the risk of discomfort, adjust the inter-pupillary distance (IPD) for each user before use of the headset.
- A comfortable virtual reality experience requires an unimpaired sense of motion and balance. Do not use the headset when you are: Tired; need sleep; under the influence of alcohol or drugs; hung-over; have digestive problems; under emotional stress or anxiety; or when suffering from cold, flu, headaches, migraines, or earaches, as this can increase your susceptibility to adverse symptoms.
- We recommend seeing a doctor before using the headset if you are pregnant, elderly, have pre-existing binocular vision abnormalities or psychiatric disorders, or suffer from a heart condition or other serious medical condition.

⚠ WARNING Seizures:

Some people (about 1 in 4000) may have severe dizziness, seizures, eye or muscle twitching or blackouts triggered by light flashes or patterns, and this may occur while they are watching TV, playing video games or experiencing virtual reality, even if they have never had a seizure or blackout before or have no history of seizures or epilepsy. Such seizures are more common in children and young people under the age of 20. Anyone who experiences any of these symptoms should discontinue use of the headset and see a doctor. Anyone who previously has had a seizure, loss of awareness, or other symptom linked to an epileptic condition should see a doctor before using the headset.

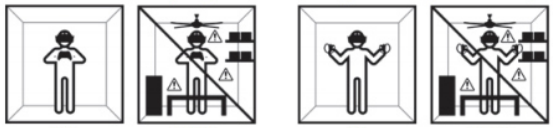
⚠ WARNING Children:

This product should not be used by children under the age of 13, as the headset is not sized for children and improper sizing can lead to discomfort or health effects, and younger children are in a critical period in visual development. Adults should make sure children (age 13 and older) use the headset in accordance with these health and safety warnings including making sure the headset is used as described in the Before Using the Headset section and the Safe Environment section. Adults should monitor children (age 13 and older) who are using or have used the headset for any of the symptoms described in these health and safety warnings (including those described under the Discomfort and Repetitive Stress Injury sections), and should limit the time children spend using the headset and ensure they take breaks during use. Prolonged use should be avoided, as this could negatively impact hand-eye coordination, balance, and multi-tasking ability. Adults should monitor children closely during and after use of the headset for any decrease in these abilities.

⚠ WARNING General Precautions:

To reduce the risk of injury or discomfort you should always follow these instructions and observe these precautions while using the headset:

- **Use Only In A Safe Environment:** The headset produces an immersive virtual reality experience that distracts you from and completely blocks your view of your actual surroundings.
  - **Always be aware of your surroundings before beginning use and while using the headset. Use caution to avoid injury.**
  - Use of the headset may cause loss of balance.
    - Remember that the objects you see in the virtual environment do not exist in the real environment, so don't sit or stand on them or use them for support.
    - **Remain seated unless your game or content experience requires standing.**



Sound

Sound is a pressure wave in a material medium (air or water for example) created when an object vibrates back and forth. The frequency of the sound is dependant on the number of full oscillations that occur during one second.

Humans can hear frequencies from roughly 20 to 22,000Hz but are most comfortable with frequencies of 2,000 - 4000Hz, Why?

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Most useful for speech recognition!

Perceived Sound

Sound enters the ear vibrating the ear drum, these vibrations are picked up by receptor cells that transduce(electrical signal) those vibrations into a signal to be interpreted by the brain. The brain processes the signal in order to identify qualities such as loudness, pitch and timbre.
What is timber?

Perceived Sound

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What is timber?

The character or quality of a musical sound or voice as distinct from its pitch and intensity.

Binaural Sound

"Binaural recording means constructing an accurate artificial head, and placing microphones in the position of the eardrums. The resulting audio accurately records the effect of the sound travelling through the skull and ears, resulting in incredibly accurate positional sound that can be played back through any standard stereo headphones."

"Although it is a challenging technical task this can be simulated digitally, resulting in a a more immersive experience for all headphone wearing players, but of huge benefit for players with impaired vision, allowing accurate enough spatial awareness to navigate 3D environments via standard stereo headphones."

http://gameaccessibilityguidelines.com/

Two Big Ears

Head Related Transfer Functions (HRTF)

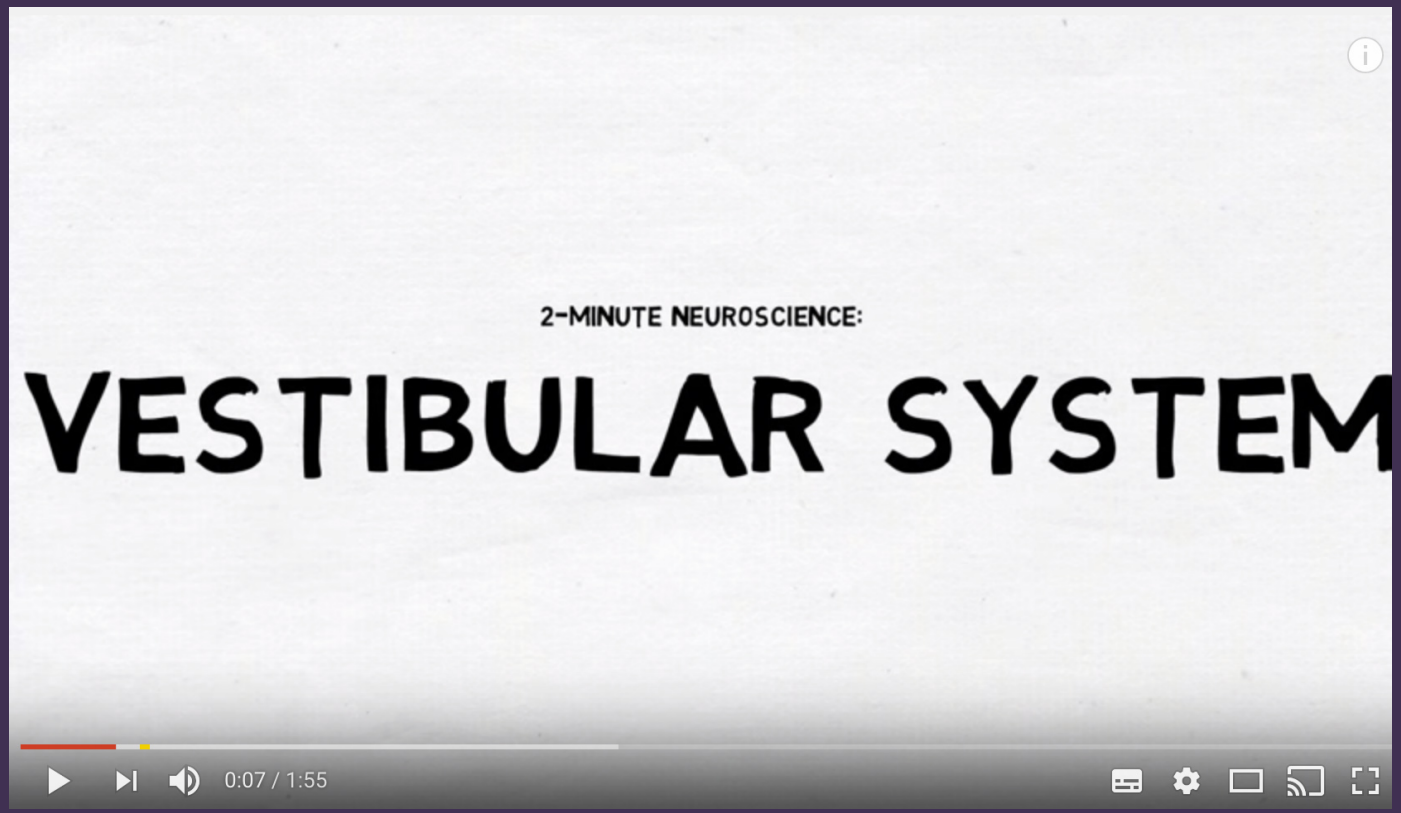
"HRTFs work by filtering an audio signal to recreate the complex cues that help us, as humans, localise sounds. The cues are influenced by multiple factors, including the listening environment and the shape of your body, head and ears. In reality, we move our heads and reorient ourselves to localise sounds. We constantly try to bring sounds (or the objects that are creating such sounds) into our line of sight to overcome the ambiguity of spatialisation."

Balance

There are three systems at work to aid in balance:

- Vestibular System (motion, equilibrium, spatial orientation)
- Proprioception (position, motion, and equilibrium)
- Vision (sight)

Vestibular System

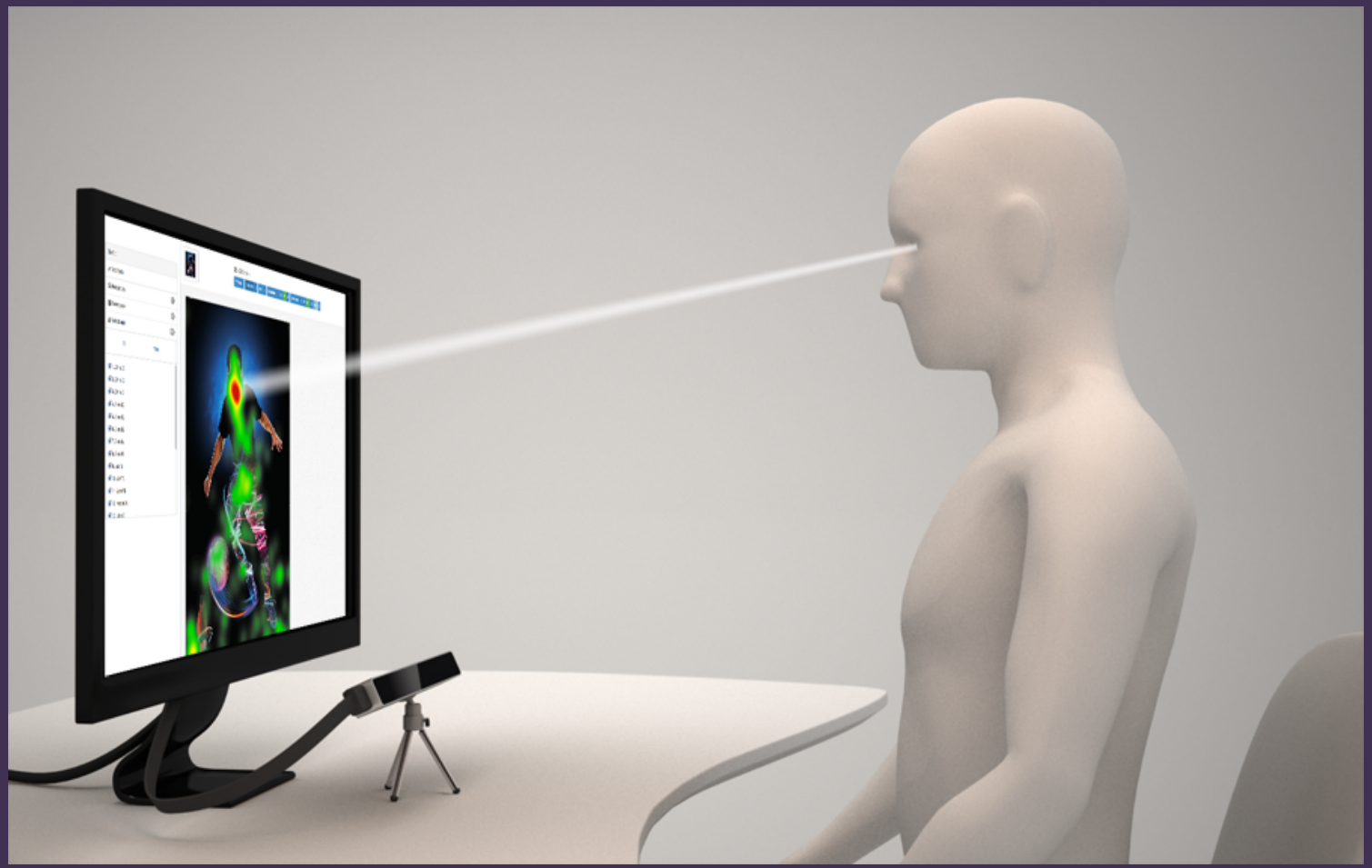


Visually induced motion sickness (VIMS) is a specific type of motion sickness caused by a conflict between vision and both the proprioception and vestibular systems.

According to Forbes, when a player is cycling a bike in VR, they have a tendency to lean to accommodate for corning, and as a consequence they fall off.

When tradition big screens cause VIMS the viewer can just look away but in VR this is not possible.

Eye Tribe - Demo



What is eye tracking good for?

- What parts of the page the user is looking at
- How long that section of the page holds their gaze
- How the user gaze moves from item to item
- What parts of the layout are overlooked
- How the user navigates the page
- How the proportions of items change the way the user interacts with the page

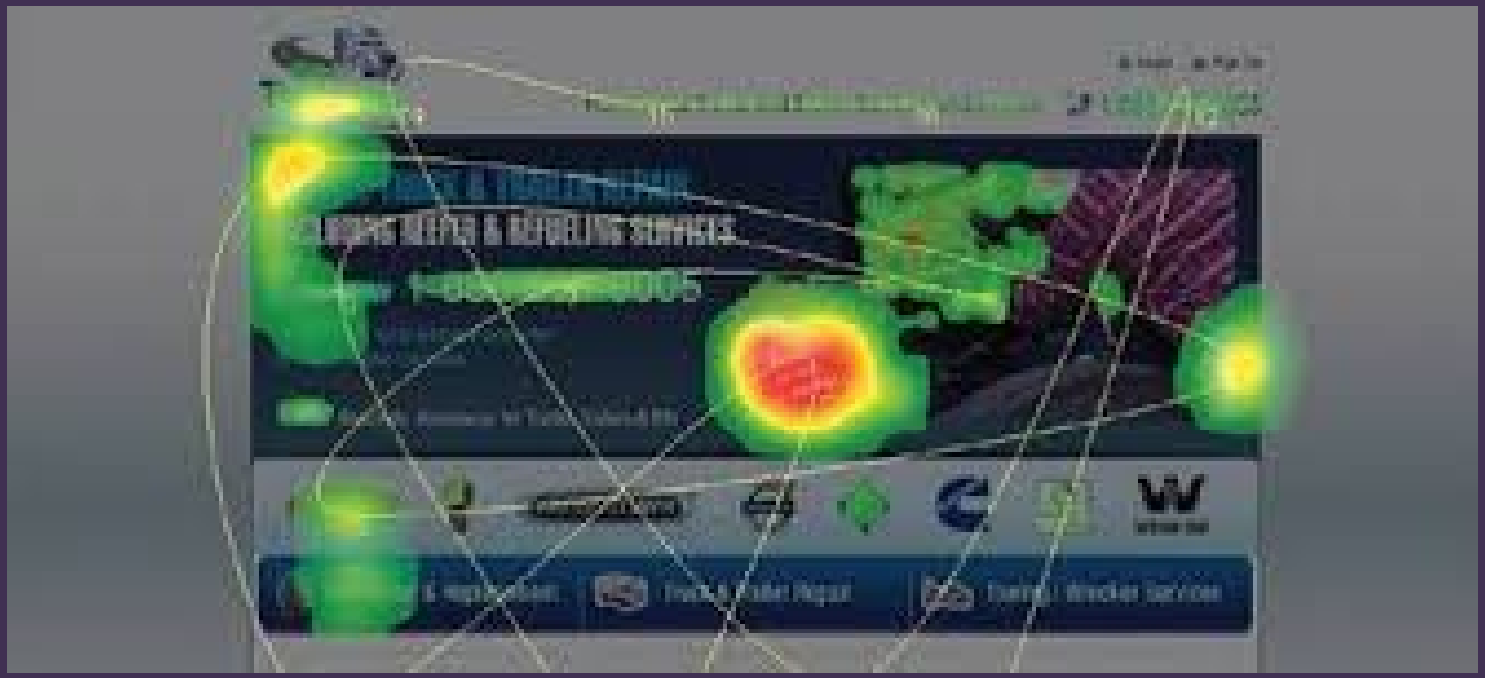


Figure: A color scale moving from blue to red indicates the duration of focus)

Figure: Red circles indicate the area of focus and the lines indicate the path.)

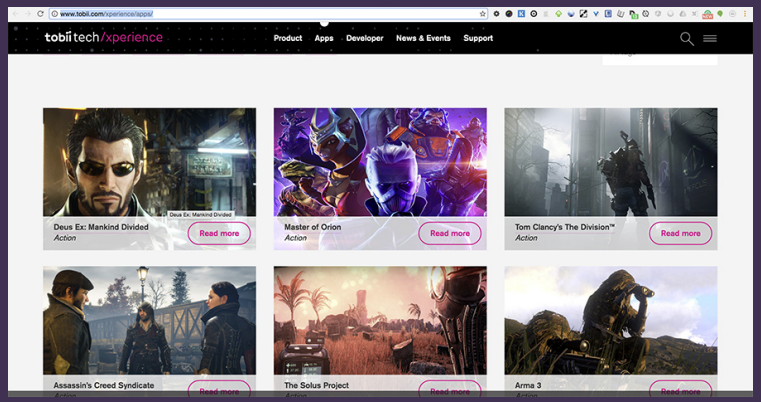
Eye Tribe - Considerations

- First and foremost, the user's position must be consistent in relation to the calibration.
- Sensor position must be solid and stable.
- Sensor most be under the monitor, not too close but also not too far away.
- Each tester will have a different setup. Allow time for this. (chair height, monitor position and so on.)
- The test environment should be distraction free.
- The user will naturally scan the whole screen before executing a task.

Think-Aloud Protocol

Eye tracking can be used in conjunction with other testing methods, although it is important to consider how this might effect the users attention and gaze.

DEMO - Calibrate and Control



Eye tracking is inevitable.

Eye Tracking control