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COMPUTER VISION

Machine Learning & Neural Networks

5.- Bio-inspiration

by
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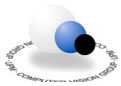
U.P.M. - DISAM



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topics

- *Intelligence and the cortex*
- *Cortex structure*
- *Visual intelligence*
- *Visual cortex*
- *Cortex working conclusions*

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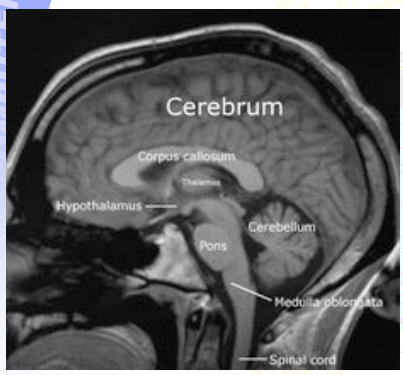
Intelligence and the cortex



- *Intelligence seems to be mainly in the cortex, the thalamus and the hippocampus.*
- *The cortex is more advance than other brain parts in an evolutive sense.*
- *Animals having small cortex may have complex behavior, but they are not flexible for new situations.*

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Caledonian raven behavior

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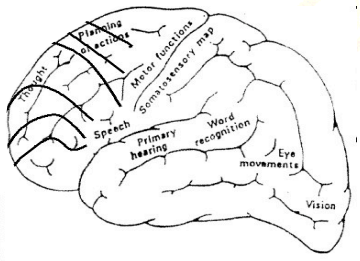
Cortex structure: neural connections

- *Cada neurona tiene varios miles de conexiones*
- *Existe un elevado numero de conexiones de arriba abajo en la jerarquía*
- *Sinapsis excitatorias e inhibidoras*
- *Si dos neuronas se activan casi simultáneamente, se refuerza la conexión entre ellas (aprendizaje Hebbiano)*
- *La unidad de procesamiento es la columna de 6 capas de neuronas*
  - Capa 1 intercambia información horizontalmente
  - Las capas 2 a 6 de forma vertical

VISION

Cortex structure: homogeneity



- *The cortex is basically flat*
- *The cortex structure is homogeneous*
- *The cortex structure is hierarchical*

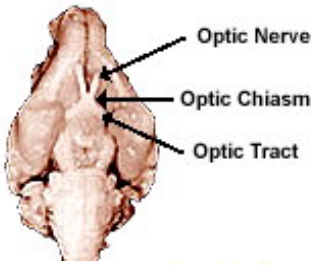
The Mountcastle hypothesis: “Every region in the cortex is interchangeable”

i.e.they all have the same working principle and they have and extreme flexibility in the source of the processed data

Cortex structure: flexibility examples

Ferret brain rewired

by Dr. Mriganka Sur MIT



Vision through the tounge

by Bach-y-Rita U. Wisconssin

Your Tongue Can S

Blind Man Gains Freedom Through

Sept. 6, 2006

Mike Ciarciello has been blind since bir
actually see.

Mike Ciarciello has been blind since birth. Now he's learning how to use his tongue to see.

"I hav
flying
even
whats
dream

His dr
about
using

At the
prepa
obsta

small camera on Ciarciello's forehead. to a small grid placed on his tongue.

"It's a concept in which you replace a Maurice Ptito, the neuropsychologist s tongue, and that gives them the feelin your brain."

When ABC News correspondent Bob Br experiment, his challenge was to ident camera scanned the shapes Brown des

"It's a pulsing sensation that imprints closer I move to the object, the more

P. Campoy

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The Blind Climber Who "Sees" With His Tongue

06.23.2008

Erik Weihenmayer's BrainPort translates images into electrical signals.

by Buddy Levy; photography by Beth Wald

Erik Weihenmayer, a blind climber, reaches for a handhold using the BrainPort.

A wiry man in his late 30s hangs near the top of a 40-foot wall, the toes of his climbing shoes barely gripping the sheer face. He clings with his left hand and pauses, swinging his right arm to the side, loosening the muscles. Then he raises his head and lunges, thrusting his right hand above him and catching a rock hold with his fingertips. With a few more moves he arrives at the top. Under normal circumstances this extreme rock climber would be worth watching. But what makes his effort even more remarkable is that he happens to be blind. Born with retinoschisis, a rare disease akin to macular degeneration, Erik Weihenmayer was sightless by age 13. Even so, he continued to pursue his dream of mountaineering, and he succeeded: In 2001 he became the first—and to date the only—blind climber to summit Mount Everest. Today he is climbing with the aid of a tool that allows him to "see" in a new way—with his tongue.

Cortex structure: flexibility examples

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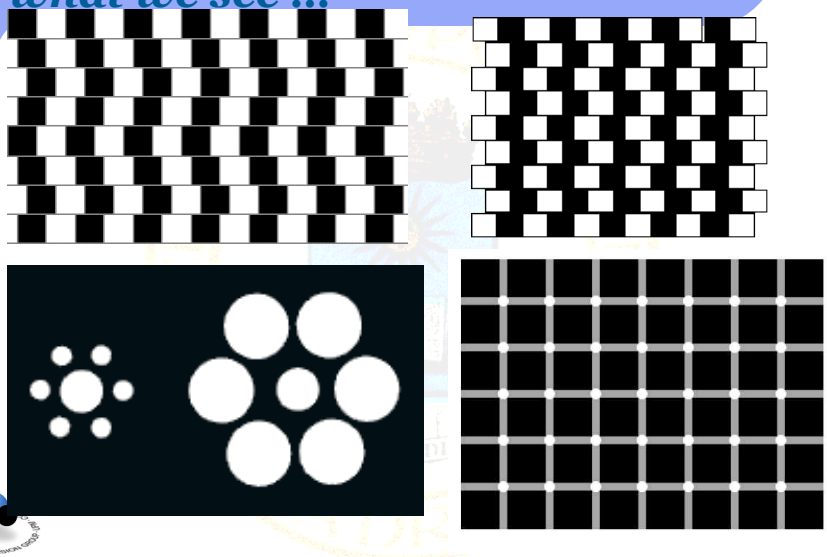
Visual intelligence: what we see ...



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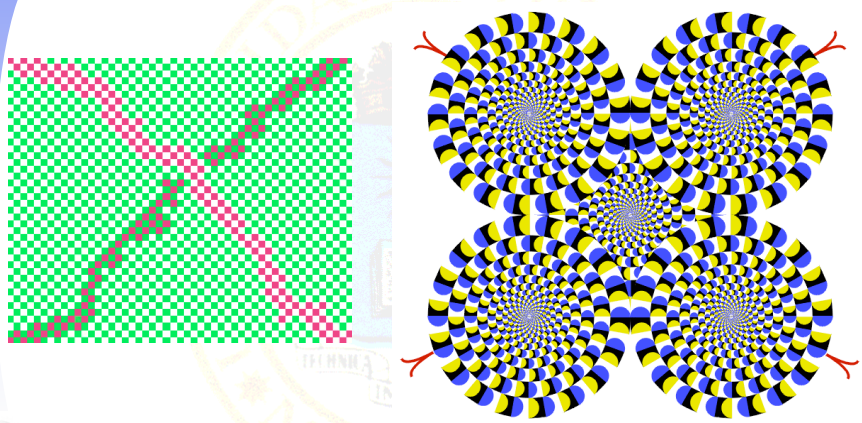
Visual intelligence: ... what we see



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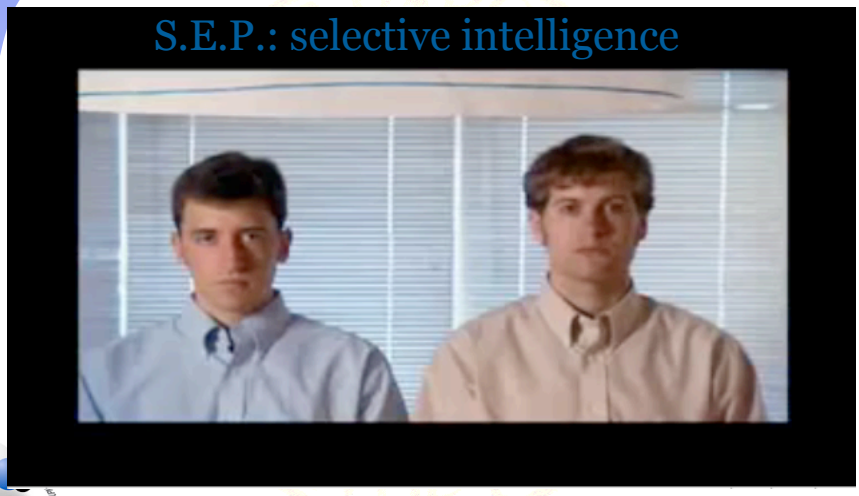
Visual intelligence: change blindness ...

S.E.P.: selective intelligence



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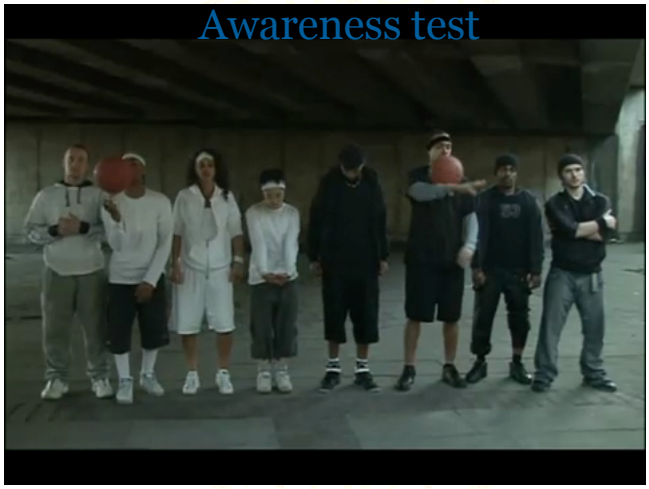
Visual intelligence: ... change blindness ...

Awareness test



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Visual intelligence: ... change blindness ...

smooth changes

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Visual intelligence: ... change blindness ...

hard changes

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Visual intelligence: ... change blindness

test at the Exploratoium Museum in S.F.

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Visual cortex

- *En los mamíferos ocupa aprox. 50%*
- *Cada 0.3 s el ojo efectúa un movimiento brusco, para conseguir una representación del entorno*
- *Tiempo de respuesta de una neurona 5 ms.*
- *Tiempo de respuesta de tarea de reconocimiento visual 500 ms.*

•=> cadena de máximo 100 neuronas para la tarea de reconocimiento. El cerebro no calcula, recupera lo aprendido, habiendo creado previamente unas "representaciones invariantes"

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Cortex working conclusions

- The cortex stores:
  - pattern sequences
  - invariant pattern representations
  - hierarchical patterns
- The cortex retrieves:
  - patterns within a sequence
  - patterns predictively
  - hierarchical patterns in an auto-associative way, by comparison with actual input

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Cortex working conclusions: hierarchical structure examples

the flake hand

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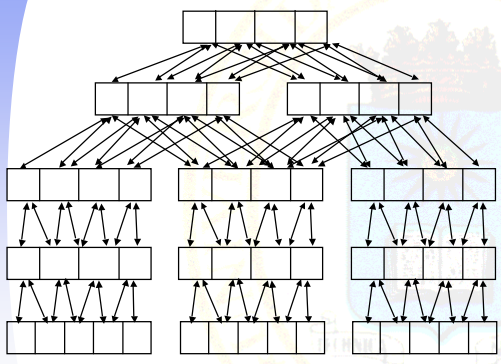
Cortex working conclusions: working structure



Higher abstraction adn less variability

More detail and more variability

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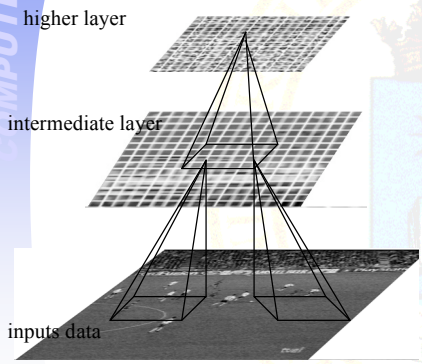
Cortex working conclusions: extrapolation to ANN



- Hierarchy
- Temporality
- Feed-back
- Flexible structure

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Cortex working conclusions: the face data base testbed