Image Rotation Laboratory Manual

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Version 1.0

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INTRODUCTION

Can people mentally rotate the images of stimuli that they have seen? This project reproduces the classic experiments that provided evidence for such a mental process. Shepard and Metzler (1971) showed people pairs of stimuli and asked them to judge whether they were pictures of the same or different objects.

The pictures had been rotated about their centers so that the two stimuli in each set were at different angular orientations. Half of the stimulus pairs were rotated versions of the same figure, while half were mirror images of each other. One way to perform this task is to mentally rotate one of the stimuli until it has the same angular orientation as the other stimulus; at that point it is easy to make a same-different judgment.

It turns out that the reaction time to decide whether the figures were the same was a linear function of the difference in degrees of orientation of the figures. In other words, the time it takes to rotate a mental image is a linear function of the required amount of spatial rotation. Experiments by Cooper and Shepard (1973), Hock and Tromley (1978), and others have further expanded our understanding of the mental rotation phenomenon.

The phenomena of mental imagery have important implications for learning and memory. The use of visual imagery can greatly improve the memory for verbal material. For example, imagery can be used to learn the names of a group of people that you have just met. Each name is first converted to a vivid mental image of an object that is related to a prominent facial feature. Suppose that the person's name is Berg and that he has a receding, triangular-shaped hairline. One could associate 'iceberg' with the person's face. Some restaurant servers use this technique to remember the different orders placed by each person in a group of customers.

A classic technique used to memorize a long lists of items is known as the 'method of loci.' The trick is to associate the items in the list with a known set of locations. Then the items can be recalled by mentally 'walking' through the locations in a known sequence. In addition, the mental imagery associated with imagined body movements has been found to be useful as a training technique in athletics.

Author: Robert D. Sorkin

PARAMETERS

All experimental conditions are constant within a single block of trials. The Experimenter can decide on the specific conditions for each block of trials, the number of blocks, the number of trials per block, and the sequence in which the blocks will be run.

To view the parameter settings for each trial block, keep clicking on the STEP button. The various settings will appear in the feedback and Stimulus boxes. To change any settings, enter the desired new setting and click the SET button. Always review the settings by clicking repeatedly on the STEP button until you have checked all the trials. (Turn the HINTS OFF by clicking on the HINTS checkbox.)

The feedback setting determines whether or not the participant will be given feedback about the correctness of a response.

The Stimulus setting determines the type of figures to be presented. There are five different stimulus types:

3d: These are two-dimensional, line-drawing projections of three-dimensional figures, similar to those used by Shepard and Metzler (1971).

2d: These are two-dimensional nonsense figures which may or may not be familiar to some participants (described in the Technical Details section; if you are to be the participant, don't read the Technical Details section until after you have run the experiment).

e: Lower-case letter e.

F: Upper-case letter F.

face: Cartoon figure of a face.

Author: Robert D. Sorkin

INSTRUCTIONS

The task is to decide, as accurately and as quickly as possible, whether or not the two displayed figures are the same or different. On half the trials, the two figures will be identical but may have different orientations on the screen. (One of the figures may be rotated from zero to 180 degrees

from the other.) On half the trials, the two figures will be different: they will be mirror images of each other (and, in addition, may have different orientations). The task is to decide whether the two figures are the same or different (mirror images). Press the s key to make a same response and the d key to make a different response.

To start a new block of trials, click on the start block button or press the enter key or space bar. To examine your performance, click on the peek/reset block button. (Note: Clicking on the peek/reset block button resets the trial counter to the next block of trials.)

Author: Robert D. Sorkin

TECHNICAL DETAILS

There are five different types of stimuli in the experiment:

3d: Two-dimensional, line-drawing projections of three-dimensional figures, similar to those used by Shepard and Metzler (1971).

2d: Two-dimensional figures created from low resolution silhouettes of a military jet aircraft; the performance of a participant may depend on how familiar the participant is with such stimuli and whether or not these figures are perceived as being aircraft in different positions.

e: Lower-case letter e.

F: Upper-case letter F.

face: Cartoon figure of a face.

The individual stimuli are selected randomly from among the set of 7 possible orientations

The program selects (with probability =1/2) whether the two stimuli shown will be the same or different. The program then selects (with probability =1/2) which of the two stimulus prototypes will be shown. Finally, the program independently selects the orientation of each stimulus (with probability=1/7); that is, which of the 7 possible angular orientations will be used for each stimulus of the pair.

The timing of the trial events is:

stimulus (duration terminated by response, maximum duration=5 s)
answer period begins with stimulus onset
(the trial continues if no response has been made within 5 seconds)
feedback period-1.5 seconds

The resolution of the reaction timer is 3 ms.

Author: Robert D. Sorkin

DATA ANALYSIS

The data will be in the form: block,trial,stype,s/d,Pos1,Pos2,resp,correct,time.

block block number
trial trial number within block
stype stimulus type (3d, 2d, Es, Fs, Fa)
s/d stimulus pair (same, diff)
Pos1 orientation of stimulus in lefthand position (0,30,60, 90,120,150,180)
Pos2 orientation of stimulus in righthand position.
resp response (same, different)
correct response was correct or incorrect

time response reaction time (ms)

The seven different stimulus orientations that are possible in each position are:

A typical data file for this experiment (but showing only a few trials per block) is:

block	trial	stype	s/d	Pos1	Pos2	resp	correct	time
1	1	3d	diff	0	60	same	incorrect	2727
1	2	3d	diff	150	60	same	incorrect	1089
1	3	3d	same	0	0	same	correct	1266
1	4	3d	diff	180	150	same	incorrect	2580
1	5	3d	diff	30	120	same	incorrect	2349
2	1	2d	same	120	180	diff	incorrect	1758
2	2	2d	diff	30	60	diff	correct	2403
2	3	2d	same	60	120	same	correct	1419
2	4	2d	diff	180	90	diff	correct	1506
2	5	2d	diff	180	60	diff	correct	3312
3	1	Es	diff	90	30	diff	correct	1485
3	2	Es	same	180	150	same	correct	1272
3	3	Es	diff	120	30	diff	correct	2451
3	4	Es	same	120	120	same	correct	996
3	5	Es	same	30	0	same	correct	780

You may wish to first examine how many errors were made by the participant, and whether the number of errors in different conditions was correlated with changes in reaction time.

If not, it could indicate that there was a trade-off between speed and accuracy; this would greatly complicate any intrepretation of the results. That is, if the participant used a different speed-accuracy strategy in different conditions, it would be difficult to attribute changes in reaction time to the different experimental manipulations.

After removing the trials when the responses were incorrect, you can determine how reaction time varied with the difference in orientation of the stimuli on same trials (Average reaction time is the dependent variable and difference in orientation, Pos1-Pos2, is the independent variable). You also could examine whether there is a effect of having either one of the stimuli presented at an orientation near 0 degrees. Finally, you might check (with other experimenters) whether they obtain the same results that you observed with the two-dimensional stimulus set.

Sample Spreadsheet Analysis

A sample of some data obtained from the rotation experiment (using stimulus type 3d) is shown below:

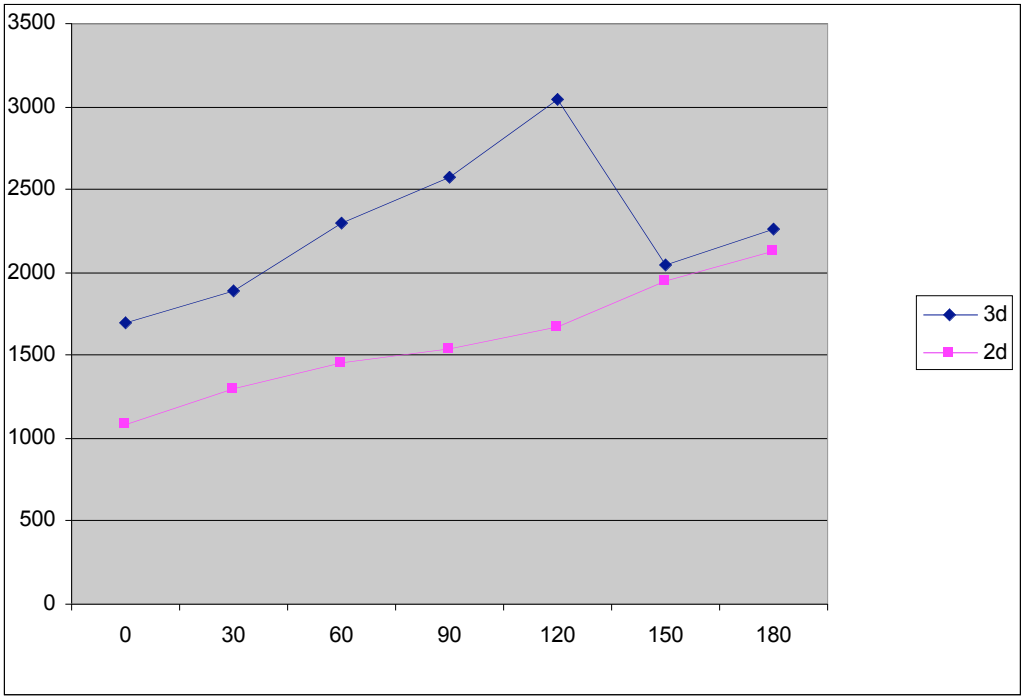
block	trial	stype	s/d	Pos1	Pos2	resp	correct	time	p1-p2
1	4	3d	same	120	150	same	correct	2376	30
1	6	3d	same	150	150	same	correct	906	0
1	9	3d	diff	90	0	diff	correct	2160	90
1	11	3d	same	150	150	same	correct	963	0
1	12	3d	same	90	120	same	correct	1386	30
1	15	3d	diff	150	30	diff	correct	3390	120

These data will be analyzed in individual blocks. First, sort out the trials in the block when an error occurred (when the correct entry is not correct). Move any rows that contain an error to another portion of the spreadsheet, so that you can keep track of how many (and which) errors occurred in each condition. Then highlight the remaining rows of data in the block and click on the pivot table tool. Select p1-p2 for the row headings (left column of pivot table) and s/d for the column headings (top row of pivot table). Select time for the pivot table entry and then double click on time and select average (rather than sum or count) for the pivot method. Place the resulting pivot table in a convenient area of the spreadsheet.

Average of time	s/d		
p1-p2	diff	same	Grand Total
0	2217	876	3093
30	1254	1034	2288
60	1884	1844	3728
90	1602	2134	3736
120	1700	3024	4724
150	1422	3378	4800
180	1899	4287	1899
Grand Total	11978	16577	24268

Then plot the obtained data from the pivot table. (If you are missing entries at some values of p1-p2, you may wish to recopy the table so that the x values are plotted correctly on the absissca of

the graph. Excel interprets the pivot table values as labels, and plots them at equal intervals on x.) In the graph plotted below, reaction time for the same trials was a linear function of the rotation angle.



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