Perception, Attention and Problem Solving on the Block Design Task
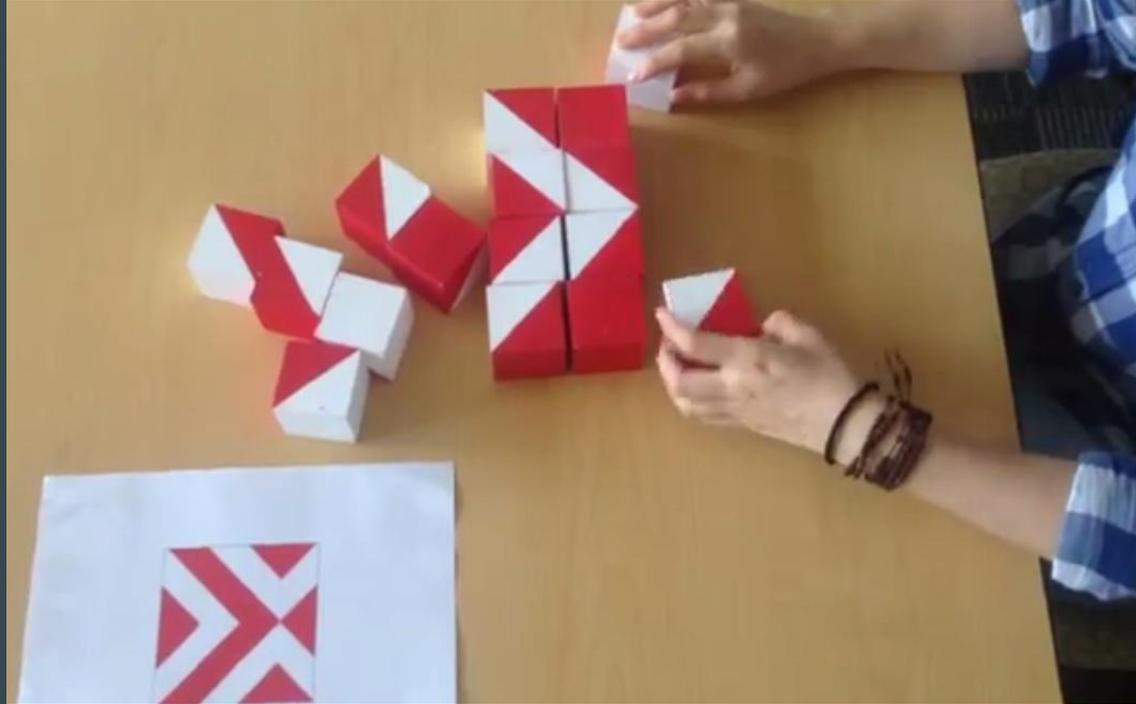
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Overview

1. The block design task

2. Previous work

3. Block design and Soar

4. Future work

The Block Design Task

Significance of the block design task

- The Block Design Task is commonly used to measure nonverbal reasoning, and more specifically perceptual reasoning [1].
    - Wechsler Adult Intelligence Scale
    - Wechsler Intelligence Scale for Children

- Performance is very sensitive to atypical neurophysiological development, and is commonly used in neuropsychological assessment.
    - Block Design is an ability peak for individuals with Autism. [2]
    - Patients with different types of neuropsychological disorders will perform poorly, in different ways. [3]

Problem Solving Strategies

- Analytic Strategy [4]
  - The design is mentally segmented into individual block faces.
  - Strategy allows for the task to be split into subtasks:
    - Picking a block
    - Rotating it to fit the segmented block face
    - Placing the block into its corresponding location
- Synthetic Strategy [4]
  - The gestalt-appearance of design is considered
    - "Focusing on the whole and not the parts"
  - Some blocks are manipulated till the correct design *clicks*.
  - Problem solving using the Synthetic strategy is usually more complex, and involves assembling subsections of the design till the correct design is (thought to be) reached.
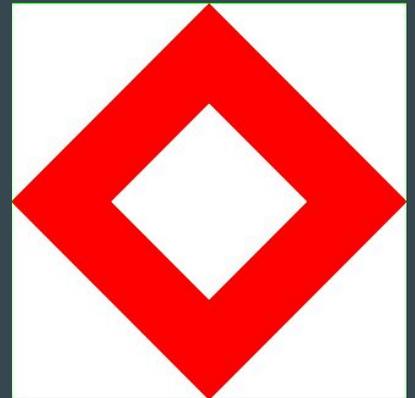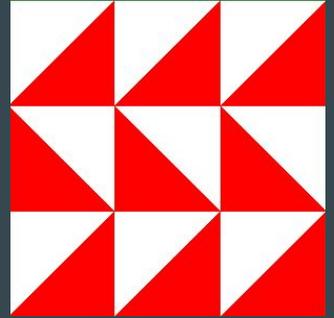
Previous work

- The computational model shown was developed to solve the task [5]:
  - Visual mental images are the main form of representation
  - The task was done in a simulated environment represented by a top-view image of the table
- The work was focused on providing ways to changes in strategy to behavior (specifically accuracy on the task, and gaze transitions)
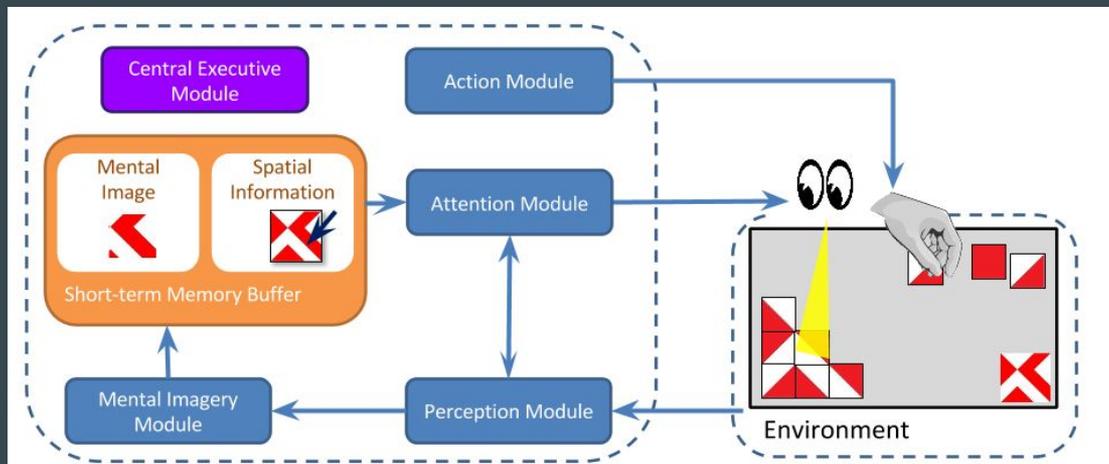
Relevance to Soar

- Solving the task combines perception, action, and reasoning, which makes it a suitable task for Soar.
- There is a wide range of solution strategies to solve the task, with some strategies being more suited to certain design patterns.
- Some strategies require rich and complex mental imagery representations and operations to be used efficiently.
- Choice of strategy was found to be affected by the visual features of the specific design being replicated [7].

SVS vs Block Design Architecture

- The Soar Architecture is currently missing:
  - An attention module
  - Visual Information in the spatial scene

- Through incorporating some (or all) of the missing components into Soar, the block design task can be solved through planning.

Wintermute (2009)
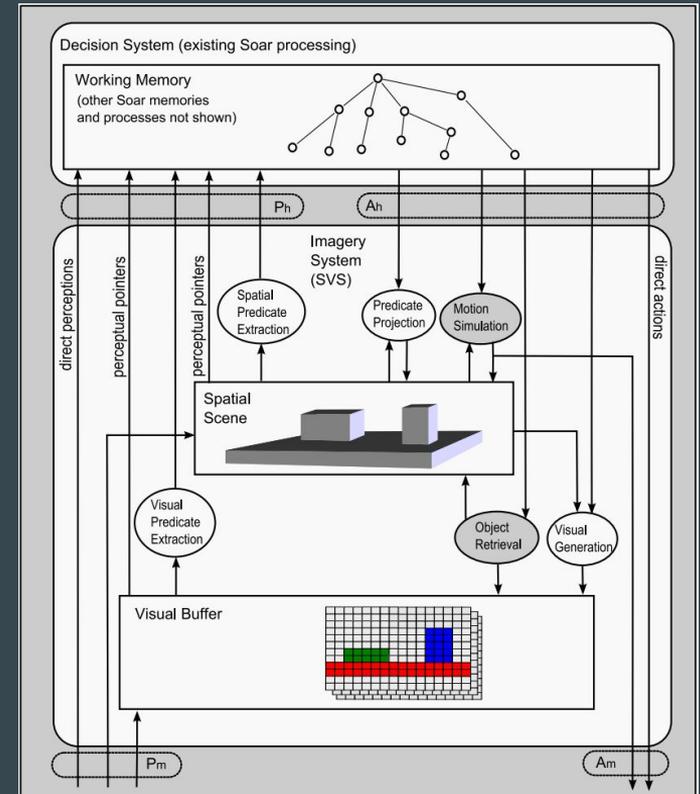
Block Design Soar Agent (Possibly)

- Action Module
  - Pick block
  - Rotate block
  - Place block
- Perception Module
  - Update the percept of the current visual field
    - Depending on current gaze location and level of abstraction
- Attention Module
  - Change gaze location
  - Perform visual search in field of vision for a specific visual cue
- Mental Imagery Module
  - Produce a mental representation from a perceptual image
  - Manipulate the stored mental image:
    - Manipulate mental image (via visual transformations)
    - Compute visual similarity

Future Work and Nugget/Coal

- Implement the block design model into Soar
- Add a notion of attention to Soar
- Expand SVS to incorporate more visual features and more complex shapes
  - such as the blocks in this task

Nugget:

The task is already clearly framed

Coal:

It's not implemented in Soar yet!

References

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