

# Magic in the Brain: what visual illusions and magic tricks can reveal about how we see and about the human brain



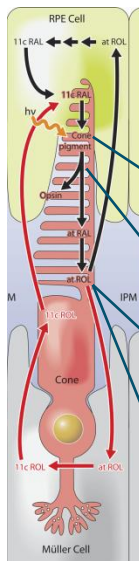
## Introduction

- Over the centuries magicians have learned to perform acts that defy the laws of nature by using completely natural means, such as **visual illusions** and **cognitive illusions**.
- Visual illusions are phenomena in which the subjective **perception** of a stimulus does **not** match the physical **reality** of it.
- Cognitive illusions, on the other hand, involve higher level cognitive functions, such as attention and expectation.
- The **aims** of this study are to **present a visual illusion and a magic trick** to approach the workings of the human visual system and brain and to **discuss** the **tools** that **magic** and visual illusions can provide in the future to study attention, awareness and the human consciousness.

## Methods

- Literature research on PubMed:** selection of 20 out of 50 original articles and reviews according to their novelty and to the quality of the journal and authors.
- Design of The Color Switch Illusion:** selection of a personal picture, creation of a symmetrical copy using an image editing program and drawing of a green and a red squares. Assembly of the components to create *The Color Switch Illusion* (**Fig.2**)
- Learning of The Vanishing Ball Illusion:** meeting with the magician Mag Rovi, learning of the trick and experimentation with volunteers to know their reactions. Recording and footage editing of *The Vanishing Ball Illusion* (**Fig.3**)

## How we see

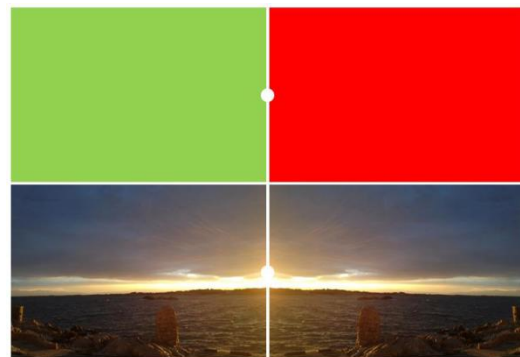


### Cone pigment

- Cone opsin:** glycoprotein with seven transmembrane alpha helices coupled with a G-protein.
  - 11-cis retinal (11c RAL):** compound derived from vitamin A.
- A photon absorbed by its specific opsin interacts with the **11c RAL**, turning it into **all-trans retinal (at RAL)**
  - This change **activates** the opsin, initiating the **signal transduction cascade** that will convert a light stimulus into an electric signal.
  - The transformation into at RAL turns the **complex opsin-retinal** unstable, and they **separate**.
  - To respond to new stimuli, the at RAL must be **recycled** to 11c RAL, through previous conversion to all-trans retinol (at ROL) and 11-cis retinol (11c ROL), and reunited with the opsin.
  - Under a **persistent stimulus** there is not enough time to recycle all the at RAL into 11c RAL to keep up with the entrance of new information.
  - This will lead to a decrease in the sensitivity to this stimulus a phenomenon known as **visual adaptation**

**Fig.1.** Visual cycle in the vertebrate eye. *IPM*, interphotoreceptor matrix. *hv*, photon of light. *RPE*, retinal pigmented epithelium. Adapted from Kefalov et al.

## The Color Switch Illusion



### Instructions

- Check that the two inferior pictures are the same but symmetrical image.
- Then fix your eyes on the superior white dot between the two colored squares during 30 seconds.
- Finally, fix your eyes in the inferior white dot between the two symmetrical photographs.

**Fig.2.** The Color Switch Illusion. Ideas adapted from Beau Lotto

- By staring 30 seconds at the white dot between the two colored squares you have **run out of 11c RAL** in your right-eye red cones and in your left-eye green cones.
- As it takes time to recycle the at RAL back to 11c RAL, when you switch your gaze from the superior to the inferior white dot after these 30 seconds your **right** eye has suffered **visual adaptation** to the **red color** wavelength and your **left** eye to the **green** one.
- This is why you see the right picture as if the red color had been wiped out (or as if you were using a red filter) and the left picture as if the green color did not exist (green filter).

## The Vanishing Ball Illusion

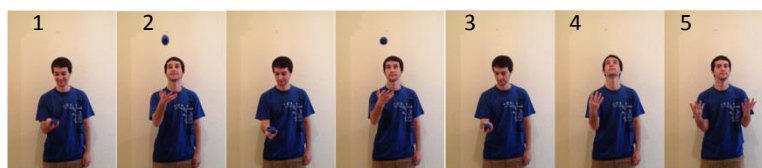
- The spectator is **primed** to see how it is like to throw a ball and catch it, and thus he knows what to **expect**.

- In the final toss the spectator is **expecting** a ball to be thrown up and caught just like the previous attempts. His **attentional** levels are **lower** than at the beginning because of the **repetition**.

- Misdirection:** using his gaze the magician draw the **attention** of the audience to the **effect** (the ball disappearing) and away from the **method** (the ball being hidden in the palm).

- Magic:** the spectator saw a ball going upwards that does not come down. The brain checked that everything was like the previous attempts: thus, the last plausible explanation is that the **ball has magically vanished**.

Despite knowing that the **ball is hidden** in the palm, each time you experience the illusion you "**see**" the ball going upwards. In that way, your brain is tricked every single time.



**Fig. 3.** Footage from The Vanishing Ball Illusion. Full recording available at: <http://youtu.be/4IYppduuESw>

### Summary

- Priming
- Repetition
- Expectation
- Misdirection
- Magic

## Conclusions

- Visual illusions **reveal** and exemplify the **underpinnings of human vision**.
- The **design of new illusions** could become a **line of research** to shed light on some concepts about vision that remain unknown.
- Magicians' techniques can provide **powerful methods** to manipulate attention and awareness in the laboratory, in order to design more robust experiments to **study the human consciousness**.
- These new techniques can lead to **diagnostic** and **treatment** methods for patients suffering from brain trauma derived **attention deficits**, **autism** and **attention-deficit hyperactivity disorder**.
- Despite the benefits that a science of magic would entail, it is necessary to remember that magic is one of the oldest forms of art and relies on people's ignorance of its methods. **Care has to be taken** in using these techniques to **investigate the human mind without destroying the mysteries** that give us so much joy.

## Acknowledgements

I would like to thank Mag Rovi for introducing me to the world of magic and for sharing the foundations of incredible tricks.

## Contact information

In case you have any question, ask me or contact me at [o.pavon.5ht@gmail.com](mailto:o.pavon.5ht@gmail.com)



## References

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