Cognitive Approach to Creativity

Cognitive View of Creativity
- Everybody has the ability to be creative
- Normal cognitive processes
  - Memory retrieval, analogy, problem solving
- Normal knowledge structures
  - Schemas, category knowledge, episodic memory
- Focus on psychological creativity
- Focus on problem solving

Problem Solving
- Creativity occurs during problem solving
  - Poets
  - Painters
  - Actors
Problem Solving

• Poets
  • Expressing feelings within constraints of a poem

“I was angry with my friend: I told my wrath, my wrath did end. I was angry with my foe: I told it not, my wrath did grow.”

William Blake

Problem Solving

• Painters
  – Problems of design, balance, expression

Salvador Dali

Problem Solving

• Actors
  – Expressions and movements to convey the character
  • Creative solutions to problems within a domain

Al Pacino
Problem Solving

- Scientists
  - Experiments, theories

Predictions of the Cognitive View

- Problem Solving: Same characteristics for Creative and Normal
- Cognitive Processes: Operate similarly for both types
- Knowledge Structures: Should be evident in creative products

History of Cognitive Approach to Creativity

- Problem Solving research
  - Spurred by advent of computers
- Realization that computers have capacity for intelligent thought
  - Search for Artificial Intelligence (AI)
History of Cognitive Approach: Turing Test

- Operational definition of intelligence
  - Ability to achieve human-level performance on cognitive tasks

History of Cognitive Approach: Turing Test Skills

- Natural language processing
  - Communicate successfully
- Knowledge representation
  - Store information
- Automated reasoning
  - Answer questions/draw conclusions
- Machine learning
  - Adapt to new circumstances

Cognitive Modeling of Problem Solving

- Designing programs that think like humans
- Need to determine human thought processes
  - Introspection
  - Human experimentation
- Express theories as programs
Cognitive Modeling of Problem Solving: GPS

- General Problem Solver (GPS)
- Uses means-ends approach
- Used to solve well-defined problems

GPS mimicked human problem solving processes including mistakes
- Newell & Simon’s approach developing GPS
  - Started field of Cognitive Science
  - Terminology and framework for problem solving

Problem Solving: Terminology

- Problem solving
  - Goal is not readily available
  - Use knowledge to reach goal
- Initial state
  - State you are in when you encounter problem
Problem Solving Terminology:
Problem Space

- Set of choices
  - Found at each step of solving the problem
- Includes
  - Initial, intermediate, and goal states
  - Knowledge being applied to problem
  - Knowledge that could be applied
  - External devices, objects, resources
- Range on continuum from large to small
  - YBO versus LSOCOYYHGP

Problem Solving Terminology:
Operators

- Legal operators or moves performed during problem solving
- Classes
  - Algorithms
  - Heuristics

Problem Solving Terminology:
Algorithm

- Precise rule
  - Always yields a correct solution to the problem
- Frequently slow and inefficient
  - Exhaustive search
    - Search entire problem space
    - Difficult for humans
    - Easy for computers
Problem Solving Terminology: Heuristic

- Rule of thumb
  - Likely, but not guaranteed, to generate solution
- Selective search of problem space
  - Examine only those parts likely to lead to solution

Problem Solving Terminology: Goal state

- Ultimate solution to problem
- Problem defined in terms of goal state specification
  - Well-defined problems
  - Ill-defined problems

Well-defined and Ill-defined Problems

- Well-defined
  - Clear goal
  - Small set of information to start
  - Guidelines or rules
- Ill-defined
  - Unclear goal
  - Starting information, operators or both are vaguely specified
  - Many real world problems
Gestalt View of Problem Solving

- Gestalt psychologists
  - Perception and the structure of patterns
  - Arrangement problems
- Kohler (1925) & Sultan
  - Cage contained sticks and boxes
  - Rearrange objects to get fruit

Gestalt View of Problem Solving

- Problem solving theories based in perception theories
  - Global restructuring of knowledge
  - Associated with “flash” of insight

Insight Problems

- Insight problems (Radiation problem)
  - Solution suddenly enters the mind
    - Immediately recognized as correct
    - Accompanied by an “AHA!” experience
- Non-insight problems (Anagram problem)
  - Solve problem gradually
  - Reasoning skills and routine procedures
Insight vs. Non-insight Problems

• Metcalf & Wiebe (1987) studied insight problems
• Compared insight to algebra problem solving
  – "Warmth ratings"

Characteristics of Insight Problems

• People initially have no idea how to solve problem
• No linear “feeling of warmth”
  – No sense one is getting closer to the goal
• Period of incubation
  – Time spent away from problem
• Solution appears suddenly
  – Solution is fully formed

Insight Problem Solving Explanations

• Special Processes Explanations
  – Unconscious work hypothesis
  – Chance encounter hypothesis
• “Business as Usual” Explanations
  – Insight “feels” different
  – Restructure representation of problem
  – Fixation explanation
Special Processes Explanations

- Unconscious Work
  - Incubation
    - Discussed further in “Brain influences” lecture
- Chance encounter
  - Maier “two string problem”

Business as Usual Explanations

- Some researchers (Weisberg) question the concept of insight
- Propose
  - Gradually work towards a solution
  - Solution just “feels” different
- Some non-insight problems solved by restructuring

Business as Usual Explanations: Restructuring

- Change mental representation of problem
  - Problem space
    - Initial or goal states
    - Available operators
    - Constraints

If a pond lily doubles every day and it takes 30 days to completely cover a pond, on what day will the pond be 1/2 covered?
Business as Usual Explanations: Mental Activation

- Spread of activation
- Incorrect solution/representation activated
- Causes impasse
  - Inability to solve problem

Stimuli from Smith & Blankenship (1991)

<table>
<thead>
<tr>
<th>Remote Associates Test Problems</th>
<th>Blockers</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SALAD HEAD GOOSE</td>
<td>lettuce</td>
<td>egg</td>
</tr>
<tr>
<td>BED DUSTER WEIGHT</td>
<td>room</td>
<td>feather</td>
</tr>
</tbody>
</table>

Incubation & Fixation in RAT Problem Solving

![Incubation Effect Diagram]

From Smith & Blankenship (1991)
Barriers to Problem Solving

• Problem solving involves some sort of obstacle to overcome in the process of reaching a goal
• Fixation
  – An impediment to problem solving

Perceptual fixation

• Involves perceptual (visual/spatial) assumptions about the problem domain that blocks your ability to reach a solution

Mental Set

• Rule-based fixation
• Getting stuck on a set of rules to solve a problem
Functional Fixation
- Getting stuck on a particular use for an object
- Can't see different use for an object which will enable you to solve the problem

Creative Cognition
(Finke, Ward, Smith)
- Adapted from cognitive psychology paradigms
- Examples
  - Visual Imagery – Creative imagery (Finke)
  - Mental set – Fixation (Smith)
  - Concept generation – Conceptual expansion (Ward, Sifonis)
  - Analogy – Creative analogy (Sifonis)

Geneplore Model
- Heuristic model of creative functioning
- Two stage model
  - Generate ideas
  - Explore ideas
- External constraints
  - Influence both stages
Geneplore Model: Processes

- Idea generation
  - Supported by generative processes
- Idea Exploration
  - Searching the generated ideas
- Creative thinking = various combinations of the two processes

Geneplore Model: Structures

- Operated on by processes
- Existing knowledge
- Preinventive structures
  - Formed in generative stage
  - Incomplete ideas that show promise
  - Symbolic visual patterns, 3-d forms, mental blends….

Geneplore: Assumptions

Noncreative Thinking

Psychological Creativity

Emergent Features
Preinventive Structures
Generative, Exploratory Processes

Creative Thinking
Historical Creativity