PERCEPTION AS THE SOLUTION OF AN INVERSE PROBLEM

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BERTRAND RUSSELL (1872-1970)

"A physical process starts from a visible object, moves to the eye, there changes into another physical process in the optic nerve, and finally produces some effects in the brain simultaneously with which we see the object from which the process started, the seeing been something "mental", totally different in character from the physical processes which preceded and accompanying it. This view is so queer that metaphysicians have invented all sorts of theories designed to replace it with something less incredible."

VISUAL PERCEPTION AS THE SOLUTION OF AN INVERSE PROBLEM

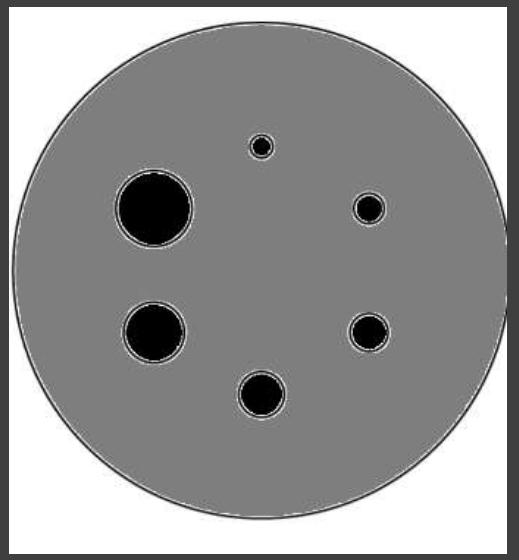
Perception is achieved via
deconstruction & reconstruction

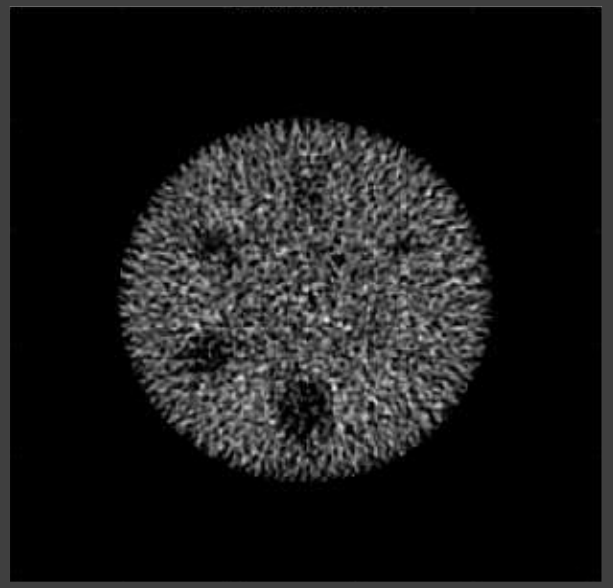
For the recognition of a specific percept, the brain's input is the distribution of photons emitted from this object. As soon as the photons arrive at the retina, a complicated neural process is initiated that finally gives rise to the creation of the **mental image** of the object.

JASZCZAK PHANTOM

Medical Imaging:

Reconstruction via SPECT





$$\widehat{f}_{\mu}(\rho,\theta)=\int_{-\infty}^{\infty}e^{-\int_{\tau}^{\infty}\mu(s\cos\theta-\rho\sin\theta,s\sin\theta+\rho\cos\theta)\mathrm{d}s}\times$$

$$f(\tau\cos\theta-\rho\sin\theta,\tau\sin\theta+\rho\cos\theta)\mathrm{d}\tau,\ 0\le\theta<2\pi,\ -\infty<\rho<\infty$$

$$f(x_1,x_2)=-\frac{1}{2\pi}\int_0^{2\pi}e^{M(\tau,\rho,\theta)}\left[M_\rho(\tau,\rho,\theta)G(\rho,\theta)+G_\rho(\rho,\theta)\right]\Big|_{\substack{\rho=x_2\cos\theta-x_1\sin\theta\\ \tau=x_2\sin\theta+x_1\cos\theta}}d\theta,$$

$$G(\rho,\theta)=e^{-\frac{1}{2}\widehat{\mu}(\rho,\theta)}\left[\cos\left(F(\rho,\theta)\right)G^C(\rho,\theta)+\sin\left(F(\rho,\theta)\right)G^S(\rho,\theta)\right],$$

$$G^C(\rho,\theta)=\frac{1}{2\pi}\oint_{-\infty}^{\infty}e^{\frac{1}{2}\widehat{\mu}(r,\theta)}\cos F(r,\theta)\frac{\widehat{f}_{\mu}(r,\theta)\,dr}{r-\rho},$$

$$G^S(\rho,\theta)=\frac{1}{2\pi}\oint_{-\infty}^{\infty}e^{\frac{1}{2}\widehat{\mu}(r,\theta)}\sin F(r,\theta)\frac{\widehat{f}_{\mu}(r,\theta)\,dr}{r-\rho}.$$

VISUAL PERCEPTION

Visual perception involves the process of deconstruction and the solution of a complicated inverse problem. The latter solution is achieved via unconscious neural computations, which illustrate the crucial importance of unconscious processes.

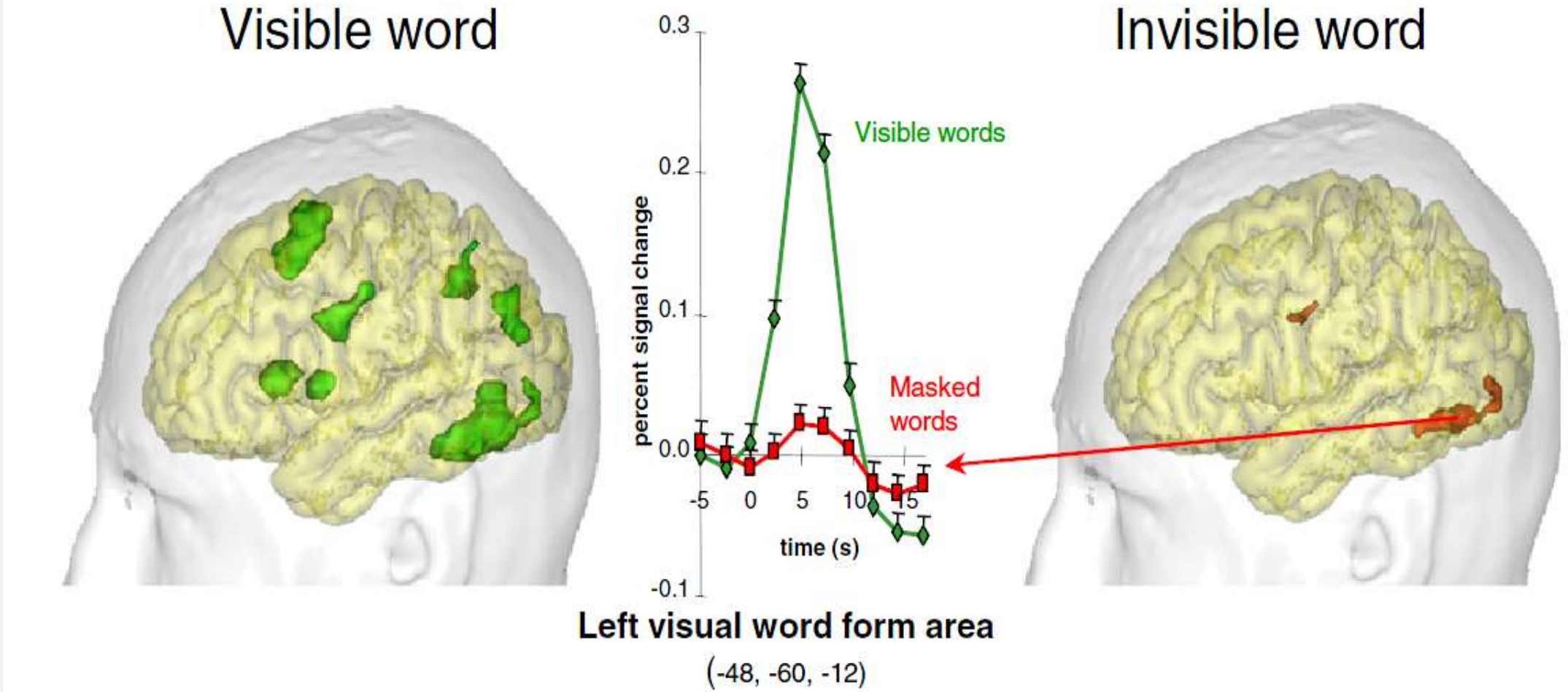
In visual perception, **awareness** is preceded by an **unconscious process**.

First hypothesis:

every conscious experience is preceded by an unconscious phase.

MENTAL REPRESENTATIONS

The **mental representations** of the constituents of a percept are constructed via the solution of different inverse problems. In visual perception, the solution of such inverse problems reconstructs the *orientation*, *colour*, and *motion* of a given percept. These reconstructions are achieved by employing unconscious neural computations of **local neural circuits** that are in different parts of the brain.


Visible word
Invisible word
0.3
0.2
0.1
0.0
-0.1
percent signal change
Visible words
Masked words
-5
0
5
10
15
time (s)
Left visual word form area
(-48, -60, -12)

If the presentation of the percept lasts for a sufficiently long time, then there will be a sufficient amount of incoming energy capable of exciting several of the local neural circuits *associated* with elements of this percept. This gives rise ***to global activation*** and the creations of a mental image.

Consciousness:

the creation of a mental image which is generated following the global binding of the local neural circuits involved in the solution of the inverse problems associated with parts of a given percept.

HOMEOSTASIS AND EMOTIONS

Life is maintained only when several conditions are simultaneously met in the interior of an organism.

The process of maintaining a state necessary for survival and reproduction is called ***homeostasis***.

Emotions provide the response of the organism to a detected homeostatic disturbance in the structure or function of the viscera caused by the change of a specific physiological quantity.

Example
When leptin decreases: unconscious processes give rise to the objective **feeling of hunger** and also yield a **decrease of energy expenditure**. The latter processes do not lead to awareness.

Emotions include the *full* set of unconscious processes preceding a feeling.

By generalizing the role of emotions in homeostasis, it is natural to assume that **emotions characterize the response of an organism to any internal change and to any change in the exterior of the organism** (detected via specialized sensory probes).

Emotions capture the body's state in the reactive phase that follows internal or external changes. Such changes include the dynamic processes of creating thoughts**.** It is natural to speculate that every **mental function is accompanied by an appropriate emotion, which depending on the circumstances may or may not be expressed as a feeling.**

WAYS OF COMPREHENDING

The Continuum of Unconscious and Conscious Processes:

- Analogical Thinking
- Generalisation
- Abstraction
- Unification versus Reduction
- Local versus Global Processes
- Simplicity versus Complexity.

WASSILY KANDINSKY

By combining the basic ***local*** elements used by the brain in visual processing, i.e. line-colour-motion, he created marvellous **global** structures.

- The line no longer serves as outline of concrete figures, but has attained the freedom of an independent compositional element.
- The role of any visual motif is now played by different forms of colour.
- Immobility has been replaced by a vortex type motion.

Composition VI (1912)

Meticulous synthesis of **simple elements** can produce a highly **complex composition.**

Zooming at any specific area it becomes clear that the local building blocks are line elements of varying width, length and texture, surrounded by various forms of colour.

The synthesis of these *simple local* ingredients gives rise to a *global* composition of highly dynamic evocative complexity.