Informatics 1 Cognitive Science

Lecture 12: Visual Perception Part 1

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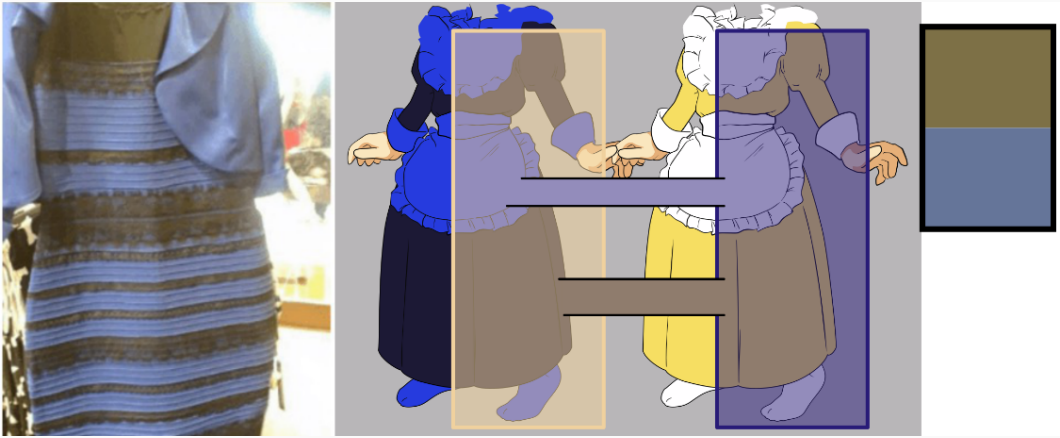
Overview

Sensory systems and the world

Do we perceive the world the same?

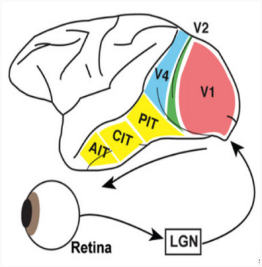
Experiment: What is the colour of the dress?

In vision (interpretation of) context matters



An everyday task for the brain

Sensory input



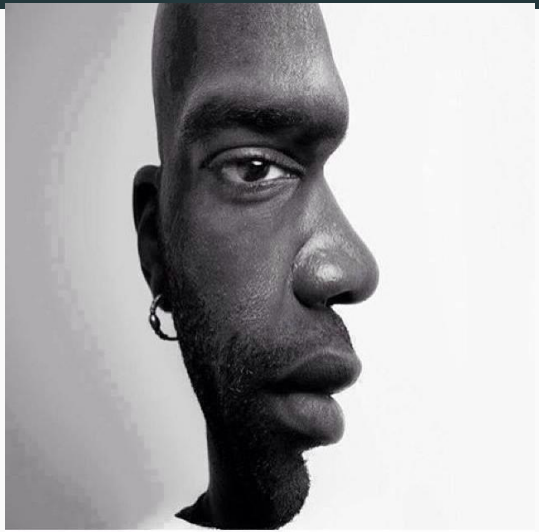
Motor output

In daylight conditions, about 6 million photoreceptors send their signals to various brain areas that process visual information. What we perceive is an interpretation of the image, much detail is discarded along the way.

An everyday visual scene?

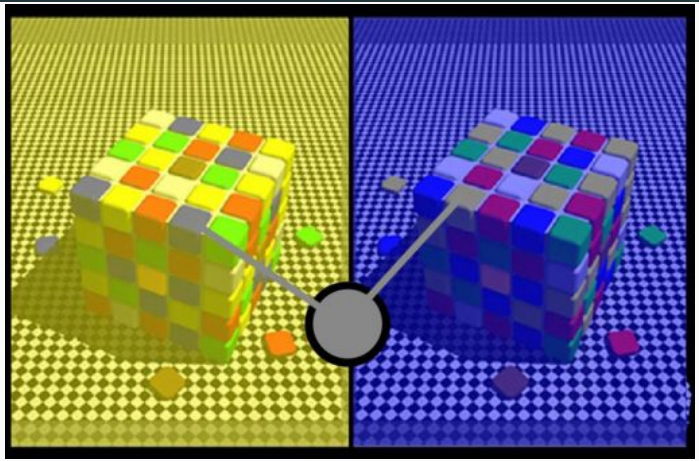
Three Sphinxes of Bikini - Salvador Dali

Are visual percepts unambiguous?



Bistable perception

Does the same always look the same?



Colour constancy

Is this the same Haystack?

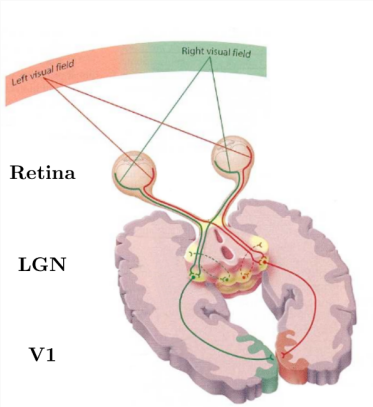
Claude Monet's Haystacks

Understanding visual perception

- The sensory world is high-dimensional: Requires compression and simplification.
- Biological systems have limitations: Optimality under resource constraints.
- Elanor and James Gibson's ecological constraints: Environment and animal are inseparable, hence the senses are adapted to the environment.

Structure of the visual system: Visual pathways

The Occipital Lobe

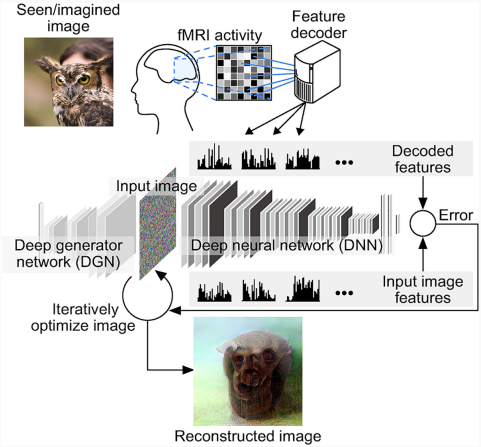


Light → Retina → Lateral Geniuclate Nucleus (LGN) → Primary Visual Cortex (V1)
Information also travels to other sub-cortical brain areas. Visual cortex activation is required for conscious perception.

Representation of the Visual Field

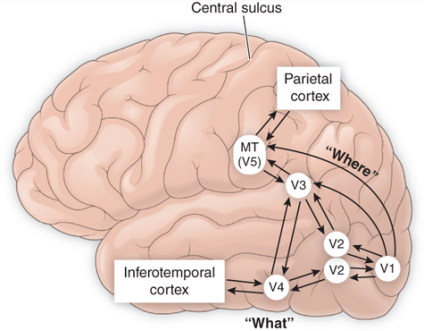
The projection from the retina to V1 is *retinotopic* – adjacent points in the image are represented by neighbouring neurons. The largest part of the visual cortex is dedicated to the central visual field - the fovea in the retina.

Retinotopy enables Image Decoding



A decoder (here a neural network) is trained on fMRI recordings. (Shen G, Horikawa T, Majima K, Kamitani Y (2019). PLoS Comput Biol 15(1): e1006633)

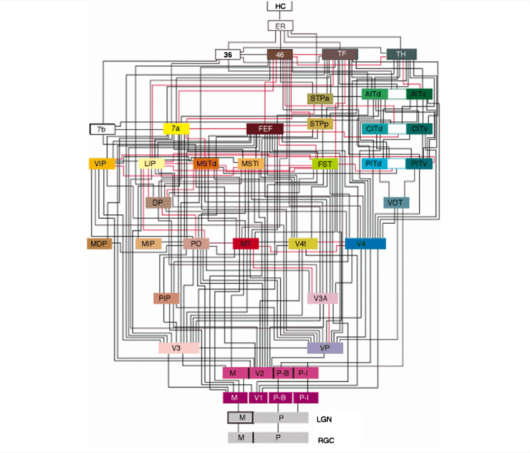
Higher Visual Cortices



Dorsal "where" pathway: Location and movement, spatial and attention.

Ventral, "what" pathway: Form, shape and object recognition.

Complexity of Anatomical Visual Pathways



Felleman & Van Essen, 1991

Summary

Summary

- Vision is an interpretation: context and prior assumptions shape what we perceive.
- Constancies (e.g. colour constancy) stabilise perception.
- The sensory world is high-dimensional, so the visual system compresses and discard detail.
- Main pathway: Retina $\rightarrow$ LGN $\rightarrow$ V1; V1 activity is required for conscious vision.
- Higher visual areas split into dorsal ("where") and ventral ("what") pathways.