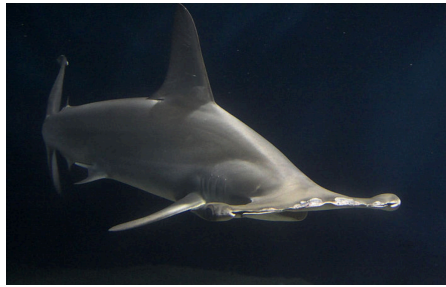
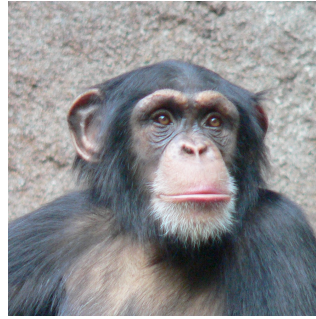




# 3D vision in the animal kingdom

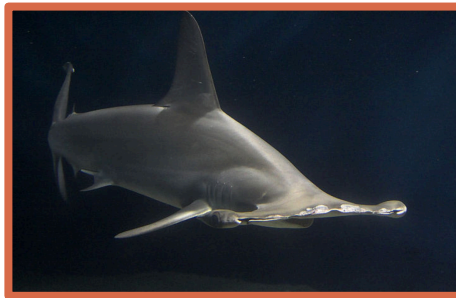
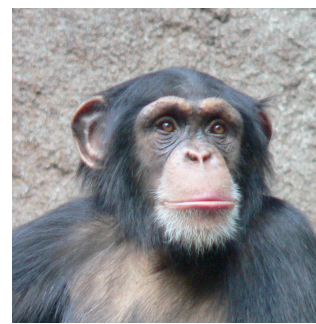
Which species, at what cost, and for which advantages?

# Many species, of different taxa



... have stereovision

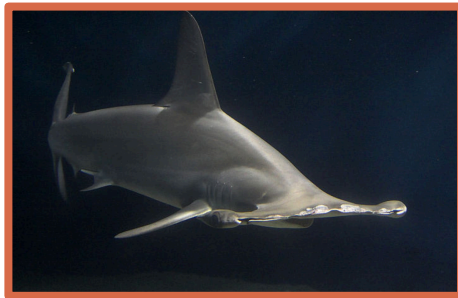
# Many species, of different taxa



... have stereovision



# Many species, of different taxa



## ... have stereovision



# Ingredients for stereovision

# Ingredients for stereovision

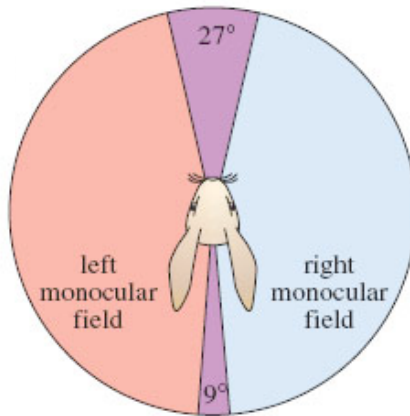
- Binocular overlap



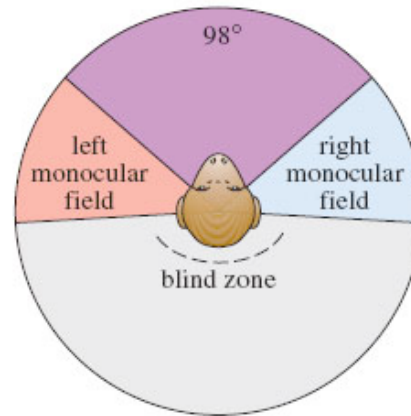
# Ingredients for stereovision

- Binocular overlap

Trade-off: Spotting predators (panoramic viewing)  
vs discerning preys (reduced field of view)



(a) rabbit



(b) monkey



# Ingredients for stereovision

- Binocular overlap
- Good acuity in both eyes

<b>E</b>	1	20/200
<b>F P</b>	2	20/100
<b>T O Z</b>	3	20/70
<b>L P E D</b>	4	20/50
<b>P E C F D</b>	5	20/40
<b>E D F C Z P</b>	6	20/30
<b>F E L O P Z D</b>	7	20/25
<b>D E F F O T E C</b>	8	20/20
<b>L E F O D P C T</b>	9	
<b>F D F L T C E O</b>	10	
<b>F E Z O L C F T D</b>	11	

# Ingredients for stereovision

- Binocular overlap
- Good acuity in both eyes
- Accurate co-ordination between two eyes in all directions of gaze



# Ingredients for stereovision

- Binocular overlap
- Good acuity in both eyes
- Accurate co-ordination between two eyes in all directions of gaze
- Ability of the brain to cause fusion of two slightly different images





# Ingredients for stereovision

- Binocular overlap
- Good acuity in both eyes
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- Ability of the brain to cause fusion of two slightly different images

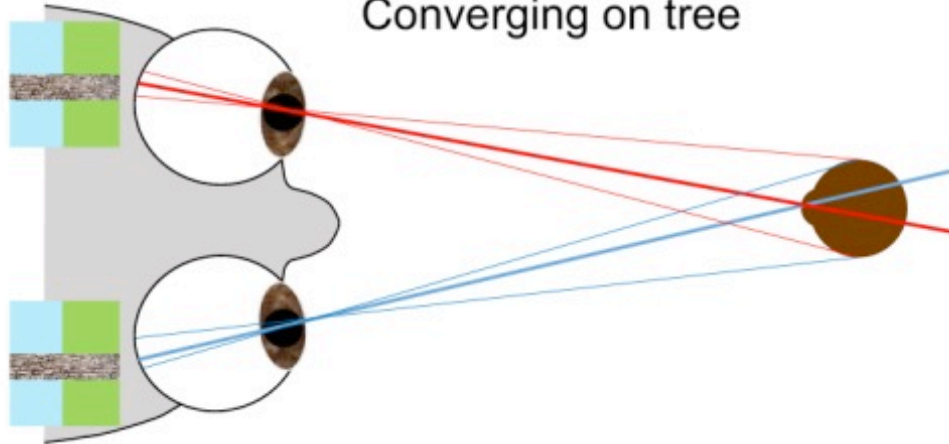


# Ingredients for stereovision

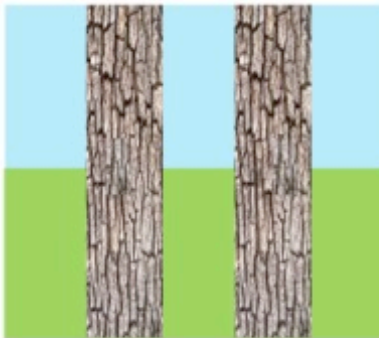
Binocular fusion



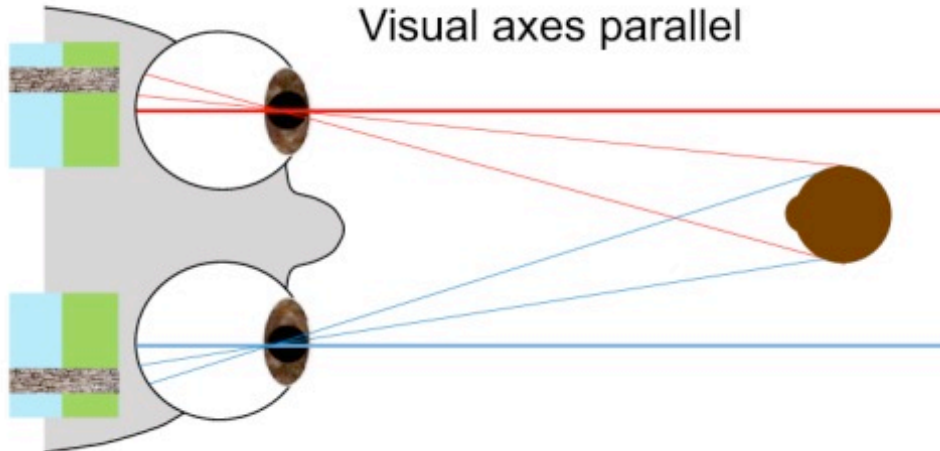
Converging on tree



Double vision

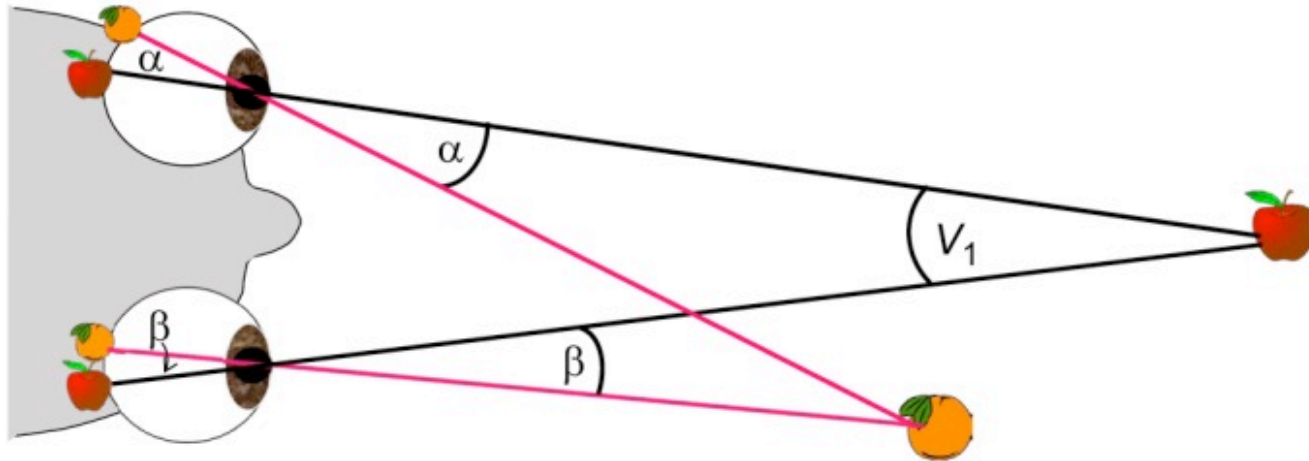


Visual axes parallel

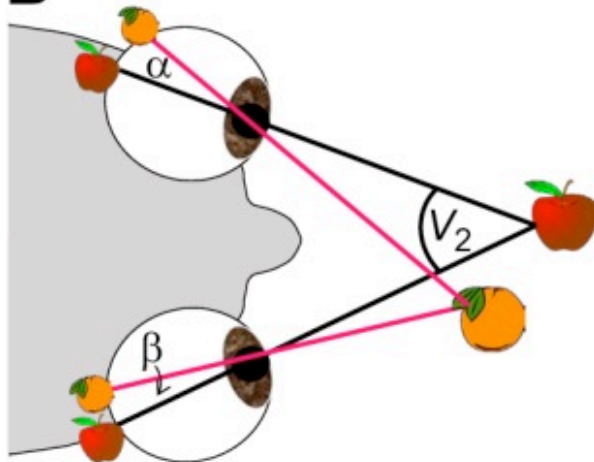


# Triangulation depth cues

**A**



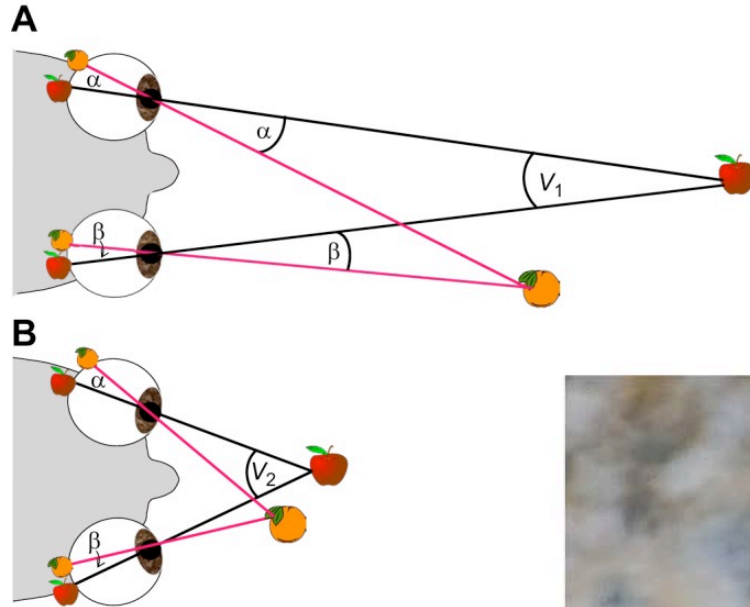
**B**



Projection on the retina  
+ angle of vergence

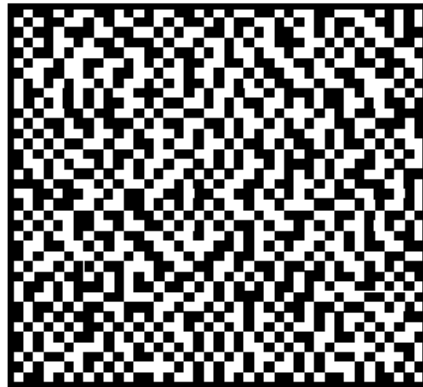


# Triangulation depth cues

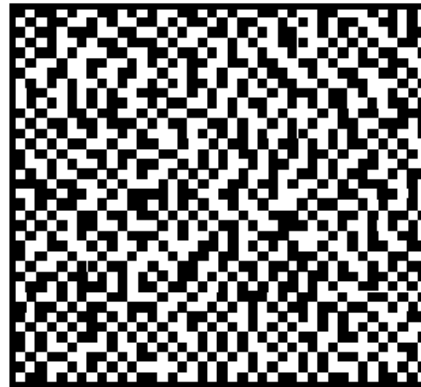


# How do we test stereopsis?

- Behavioural demonstration: Random-dot stereograms (Julesz)
  - Prisms, anaglyph filters, stereoscopes
- Neuron recording



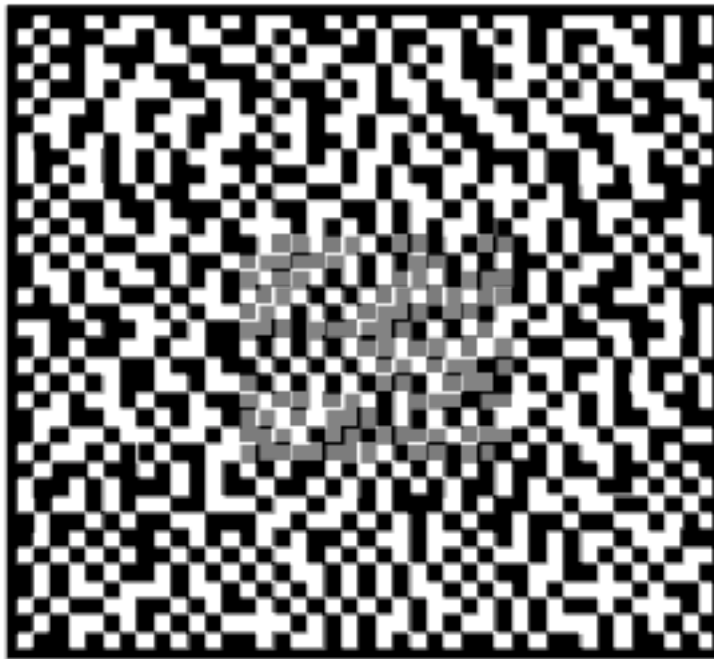
*Left eye*



*Right eye*

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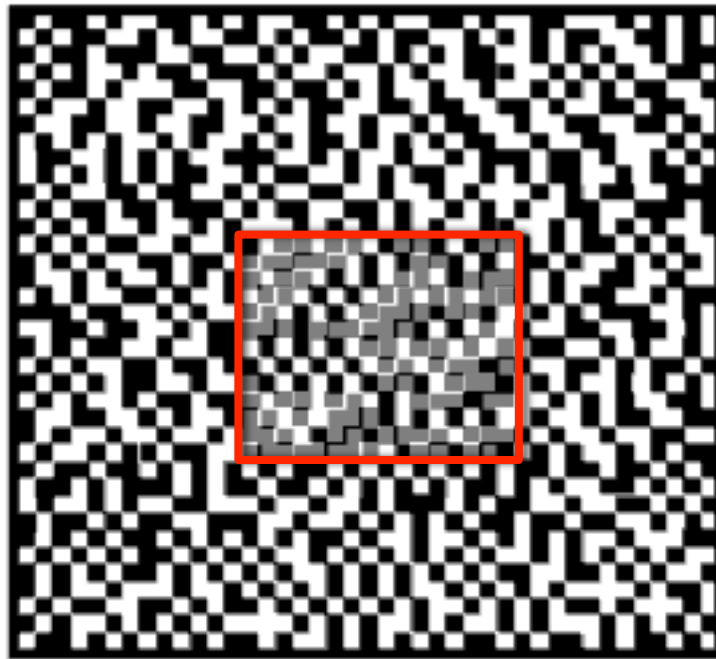


*Fused eyes*



# How do we test stereopsis?

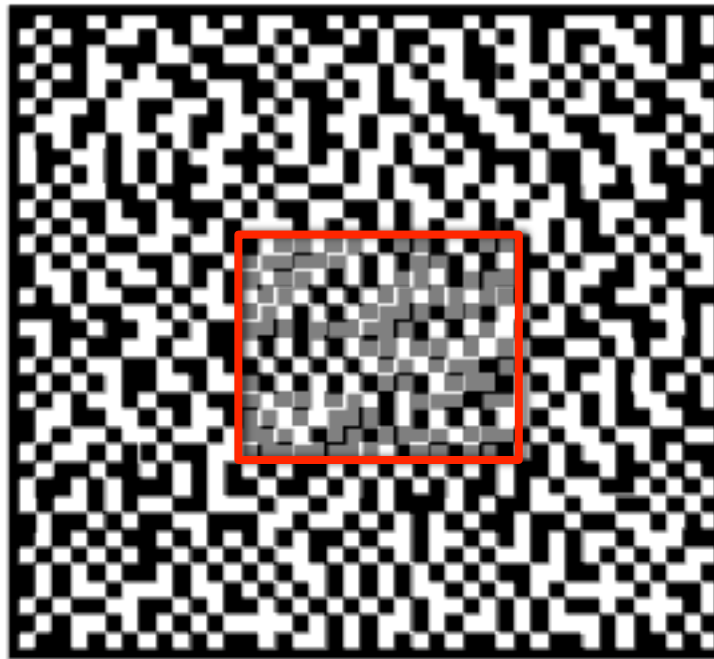
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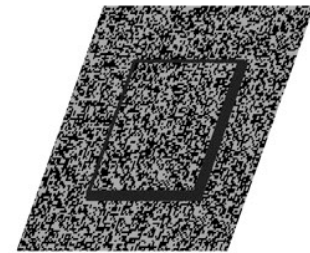
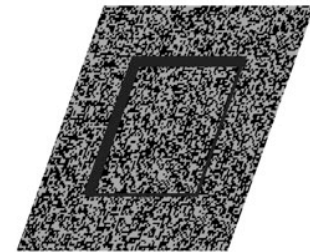
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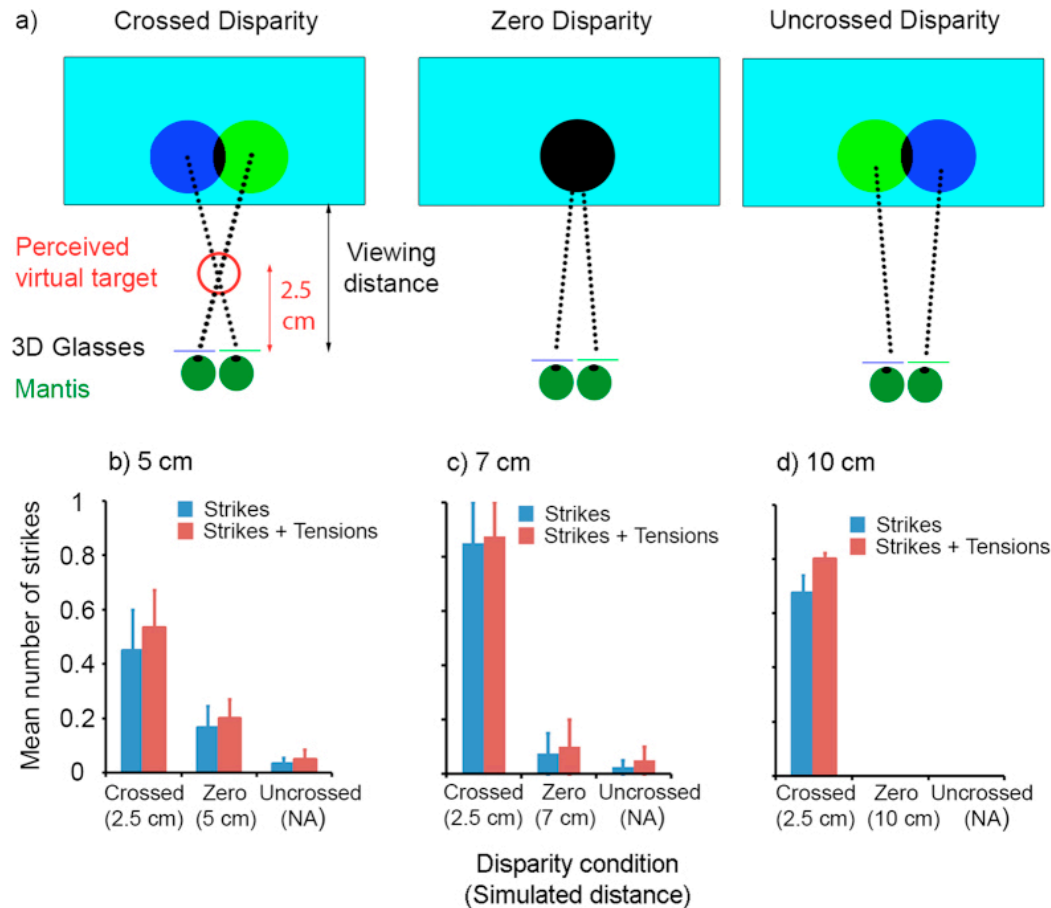


*Fused eyes*



*Visual percept*

# A behavioural study example



Nityananda, V., Tarawneh, G., Rosner, R., Nicolas, J., Crichton, S., and Read J. (2016). Insect stereopsis demonstrated using a 3D insect camera. *Scientific Reports*, 6, 18718.



<https://www.museum.toulouse.fr/-/evolution-et-vision-le-vivant-a-de-la-profondeur->