Problems, strategies, insight, and analogical problem solving

Lesson VIII: Problem Solving
module 39
Insight as a cognitive phenomenon

- **Gestalt view**
  - The problem is restructured when solved - much like the sudden perception of an ambiguous image

- **Köhler’s work with non-human primates**
  - Non-human primates show evidence for planning an action and sudden restructuring of problems
  - Examples: Use of tools (sticks, boxes) to reach otherwise unattainable objects

- **Wertheimer’s work on problem solving and creativity**
  - Insight accompanies many scientific findings
  - The story of the young Gauss (adding numbers 1 - 100)
The feeling of problem solving success

- Metcalfe & Wiebe’s (1987) study on how close participants felt to the solution of a problem
- In routine problem solving, ratings of warmth indicating the closeness to the solution increased monotonically during the process
- Insight problems show sudden shift from no-warmth to warmth
Mental set and functional fixedness

- **Mental set**
  - A frame of mind involving a particular representation of a problem or the operators

- **Luchins (1942)**
  - Try to produce the desired quantity by pouring water between the three different containers

<table>
<thead>
<tr>
<th>Result</th>
<th>Container 1</th>
<th>Container 2</th>
<th>Container 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>21</td>
<td>127</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>14</td>
<td>46</td>
<td>5</td>
</tr>
<tr>
<td>65</td>
<td>13</td>
<td>92</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>15</td>
<td>39</td>
<td>3</td>
</tr>
</tbody>
</table>
Mental set and functional fixedness

- When is mental set a problem
  - When a problem requires different operators or the combination of operators in unusual ways
  - Anytime a non-standard solution is required

- Other examples for expectations and mental set
  - Remember the "numerical" sequence from the first module in this lesson?

- Functional fixedness
  - Inability to think of a new use of an object because of its common function
  - Examples from the textbook
The original Duncker problem
- Suppose you are a doctor faced with a patient who has an inoperable stomach tumor. You have at your disposal rays that can destroy human tissue when directed with sufficient intensity. How can you use these rays to destroy the tumor without destroying the surrounding healthy tissue?

How can you destroy the tumor without destroying the surrounding tissue?

Does this problem solution help you with the first?
- A general wishes to capture an enemy fortress. Radiating outward from the fortress are many roads, each mined in such a way that the passing of any large force will cause an explosion. This precludes a full-scale direct attack. The general's plan is to divide his army, send a small group down each road, and converge on the fortress.
Analogical problem solving

Content vs. structure (Gentner, 1983)
- Solutions to a problem that has the same structure can be applied to a new (target) problem
- Solutions to problems with the same content but with different structure are generally inapplicable
- Problem solver needs to identify the underlying deep structure of the problems and map the different parts onto each other
- Problem solving then requires only the mapping of the operations from the original problem solution to the target problem

- Problem: humans often rely on content similarity, not structural similarity between problems
- Mappings thus often inaccurate / unproductive
Analogical problem solving

- **Transfer**
  - the solution of one problem has a carryover effect on another problem
  - Negative vs. positive transfer

- **Gick & Holyoak (1983)**
  - Duncker’s radiation problem
  - Positive transfer increases if...
    - The source problem is pointed out as a potential help to solving the target problem (71%)
    - The source problem is presented as a problem than if the source problem is presented as something to memorize

- **Understanding**
  - Analogical problem solving most effective if person fully understands why a solution is a good solution
Incubation
- Phenomenon that a problem solution sometimes occurs only after an extended period of absence from the problem
- Extensive anecdotal evidence
- Seems to require extensive initial processing

Possible mechanisms
- Changes in mental set
- Random fluctuations of mappings, feature weights
- Internal or external stimuli might lead to new interpretations in cognitive processing
Expertise: How experts differ from novices

- **Organization of knowledge**
  - Chess studies show that grandmasters of chess can recall many more meaningful board positions than novices
  - Experts also can perceive and identify odd elements much faster than novices
  - Knowledge base alone allows experts to outperform novices, even under intense time pressure

- **Strategic / meta-cognitive differences**
  - Experts spend more time “setting up” the problem
  - What information is given? - what solution is required?
  - Development of different schemas, automatization