Foundations of *Artificial* Intelligence (FAI)

DA103DSAI

FAI *or* Φ

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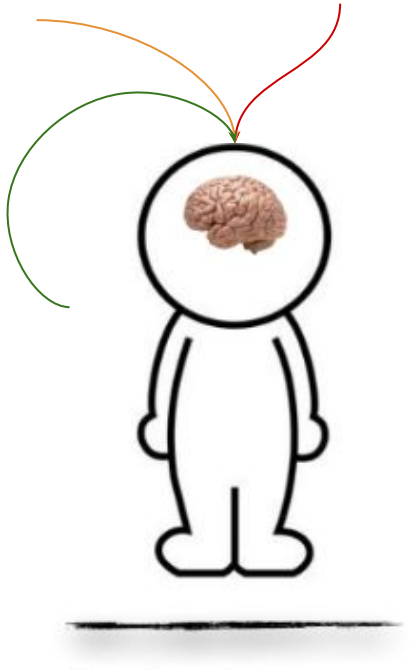
Lecture | 04

Sensing

Humans use distinct senses to capture different kinds of stimuli -

sight, sound, touch, and more

- forming the basis for perception



Perception

The process of acquiring and interpreting sensory information from the environment.

Interpreting means transforming raw sensory signals into meaningful patterns or features.

For humans:

- Recognizing a shape as a face.

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Perception includes not just receiving sensory input, but processing it enough to identify "what it is" at a basic level - before any deeper reasoning (**cognition**) happens.

Amazingness of Perception

Perceptual Ability	What It Looks Like in Humans	Why It's Impressive
Phoneme Discrimination	Babies detect tiny differences in foreign language sounds	Exceeds adult ability; shaped by exposure over time
Visual Constancy	Recognize objects regardless of angle, size, or lighting	Brain "corrects" raw input to stabilize perception
Change Blindness	Often miss obvious changes in visual scenes	Brain prioritizes attention; filters irrelevant data
Motion Sensitivity	Spot a predator's movement in grass instantly	High temporal precision; unconscious awareness
3D Inference from 2D	Perceive depth and shape from flat images	Uses prior knowledge and assumptions unconsciously

Cognition

The mental processes involved in understanding, reasoning, decision-making, and learning.

- Operates on interpreted data (from perception)
- Involves memory, attention, reasoning, planning
- Often top-down (goal-driven)

Perception and Cognition

Stimulus	Perception (Sensing + Interpreting)	Cognition (Reasoning, Understanding)
Light waves	Seeing a red ball	Predicting it will bounce if dropped
Sound waves	Hearing a voice	Recognizing emotion or meaning in the tone
Touch (pressure)	Feeling a sharp object	Deciding to avoid it to prevent pain
Words on screen	Recognizing letters and words	Understanding the sentence's meaning
Image of a traffic light	Detecting red light	Deciding to stop the car

Thus, signal processing pipeline includes …

Multi-sensory Perception

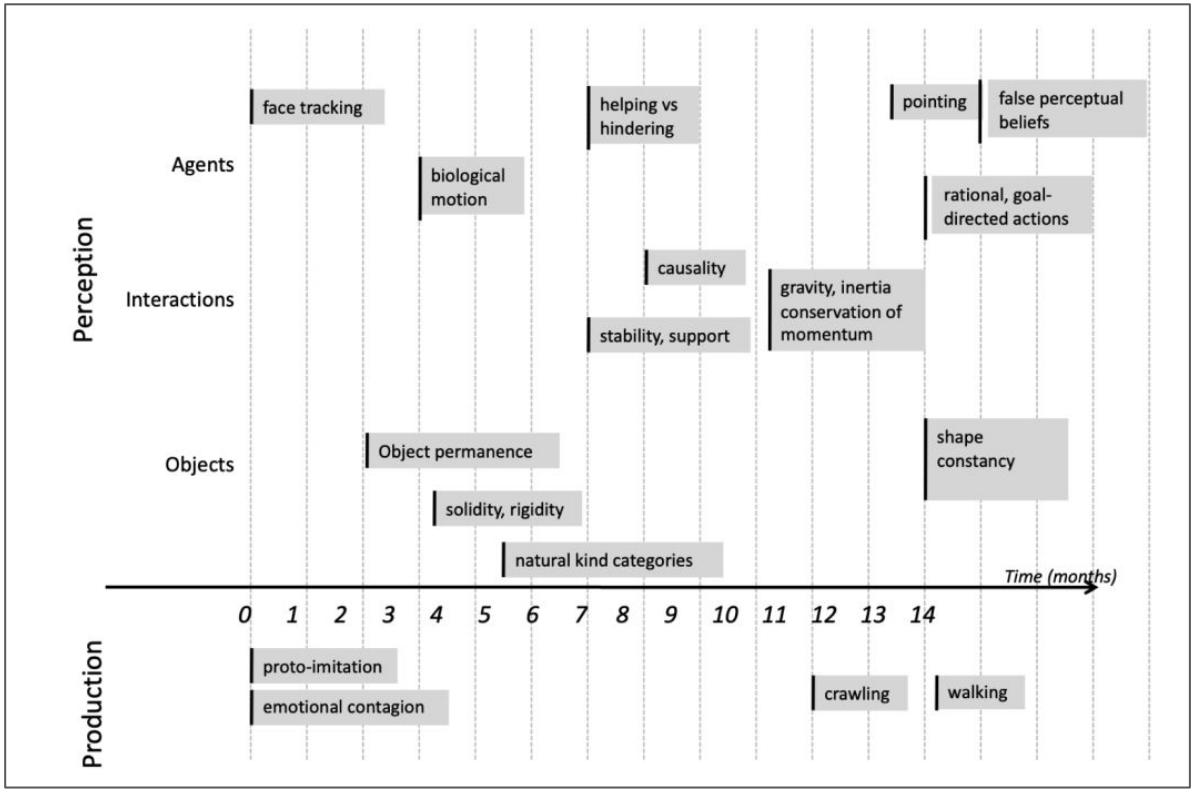
Integration of multiple sensory modalities (e.g., vision + audio) to create a unified understanding of the environment.

Enhances understanding, robustness and accuracy.

Multi-sensory Perception

Task	Uni-sensory Perception	Multi-sensory Perception
Recognizing someone speaking	Hearing the voice only	Hearing the voice + seeing lips move (audio + visual)
Identifying an object	Seeing the object	Seeing + touching (visual + tactile)
Navigating in the dark	Feeling the walls with hands	Feeling + hearing (e.g., echo, spatial sound cues)
Understanding emotion	Listening to tone of voice	Tone + facial expression + body language
Cooking	Smelling the aroma	Smell + taste + visual appearance of food
Reading text	Reading with eyes (vision only)	Reading + hearing (e.g., reading along with an audiobook)

Timescale of gaining cognitive abilities … in babies



Reference: E. Dupoux et al., IntPhys 2019: A Benchmark for Visual Intuitive Physics Understanding, IEEE PAMI, 2022

What does it Mean to “Learn”?

Descartes' Views

Descartes believed that:

"I think, therefore I am" (Cogito, ergo sum)

- The mind (res cogitans) is non-material - it is the realm of thoughts, consciousness, will.
- The body (res extensa) is material, governed by physical laws.

According to him (likely), thinking (and by extension, learning) is a property of the immaterial soul, not just the physical brain.

Rene Descartes
(1596 - 1650)

Descartes (Dualist)	Modern Neuroscience/AI (Materialist)
Mind ≠ Brain	Mind = Emergent property of the brain
Learning needs soul/consciousness	Learning is neural adaptation/synaptic change
Machines ≠ thinkers	Machines can think functionally (e.g., AI)

Focus of this course

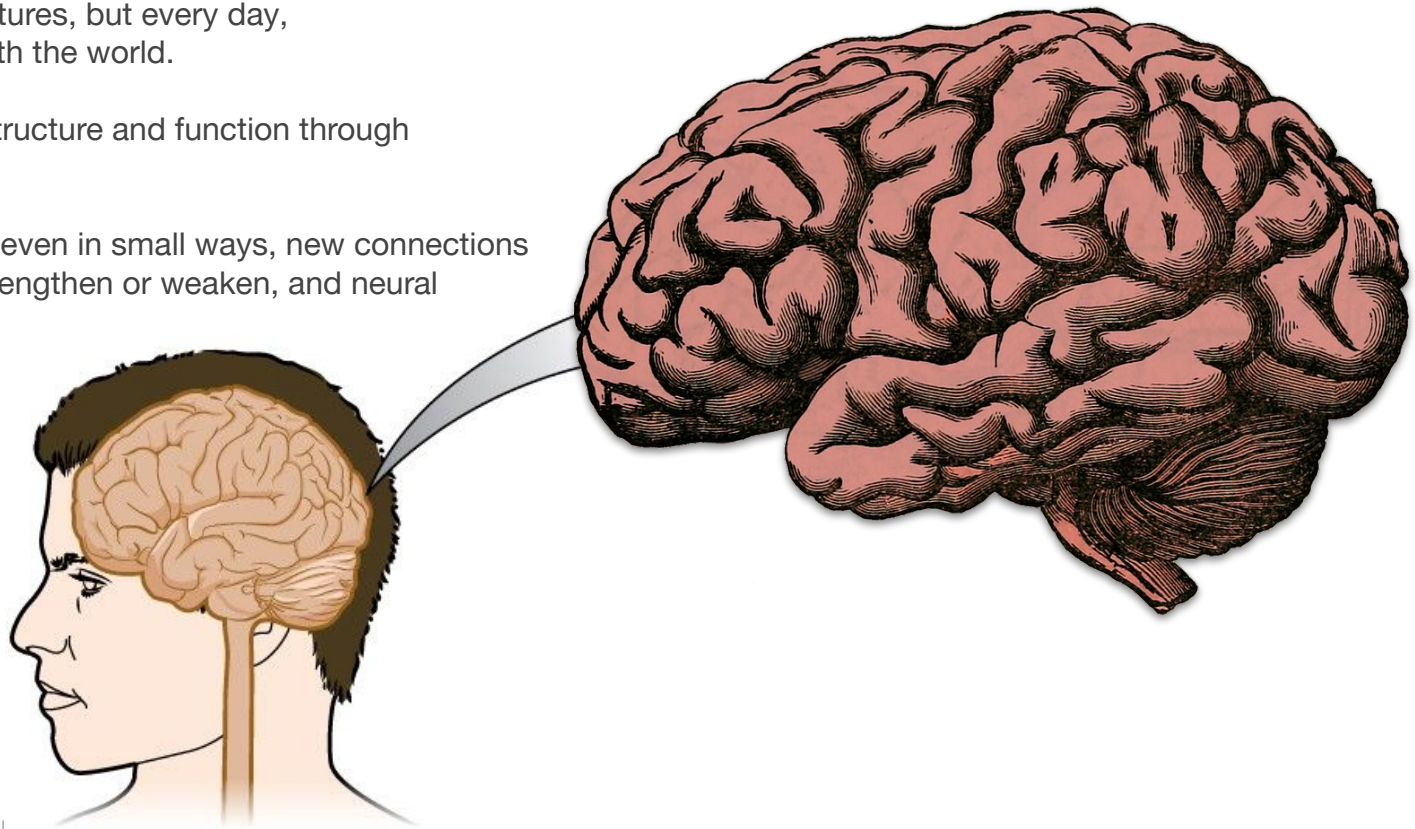
Descartes (Dualist)	Modern Neuroscience/AI (Materialist)
Mind ≠ Brain	Mind = Emergent property of the brain
Learning needs soul/consciousness	Learning is neural adaptation/synaptic change
Machines ≠ thinkers	Machines can think functionally (e.g., AI)

Learning reshapes the brain

– not just during exams or lectures, but every day, every moment you interact with the world.

– Learning alters the brain's structure and function through neuroplasticity.

– This happens continuously, even in small ways, new connections form, existing connections strengthen or weaken, and neural pathways reorganize.



Thank you