

Thinking about Thought

- Introduction
- Philosophy of Mind
- Cognitive Models
- Machine Intelligence
- Life and Organization
- Ecology
- The Brain
- Dreams & Emotions
- Language
- Modern Physics
- Consciousness

Session Two: Theories of Cognition

for Piero Scaruffi's class

"Thinking about Thought"

at UC Berkeley (2014)

- Roughly These Chapters of My Book “Nature of Consciousness”:
 - 4. Cognition: A General Property Of Matter
 - 8. Memory: The Mind’s Growth

COGNITION

- Cognition: the set of faculties that allow the mind to **process inputs** from the external world and to determine **action** in the external world
 - Perception,
 - Learning,
 - Memory,
 - Reasoning
 - Vision,
 - Language, ...

COGNITION

- The level of awareness for the same cognitive faculty may vary wildly
- Cognitive faculties and consciousness seem to be independent processes

COGNITION

- What is unique about human cognition?
 - Language?
 - Tools?
 - Fire?
 - Clothes?

What Early Humans Knew

- Inventions
 - Tools (2 million years, Africa, Homo Habilis)
 - Fire (1.9 million years, Africa, Homo Erectus)
 - Buildings (400,000 BC, France, Homo Erectus)
 - Cooking fires (250,000 BC, Europe and Middle East)
 - Paint (100,000 BC, South Africa)
 - Burial (90,000 BC, Israel & 70,000 BC, Neanderthal: belief in the afterlife older than the human species?)
 - Upper Paleolithic (40,000 - 10,000 BC): more specialized and varied tools, durable dwellings (not just caves), better clothing for cold weather, also non-utilitarian artifacts (art)
 - Art (28,000 BC, Austria, Homo Sapiens)

What Early Humans Knew

- Inventions
 - Epipaleolithic 18,000-9,000 BC: open air settlements made possible by warming of climate
 - Lamp (17,000 BC, France)
 - Farming (14,000 BC, Mesopotamia)
 - Slavery? (earliest known case: 8,000 BC Libya)
 - Domesticated animals (12,000 BC, Kurdistan)
 - Boat (8,000 BC, Holland/ Norway, but earlier in Oceania, and some seafaring technology as far back as 130,000 BC in the Mediterranean)
 - Weapons (bow, sling, dagger, mace) (8,000 BC)

What Early Humans Knew

- Inventions
 - Pottery (7,900 BC, Japan)
 - Weaving (6,500 BC, Palestine)
 - Trade/Buying-selling/Money
 - Musical instruments (5,000 BC, Sumeria)
 - Metal (4,500 BC, Egypt)
 - Domestication of the horse (4,000 BC, Eurasian steppes)
 - Bridge (4,000 BC, Egypt)
 - Copper: Byblos, fishing hooks (4,000 BC)
 - Wheel (3,500 BC, Mesopotamia)
 - Glass (3,000 BC, Phoenicia)
 - Sundial (3,000 BC, Egypt)

What Early Humans Knew

- Revolutions
 - Homo Sapiens (150,000 BC)
 - Religious revolution (70,000 BC)
 - Artistic revolution (28,000 BC)
 - Agricultural revolution (10,000 BC)
 - Metalwork revolution (4,500 BC)
 - Urban revolution (3,700 BC)
 - Writing revolution (3,300 BC)
 - Spiritual revolution (500 BC)
 - Scientific revolution (17th c)
 - Digital revolution (20th c)

MEDIATION



- Hermann Helmholtz (19th c)
 - Perception and action are mediated by a process in the brain
 - The "reaction time" of a human being is high because this brain process is slow
 - Perceptions are derived from unconscious inference on sense data
 - The brain turns perceptions into knowledge
 - All knowledge comes from experience, there is no innate knowledge
 - Perceptions are mere hypotheses about the world and can be wrong (optical illusions)
 - Perceptions are hypotheses based on our knowledge

REPRESENTATION



- Kenneth Craik (1943)
 - Mind may be a particular type of machine which is capable of building internal models of the world and processing them to produce action
 - Internal representation
 - Symbolic processing of such representation
 - Intelligence = inferential processing of knowledge
 - Descartes' automaton: mechanical reactions to external stimuli - no knowledge and inference
 - Craik's automaton: action based on knowledge and inference

SYMBOLIC PROCESSING

- The computer architecture is able to achieve cognitive faculties
- Computers consist of interacting modules each processing symbols
- Maybe the human mind too can be reduced to an architecture of interacting modules and sequential computation of symbols



SYMBOLIC PROCESSING



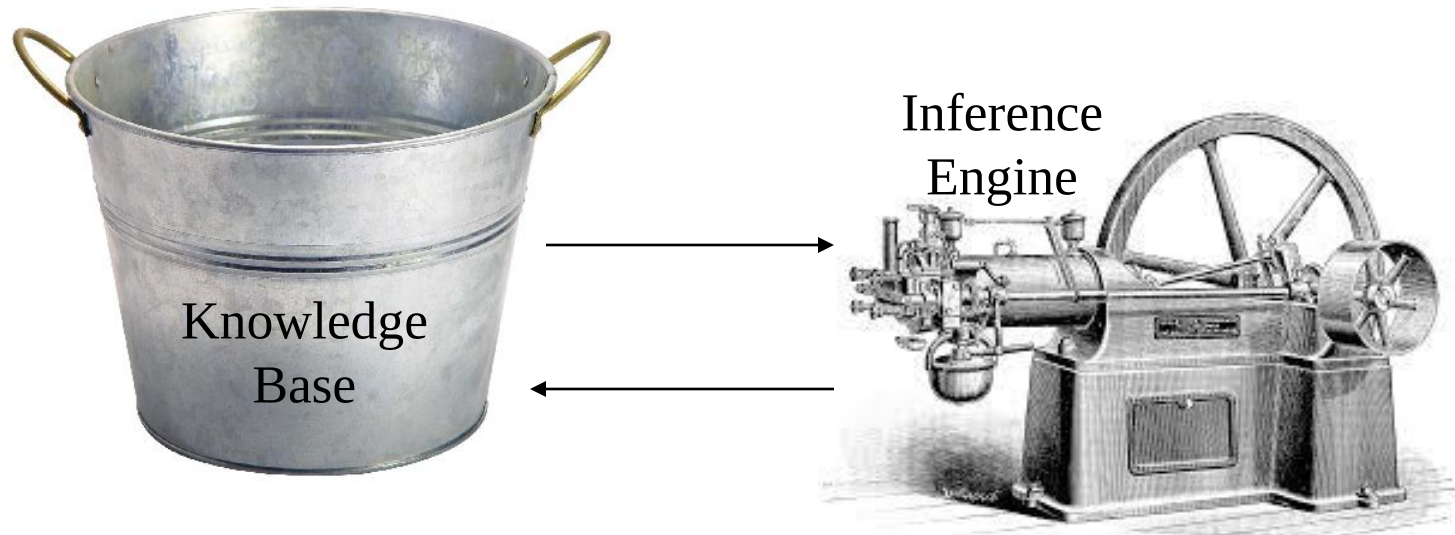
- Herbert Simon & Allen Newell: Physical Symbol Systems (1976)
 - Systems that process symbols to achieve a goal
 - **"A physical symbol system has the necessary and sufficient means for intelligent action"**
 - A physical symbol system is quite simple: the complexity of its behavior is due to the complexity of the environment it has to cope with
 - Physical symbol processors are Turing machines
 - No complex system can survive unless it is organized as a hierarchy of subsystems

SYMBOLIC PROCESSING

- Physical Symbol Processor/ predecessors
 - Thomas Hobbes: reasoning is "nothing more than reckoning"
 - Gottfried Leibniz: a logical calculus of human thought
 - David Hume: perceptions can be reduced to "atomic impressions"
 - Hilary Putnam, Jerry Fodor: the computational theory of mind

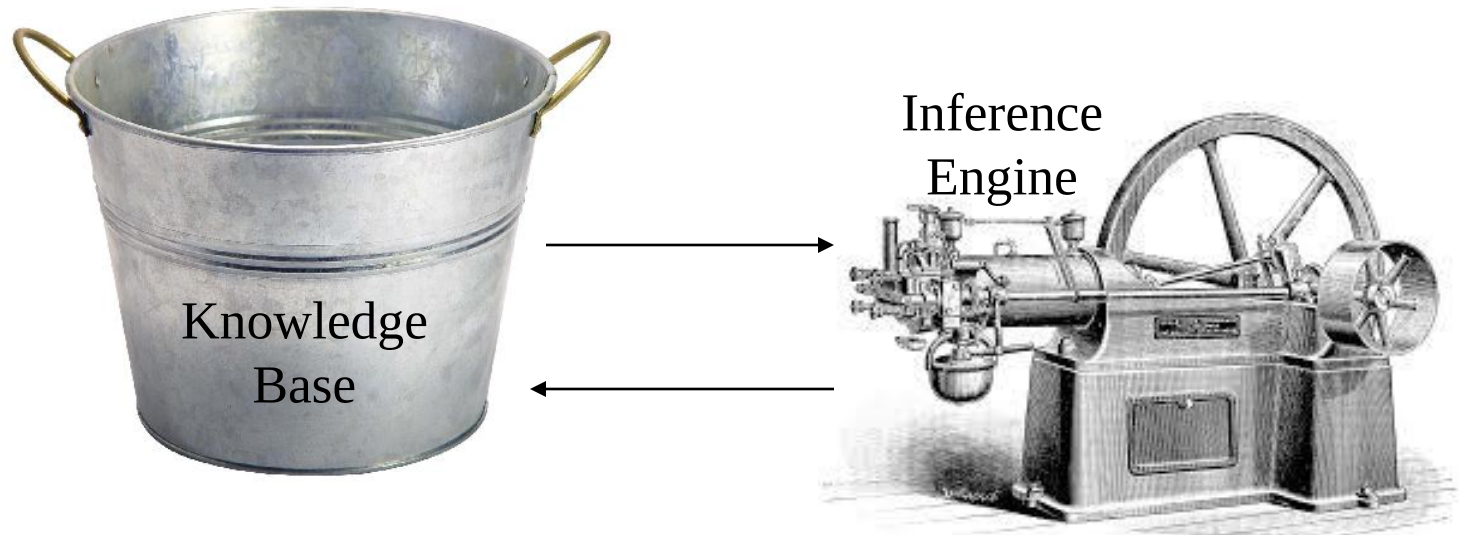
SYMBOLIC PROCESSING

- Physical Symbol Systems
 - A memory containing knowledge is operated upon by an inference engine; the results are added to the knowledge base; inference engine operates on the knowledge base;...



SYMBOLIC PROCESSING

- Physical Symbol Systems
 - Knowledge is continuously created, whether acquired from the external world or inferred from the existing knowledge



SYMBOLIC PROCESSING



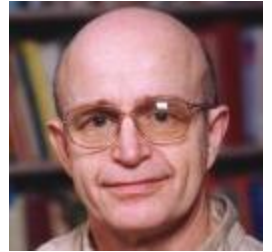
- Production Systems
 - John Anderson's Act (1976)
 - Knowledge is expressed in “production rules” (“If it is raining, take the umbrella”)
 - Declarative knowledge (“knowing that”) that can be consulted vs procedural knowledge (“knowing how”) that must be enacted in order to be used

I know that a bicycle has two wheels

I know how to ride a bicycle



SYMBOLIC PROCESSING



- Production Systems
 - ACT (1976)
 - Knowledge is continuously compiled into more and more complex procedural chunks through an incremental process of transformation of declarative knowledge into procedural knowledge
 - Two kinds of memory: a declarative memory (that remembers experience) and a procedural memory (that remembers rules learned from experience)

SYMBOLIC PROCESSING

- Production Systems
 - John Laird and Paul Rosenbloom's SOAR (1987)
 - “Universal weak method”: the kind of knowledge determines the kind of reasoning that can be applied
 - “Universal sub-goaling”: break down a problem (top-down reasoning)
 - When a goal is successfully completed, a chunk that represents the results of the task is created
 - “Chunking”: create new production rules (bottom-up reasoning)



SYMBOLIC PROCESSING



- Production Systems
 - SOAR (1987)
 - A task is implemented as a goal hierarchy
 - Final goal: a chunk for the top-level goal
 - “Power law of practice”: the more you practice, the better you get at it



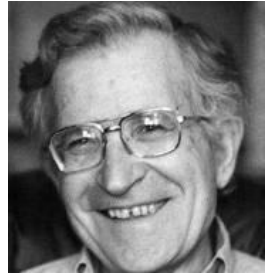
MENTAL MODULES



- Mental Modules (David Marr, 1982)
 - The vision system must employ innate information to make sense of the ambiguous signals that it perceives from the world
 - Innate and universal knowledge coexist and collaborate
 - Processing of perceptual data must be performed by specialized "modules" which are controlled by a central module

MENTAL MODULES

- Mental Modules
 - Marr, Chomsky and Fodor:
 - 1. the mind can be decomposed in modules, and
 - 2. syntactic processing can account for what the mind does



MENTAL MODULES



- Vision (David Marr, 1979)
 - Three levels of abstraction created by the modules of the vision system:
 - the "primal sketch": a symbolic representation drawn from the meaningful features of the image (boundaries, contours, shading, textures)
 - a two-and-a-half dimensional sketch, which is a representation centered on the visual system of the observer (distances and orientation)
 - the tri-dimensional representation, which is centered on the object
 - Memory: not what the retina picked up, but what the brain computed

MENTAL MODELS



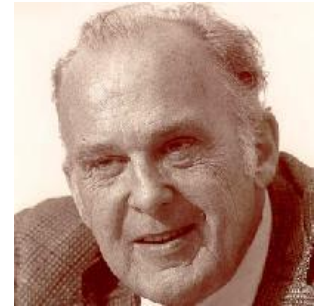
- Mental Models (Philip Johnson-Laird, 1983)
 - Production rules implausible
 - Minds construct mental models
 - Minds solve problems by building mental models
 - A sentence is a procedure to build, modify, extend a mental model
 - Mental models allow the mind to find "adequate" solutions

MENTAL SPACES

- Mental Spaces (Gilles Fauconnier, 1994)
 - Mental spaces proliferate as we think or talk
 - "Conceptual blending"
 - "creative" thinking
- Cognitive Models (George Lakoff): embodied, i.e. they are linked with bodily experience.



UNIVERSAL SELECTIONISM



Donald Campbell (1970)

- The brain produces many different visualizations of a problem until one "fits"
- Then the solution is obvious
- A selectionist process (blind variation and selective retention) at work in all the brain functions, from perception (recognizing that something is something) to problem solving
- At all levels the brain does not really "know" what to do: it just guesses, and the correct guesses are rewarded.
- Thinking originates from a population of guesses that evolve based on their usefulness or uselessness.

KNOWLEDGE REPRESENTATION

- Otto Selz's Schema (1920s)
 - To solve a problem entails to recognize the situation and to fill the gaps
 - Information in excess contains the solution



KNOWLEDGE REPRESENTATION



- Otto Selz's Schema (1920s)
 - Representation of past experience is a complete schema. Representation of present experience is a partially complete schema
 - Schema's anticipatory nature: to solve a problem is equivalent to comprehending it, and comprehending ultimately means reducing the current situation to a past situation

KNOWLEDGE REPRESENTATION



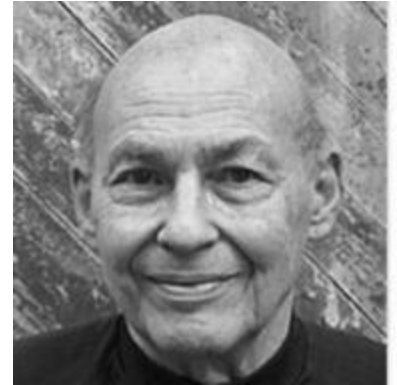
- Otto Selz's Schema (1920s)
 - Infer = anticipate
 - To solve a problem = to comprehend it
 - Comprehending = reducing the current situation to a past situation

KNOWLEDGE REPRESENTATION

- Otto Selz's Schema
 - Both a mental representation of the world and a process that determines action in the world

KNOWLEDGE REPRESENTATION

- Marvin Minsky's "Frame" (1974)
 - A packet of information that helps recognize and understand a scene
 - Stereotypical situations
 - A category by means of a prototypical member (default properties) and a list of actions that can be performed on any member of the category
 - Memory is a network of frames



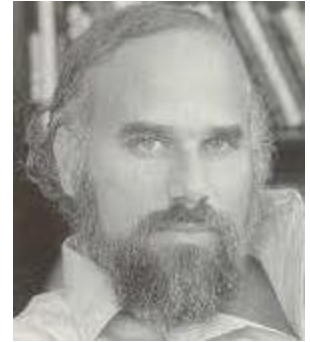
KNOWLEDGE REPRESENTATION

- Marvin Minsky's "Frame"
 - Each perception selects a frame, i.e., classifies the current situation in a schema
 - This is equivalent to interpreting the situation and deciding which action must be performed
 - Reasoning is adapting a frame to a situation.
 - Knowledge imposes coherence on experience
 - Unity of perception, recognition, reasoning, understanding and memory

KNOWLEDGE REPRESENTATION

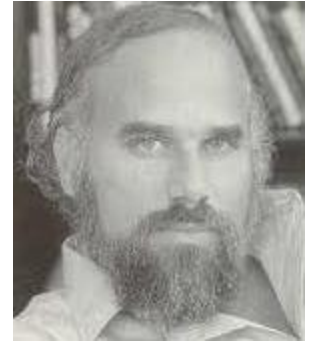
- Marvin Minsky's "Frame"
 - Perception, recognition, reasoning, understanding and memory cannot be separated

KNOWLEDGE REPRESENTATION



- Roger Schank's Script (1975)
 - Case-based reasoning
 - analogical reasoning
 - the elementary unit is the “case”, or situation
 - Episodic memory archives generalizations of cases
 - Whenever a new case occurs, similar cases are retrieved from episodic memory.
 - the new case is interpreted based on any similar cases that were found in the episodic memory
 - the new case is used, in turn, to further refine the generalizations

KNOWLEDGE REPRESENTATION



- Roger Schank's Script (1975)
 - A dynamic memory that grows from experience
 - Expectation-driven
 - Script = stereotypical knowledge of situations as a sequence of actions and a set of roles
 - Script = helps understand the situation and predicts what will happen
 - New memories = expectation failures

KNOWLEDGE REPRESENTATION

- Roger Schank's Script
 - Anticipatory reasoning
 - Remembering is closely related to understanding and learning.
 - Memory has the passive function of remembering and the active function of predicting.
 - The comprehension of the world and its categorization proceed together.
 - Knowledge is stories
 - Conversation is reminding and storytelling is understanding

KNOWLEDGE REPRESENTATION

- Self-organizing behavior
 - Charles Peirce (1906): "Habit", a set of operational rules that, by exhibiting both stability and adaptability, lends itself to an evolutionary process
 - Jean Piaget (1930s): Schemas are compounded as they are built to yield successive levels of a cognitive hierarchy
 - Categories are not innate, they are constructed through the individual's experience. What is innate is the process that underlies the construction of categories.

KNOWLEDGE REPRESENTATION

- Jeff Hawkins (2005)
 - Memory is a reservoir of possible solutions to problems.
 - Memory constantly predicts what will happen next.
 - That's how it can keep track of situations that would require almost infinite computational capabilities



A BRIEF DETOUR/1

- Vernon Mountcastle (1978)
 - The neocortex is uniform
 - There is no indication that any region of the neocortex operates differently from the other regions
 - What makes the difference between seeing and hearing if the cortex that process them is the same?
 - The difference in "output", though, must be due almost entirely to the different inputs
 - What is different is the pattern: spatial patterns versus temporal patterns.



A BRIEF DETOUR/1

- Vernon Mountcastle (1978)
 - The vision of something and the hearing of something are created in the brain
 - It is the brain that sees, not the eye. It is the brain that hears, not the ear.



A BRIEF DETOUR/2

- Maurice Merleau-Ponty (1960s)
- Cognitive scientists tend to focus on the input (perception) and neglect the output (action).
- Most models of the mind have been built by concentrating on perception: how the world is perceived by the mind. Very little is usually said on how the mind acts on the world
- Maxine Sheets-Johnstone (1999): thinking is modeled on the body and grounded in animate form
- All our cognitive life is grounded in movement.

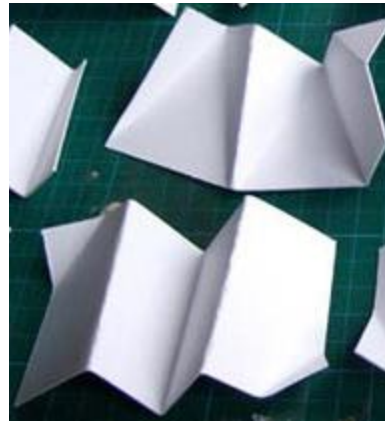


THE UNITY OF COGNITION

- Perception, memory, learning, reasoning, understanding and action are simply different aspects of the same process.
- All mental faculties are different descriptions of the same process
- Cognition does not seem to require consciousness

THE UNITY OF COGNITION

- Cognition = algorithm, refined by natural selection, that operates on structures that reflect our experience
- Various levels of cognition can be identified in other systems
- Everything in nature can be said to remember and to learn something
- Cognition: a general property of matter?



Paper that has “learned” a position after being repeatedly bent

Summary

- Hermann Helmholtz: Mediation
- Kenneth Craik: Representation
- Simon & Newell: Physical Symbol Processor
- Mental Modules (David Marr)
- Mental Models (Philip Johnson-laird)
- Mental Spaces (Gilles Fauconnier)
- Embodied Cognitive Models (George Lakoff)
- Otto Selz's Schema
- Marvin Minsky's Frame
- Roger Schank's Script
- Unity of Cognition

Break



"The foolish ask questions the wise cannot answer" (Oscar Wilde)

Memory

Alice: I can't remember things before they happen.

Queen: It's a poor sort of memory that only works backwards.



Memory vs Storage

- Animal memory is not just like a computer memory: real-life tasks rarely require perfection but do require speed and capacity
- Memory is more than storage. Memory is also recognition
- Without memory we would not see trees, but only patches of brown and green.

Memory is not just Storage

- Memory is capable of organizing experience into concepts
- Mental life “is” those concepts
- The process of thinking depends on the process of categorizing
- All cognitive faculties use memory and would not be possible without memory. They are, in fact, but side effects of the process of remembering

Memory sucks...

- The most peculiar feature of our memory is, perhaps, the fact that it is so bad at remembering.
- Our memory forgets most of the things that happen
- Even when it remembers, it does a lousy job of remembering
- Memory of something is almost always approximate
- Many details are forgotten right away
- Sometimes memory is also very slow

Memory sucks...

- We cannot count very easily.
- If you see a flock of birds in the sky, you can tell the shape, the direction, the approximate speed... but not how many birds are in the flock, even if there are only six or seven.
- We are not very good at remembering the temporal order of events: we have trouble remembering if something occurred before or after something else.

Memory's limitation...

- Human memory is a bizarre device that differs in a fundamental way from the memory of machines: a camera or a computer can replicate a scene in every minute detail, whereas our memory was just not designed to do that



...and Memory's power

- On the other hand, we can recognize a plot, told by somebody else, as the plot of the same novel that we read, even if that person's version of the plot and our version of the plot probably do not share a single sentence



Memory and Concepts

- It is hard to think of something without thinking also of something else. It is hard to focus on a concept and not think of related concepts

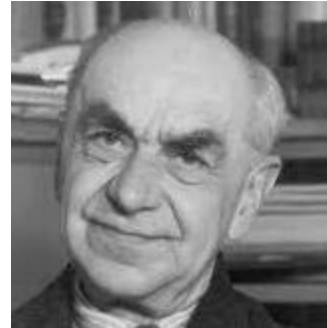


evokes...



Memory

- Frederic Bartlett's reconstructive memory (1930s)
 - We can easily relate the plot of a movie, but we cannot cite verbatim a single line of the movie
 - If we relate the plot three times, we will use different words each single time
 - Events are not stored faithfully in memory: they are somehow summarized into a different form, a "schema"
 - Memories do not passively record stories verbatim, but rather actively code them in terms of schemas, and then can recount the stories by retranslating the schemas into words.
 - Optimized storage: only what is strictly necessary is “memorized”



Memory



- Richard Semon's cue (1904)
 - Memory is as much about retrieval as about storage.
 - “engram”: the unit of memory, or, better, the pattern used to encode it (the "memory trace").
 - the “ecphoric stimulus”: the cue that helps retrieve a specific memory
 - The likelihood of finding a memory depends also on the cue that is used to retrieve it
 - The power of the cue
 - Sometimes we remember even what we want to forget

Memory



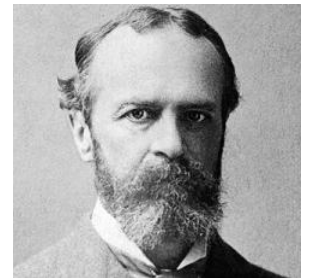
- Edward Tolmans' cognitive map (1932)
 - Learning involves acquisition of knowledge about the world (a "cognitive map")
 - A cognitive map encodes "expectations" about the world
 - We don't act in the world, we respond to the world

Cognitivism

- Behaviorism: focus on the output that corresponds to an input
 - 1959: Noam Chomsky's review of a book by Skinner ends the domination of behaviorism and resurrects cognitivism
- Cognitivism: focus on the processing between input and output
 - George Miller (1956)
 - Donald Broadbent (1957)
 - Allen Newell (1958)
 - Noam Chomsky (1957)

Cognitivism

- Predecessors
 - Theodore Ribot's experiments on amnesia: the loss of memory is inversely proportional to the time elapsed between the event and the injury (1882)
 - William James: "primary" and "secondary" memory (1900)



Cognitivism



- Donald Broadbent
 - Short-term memory (fast, small) vs long-term memory (slow, large)
 - Short-term memory points to long-term memory
 - The selective character of attention is due to the limited capacity of processing by the brain
 - The brain can only be conscious of so many events at the same time
 - Filter theory
 - Information about stimuli is temporarily retained but it will fade unless attention is turned quickly to it

Cognitivism

- George Miller
 - Seven “chunks”
- Alan Baddeley (1974)
 - Working memory



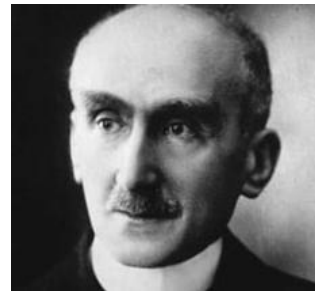
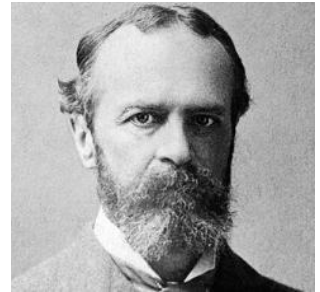
Memories



- Endel Tulving (1970s)
 - “Intension” (concepts) vs “extension” (episodes)
 - “Episodic” memory contains specific episodes of the history of the individual, while semantic memory contains general knowledge
 - “Semantic” memory is organized knowledge about the world.
 - The remembering of episodes depends on the interaction between encoding and retrieval conditions (between the "engram" and the "cue")

Memories

- Procedural memory (Henry Bergson - 1911)
 - Learn new skills and acquire habits
 - Each stimulus-response pattern, once learned, becomes the building block for more complex patterns which are our “habits”, each of which is in turn a building block to create more complex “habits”
 - Maine de Biran: “The Influence of Habit on the Faculty of Thinking” (1804)



Memories

- Implicit (unconscious) memory
 - Weakly encoded memories which affect conscious thought and behavior
 - “Implicit memory is revealed when previous experiences facilitate performance on a task that does not require conscious or intentional recollection of those experiences” (Daniel Schacter)
 - Implicit memories are not lost: they just cannot be retrieved
 - Amnesia is the standard condition of human memory
 - Memories of childhood are preserved without awareness of remembering

Memories



- Neal Cohen (1980)
 - “Declarative” memory (the memory that one can consciously remember, which is forgotten in an amnesia)
 - “Procedural” memory (the skills and procedures which are usually not forgotten, as people with amnesia can still perform most actions they have learned throughout their lives)
 - “Emotional” memory (amygdala)
 - These three memory systems are physically connected to the cortex along different pathways, which means that they can work in parallel.

Memories



- Tulving's "encoding specificity principle":
 - Remembering depends on the affinity between encoding and decoding.
 - Memories are encoded in a way that depends on the circumstances when the event originally happened.
 - The likelihood of recalling a memory (of decoding it) depends on recreating those circumstances, on reinstating the same psychological state.
 - The rememberer does more than retrieve information about a past event: the rememberer experiences that event again.

Memories



- Daniel Schacter (1996)
 - “Memory” is actually a set of different kinds of memory, each specialized in a different kind of task and implemented by a different brain circuit
 - Different aspects of a memory are stored in different regions of the brain
 - “Field memory” (you are in it) vs “observer memory” (you are not in it).
 - We tend to recall older events as field memories, and more recent ones as observer memories.
 - If asked to focus on the details of an event, we recall them as observer memories. If asked to focus on our feelings during the event, we tend to switch to a field memory. .

Memories



- Daniel Schacter
 - Memory is more than a recording of what happened: it contains information on how to operate in a similar situation.
 - Memory of the past determines how we act in the future.

Memories



- Daniel Schacter
 - “A memory is an emergent property of the cue and the engram”
 - Why we forget: new experiences blur previous engrams. - cues that used to be very effective become less and less effective.
 - We consolidate memories mainly through "reuse" of them: when we use and reuse a memory, the brain rehearses how to reconstruct that memory

Memories



- Daniel Schacter
 - The encoding process is subjective
 - There is a limit to how accurate the decoding can be
 - We distort our memories of ourselves
 - We construct our own autobiography, which is only loosely based on what truly happened.

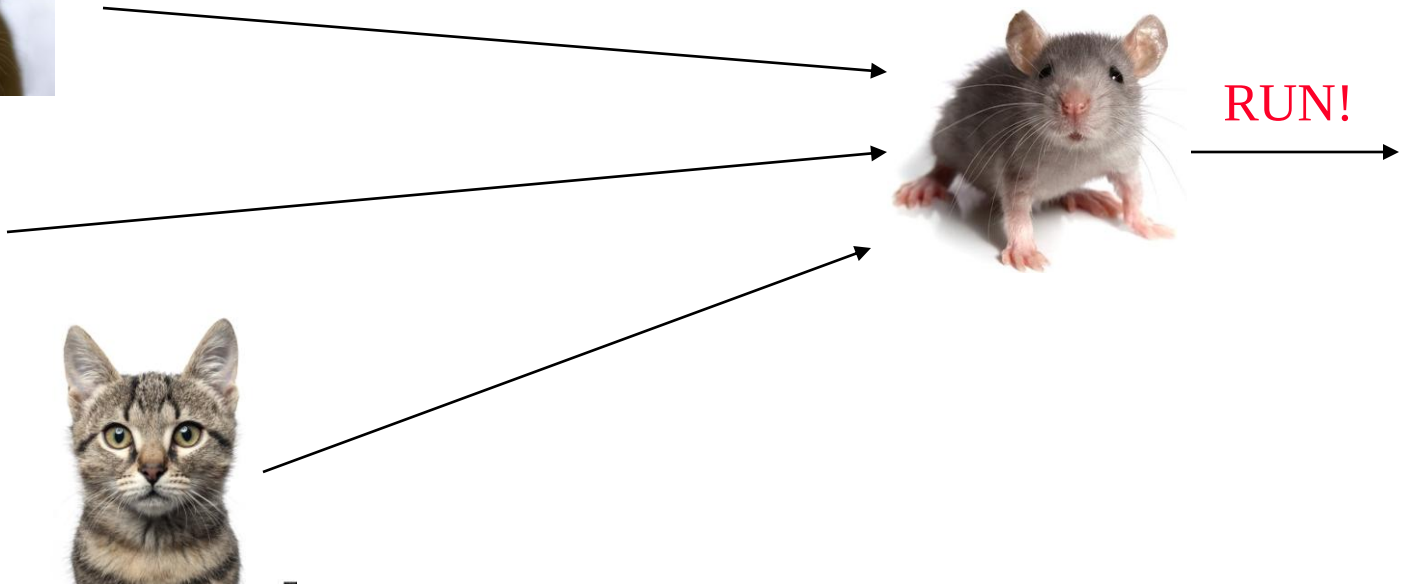
Memory and Knowledge: Categories

- Categorization is the main way that humans have of making sense of their world.
- Categorization: using the literal past to build abstractions that are useful to predict the future



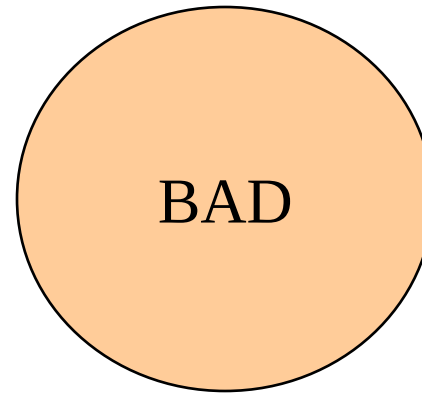
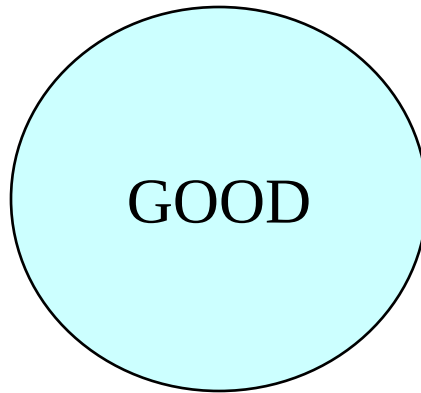
Categories

- Eric Lenneberg (1967):
 - All animals organize the sensory world through a process of categorization
 - All animals respond to categories of stimuli
 - Enables “similar” response to “different” stimuli



Categories

- Classical categories
 - Closed by clear boundaries and defined by common properties of their members



Categories

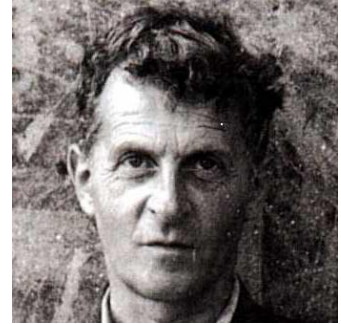


- Jerome Bruner's categories (1956)
 - A category is defined by the “set of features” that are individually necessary and jointly sufficient for an object to belong to it
 - Most cognitive processes are nothing but classification processes in disguise
 - Cognitive activity ("thinking") depends on placing an event or situation in the appropriate category
 - A category is basically a set of events that can be treated the same way by the cognitive organism

Categories

- Jerome Bruner's categories
 - Categories are not "discovered" but "invented".
 - They do not exist in the environment: they are construed by the human mind.

Categories



- Ludwig Wittgenstein (1930s)
 - What is a sport?
 - A dog that does not bark or a dog with three legs or a vegetarian dog is still a dog
 - Family resemblance
 - Sets of positive and negative examples
 - Boundaries can be extended at any time

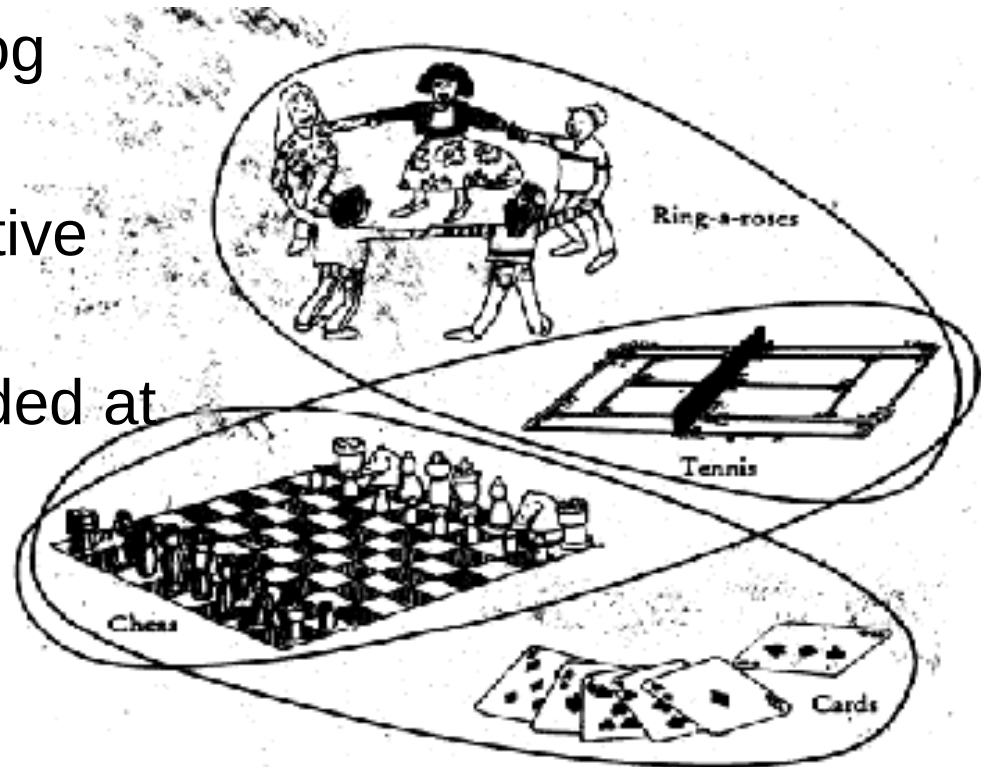
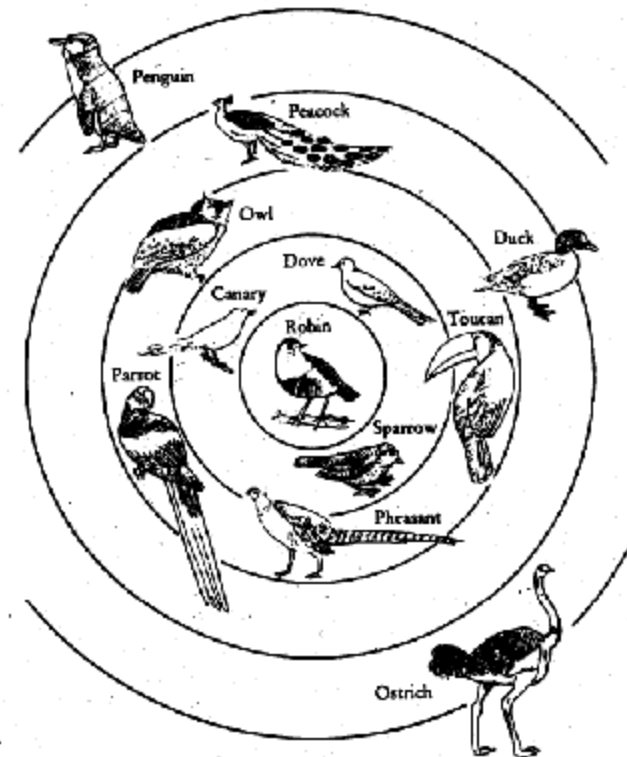


Figure 4.4 Family resemblances among games

Categories

- Eleanore Rosch's prototype theory (1978)
 - The best way to teach a concept is to show an example of it
 - Prototype = “best” example of the category
 - Membership of an individual in a category is determined by the perceived distance of resemblance of the individual to the prototype of the category



(Holger Diessel)

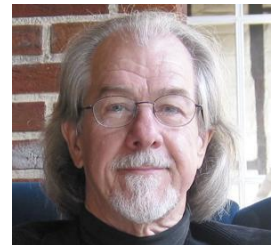
Categories



- Eleanor Rosch's prototype theory (1978)
 - We do categorization because it helps save a lot of space in our memory and because the world lends itself to categorization.
 - Concepts promote a cognitive economy by partitioning the world into classes, and therefore allowing the mind to substantially reduce the amount of information to be remembered and processed
 - The task of category systems is to provide maximum information with the least cognitive effort

Categories

- Roger Brown (1958):
 - Children learn concepts at a level which is not the most general and not the most specific (“chair”, rather than “furniture” or “armchair”)
 - “distinctive action”: the level at which we “naturally” name objects
- Brent Berlin (1968)
 - Adults too (a cat is also a feline, a mammal, an animal, and it is also a specific variety of cat, but we normally call it “a cat”)



Categories



- Eleanor Rosch
 - We classify artifacts at a "basic level"
 - At the basic level we can form a mental image of the category
 - Categorization occurs based on our interaction with the object (we have a motor program for interacting with "chair", not with "furniture")
 - Meaning is in the interaction between the body and the world
 - Basic-level categories are the first ones learned by children

Categories



- Eleanor Rosch
 - Categories are created by generalization and specialization of the basic level
 - At the basic level, categories are maximally distinct, i.e. They maximize perceived similarity among category members and minimize perceived similarities across contrasting categories
 - Categories are not mutually exclusive: an object can belong to more than one category to different degrees (categories are “fuzzy”)

Categories

- Standard model
 - Categories are organized in a taxonomic hierarchy
 - Categories in the middle are the most basic
 - Knowledge is mainly organized at the basic level
 - Categories are defined by common features of their members
 - Thought is the “disembodied” manipulation of abstract symbols
 - Concepts are internal representations of external reality
 - Symbols have meaning by virtue of their correspondence to real objects.

Categories



- Mark Johnson (1987)
 - Experience is structured in a meaningful way prior to any concepts: some schemas are inherently meaningful to people by virtue of their bodily experience (e.g., the “container” schema, the “part-whole” schema, the “link” schema, the “center-periphery” schema)
 - We “know” these schemas even before we acquire the related concepts because such “kinesthetic” schemas come with a basic logic that is used to directly “understand” them.

Categories



- George Lakoff (1987)
 - Categories depend on the bodily experience of the “categorizer”
 - Concepts grow out of bodily experience and are understood in terms of it
 - The core of our conceptual system is directly grounded in bodily experience.
 - ... and on the “imaginative processes” (metaphor, metonymy, mental imagery) of the categorizer

Categories

- George Lakoff (1987)
 - The conceptual system of a mind is normally not consistent.
 - We have available in our minds many different ways of making sense of situations.
 - We constantly keep alternative conceptualizations of the world.



Creativity



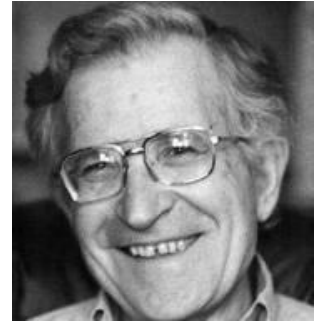
- Gilles Fauconnier
 - Mental spaces allow for alternative views of the world
 - The mind can create multiple cognitive spaces
 - We are creative

Origin of categories



- Immanuel Kant
 - Experience is possible only if we have knowledge
 - Knowledge evolves from concepts
 - Some concepts must therefore be native
 - We must be born with an infrastructure that allows us to learn concepts and to build concepts on top of concepts

Origin of categories



- Noam Chomsky
 - Human brains are designed to acquire a language
 - They contain a "universal grammar"
 - We speak because our brain is meant to speak
- We think in concepts because we are meant to think in concepts
- Our mind creates categories because it is equipped with some native categories and a mechanism to build categories on top of existing categories

Holism

- Pierre Duhem (1906)
 - Scientific hypotheses cannot be tested in isolation from the whole theoretical network in which they appear



Holism



- Willard Quine (1951):
 - A hypothesis is verified true or false only relative to background assumptions
 - Each statement in a theory partially determines the meaning of every other statement in the same theory
 - The structure of concepts is determined by the positions that their constituents occupy in the "web of belief" of the individual

Holism



- Frank Keil (1989):
 - No concept can be understood in isolation from all other concepts
 - Concepts are embedded in theories about the world
 - Natural kinds (eg, “gold”) are not defined by a set of features or by a prototype: they are defined by a “causal homeostatic system”, which tends to stability over time in order to maximize categorizing.

The Mind's Growth



Farside

The Mind's Growth

- Mind is not always the same: it grows
- Not just learning about the environment, but also capability of new types of actions in the environment
- How "Nature" and "Nurture" (instincts and experience) interact ("Nativism" vs "Constructivism")

The Mind's Growth



- Jean Piaget's constructivism (1923)
 - Living beings are in constant interaction with their environment
 - Survival depends on maintaining a state of equilibrium between the organism and the environment
 - Regulation of behavior in order to continuously adapt to the information flow from the environment
 - Cognition, therefore, is but self-regulation

The Mind's Growth



- Jean Piaget's constructivism
 - Cognition is a dynamic exchange between organism and environment
 - “Genetic epistemology”
 - Cognitive process = a loop of assimilation and accommodation that proceeds in stages

The Mind's Growth

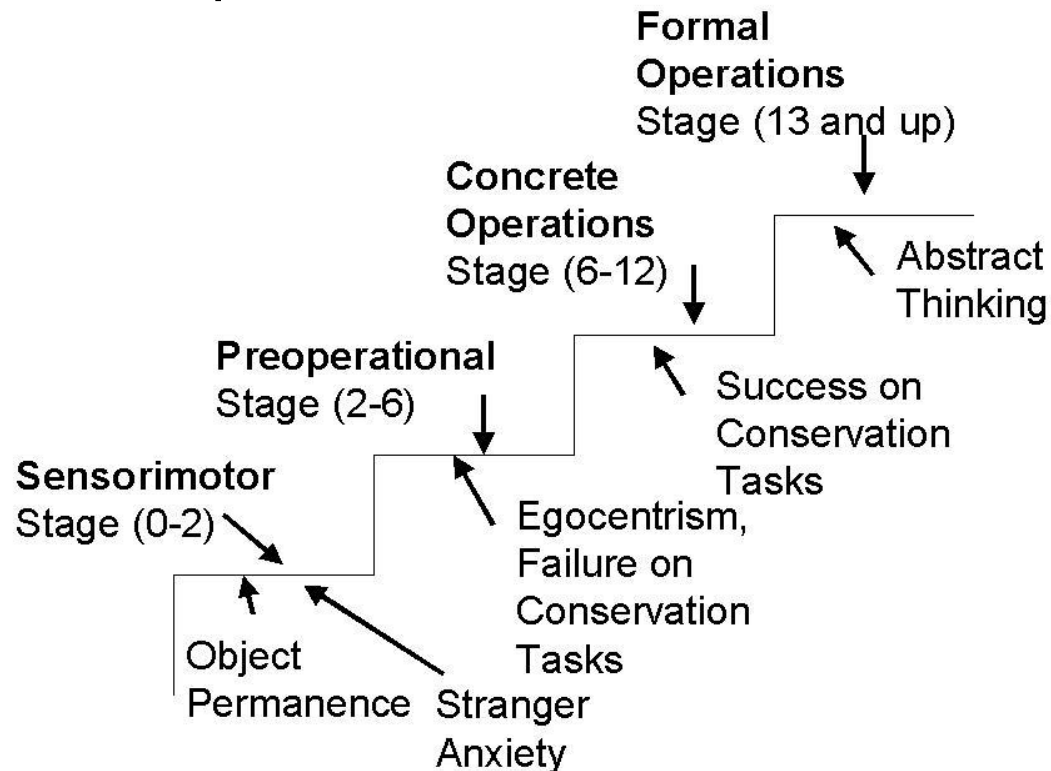


- Jean Piaget's constructivism
 - Cognitive faculties are not fixed at birth but evolve during the lifetime of the individual.
 - Not by gradual evolution but by sudden rearrangements of mental operations
 - Progress from simple mental arrangements to complex ones
 - "Literal", sensorymotor life
 - "Schemas" of behavior in the world
 - Self-regulated functioning of "schemas" leads to interiorized action
 - Internal symbols and introspection
 - Internal manipulations on symbols
 - Abstract objects

The Mind's Growth



- Jean Piaget's constructivism
 - Progress from simple mental arrangements to complex ones



The Mind's Growth



- Jean Piaget's constructivism
 - Growth produces qualitatively new forms of thought
 - Cognitive faculties are not fixed at birth but evolve during the lifetime of the individual
 - Cognitive growth = transition from a stage in which the dominant factor is perception, which is irreversible, to a stage in which the dominant is abstract thought, which is reversible
 - No innate knowledge: only a set of sensory reflexes and three processes (assimilation, accommodation and equilibration)

The Mind's Growth



- Jean Piaget's constructivism
 - Rationality is the overall way in which an organism adapts to its environment.
 - Rational action occurs every time the organism needs to solve a problem, i.e. when the organism needs to reach a new form of balance with its environment.
 - Once that balance has been achieved, the organism proceeds by instinct.
 - Rationality will be needed only when the equilibrium is broken again.

The Mind's Growth



- Annette Karmiloff-Smith (1992)
 - Mind is made of a number of independent, specialized modules (a` la Fodor)
 - Modules are not static but "grow" during child's development
 - New modules are created during child's development
 - Child development is not only about learning new procedures, it is about building theories of why those procedures do what they do ("representational redescription")
 - Different levels at which knowledge is encoded

The Mind's Growth



- Patricia Greenfield (1991)
 - Initially the child's mind has no modules, only a general-purpose learning system
 - Modules start developing later in the life of the child.
 - There is a common neurological layer in the early stages of development (up to two years old) that accounts for both linguistic skills and object manipulation skills.
 - As the child's brain develops, those skills split.

The Mind's Growth



- Eric Erickson (1959): adulthood
 - Personal development is structured in eight stages that extend from birth to death (and not only from birth to late childhood)

The Mind's Growth



- Lev Vygotsky (1934)
 - Children initially behave like chimpanzees: language and thought are unrelated (language is irrational, thought is nonverbal).
 - They learn the names of objects only when told so.
 - Later the attitude changes: it is the child who becomes curious about the names of things.
 - Then the child's vocabulary increases dramatically, with much less coaching from adults.
 - Thought and speech merge.

The Mind's Growth



- Lev Vygotsky
 - One generally becomes aware of her/his actions when they are interrupted
 - Speech is an expression of the process of becoming aware of one's actions
 - The child's egocentric speech is the sign of a process of becoming aware after something disrupted the action underway
 - In other words, the child is thinking aloud.
 - A few years later this process has become silent: when the child needs to find a solution to a problem, the "thinking" is no longer aloud

The Mind's Growth



- Lev Vygotsky
 - Speech is originally social in nature
 - Egocentric speech is an evolution of social speech that eventually becomes silent thought.
 - Cognitive faculties are internalized versions of social processes.

The Mind's Growth



- Lev Vygotsky
 - Thought is determined by language.
 - And both are determined by society.
 - Language guides the child's cognitive growth.
 - Cognition thus develops in different ways depending on the cultural conditions.

The Mind's Growth



- Alison Gopnik (2009)
 - Childhood must serve a purpose, especially human childhood
 - Children spend years practicing a form of mental gymnastics
 - Children practice the ability to map the world and to imagine worlds that don't exist
 - The ability of imagining alternative worlds (of dealing with "counterfactuals") peaks during childhood.
 - Children understand how the real world works and then project that knowledge into many other possible worlds

The Mind's Growth



- Alison Gopnik (2009)
 - The fact that children don't seem to be capable of distinguishing between reality and fantasy should not be taken as evidence of cognitive limitation but of cognitive power: they are very creative instead of being passive
 - The way children understand psychology is similar to the way they understand the physical world: they create "psychological counterfactuals", i.e. imaginary companions.
 - With them they rehearse the rules of psychology the same way that they rehearse the rules of physics when they imagine hypothetical worlds.

The Mind's Growth



- Alison Gopnik (2009)
 - Children constructs maps of both the physical world and of the psychological world.
 - In both cases children first understand the world, then they imagine hypothetical worlds, then they are ready to actually create worlds.
 - In the physical world this translates into action.
 - In the psychological world this translates into dealing with other minds

The Mind's Growth



- Michael Tomasello (1999)
 - Humans are genetically equipped with the "ability to identify with conspecifics."
 - Children spend most of their time imitating others.
 - Natural selection rewarded the best "copycats".
 - This ability is crucial to the development of social skills such as language
 - Humans do not just imitate other humans: humans also understand why other humans did what they did.

Summary

- Memory vs Storage
- The Age of Cognitivism
- Kinds of Memory
- Categories
- Creativity
- Nativism
- Holism
- The mind evolves

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Cognition

Better to understand a little than to misunderstand a lot
(One-liner signature file on the internet)

Consciousness

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