Cognitive development
What’s it about?

- How the mind develops.
- How the mind becomes equipped with the mind tools we have been considering.
- Some of the important concepts, theories and people
- The growth and decline of cognition
How the mind develops

• Brain growth
  – Human brain size and premature birth
  – Overproduction and pruning of neurons
  – Myelination speeds flow of information
  – Lateralization of brain functions
  – Use it or lose it
  – Continued synaptic formation encoding knowledge

• Stage theories

• Differences between experts and novices

• Differences between younger and older
Some people

- Jean Piaget (1896-1980)
- Lev Vygotsky (1896-1934)
- Many contemporary investigators
Connections among people

19th century ideas of Darwin, Marx, Kant and linguists

- Vygotsky 1896-1934
- Piaget 1896-1980
- W. Kohler 1887-1967
- Binet (1857-1911)
- Baldwin (1831-1934)

Contemporary cognitive developmental psychology
Some Concepts

• Conservation
  – The idea that some concepts remain constant even when appearance is transformed

• Meta-cognition
  – The process of thinking about and controlling one’s own thoughts (self-priming, use of mind-tools)

• “zone of proximal development” ZPD
  – A range between what a child does and can do with help, experience....(think “readiness”)

• Formal operations
  – Tools for scientific thinking

• “theory of mind” (ToM)

• Role of language
Conservation of liquid

despite the change in appearance. The concrete-operational child, however, says that the beakers contain the same amount of liquid, based on the child’s internal schemas regarding the conservation of matter.

What can the concrete-operational child do that the preoperational child cannot? The concrete-operational child can manipulate internal representations.
Conservation of quantities - area and volume

<table>
<thead>
<tr>
<th>Type</th>
<th>The Child Is Shown:</th>
<th>The Experimenter:</th>
<th>The Child Responds:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td><img src="image" alt="Area Example" /></td>
<td><img src="image" alt="Area Example" /></td>
<td>Preoperational child: The blocks on Board B take up more space; Concrete-operational child: They take up the same amount of space.</td>
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<tr>
<td></td>
<td>two boards with six wooden blocks and agrees that the blocks on both boards take up the same space</td>
<td>scatters the blocks on one board and asks if one board has more unoccupied space or if both have the same</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td><img src="image" alt="Volume Example" /></td>
<td><img src="image" alt="Volume Example" /></td>
<td>Preoperational child: The water in the glass with the flat piece won’t be as high as the water in the other glass; Concrete-operational child: Nothing has changed; the level will be the same in each glass.</td>
</tr>
<tr>
<td></td>
<td>two balls of clay put in two glasses equally full of water and says the level is the same in both</td>
<td>flattens one ball of clay and asks if the water level will be the same in both glasses</td>
<td></td>
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</tbody>
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Meta-cognitive processes

- These deal with our abilities to monitor and regulate our own cognitive processes.
- They would include use of self-priming, memory strategies, conscious problem solving techniques, and many aspects of mind tool use.
- These may develop in some cases spontaneously but in many cases are taught.
- Examples include use of mnemonics, verbal rehearsal, and sketches or plots.
“theory of mind” (ToM)

• Developed from Piaget’s idea of egocentric thought in younger children.
• Having a notion of mind that includes understanding others behave according to their beliefs AND those beliefs can differ between people.
• This transcends egocentric thinking --when used!
• The “false-belief” test assesses the most advanced of a collection of social-cognitive skills enabling “mind-reading” of others.
• “mind reading” includes attending to gaze and inferring emotions, desires, and beliefs of others.
• ToM is not related to general intelligence
The role of language in development

- Both Vygotsky and Piaget give a large role to language in cognitive development.
- Vygotsky -- a socialist/Marxist -- nearly gives language credit for distinguishing humans from chimps -- beginning at the earliest use of language.
- Piaget reserves language for the transition from concrete to formal operations.
- Meta-cognitive activities may require some form of language representation.
- “Mind-tool” acquisition and generally learning from others is facilitated by human language.
Language growth from 1-5 years

- Correlation between age and utterance length and variance is close to 1.0!!

Jonathan from Wells (1985)
Stage theories

• Reflect qualitative changes in ability

• For Piaget, stages reflect differences in modes of thought
  – Action in sensorimotor stages
  – Imagery in figurative stage
  – Concrete (thought about particulars) logical
  – Formal (abstract) logical
Piaget's stages

One child's data at 40 months:
2500 word vocabulary
mlu=7
words spoken in one day 14,930
sentences in a day 1,967
questions in a day 397
(Brandenburg, 1919)

S-M Stages
1. reflexes
2. coordination of responses
3. circular reactions
4. means-end coordinations
5. object concept
6. object permanence

means-end coordinations (practical causality)
object permanence
self-recognition (chimps, orangutans, gorillas?)
use of human-based language code (a "pidgin" for here and now actions)
(~200 symbols, mlu <2)
social cognition (manipulation, deception, limited conception of others)
Transitivity - an example of modes of thought solving the same problem

- The red stick is larger than the green stick.
- The green stick is larger than the blue stick.
- Is the red stick larger than the blue stick?
Solution by abstract logic (formal operations)

• If A>B and B>C, then A>C.
• Let A=red, B=green, C=blue.
• Therefore, red is greater than blue.
• Note that this is necessary conclusion -- there’s no need to measure the sticks or even look at them. Nor does it matter how MUCH difference there is between any pair or whether you have ruler, etc.
Solution by concrete logic

- This is similar to the formal logic schema but doesn’t include variables, A, B, C. The child just knows that if the red stick is greater than the green one, and the green one is greater than the blue one, then the red stick is greater than the blue stick.
- Maybe the child imagines three sticks? If so it won’t matter exactly what these mental representations look like.
Solution by images

- Looking at the three sticks children mentally compare the size of each. If the sticks are not too similar, the child might get the right answer.
- Note this is an empirical solution; no real logic is involved. Just a comparison of the actual sticks, two at a time.
- Apes may or may not be able to do this; they can certainly learn to pick the longer of two.
The three sticks

- Easier
- Pre-logical solutions
- Harder
Solution by sensorimotor comparison - you might even get an ape to do this!

- Grab the red one; put it along side the blue one! Which is longer? No imagination, no logic -- just compare.
Solution by sensorimotor comparison
Quantitative skills-1

• Many animals can learn to make comparative judgments -- go to the larger square for dinner, etc.
• Many animals have some basic quantitative skills, e.g. subitizing or estimating abilities based on extent or visual correspondence of small quantities (< <10).
• Some birds and apes, even Clever Hans, can perhaps do some addition within this framework.
Quantitative skills-2

- Infants demonstrate these basic “math” abilities
- Counting emerges from a blend of language skills and preverbal mathematical skills
- Not until 5 or 6 years do conservation of number and other elements of distinctly human mathematics show up -- including notions of infinity and class inclusion
- The “phonological loop” in working memory plays an important role for many of these skills.
- Visual-Spatial representations also contribute complementary capability to mathematical skills.
Differences between younger and older in abilities

![Graph showing differences in abilities between age groups.](image)
younger and older brains

Young - spatial working memory

Seniors - spatial working memory