Figure 1: Based on Shepard & Metzler's 'Mental Rotation Task'

Figure 2: Mental Rotation Task Based on Canonical Orientations

Lab 3 Made Easy: Mental Rotation

How is information represented in the mind? So far across our three previous labs, this question has played a central role in our research projects. For example, Lab 1 asked how the encoding context in which information is studied influences its retrieval. In lab three, we looked at the structure of categories and how people make generalizations from examples to novel items. In our final lab, we will take another look at this issue through the lens of mental rotation.

If you want to you can image in your mind pretty much any kind of concept. For example, you can image a dog walking down a New York street. Then you can imagine the dog has only three legs instead of four. Then you can imagine putting back the fourth leg, but making the dog wear a sweater, etc... What is the nature of our ability to imagine visual images? One of the most contentious issues in cognitive psychology in the late 1960s was if mental imagery was a separate way the mind represented information. It may seems at first a silly kind of argument to make because the vividness of our imagination seems to clear to us. However, the central question in this early work on mental imagery is if the mind actually represents information in the form of images (just like a JPEG or PDF figure you put in your paper) or if all thought is mediated by verbal/language processes. The very idea of a "mental image" suggest that certain kinds of thinking can happy without mediation by any language. Once again the focus of this work was on the way information was represented in the mind (analog, image-like representations, or propositional, language-like representations) and what implications that has on behavior. A key point though is that the people who believed in propositional representations (Pylyshyn) didn't necessarily claim that mental rotation and other feats of mental imagery were accomplished *verbally*, just that it was accomplish via a process with similar properties of compositionally.

Mental Rotation

The original mental rotation experiments were done by Roger Shepard and Jean Metzler in 1971. In these experiments participants viewed pairs of objects like the ones at the top of the page and were asked to judge if they were the same the object (just from a different view) or were different (in the sense of being a mirror image of the each other). The key manipulation was that on the "same" trials the objects were rotated in various ways. For example imagine you are holding a Oren's Coffee in your hand. Now rotate the cup 15 degrees to clockwise. Good. Now go a bit further, 30 degrees. Watch out! The liquid might fall out!

In the Shepard & Metzler experiments the time it took people to decide if an object was the same (just rotated) or different (a mirror reflection) depended on the angle of rotation. In other words, it would take you longer to decide if the 30 degree rotated version of your cup was the same as the upright version relative to the 15 degree rotated version. The idea then was that in order to make the same/mirror judgement, people actually *mentally rotate* the

object. Bigger angle require more time to "rotate" in your mind just as they would in the real world. Thus, the mental rotation experiments of the early 70s suggested that the mental processing of object in our mind followed similar principals to those in the real world. In a lot of ways this makes sense, our brain evolved to take advantage of the structure of the real world, and thus mental rotation experiments.

The debates about mental imagery are a little less contentious currently, although the question of the substrate of mental representation is still very much with us. The movement which inherited the analog/imagery perspective is most often associated with the embodied cognition movement (which argues that much of thinking is tied to the spatial properties of the world that we have to interact with). Interestingly, there have been a number of attempts to "blend" these ideas, most notably the perceptual symbols systems approach from Barsalou which argues for a propositional representation that operates OVER images.

Step 1: Collect Data
To collect data for our experiment we are going to use a web based version of the mental rotation task. Unfortunately, since the computers in our lab are without internet, you will do this at home.

The URL for the experiment is here:
http://psych.hanover.edu/JavaTest/CLE/Cognition/Cognition/mentalrotation_instructions.html

When you click the link at the bottom of the page that says "Click here to start the experiment" a window will pop up that should take over your entire screen.

The first page lets you configure various aspects of the experiment. We want to test the following parameters:

> **Stimulus Type:** Original 3D
>
> **Number of Rotation Angles:** 7
>
> **Should the left stimulus be allowed to rotate or by fixed?** Rotate
>
> **Stimulus Size:** 100 pixels
>
> **Number of Trials Per Level:** 15
>
> **Distance from Fixation (proportion of distance) :** 0.150
>
> **Delay before stimuli:** 1000
>
> **Stimulus on Till Response:** YES

When you have this entered in correct, press "Done" to begin the experiment. A fixation cross will appear in the center of the screen. Press the space bar when you are ready to begin.

On each trial view the pairs of items. If they are the same item (ignoring rotation) press 's'. If these are mirror reflections (i.e., you can't rotate one to make it the same as the other), press 'm' (for mirror reflection).

Step 2: Get Results and process it

When you get done, the experiment will display a set of results. Write down or take a screen shot of the display. Finally, at the bottom of the screen is a button that says "Show Trial Data". When you press this it will pop up your data in a format looking like this:

```
Trial : Angle : Stimulus : Response : RT(msec)
1 : 180 : Mirror : Same : 10421.0
2 : 90 : Same : Same : 469.0
3 : 90 : Mirror : Same : 272.0
4 : 0 : Same : Mirror : 376.0
5 : 90 : Same : Same : 112.0
6 : 0 : Mirror : Mirror : 79.0
7 : 0 : Mirror : Same : 8.0
8 : 90 : Mirror : Mirror : 87.0
9 : 0 : Mirror : Same : 87.0
10 : 180 : Mirror : Mirror : 80.0
11 : 90 : Same : Same : 47.0
12 : 90 : Same : Mirror : 95.0
13 : 0 : Same : Same : 80.0
14 : 180 : Same : Mirror : 15.0
15 : 180 : Mirror : Same : 80.0
16 : 180 : Same : Mirror : 16.0
17 : 0 : Same : Mirror : 1015.0
18 : 0 : Mirror : Mirror : 496.0
19 : 90 : Mirror : Same : 176.0
20 : 180 : Same : Mirror : 271.0
21 : 0 : Mirror : Same : 968.0
22 : 180 : Same : Mirror : 784.0
23 : 0 : Same : Same : 488.0
24 : 180 : Mirror : Mirror : 336.0
25 : 180 : Same : Mirror : 592.0
26 : 0 : Same : Mirror : 368.0
27 : 180 : Mirror : Mirror : 544.0
28 : 90 : Mirror : Mirror : 527.0
29 : 90 : Same : Mirror : 600.0
30 : 90 : Mirror : Mirror : 352.0
...
```

Select all the data in the window and copy-paste it into a text file (using text edit on the mac or wordpad on the PC). Save the data to a text file on your computer (like Todd.txt). Email it to me todd.gureckis@nyu.edu. Subject: [lhc]: lab 3 data