Cognitive Cubes: a TUI for Cognitive Assessment

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What’s coming

Interface: ActiveCube

Application: cognitive assessment

System: Cognitive Cubes
ActiveCube: a 3D interface

Intuitive 3D modeling

Real-time interaction

Bi-directional interface
ActiveCube: 3D modeling

Intuitive 3D modeling

In construction of 3D shape
In understanding of 3D shape

Real-time interaction

Bi-directional interface
ActiveCube: real-time

Intuitive 3D modeling

Real-time interaction

*Interactive capture of 3D shape*

*Physical & virtual object consistency*

Bi-directional interface
ActiveCube: bi-directional

Intuitive 3D modeling

Real-time interaction

Bi-directional interface

Other I/O functions in cubes
Can arrange functions spatially
Clear causality between I/O
ActiveCube: video
ActiveCube: other apps

Consistency
- shape
- functionality

Medical Assessments

Intellectual toys

rapid prototyping

3D object modeling

training/rehabilitation tools

intuitive interface for CAD
Assessment: why do it?

Diagnosis
  Of disease and injury

Monitoring
  Of recovery and decline

Research
  About brain function
Assessment: spatial tests

Constructional

*Integrating of perception & action*

Relevant

*Strongly related to everyday tasks*

International

*Little dependence on language & culture*
Assessment: typical test
Assessment: why automate?

Reliability
  Consistent testing & scoring

Sensitivity
  3D complexity & high res measures

Reduced cost
  Less training & adaptive testing
Cognitive Cubes: task

Match this... ...with this.

3 task types: follow, match & reshape
Cognitive Cubes: 4 measures

Time to completion

Similarity at completion
   \# intersecting cubes - \# extra cubes

Derivative of similarity
   Change in similarity over time

Zero crossings of similarity
   \# times similarity worsened
Cognitive Cubes: similarity
Cognitive Cubes: evaluations

Cognitive sensitivity evaluation
  To known cognitive factors

Test comparison evaluation
  To standard mental rotation assessment
Cognitive Cubes: test variables

Age
Seven < 37 yrs, seven > 55 yrs, (2 AD)

Task type
8 follow, 15 match, 10 reshape

Shape type
9 two dimensional, 24 three dimensional
Cognitive Cubes: sensitivity

Age: significant by time & derivative

Task type: by all measures

Shape type: by all measures

Task x shape: by all measures

  2D: reshape > match = follow

  3D: reshape > match > follow
Cognitive Cubes: sensitivity

Derivative

[Graph showing Sim/Sec for young, elderly, and AD categories]
Cognitive Cubes: sensitivity

Derivative

<table>
<thead>
<tr>
<th>Sim/Sec</th>
<th>follow</th>
<th>match</th>
<th>reshape</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D</td>
<td><img src="image" alt="2D follow bar chart" /></td>
<td><img src="image" alt="2D match bar chart" /></td>
<td><img src="image" alt="2D reshape bar chart" /></td>
</tr>
<tr>
<td>3D</td>
<td><img src="image" alt="3D follow bar chart" /></td>
<td><img src="image" alt="3D match bar chart" /></td>
<td><img src="image" alt="3D reshape bar chart" /></td>
</tr>
</tbody>
</table>
# Cognitive Cubes: comparison

<table>
<thead>
<tr>
<th>Measures</th>
<th>All</th>
<th>Shape</th>
<th>Task</th>
<th>Task</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Time</td>
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<td>Similarity</td>
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<td>Crossings</td>
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<tr>
<td>Derivative</td>
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</tbody>
</table>

- Marg Sig Correlation
- Stat Insig Corr > .2
- Correlation < .2
Conclusions

Promising results

*Sensitivity to factors, some correlations*

Readying for prime time

*Extensive studies of score distributions*

Future research

*Difficulty and shape complexity*

*Decision trees*
Questions?