Creating Science – A Hole in Your Hand and our Sense of Sight

What you see, and how you make sense of what you see, are very different things – how?!

#CreatingScienceHoleInYourHand

Suggested outcomes

Science understanding

- Physical sciences 1: Light and sound are produced by a range of sources and can be sensed.

Also

- Physical sciences 5: Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science inquiry skills

- Planning and conducting F: Participate in guided investigations and make observations using the senses.
- Questioning and predicting 4: With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (ACSIS064)

Science as a human endeavour

- Use and influence of science 7: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Cross curricular outcomes

Health and physical education

- Contributing to healthy and active communities 4: Discuss and interpret health information and messages in the media and internet (ACPPS039) though exploring eye health, safety, and some fun science activities.

Science vocabulary words

Tier 1 (Everyday words) – eye, sight, seeing, illusion.

Tier 3 (Specialised vocabulary)

- Perception: organising our raw sensory information. Making sense of our senses.
- Inference: Assigning meaning and reasons to our perceptions, exploring the underlying causes of what we sense.

Warning

- Be careful with eyes! Some activities require students to look through things, bringing them close to their face. Help students understand and exercise eye care and first aid if necessary.

Preparation

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- Prepare a group of illusions for students to enjoy. There are plenty online, and in real life such as:
    - The Poggendorf illusion – the British flag (on a corner of the Australian Flag)
- You might like to print out, or present on a tablet computer, the images in this document at some point. Please have such a device ready with the information already downloaded.

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students' questions can and should guide student learning, more material is presented for your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

This activity is well suited to this age group.

Children at this age can have difficulty with focus. Avoid tangents into interesting side tracts if you're attempting to make a key point.

Middle:

This activity is excellent for this age group, and a great way to challenge expectations and beliefs. Challenge students to uncover new illusions, perhaps regarding another sense such as touch.

Teen:

Challenge student further to find and describe the underlying explanations (there are usually several) of why one particular illusion works. This is more challenging than it sounds – some explanations are quite technical. We recommend a 'near explanation' with honest ignorance is better that a fake, confusing, sciency technical explanation that leaves everyone less wise.

Learning Intent (student friendly)

'We are learning to' (WALT) appreciate our sense of sight though exploring illusions.

Success criteria

'What I'm looking for' (WILF) students to explore sight by finding their blind spot, or reporting they can successfully see the reversed image or make ‘a hole in their hand’.

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as ‘find my blind spot’, ‘make an illusionary hole in my hand’, or ‘explain how perception works’.

Evidence of learning

How will you know when the learning goal is achieved? What EVIDENCE do you have that your students have met or exceeded the learning expectations?

- Students can label some parts of the eye, depending on year level, and trace the path of light as it moves though the eye – including the reversed image that falls on the retina.
- Students will have gathered some interesting illusions and shared them with others.

Engage

Remind students that:

- Today we’re going to have some FUN with vision – remember, this is NOT a professional diagnosis. If you are concerned about your vision or perception in any way, please see your health care professional.

Show them the “Oh it’s a hippo’s head” at the end of this document.

⇨ After a giggle, ask: why did you think the man said that?

Explain: this is an example of visual constancy.

Explore

Ask:

- You see half a cat, do you believe the other half is still there?
- A hand grows larger in our visual field – is it growing, or getting closer?
- Does the sun move after crossing the horizon? Copernicus and Galileo had to convince us otherwise – that compared to the Earth, the sun does not move at all!

Ask: what is this an example of? (Visual perception)

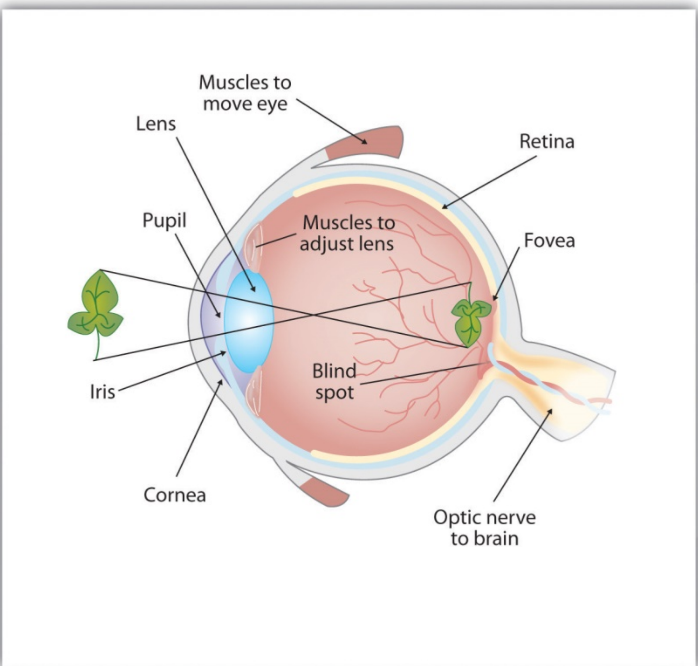
Explain: what we see, and how we make sense of what we see, are very different things! First, let us explore seeing.

Explain

Explain: Our sense of sight is, for most humans, our most important and dominant sense. Every part of that sense needs care and protection, and professional medical help when things go wrong.

How it works

- Light comes in through the clear cornea (it gets its oxygen supply directly from the air and has no blood vessels, thankfully, or the blood would get in the way of us seeing!)
- Light passes through the small hole known as the pupil, which can change its shape to let in more or less light.
- The light is focused by the lens, which can change shape as the muscles around it contract and relax. As we get older the lens gets firmer, making it harder to focus.
- The light shines through the vitreous humour (Latin for 'glassy fluid' – yup, it's like jelly, but it helps to keep the eye inflated and if it was full of air instead, it would be likely to pop!).
- The light flips upside down and back to front to land on the retina, which is a kind of screen that detects light. It has two kinds of detectors, rods and cones.
    - Cones correspond (roughly) to red, green and blue. (They also block out the opposite colour, which is why we can get the after image effect.)
    - Rods are sensitive to any kind of light, and are particularly effective at low levels, such as at night.
- The retina turns those light pulses into electrical signals, and sends it towards the brain.
    - The focal point of the retina is an indent called the fovea. It has no rods, and an intense collection of cones.
- The nerves that send the light to the brain are collectively called the optic nerve. This nerve also helps to process the information, helping to define edges, recognisable shapes, and motion.
- The nerve passes through the midbrain, where the information from the left side of your body is passed to the right side of the brain, and the information from the right side of your body is passed to the left side of the brain. Why? To give it more time to organise and interpret information from all the senses. The midbrain reacts very quickly



http://open.lib.umn.edu/intropsyc/chapter/4-2-seeing/

to threats, but does not think about them very much. [1]

- The optic nerve (and associated nerves) ends up at the optical cortex, located at the back of the head. Here is where the actual seeing happens, as opposed to detecting light.

Elaborate

There are loads of fun ways to trick our visual ability.

Perceptual constancy

From birth and perhaps even before that, our brain needs to learn a whole bunch of tricks for organising what it sees and how that relates to reality.

One trick is perceptual constancy – the theory that an object will continue to maintain certain characteristics even when it appears to change, or even when the object disappears completely.

- For example, as an object gets nearer to our face, it appears to grow in our visual field. Is this because it is actually getting bigger? Babies soon learn that visual size often indicates closeness, not actual size. (We still have a blinking reflex to keep us safe, however).
- Also, seeing the head of a cat, especially one that is moving as though it is alive, usually means that the rest of the cat is there, but not visible.
- And when someone places an object under a cup, the object is still there, but it no longer visible.

These are examples of perceptual constancy.

A still world

Are you on a moving world?

What does it mean when the sun goes below the horizon – has it moved, or you?

Galileo and others convinced science that, despite the evidence of our senses, the earth moves and not the sun (relative to each other, at least).

But it doesn't feel like it, because it is a very smooth ride!

Or is this a better example of an equilibrium illusion than a visual one?

Dominant eye

1. Look at a spot on the far wall
2. Both eyes open, cover the spot with your finger
3. Slowly trace your finger back to your face, while covering the image at all times. You will end up pointing at only one eye - your current dominant eye.

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[1] I once knocked a glove from the top shelf of my cupboard. On its way, flailing down, it looked maybe just a little like a spider. By the time it hit the ground I'd already realised it was just a glove, but my midbrain was too quick to judge, and I leapt back anyway!

Just like many of us have a dominant hand that we tend to use the most, with the other one coming in for support, we often have a dominant eye that does a majority of the perception work.

Sometimes one eye (and its associated brain tissues) becomes so lazy it will all but stop seeing completely. This can be a big problem in young children – but it's easy enough to fix, they just have to wear an eye patch over their good eye for a few hours a day to get their lazy eye working like it should.

After image

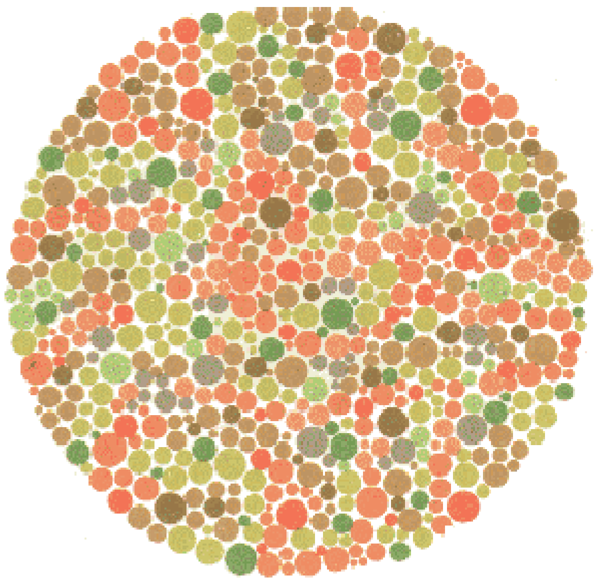
Stare at any picture for around 30 seconds without moving your eyes, then close them tight. You will get a reverse colour image of the picture. This is because our eyes, like most of our senses, acclimatise to certain sensations over time. Our eyes are constantly moving to try and overcome this tendency, and we almost never notice! (Some eyes move way too much, and that's a problem too.)

Taken 15 may 17 from https://www.moillusions.com/black-and-white-spanish-castle-in/

Bifocal vision

Our brain has to combine two separate images, one from each eye, into a coherent image. We can have a lot of fun with that!

- ⇨ Try the 'hole in the hand' activity from the hand out.
- ⇨ Try the 'floating finger' activity.
- ⇨ Try the '3d images from 2d pictures', found in books or the internet, also known as Magic Eye pictures.



Colour vision

Ishihara plates taken 15 may 2017 from Public Domain, - see appendix https://commons.wikimedia.org/w/index.php?curid=1696003

Our blind spot

While our fovea is the place our eyes use to focus on details, the fact is the nerve endings run over the TOP of the retina, and not underneath it. (We don't yet know why!) Making it even harder for our eyes to see.

All those nerves collect together, and need to exit the eye somewhere so they can make their way to the brain. That place is called the optic nerve, and where it leaves the eye there's no room for a bundle of rod or cone cells – SO THAT PART OF EVERY HUMAN'S EYE IS BLIND.

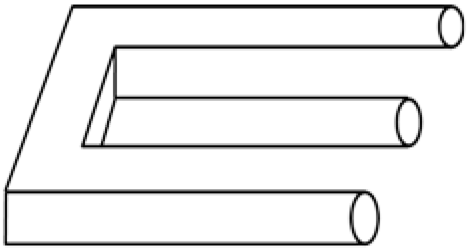
But what's even more amazing, is that we are BLIND TO BEING BLIND – our brain covers up that gap using the image from the other eye, so that we rarely even notice it. Activities like the following can help bring out the blind spot. With practice you can find it any time you like, but you need to keep one eye closed!

- ⇨ Find your **blind spot**: Cover your left eye, look at the circle, move your head forwards and backwards until the star disappears! (at about 30 centimeters).

Having trouble? Don't despair! It's very tricky the first few times!

- ⇨ Try this: Cover your right eye, look at the star, move your head forwards and backwards until the circle disappears!

Impossible object



Art that in part makes sense, but as a whole would be physically impossible.

Wikipedia: "The unsettling nature of impossible objects occurs because of our natural desire to interpret 2D drawings as three-dimensional objects."

The artwork of M.C. Escher is a great example – look it up!

And many more!

Enjoy many illusions, and try to figure out how they trick your brain. You may need to research your own questions online.

Evaluate

- ⇨ Review with students what they felt they learnt from this lesson. Did they have any questions at the start that they feel were answered?

Success criteria

- ⇨ Review the Learning Intentions of this lesson with students. Was it met?

At the end of each class, review the learning objective and see how we did. Ask:

- Did you achieve your learning goal?
- What did You learn?
- What worked to help you achieve it?
- What might you do better next time?
- (If needed) where can you go for extra help or information?

Assessment

Prior learning:

Take time to focus on planned content material during the engage phase, for example,

- Have students bring in their favourite illusion to share with the group.
- Have students label a picture of the eye.
- Have students attempt to trace the path of light thorough the eye.
- Explore some illusions and offer students the chance to explain why they work.

Formative:

As students are learning, help them self-monitor their own learning and achievements. Take the time to help each student master the illusion, gaining help from each other are more-knowledgeable others such as yourself. Most illusions require some physical skill, and can be quite difficult at first.

Be sensitive, some students have serious eye issues, and sometimes they're not even aware. Remind students that everyone sees differently and that's OK. Warn parents that we will be doing work on sight and illusions to help them prepare their students.

Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do.

- Explore sicknesses and illnesses that can damage or destroy human vision, the things we are doing to help overcome them, and what we still don't know.
- Using your knowledge of visual and perceptual illusions, do you think that you might be able to create your own?

So what?

Sight is interesting, and illusions are fun!

Everyone sees differently, and that's OK. Sometimes we need professional help to overcome challenges in sight.

Creating science

Science understanding

By exploring sight and illusions, we saw that;

- Physical sciences 1: Light and sound are produced by a range of sources and can be sensed.

And in upper year levels as we traced the path of light through the eye, that;

- Physical sciences 5: Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science inquiry skills

By investigating illusions and exploring their inner workings, we;

- Planning and conducting F: Participate in guided investigations and make observations using the senses.
- Questioning and predicting 4: With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (ACSIS064)

Science as a human endeavour

As we learned about human vision and how professional help can make a difference, we saw that;

- Use and influence of science 7: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

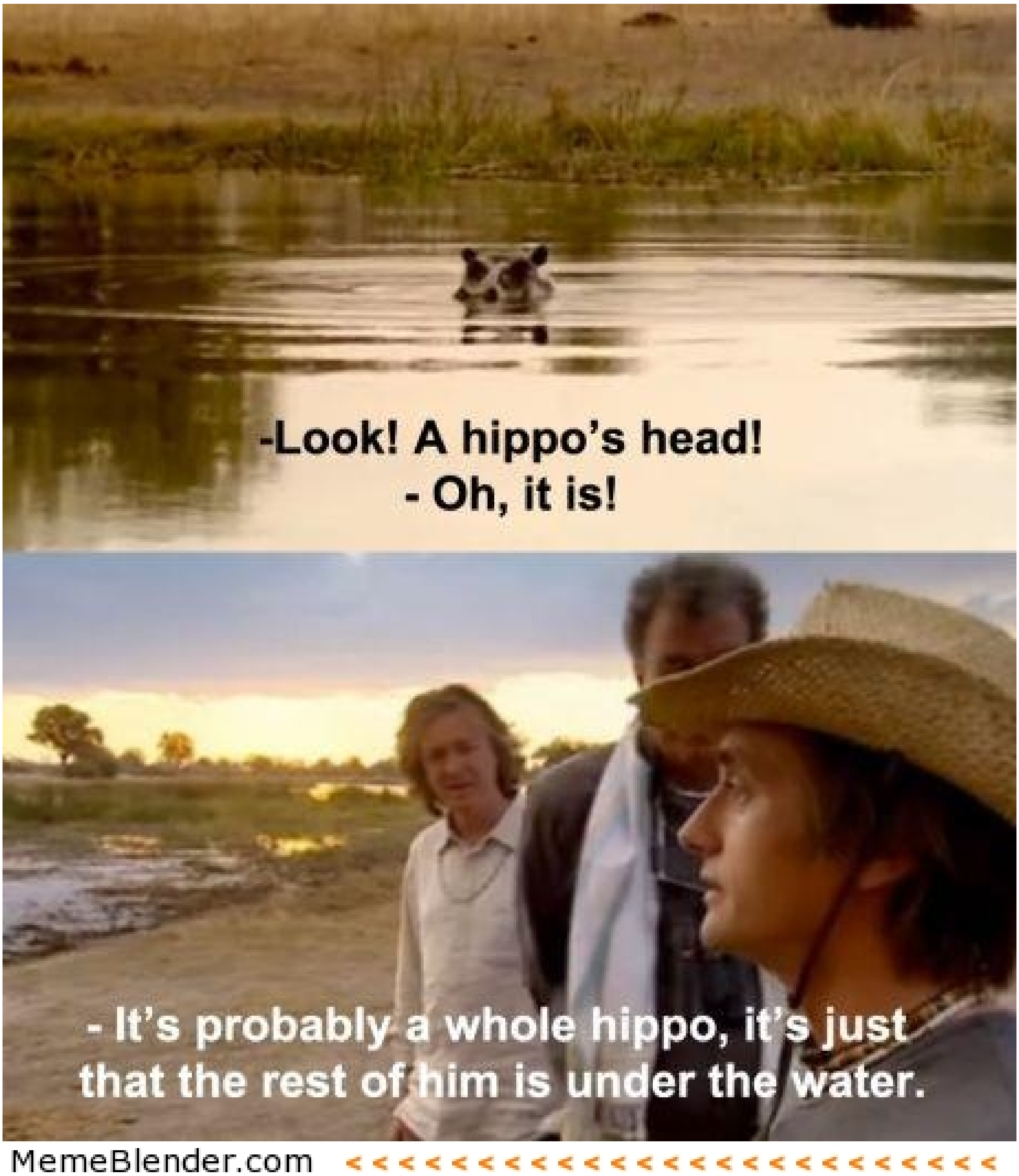
Cross curricular outcomes

Health and physical education

Though exploring eye health, safety, and some fun science activities, we had the chance to;

- Contributing to healthy and active communities 4: Discuss and interpret health information and messages in the media and internet (ACPPS039)

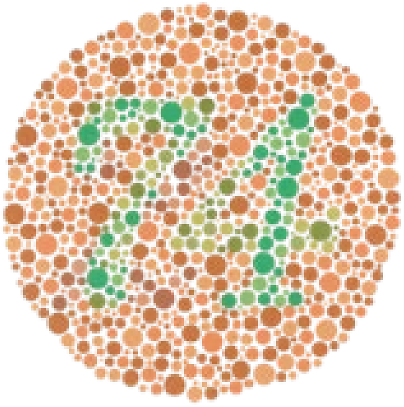
Appendix – look, it's a hippopotamus



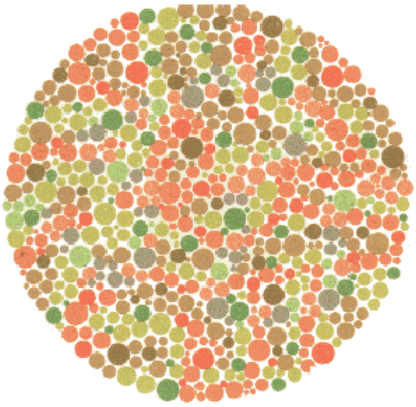
taken 15 may 17 from http://imgur.com/gallery/CfY5zAL

Appendix – Ishihara plates

Ishihara plates taken 15 may 2017 from Public Domain, https://commons.wikimedia.org/w/index.php?curid=1696003. If you are concerned about your colour vision, please see your health care professional.



Example of an Ishihara color test plate. The number "74" should be clearly visible to viewers with normal color vision. Viewers with dichromacy or anomalous trichromacy may read it as "21", and viewers with monochromacy may see nothing.



Ishihara Plate No. 19 (Nothing (hidden digit plate); Red-Green deficiency sees 2)

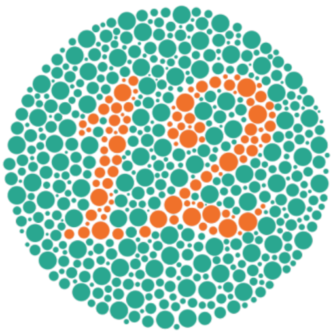
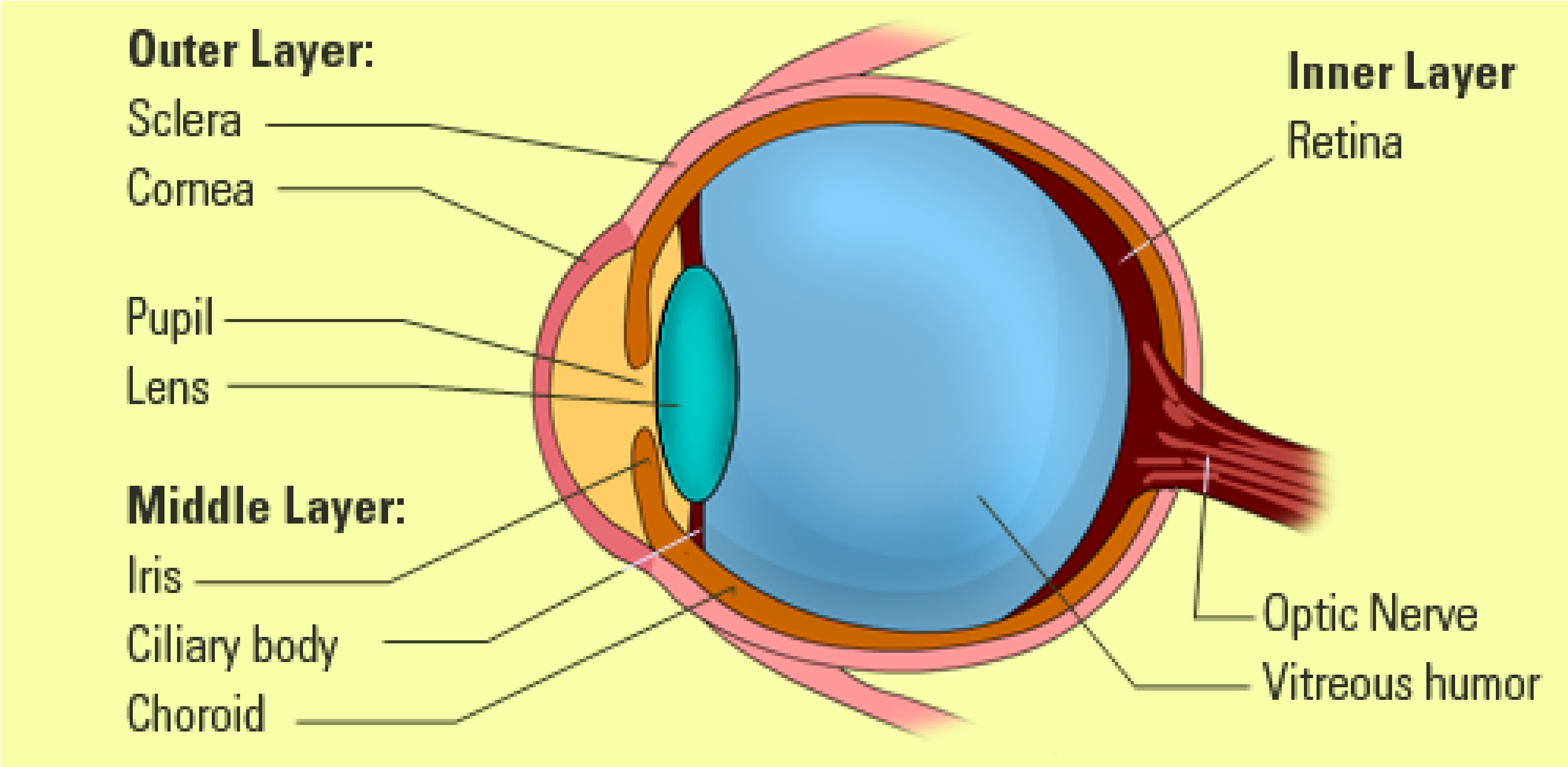


Plate 1 – most people see the number 12.

Appendix – our beautiful eye



Taken 15 may 17 from http://eschooltoday.com/science/the-five-senses/the-sense-of-sight.html