Syllogistic Reasoning Errors

- Atmosphere Effects
  - Superficial Processing
- Conversion Effects
  - Comprehension Problems
- Belief Bias
  - Intrusion of Prior Beliefs
- Figural Effects
  - Findings that suggest people more likely to produce a conclusion that relates the subject of one premise to the predicate of another
  - More indicative of reasoning process itself

Mental Models Theory

- Johnson-Laird
  - People reason by constructing models
  - Conclusions drawn by inspecting models
  - If no alternative models refute, draw inference as valid conclusion

Integrating Premises

1. Some of the artists are beekeepers.
2. All of the beekeepers are chemists.
3. Some of the artists are chemists.

<table>
<thead>
<tr>
<th>artist</th>
<th>beekeeper</th>
<th>chemist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(4) All of the artists are beekeepers.
(5) Some of the beekeepers are chemists.

<table>
<thead>
<tr>
<th>artist</th>
<th>beekeeper</th>
<th>(chemist)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(6) Some of the artists are chemists. [?]

<table>
<thead>
<tr>
<th>artist</th>
<th>beekeeper</th>
<th>(chemist)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Searching for Alternative Models

What about negatives?

None of the artists is a beekeeper.

<table>
<thead>
<tr>
<th>artist</th>
<th>~beekeeper</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>artist</th>
<th>~beekeeper</th>
</tr>
</thead>
<tbody>
<tr>
<td>~artist</td>
<td>beekeeper</td>
</tr>
<tr>
<td>~artist</td>
<td>beekeeper</td>
</tr>
</tbody>
</table>

Implicit Notation

- Each line shows representative individual with particular combination of properties
- Dots indicate there may be other types of individuals
- [ ] place restrictions on what properties implicit individuals can have
  - Individuals with brackets have been exhaustively represented
- All A are B
  \[a\] = b
  \[a\] = b
  ...
- Some A are B
  a = b
  a = b
  ...
- No A are B
  \[a\]
  \[a\]
  \[b\]
  \[b\]
  ...
Drawing Conclusions

All A are B  All B are C
[a] = b  [b] = c
[a] = b  [b] = c
...  ...

Combined
[[a] = b] = c
[[a] = b] = c
...  ...

A 3-Model Syllogism

Some B are A
No B are C
Therefore: Some A are not C.

Some B are A  No B are C
b = a  [b]
b = a  [b]
...  ...

Potential Conclusions
No A are C
No C are A

First Model

Some B are A  No B are C
b = a  [b]
b = a  [b]
...  ...

Combined
a = [b]
a = [b]
[c]
[c]
...  ...

Potential Conclusions
No A are C
No C are A

Second Model

Some B are A  No B are C
b = a  [b]
b = a  [b]
...  ...

Combined
a = [b]
a = [b]
a = [c]
[c]
[c]
...  ...

Potential Conclusions
Some A are C
Some C are A
Some A are not C
Some C are not A

Second Model

Some B are A  No B are C
b = a  [b]
b = a  [b]
...  ...

Combined
a = [b]
a = [b]
a = [c]
[c]
[c]
...  ...

Potential Conclusions
Some A are C
Some C are A
Some A are not C
Some C are not A

Second Model

Some B are A  No B are C
b = a  [b]
b = a  [b]
...  ...

Combined
a = [b]
a = [b]
a = [c]
[c]
[c]
...  ...

Potential Conclusions
Some A are C
Some C are A
Some A are not C
Some C are not A
Common Errors on this Syllogism

Premise 1: Some B are A
Premise 2: No B are C

- All A are C? (no)
  - Not compatible with any of the models!
- No C are A? (yes)
  - Compatible w/1st model, but not 2nd & 3rd
- No A are C? (yes)
  - Compatible w/first model, but not 2nd & 3rd

Evidence for Mental Models Theory

- Problems that require more models are more difficult
  3-model problems harder than 2-model problems
  2-model problems harder than 1-model problems
- Error patterns suggest people construct some (but not all) mental models

Mental Models Theory Recap

- The more models needed for valid conclusion, the more errors
  - Errors reflect conclusions from initial models

Mental Models Theory & Wason Selection Task

- If there is a circle, then there is a triangle.
  [circle] triangle
  ...
- Modus Tollens requires spelling out the dots: constructing 3 models
  circle triangle
  ~circle triangle
  ~circle ~triangle