Problem solving

Psych 414
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Problem solving

- Goal
- Obstacles
- Strategies (for overcoming obstacles)
- Evaluation of results

The development of problem solving

- Emergence of problem solving relies on the ability to generate strategic, goal-directed behavior
  - Piaget: 8-12 months of age
  - Infants’ means-end action sequences
- Age of emergence depends on complexity of task
Bullock & Lütkenhaus (1988)

- Asked 15-35-month-old children to reproduce a house built by adult
- 17-month-olds
  - Showed little goal-directed activity
  - Gave little evidence of evaluation
- 24- & 32-month-olds
  - Built the house
  - Corrected mistakes
  - 90% expressed pleasure with performance

The development of problem solving

- Involves a variety of resources and skills:
  - Domain-specific knowledge
  - Metacognition
  - Sense of game
  - Social support

Problem-solving as inducing and using rules

- Many problems solved by detecting and applying “if..then” relations
  - Piaget: formal logic
  - Inducing and discovering rules through experience
- Young children have a difficult time discovering rules
Overman et al (1996)

- Oddity problem
  - Which one of these things is not like the other?
- Tested toddlers through adults
- Participants see 3 objects, rewarded for choosing the one that is unique
- Took toddlers hundreds of trials to learn the rule; preschoolers did slightly better; 6 and older learned quickly
- Young children solved the problem easily when they told the rule

Siegler’s rule-assessment approach

- Children solve problems using increasing complex sets of rules
- Presented children of different ages with a balance scale task
  - Which side of the scale will fall (if either)?

Siegler’s rule-assessment approach

- Rule 1: Consider only the amount of weight on each side
- Rule 2: Consider weight; if weights are equal then use distance
- Rule 3: Use weight and distance: when weights are equal use distance, when distances are equal use weight, guess if weight and distance unequal
- Rule 4: Multiply weight X distance (torque)
### Siegler’s rule-assessment approach

- 88% of children consistently applied one of the four rules
- 5-year-olds: Rule 1
- 9-year-olds: Rules 2 and 3
- 13- to 17-year-olds: Rule 3
- What limits children’s problem solving?
  - Encoding of balance scale information
  - Other factors? (see text p. 173)

### Problem solving processes

- Executive functions: higher-order thought processes that depend on development of prefrontal cortex
  - Planning
    - Inhibition of prepotent response
    - Maintaining information in working memory
    - Representational flexibility
- Develop throughout childhood
  - Ages 3 to 5

### Planning

- Future-oriented problem solving
- Typically used in novel situations
- Difficult for young children:
  - Involves inhibition
  - Planning is effortful
  - Outcome is uncertain
  - Requires coordination with other people
  - “Winging it” is fun
Means-end analysis

• Comparing the goal with the current situation and reducing differences between the two until goal can be met
  – Subgoals
  – Procedures for meeting subgoals
  – Discrepancies between current state and goal

Means-end analysis

• By 12 months of age infants can solve a 3-step problem
• Ability to generate a path to reach a goal that is not visible emerges by 21 months
  – 21- to 27-month-old infants presented with 4 problems that involved assembling components to make a toy
  – Showed kids goal state, and then gave kids disassembled toy
  – Successful on 40% of problems; 90% of solutions indicated planning (performed target actions in correct order)

Tower of Hanoi

Rules:
1. Move only 1 ring at a time
2. Never place a smaller ring on a larger one
3-year-olds solve 2 move problems
4-year-olds solve 4 move problems
5- and 6-year-olds solve 5-6 move problems
Route planning

- Grocery store task (Gauvain & Rogoff, 1990; Hudson et al., 1995)
  - When children are told about potential mishaps, only 5-year-olds (not 3s and 4s) were able to generate plans to avoid the mishap.
  - 5-year-olds do item-by-item search whereas older kids look through the entire store first and then search for specific objects.

Inhibition

- The ability to inhibit a salient response and substitute a more appropriate response.
- Often tapped in tasks that require children to perform an “opposite” behavior.

Day/night task

- Tested 3.5 to 7-year-old.
- 5 and younger unable to sustain successful performance over 16 trials.
Windows task

- Training: opaque boxes, child asked to point to one box and receives chocolate when he or she points to the empty box
- Test: boxes have windows (child); have to point to deceive experimenter
- 4-year-olds succeed; 3-year-olds fail

Working memory

- Sensory memory: immediate memory for very briefly presented stimuli
- Long-term memory: Long-term storage of experiences and facts
- Working memory: “Where active thinking occurs”
  - Involves combining information from sensory memory with information stored in long-term memory

Working memory

- Limited to 3 to 7 units
- “Chunking”
- Older children can maintain more information in working memory than can younger children
Representational flexibility

- Difficulty switching perspectives, or seeing things in two different ways
- Assessed by asking children to categorize objects according to one dimension and then according to another dimension
  - Dimensional change card sort (DCCS)
  - Age-related changes from 3 to 4

Dimensional change card sort

Target cards

Test cards

Pre-switch: shape
Post-switch: color

Reasoning

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Learning objectives

• Define reasoning and recognize changes in formal reasoning
• Identify limitations of Piaget’s model of formal reasoning
• Describe children’s informal reasoning abilities

Reasoning

• Cognitive activity
  - Thinking logically, rationally, analytically
• Processes by which acquired knowledge is applied
• Manner in which knowledge is employed in the course of trying to get through a situation
• Going beyond information given to derive new information
• PROCESS WITH OUTCOME, APPLICATION OF EXISTING KNOWLEDGE, ACQUISITION OF NEW KNOWLEDGE

Conservation task

<table>
<thead>
<tr>
<th>Initial state</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>liquid</td>
<td></td>
</tr>
<tr>
<td>number</td>
<td></td>
</tr>
<tr>
<td>length</td>
<td></td>
</tr>
</tbody>
</table>
Developmental trends in reasoning

- Perceived appearances --> inferences
- Centration --> decentration
- States --> transformations
- Irreversible --> reversible
- Qualitative --> quantitative
  - Real--> possible
  - Empirico-deductive --> hypothetico-deductive
  - Intrapropositional --> interpropositional

Critiques of Piaget’s theory

- Formal reasoning forms only a subset of children’s reasoning abilities
- Stage model doesn’t always fit the data
  - Performance uneven across domains
  - Young children more competent, older children and adults less competent

Transitive inference task

- Transitive relations hold between any entities that can be organized in an ordinal series.
  - A>B>C>D>E
- Should develop at concrete operational stage (about 7).
- Bryant & Trabasso (1971): children as young as 4 can make transitive inferences if the memory demands of the task are not too high
Bryant & Trabasso (1971)

• 4 initial direct comparisons (A>B, B>C, C>D, D>E)
• 10 test comparisons (4 direct, 6 transitive inference)

Wason selection task

• 'If there is a vowel on one side of the card then there is an even number on the other side of the card'
  – Indicate those cards that need to be turned over to determine whether the rule is true or false.

A  D  4  7

Modified Wason task

• Drinking Age Problem (Griggs & Cox, 1982)
  – 'If a person is drinking beer then that person must be over 19 years of age'
  – Indicate those cards that need to be turned over to determine whether the rule is true or false.

Beer  Coke  22 years  16 years
Informal reasoning

• Content driven, probable or likely truths
• Similarity-based reasoning
  – Invoking a previous situation to solve novel situation based on perceptual similarity
• Analogical reasoning
  – Mapping elements of one situation to another situation (analogy): finding correspondences between situations
• Causal reasoning
  – Determining cause and effect based on patterns of evidence

Analogue reasoning

• Goswami (1991, 1992; Goswami & Brown, 1990)
• Evident by age 4 in A:B::C:D item analogies.
  – bird: nest :: dog: ?
  – apple: cut apple :: playdoh: ?
  – chocolate: melted chocolate :: snowman: ?
• 3 year olds can do item analogies with causal relations.

Causal reasoning

• Gopnik et al. (2001)
  – “Blicket detector”: children must infer which objects cause a machine to light up and which one causes it to stop