THE DISCIPLINE MATURES: THREE MILESTONES

THREE STUDIES

- Natural language processing: SHRDLU (Winograd)

- Mental imagery vs. Digital representation (Shepard and Metzler)
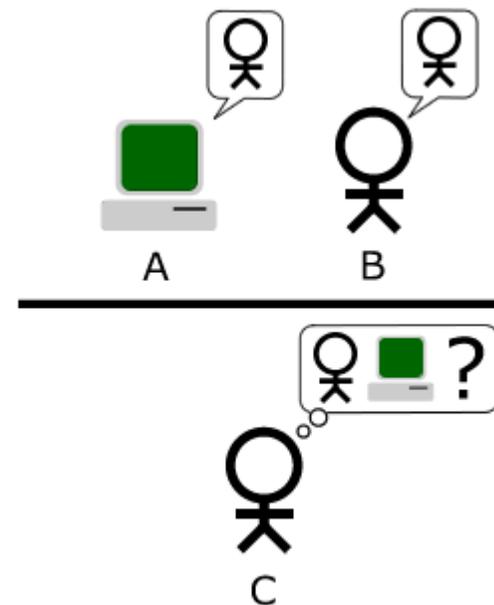
- Marr's vision

NATURAL LANGUAGE PROCESSING: WINOGRAD, UNDERSTANDING NATURAL LANGUAGE (1972)

TURING TEST

- Alan Turing
  - "I propose to consider the question, 'Can machines think?'"
  - "Are there imaginable digital computers which would do well in the *imitation game?*"

ELIZA

- Written by Joseph Weizenbaum (1966)

- Pass the Turing test for some people (fooled a number of people)

- Based upon or intended to parody typical conversational exchanges between psychotherapists and their patients

- https://www.masswerk.at/elizabot/

A conversation with ELIZA (ELIZA's responses are in upper case)

Men are all alike
IN WHAT WAY?

They are always bugging us about something or other
CAN YOU THINK OF A SPECIFIC EXAMPLE?

Well, my boyfriend made me come here
YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed much of the time
I'M SORRY TO HEAR THAT YOU ARE DEPRESSED

It's true. I am unhappy
DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY?

I need some help. That much seems certain
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP?

Perhaps I could learn to get along with my mother
TELL ME MORE ABOUT YOUR FAMILY

(From Boden 1977: 106–7)

PARRY

- Written by Kenneth Colby (1972)

- Attempted to model the behavior of a paranoid schizophrenic

- A group of experienced psychiatrists analyzed a combination of real patients and computers running PARRY through telewriter – which of the "patients" were human and which were computer programs?

- Only 48% correct identification!

PROBLEM OF ELIZA

- Does not understand the meaning of the sentences, only imitate

- Triggered by certain cues and rephrasing statements as questions

SHRDLU

- Written by Terry Winograd

- The program was capable of using language to report on its environment, to plan actions, and to reason about the implications of what is being said to it.

- Programmed to deal with a very limited virtual *micro-world*
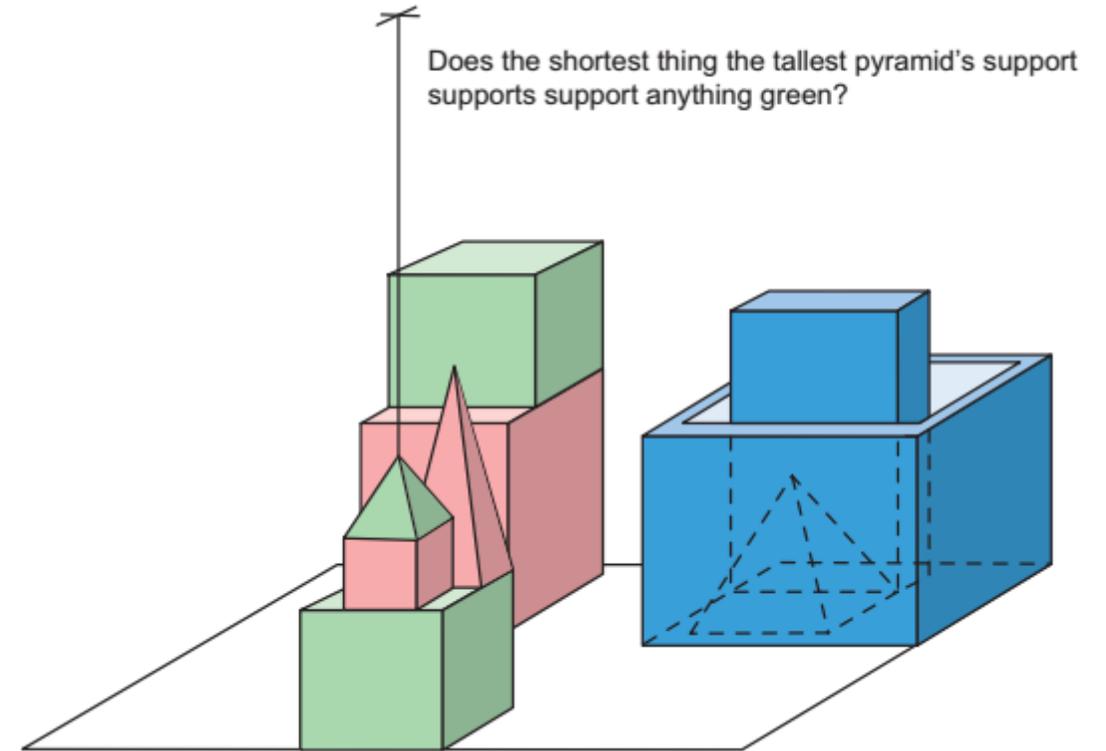
Does the shortest thing the tallest pyramid's support supports support anything green?

SHRDLU IN ACTION

1. *Pick up a big, red block.*
OK

2. *Grasp the pyramid.*
I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.

There are three pyramids in the scene and the program knows that phrases beginning with "the" are intended to refer to a specific object the speaker has in mind. So SHRDLU does nothing.
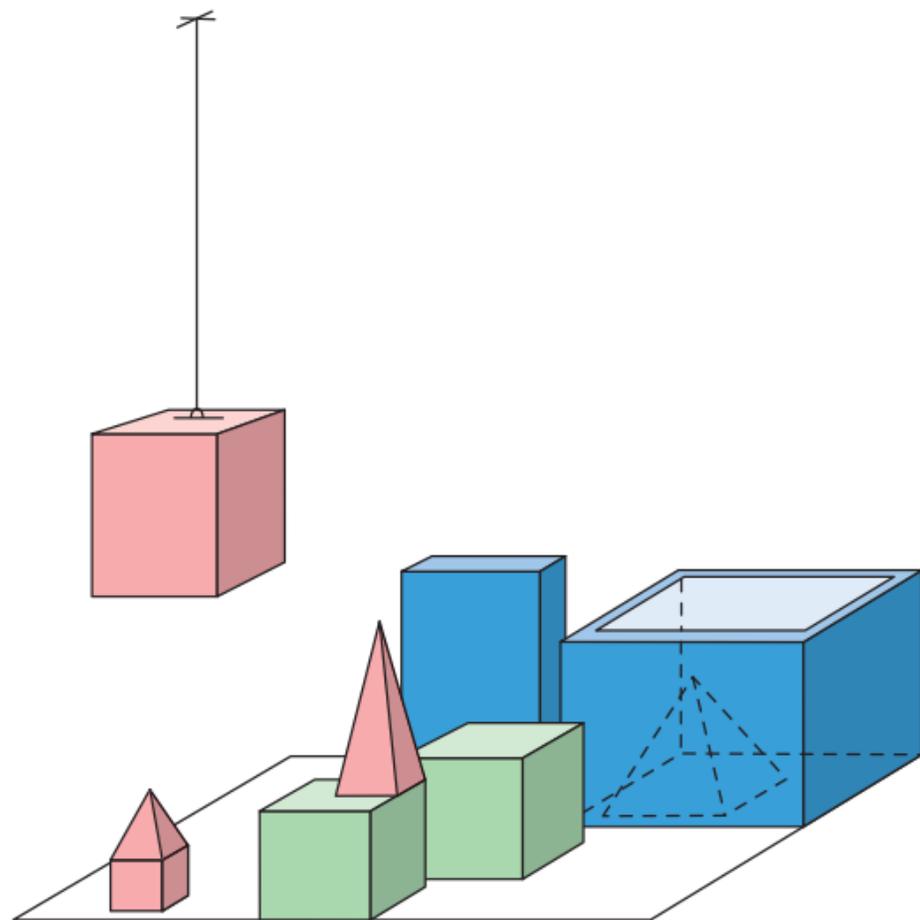
SHRDLU IN ACTION

3. *Find a block which is taller than the one you are holding and put it in the box.*

The situation is depicted in Figure 2.5. The system has to figure out what is meant by "one" and "it," as well as use deduction to decide which block it is holding.

BY "IT" I ASSUME YOU MEAN THE BLOCK WHICH IS TALLER THAN THE ONE I AM HOLDING

There were two possible referents for "*it*": the one selected, and "*the one you are holding,*"
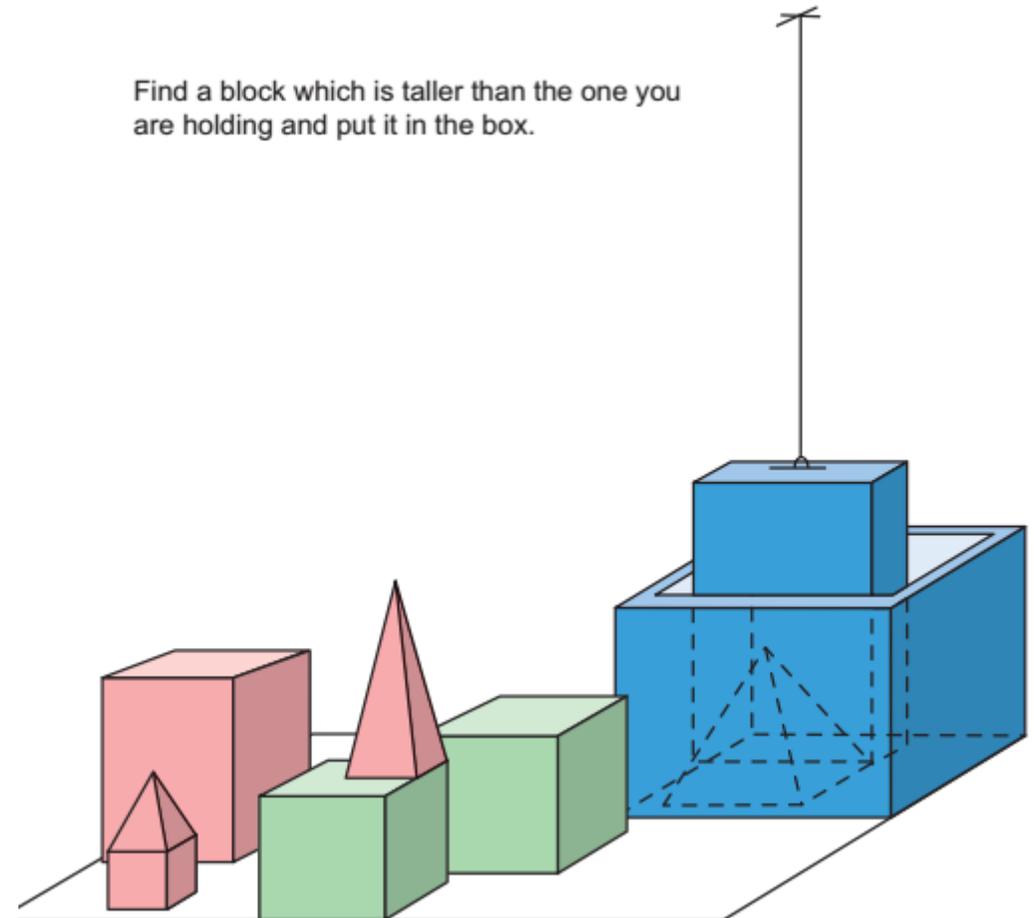
OK

The hand has to set down the red block to pick up the taller blue one. We are now at Figure 2.6.

4. *What does the box contain?*
THE BLUE PYRAMID AND THE BLUE BLOCK

5. *What is the pyramid supported by?*

Find a block which is taller than the one you are holding and put it in the box.

IMPORTANCE OF SHRDLU

1. Powerful illustration of how abstract rules and principles could be practically implemented

2. Trying to model cognitive systems by breaking them down into distinct components, each of which carries out a specific information-processing task

3. Based on the fundamental assumption that understanding language is an algorithmic process

Q1. What will be your own program that is capable of responding to your verbal command? What is difference between your program and ELIZA?

COMPONENTS OF SHRDLU

- Composed of 12 different systems, 3 groups

1. The job of syntactic analysis: "decode" the grammatical structure of the sentences → *the syntactic system*

2. The job of semantic analysis: from syntax to semantics → *the semantic system*

3. The job of integrating the information acquired with the information the system already posesses: deducing and comparing the logical consequences of stored and newly acquired information → *the cognitive-deductive system*
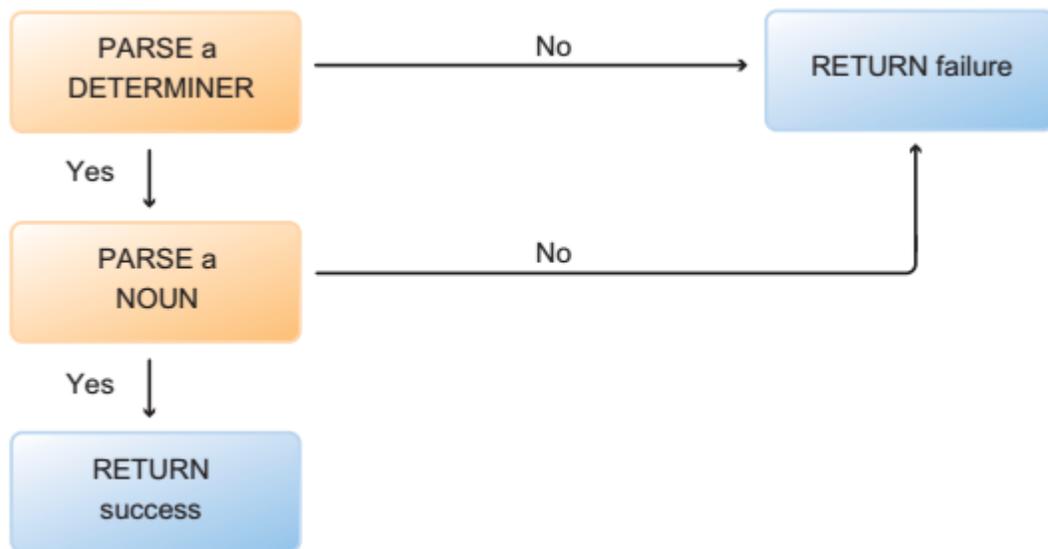
1. THE SYNTACTIC SYSTEM

- A very simple language that only contains words in the following syntactic categories

  - Noun

  - Intransitive Verb ("_ is standing up")

  - Transitive Verb ("_ is supporting _")

  - Determiner ("the" or "a")

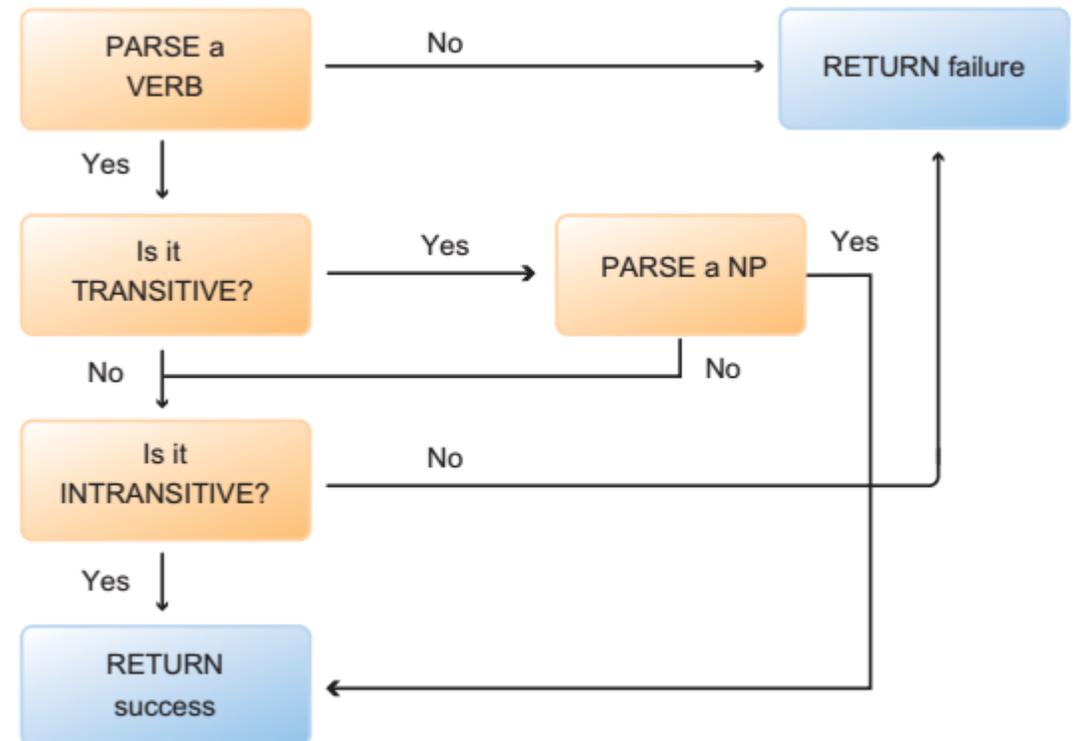- Is the input sentence or not?
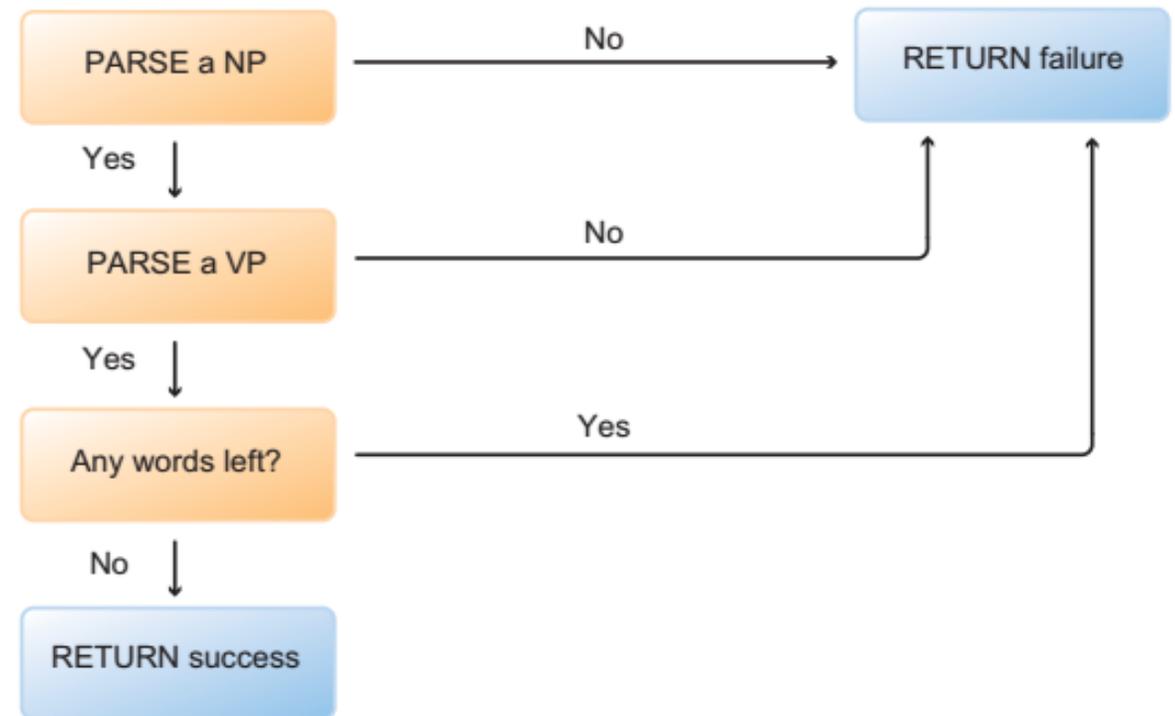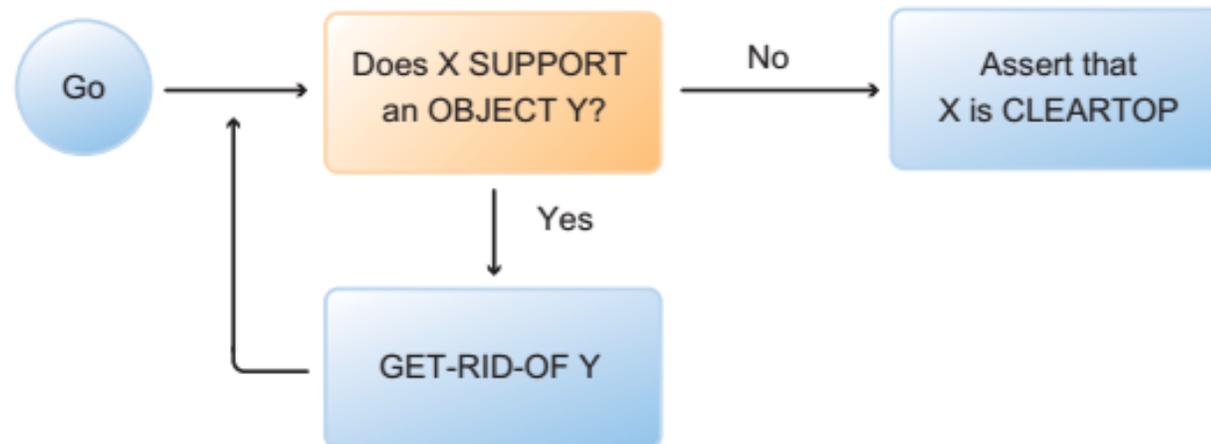
1. THE SYNTACTIC SYSTEM

- Noun Phrase?

- Verb Phrase?

2. THE SEMANTIC SYSTEM

- Representing the meanings of words by means of comparable procedures
- These procedures involve information about the micro-world and actions that the system can perform in the micro-world
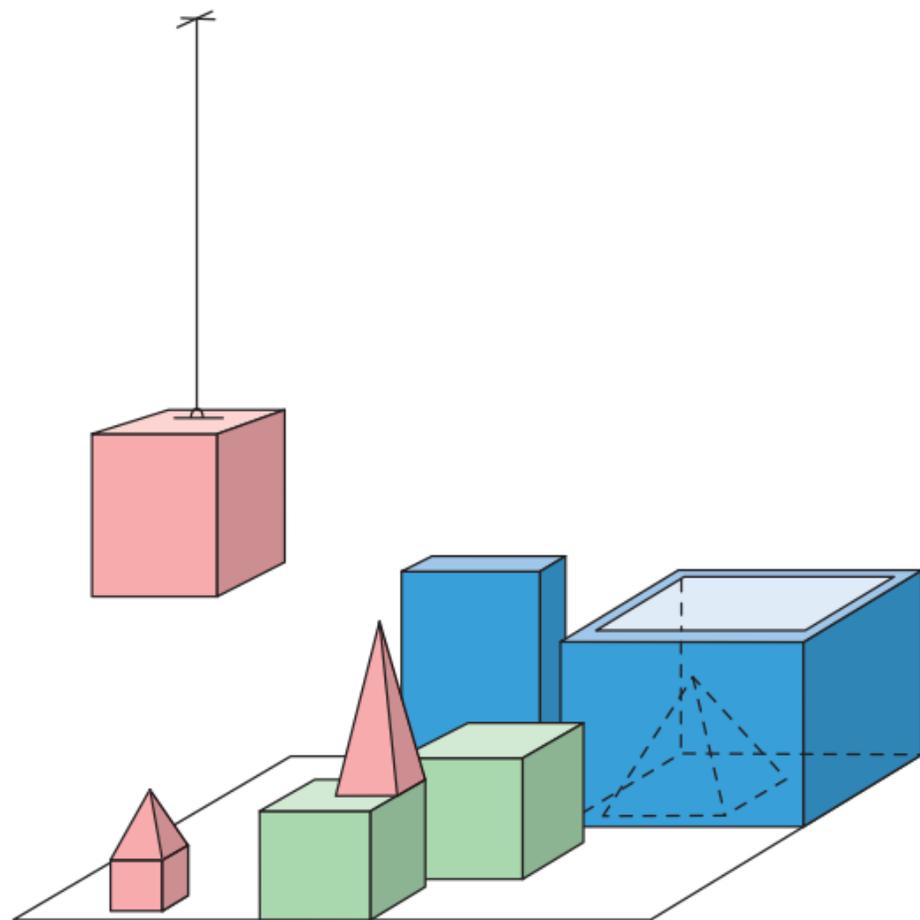
To cleartop X

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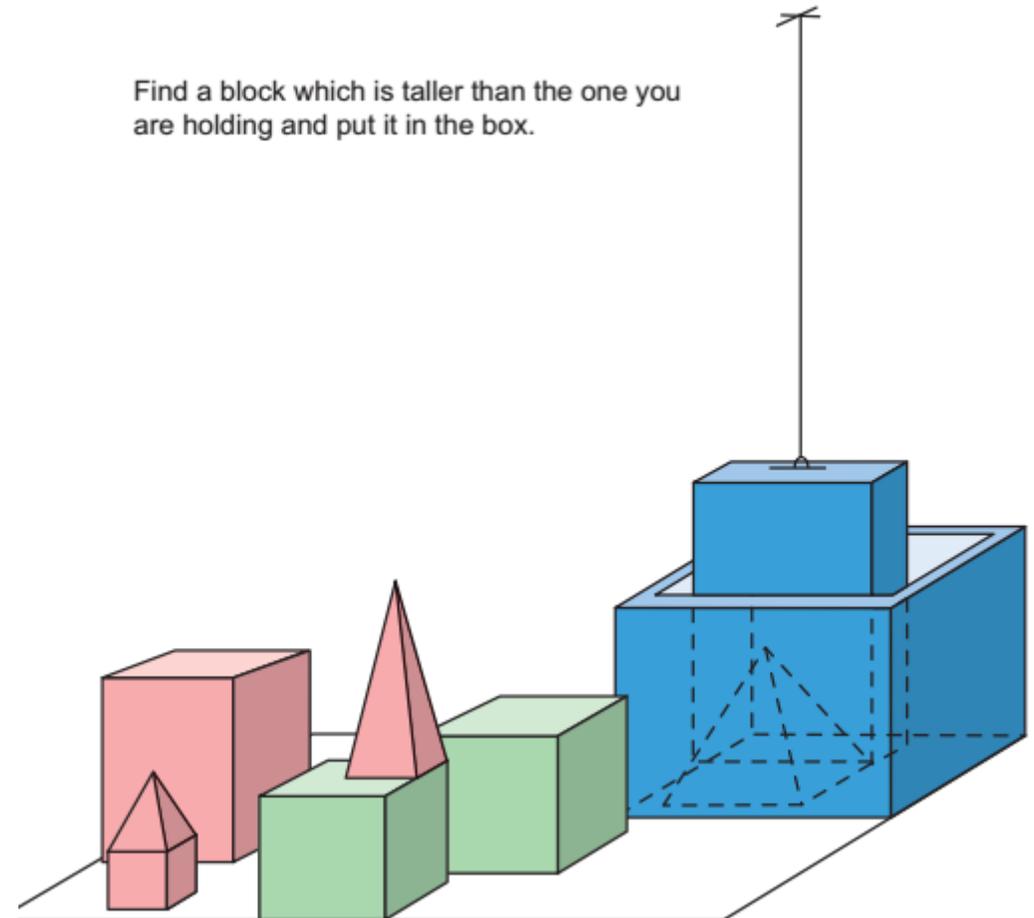There were two possible referents for "*it*": the one selected, and "*the one you are holding,*"

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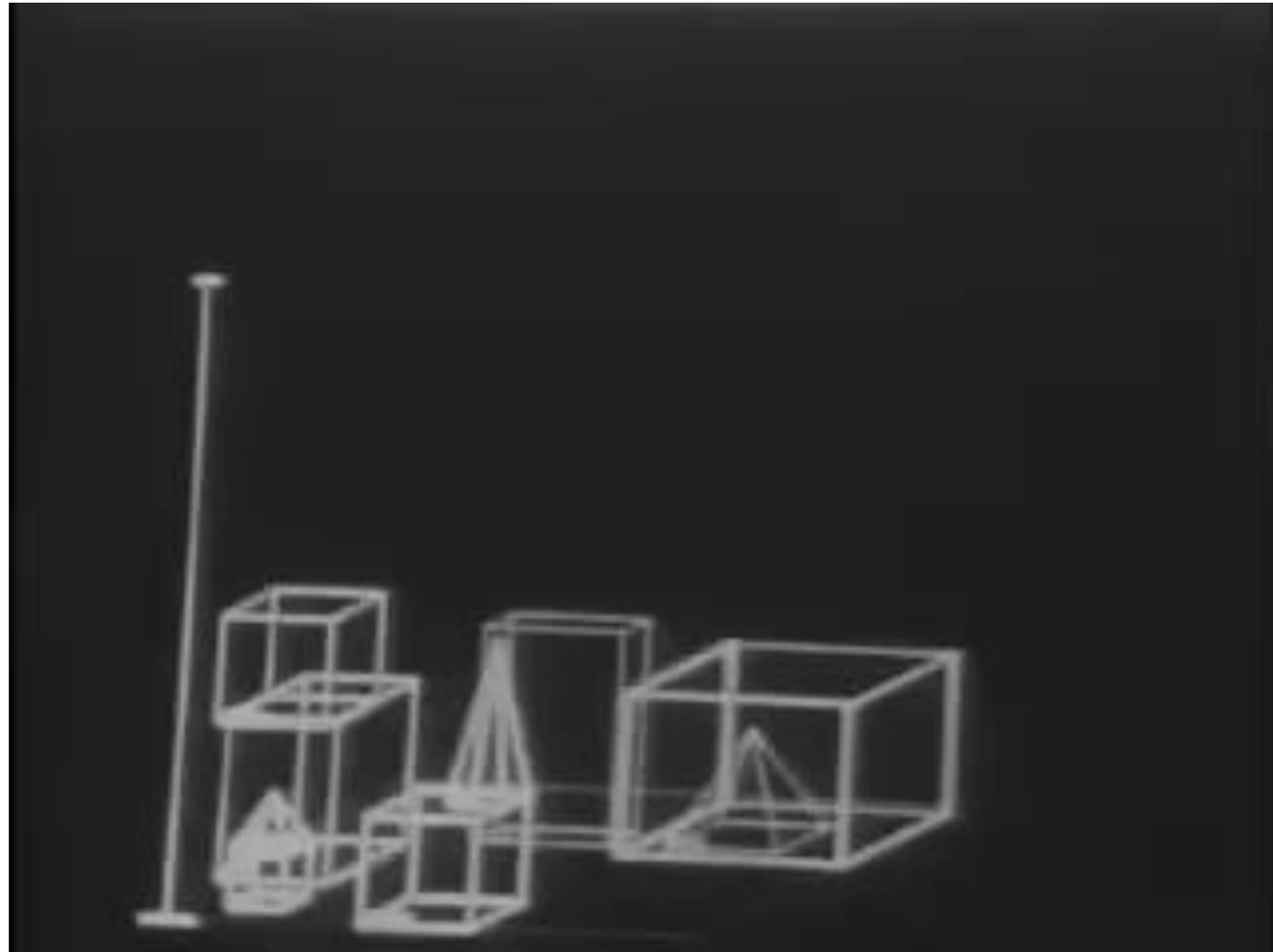The hand has to set down the red block to pick up the taller blue one. We are now at Figure 2.6.

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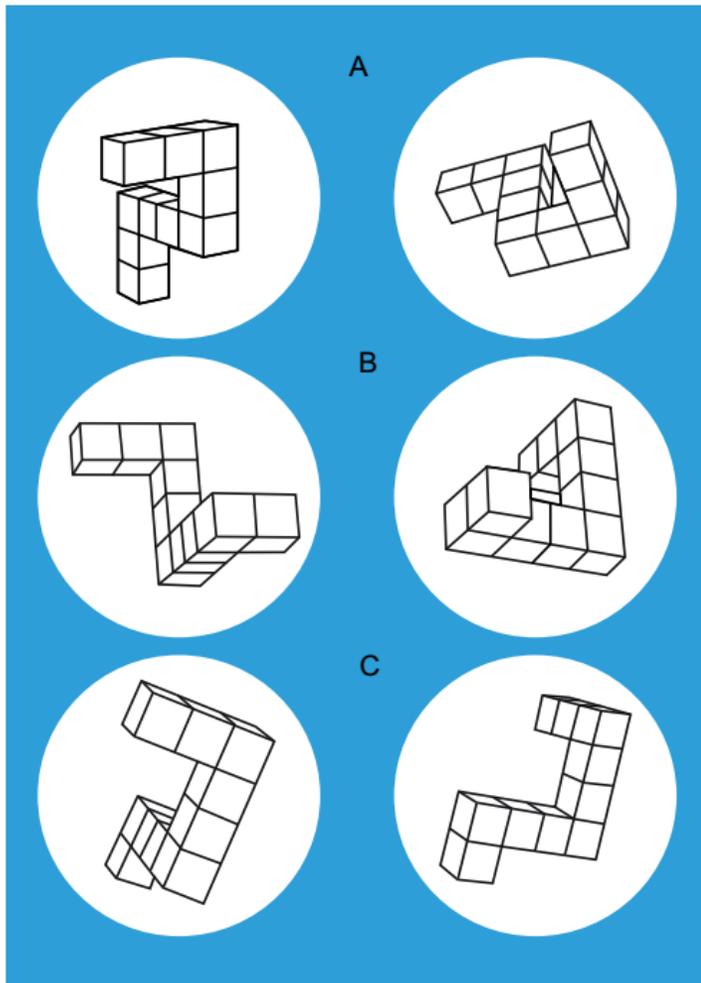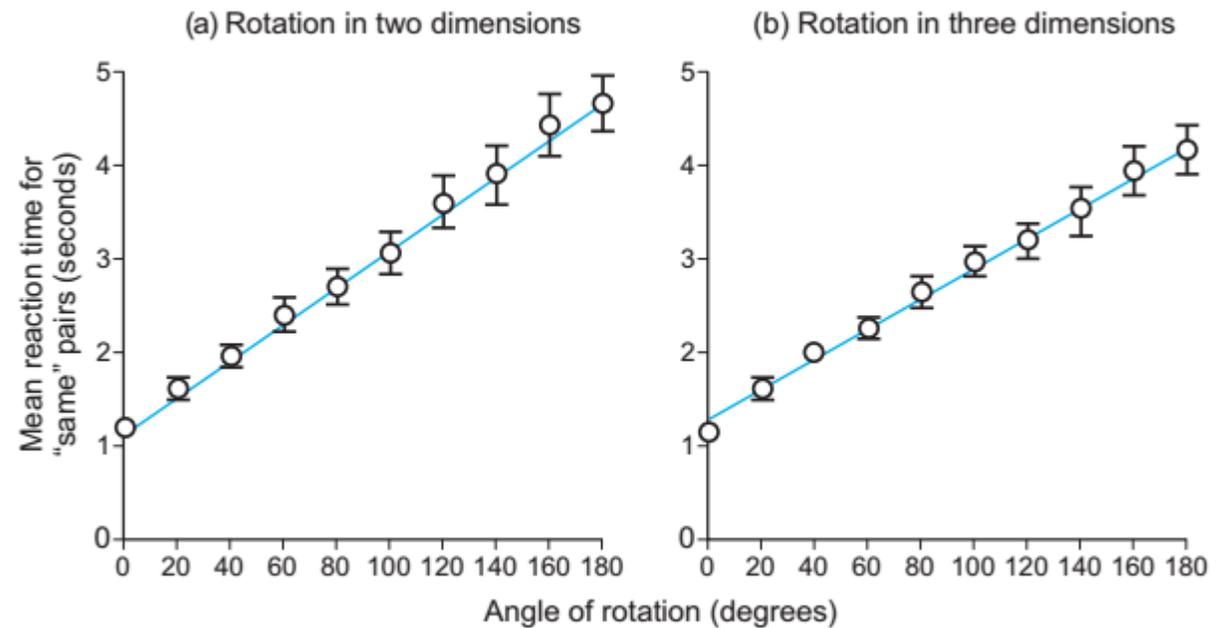Find a block which is taller than the one you are holding and put it in the box.

SHRDLU IN ACTION

HOW DO MENTAL IMAGES REPRESENT?

MENTAL ROTATION
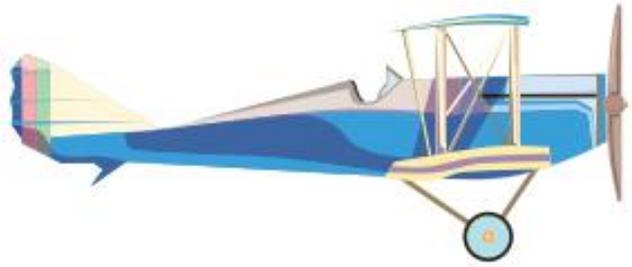

Shepard and Metzler, "Mental rotation of three-dimensional objects" (1971)

Digital representation
Vs.
Imagistic representation

KOSSLYN'S 1973 SCANNING STUDY
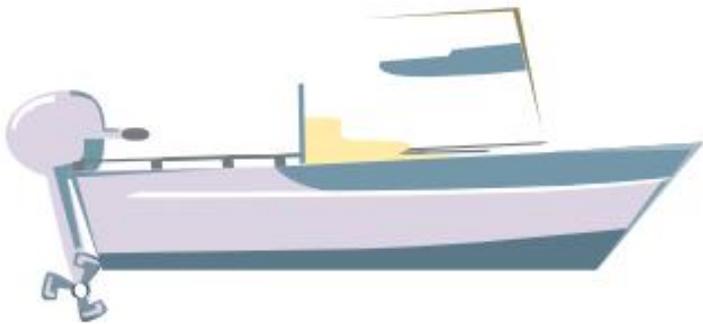
Q2. Summarize experiments and main conclusions of Shepard & Metzler (1971) study and Kosslyn (1973) study. How do they support the existence of imagistic representation?

AN INTERDISCIPLINARY MODEL OF VISION

MARR'S VISION (1982)

1. ## The computational level

   - What is the goal of the computation, why is it appropriate, and what is the logic of the strategy by which it can be carried out?

2. ## The algorithmic level

   - How can this computational theory be implemented?

3. ## The implementational level

   - How can the representation and algorithm be realized physically?

1. THE COMPUTATIONAL LEVEL

- **Elizabeth Warrington's work on patients with damage to the left or right parietal cortex**

  1. Damage to the right parietal cortex: only recognize familiar objects when they see them from conventional perspectives

  2. Damage to the left parietal cortex: identification of the shape of the object is OK

- ➤ Basic task of the visual system: to derive a representation of the three-dimensional shape and spatial arrangement of an object
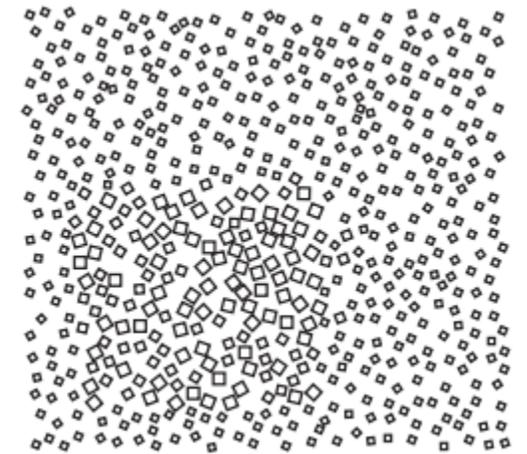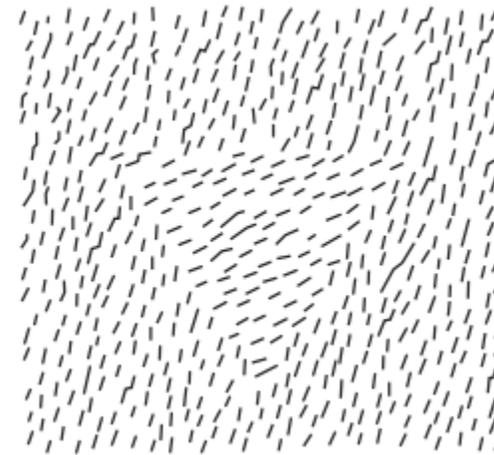

Q3. Explain influence of Warrington's patient work on Marr's analysis of visual system
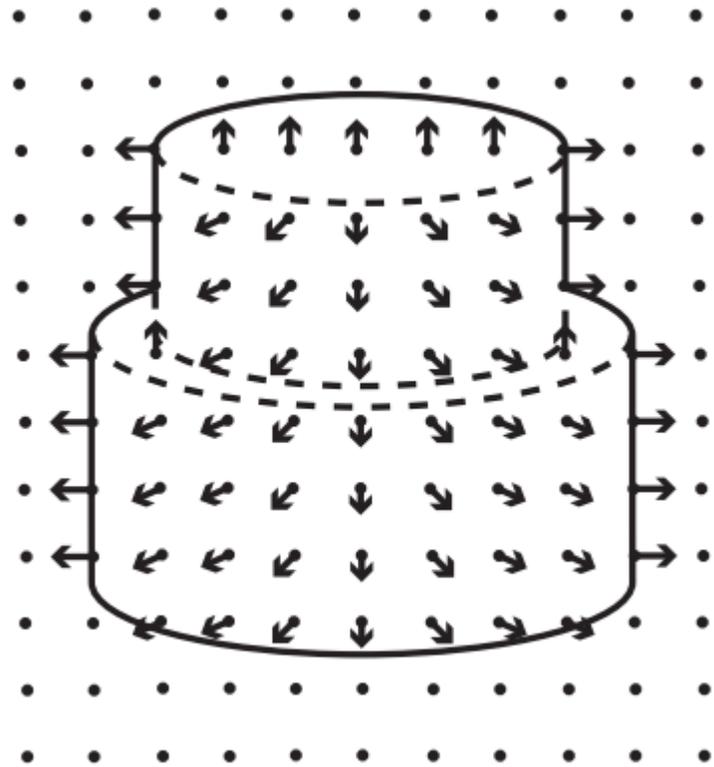
2. THE ALGORITHMIC LEVEL

- Primal sketch

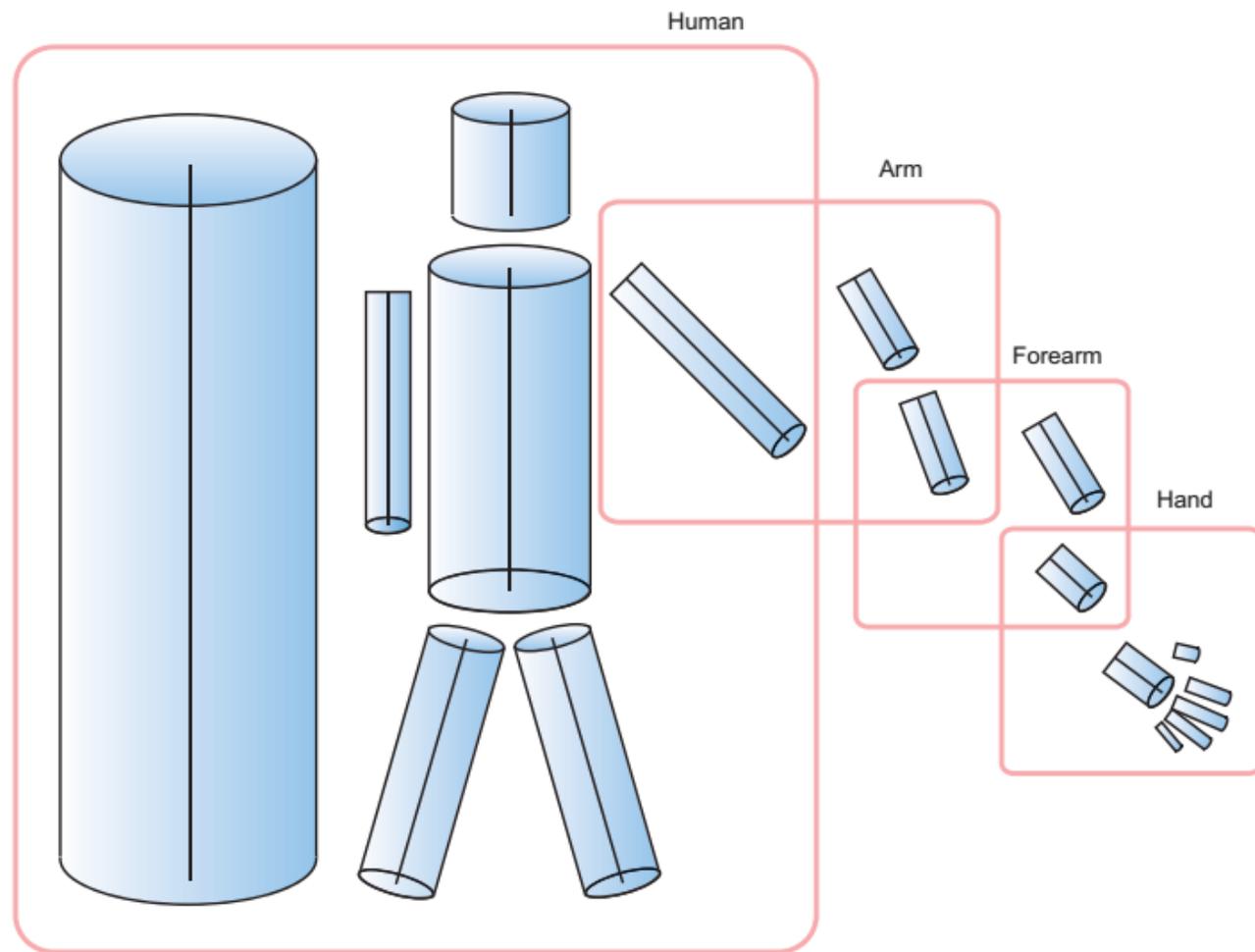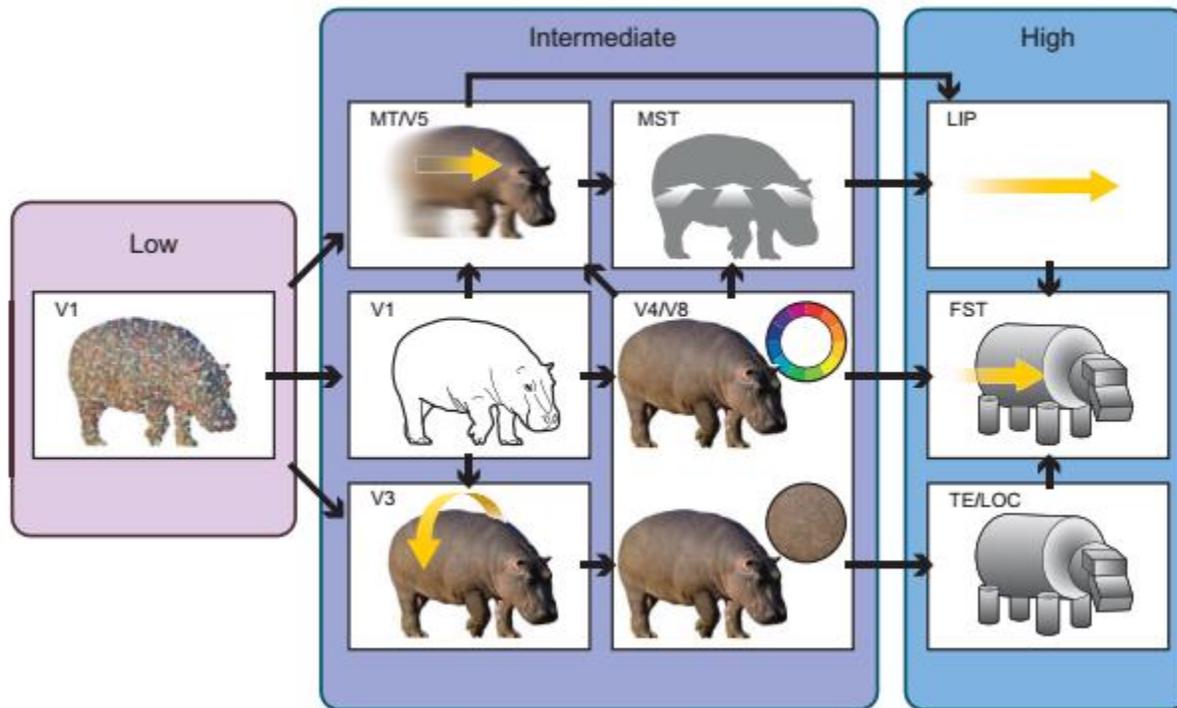# 2. THE ALGORITHMIC LEVEL

- 2.5D sketch

- *3D* sketch

3. THE IMPLEMENTATIONAL LEVEL

Key:

V1–V8: areas of the visual cortex in the occipital lobe (the back of the head). V1 produces the color and edges of the hippo but no depth. V2 produces the boundaries of the hippo. V3 produces depth. V4/V8 produces color and texture.

MT: medial temporal area (often used interchangeably with V5). Responsible for representing motion.

MST: medial superior temporal area. Responsible for representing size of the hippo as it gets nearer in space.

LIP: lateral intraparietal area. Registers motion trajectories.

FST: fundus of the superior temporal sulcus. Discerns shape from motion.

TE: temporal area. Along with LOC, is responsible for shape recognition.

LOC: lateral occipital complex

Q4. What is the difference between algorithmic and implementational explanations? Explain it using Marr's analysis of the visual system