Reasoning in the Elementary School Years

Week 9

Overview of Chapter 11
- Physical & Motor Development
- Concrete Operational Development
- Information-Processing Approaches
- The Role of Social & Cultural Contexts
- Individual Differences
- Reconsidering the Cognitive Changes

Overview of this week
- The 5-7 Years Transition
- Biological Developments
- Cognitive Developments
- Concrete Operational Thinking
- Alternative Explanations

The 5-7 years transition
- Loss of milk teeth and emergence of second teeth
  - "Age of reason"
    - New abilities to think more deeply and logically
    - Can follow through better on a problem
    - Can keep track of more than one aspect at a time
- New social intelligence
  - Acquisition of cultural knowledge and skills
  - Ability to work and adhere to social norms
  - Ability to demonstrate new levels of compassion for others
- New parental expectations…
Age at which Kipsigis mothers (Kenya) believe their children undergo basic developmental changes

Note continuity in the development of memory (needed to carry a message) and the sharp discontinuities in the estimates of personality development and abilities involving money.

Changing Patterns

- In all cultures, amount of time unsupervised by adults increases markedly during middle childhood
  - About 1/3 of settings have no adult supervision
- Compared to 50 years ago, more likely to spend time after school in front of TV or computer screen or playing interactive video games than making forts over in the back yard
  - Range of contexts children inhabit, however, still greatly expands…

Local neighborhood beyond the family begins to exert a direct impact on the child’s development

video: The 5-7 years transition
Cognitive Developments

A Change in Logical Thinking
Conservation

- Middle Childhood: 6 - 11 years
- Concrete Operational Thinking
Piaget: Conservation of Number

Children above the age of 6 or 7 now display conservation of number, and will say that the two rows are the same.
Conservation

- Understanding that some properties of an object remain the same even when its appearance is altered (e.g., beaker test..., card test...)
  - Begin to understand at age 5 or 6; typically mastered by age 8
- Mental operations
  - Identity – “They were equal to start with and nothing was added, so they’re the same.”
  - Compensation – “The liquid is higher, but the glass is thinner”
  - Reversibility – “If you pour it back, you’ll see that it’s the same

Mental operations

Identity

- an operation in which a transformation leads to the original value. E.g. X * 1 = X

Compensation

- an operation which is equivalent in its effect to another transformation. E.g. X * 2 = X + X

Reversibility

- an operation for which an inverse exists. E.g. X * 6 / 6 = X

Logical Necessity

- the conviction that it’s logically necessary for qualities to be conserved
  - “It has to be that way”
- This is Piaget’s key criterion of a stagelike change

A Change in the Logic of Thinking

- Piaget: **Concrete Operations**
  - “Concrete” because these mental actions are directed toward concrete everyday activities
  - “Operations”
  - Distinguished from preoperations by their logic properties
  - Results in more flexible and organized thinking (e.g., can think about alternatives and can reverse their thinking)
  - Allows children to think through their actions, and to mentally combine, separate, order, and transform objects and actions

Concrete Operations:

- Coordinated mental actions that fit into a logical system in a way that creates a greater unity of thinking
The preoperational child’s interaction with objects in the environment leads to contradictions:
- How can the same beaker have both more and less liquid?!
- This produces disequilibration
- Motivating constructing of new mental actions
- These are reversible

All aspects of psychological functioning are transformed
- The physical world becomes more predictable
- Thinking becomes more organized and flexible

Is conservation acquired universally?
Thus, conservation seems a universal cognitive achievement of middle childhood, as Piaget assumed it was, but is affected by the child’s familiarity with the task materials.

Other Cognitive Developments

Increased Linguistic Skills
Improved Classification Skills
### Increased Linguistic Skills

- **Vocabulary**
  - 6-year-olds understand about 10,000 words
  - 2 years later this has doubled
  - By 10 or 11, have a vocabulary of approximately 40,000 words

- **Conversation**: Older children are better at making sure they and their partners understand each other and have a greater ability to maintain coherence in a conversation over longer periods of time
  - Use linguistic markers: “Getting back to…” “As I was saying”
  - Provide ongoing feedback by nodding or saying “Uh hum”

### Improved Classification Skills

- **Piaget**: Set of brown beads and white beads
  - “Are there more brown beads or more beads?”

  Children 4-6 cannot attend to the subclass and the superordinate class at the same time; instead they compare one subclass with another subclass.

  In middle childhood gain ability to understand the hierarchical structure of categories and can categorize objects according to multiple criteria.

  Begin to collect stamps, baseball cards, etc.
Syllogistic Reasoning
- (Also called deductive reasoning)
- If you hit a glass with a feather it will break
- Jane hit a glass with a feather
- Did the glass break?

Deductive Reasoning - Concrete Operational

But is Piaget's explanation convincing?
- Assimilation and accommodation:
  - “The Batman and Robin of developmental processes. How do they operate? We know no more about them than when they first sprang on the screen!”

What Piaget ignored:
- In middle childhood, children become able to use written signs - writing, mathematical symbols...
- These external tools transform internal intellectual processes - memory, reasoning, even perception
- Writing changes the ways we think about speech
The higher mental functions:
- logical memory
- deliberate remembering
- voluntary attention
- ...all these are products of *culture*
- ...the ways language acts back on the child

Other Explanations of Developmental Changes in Cognition

1. The Influence of Memory
2. Evolution of Strategies
3. Cognitive Bridging Processes

1. The Influence of Memory
- Many psychologists believe that increases in memory account for the child's ability to keep 2 aspects of a problem in mind
- **Memory capacity**
- **Accumulating knowledge**
- **Development of cognitive strategies**
- **Metamemory**

Memory Capacity
- **Factor 1**: Increased speed and capacity of memory processing
- **Memory span**: 5-year-olds remember 4 digits, 10-year-olds remember 6, adults remember 7
- **Retrieval speed**: 11-year-olds retrieved information from long-term memory about 6 times faster than 5-year-olds
- Speed and capacity are interrelated...
Memory span

- The number of randomly presented items of information that can be repeated immediately after they are presented.

Accumulating Knowledge

- **Factor 2**: Expanded knowledge base
  - Retention improves because children have more prior information to which to relate new information.
  - Younger subjects who have a rich knowledge base in a given area remember more new information related to that area than older subjects whose knowledge base is not as rich (chess).

Knowledge base

- The store of information that children can draw upon to deal with a new situation.
Development of Cognitive Strategies

- **Factor 3**: Improved memory strategies (all are two-sided because they must simultaneously think about a goal and the way to achieve it)
  - **Rehearsal**: Repeating to oneself the material one is trying to memorize
  - **Memory Organization**: Group in meaningful clusters (e.g., by sound, by situational associations “farm things”, by conceptual categories “foods”), tested by free recall (any order)
  - **Elaboration**: Make up connections between 2 or more things to be remembered (“tomato” and “street”, imagine tomato squashed in the street), tested by paired words

Strategy

- A deliberate, controllable cognitive operation performed for the purpose of attaining a particular goal

Metamemory

- **Factor 4**: Emergence of metamemory (i.e., the ability to think about one’s own memory processes)
  - 8-year-olds have a better understanding of the limitations of their own memories than most 5-year-olds
  - Consequently they knew enough to study the materials and to test themselves on their ability to remember

Other Explanations of Developmental Changes in Cognition

1. The Influence of Memory
2. Evolution of Strategies
3. Cognitive Bridging Processes
Cognitive Development as the Evolution of Strategies

- ineffective strategies are eliminated
- development is ‘overlapping waves’ of strategies

Tic-tac-toe

- children at all ages used more than one rule
- the mixture of rules shifted in a wave-like pattern as they grew older
- most 5-year-olds used rule 1
- most 9-year-olds used rule 2 or 3
- most 13- to 17-year olds used rule 3
- very few used rule 4

Other Explanations of Developmental Changes in Cognition

1. The Influence of Memory
2. Evolution of Strategies
3. Cognitive Bridging Processes
**Additional Cognitive Strategies that bridge the islands**

- **Attention**: Ability to sustain attention grows steadily throughout middle childhood, with older children displaying a greater ability to select and execute an effective attentional strategy…

  Not until middle childhood did children pay attention to each of the four houses in a systematic way to discover the subtle differences between them.

- **Planning**: In working a maze, older children scan the route and plan their moves before they begin…

  A maze of the kind used by Garner and Rogoff (1990) to assess children’s ability to plan ahead
The sophistication of the planning strategies that children use in solving the Tower of Hanoi problem shows rapid growth at the start of middle childhood.

The Tower of Hanoi

- The Tower of Hanoi puzzle was invented by the French mathematician Edouard Lucas in 1883.
- In Benares, during the reign of the Emperor Fo Hii, there was a temple with a dome which marked the center of the world. Within the dome, priests moved golden disks between diamond needlepoints, a cubit high and as thick as the body of a bee. God placed 64 gold disks on one needle at the time of creation. It was said that when they completed their task, the universe would come to an end.
- We are given a tower of eight cups, stacked in decreasing order on one of three pegs.
- The aim is to transfer the entire tower to one of the other pegs, moving only one disc at a time and never a smaller one on a larger.

Navajo children spent almost ten times longer planning their movements than the European-American children did—and as a result, they made significantly fewer errors. Their culture values doing things thoughtfully rather than quickly.
Additional Cognitive Strategies that bridge the islands

- **Metacognition**: Ability to think about one's thoughts, assess how difficult a problem is likely to be and choose strategies to solve it.