1.3 Rotation of Mental Images

Abstract

Psychology had an early concern for mental imagery, but problems with that research led to the virtual abandonment of the study of imagery. More recently, researchers have found ways to measure certain aspects of imagery. One successful technique uses "rotation" of mental images. A person is shown two shapes and must decide whether or not they are the same (regardless of rotation). One shape is sometimes rotated with respect to the other, and people report that they make the judgment by rotating their image of one shape to determine whether it matches the other. If peoples' reports are accurate, it should take longer to rotate the image when the stimulus is rotated farther from vertical. Shepard and his colleagues (e.g., Cooper & Shepard, 1973) have done a number of experiments of this type, and have found that images do seem to be rotated, and at a steady, measurable speed. The exercise accompanying this chapter has students perform one of two versions of this task to measure the speed of rotation of mental images.

This experiment employs a single within-subject independent variable (degree of rotation of one shape relative to the other), along with a single between-subject independent variable (type of stimulus shown, e.g., letters or figures). The dependent variable is RT to decide whether or not the two shapes are the same (regardless of orientation).

List of Analyses

Analyses Rotation of Mental Images		
This workbook contains the following worksheets:		
Name	**Complexity**	**Description**
Basic Analysis	Basic	Mean RT as a function of Absolute Angle of Rotation
Congruence by Angle	Basic	Mean RT as a function of Absolute Angle of Rotation and Congruence
Analysis of Accuracy	Basic	Proportion Correct as a function of Absolute Angle of Rotation
Inter-Subject Variability	Basic	Effect of Absolute Angle, one line per subject
Single-Subject Accuracy	Medium	Proportion Correct by Subject
RT Distribution	Medium	Distribution of RTs, 50 ms bins
Trial-to-Trial RTs	Medium	Illustrates trial-by-trial variability of RT
Inferential Stats Input - RT	Advanced	Information related to generating inferential stats in a 3rd party package
SubjectMeanRT	(n/a)	Data for analyses based on mean RTs
SubjectMeanACC	(n/a)	Data for analyses based on proportion correct
TrialRT	(n/a)	Data for analyses based on single-trial data
ISInpurDataRT	(n/a)	Data for inferential statistics
SubjectMeanRTFiltered	(n/a)	Data for analyses based on mean RTs, filtered data
SubjectMeanACCFiltered	(n/a)	Data for analyses based on proportion correct, filtered data
TrialRTFiltered	(n/a)	Data for analyses based on single-trial data, filtered data
ISInputDataRTFiltered	(n/a)	Data for inferential statistics, filtered data

List of Variables

Variables Rotation of Mental Images			
The data analyses are based on the following variables:			
Between-Subject IVs:			
Variable Name	**Order of Presentation**	**Description**	**Values**
Section	n/a	unique identifier for each section of subjects	varying integer values
StimType	random	type of stimulus presented	• 2D (two-dimensional figures) • upper-case letters and numbers
Subject	n/a	unique identifier for each subject	varying integer values
Within-Subject IVs:			
Variable Name	**Order of Presentation**	**Description**	**Values (meaning)**
AbsAngle	random	angle of rotation, ignoring direction	• 0 • 60 • 120 • 180
Dependent Variables used in the analyses:			
Variable Name	**Description**	**Values**	
Stimulus.ACC	response accuracy	• 0 = incorrect response • 1 = correct response	
Stimulus.RT	reaction time, in milliseconds	varying integer values	
Additional Variables (these variables are not used in the analyses but may be of interest to the instructor)			
Variable Name	**Order of Presentation**	**Description**	**Values**
(none)			

Group Discussion/Exercises

1. Estimate the rotation rate for each subject and examine the distribution. Some subjects do not show linear rotation. How do you operationally define whether or not a person is a "rotator"? How many subjects seem to be rotators? The speed of rotation can be estimated by taking the difference in RTs between 0 and 180 degrees and dividing that time by 180 to get the rotation in time per degree. Because of the relatively small number of trials, however, this may be only a gross estimate. Another approach would be to calculate a regression line or best-fitting straight line through the set of points RT and degree of rotation for each subject, and then use the estimated RT for 0 and 180 degrees in the same calculation. (In trying to define a "rotator," students should realize that a decision as to how much someone's performance deviates from linear is difficult to decide, especially without some statistical test).

2. Did the students rotate the full image or just a part of it? That is, did the students feel that the whole figure was represented clearly in an image as they performed the rotation or were just the parts that were most salient for the comparison represented? How would you test this? Note the difficulty in testing peoples' introspective reports.

3. Were there any differences in rotating to the left or to the right? Were there individual preferences in direction of rotation? Note that problems in this regard may introduce added variability in the data due to subjects not doing the task exactly as expected. Do some students report "over-rotating" in the non-optimal direction? Many may feel that they sometimes go the "wrong way" in rotation. One common source of errors in this version of the task is that subjects sometimes "flip" one figure mentally, instead of "rotating" it. Unfortunately, flipping a mirror image makes it match the other figure, resulting in an error. Is there a learning effect in this experiment? (Students may feel that it took them some time to learn to rotate the figures correctly, especially by not flipping them instead.)

4. The Rotation of Mental Images experiment was designed to allow students to make limited modifications to create and run their own version of the Rotation of Mental Images experiment. For example, students might replace the supplied images with shapes or objects they draw themselves, they might modify the number of trials or conditions presented, or they might add variables to log additional information. Instructions for modifying Rotation of Mental Images can be found at the PsychMate Instructor web site (*http://www.psychmate.com/account/instructor/default.asp*).

Answers to Questions

1. The primary dependent variable is reaction time, with percent accuracy as a secondary dependent variable. The independent variable is degree of rotation. A number of other variables that should be controlled include ambient lighting, size of the displays or distance from the screen, and the particular shapes chosen. Different choices for the actual value of any of these variables could change the mean RTs by a constant (e.g., some figures might be faster to rotate than others). Changes that occur from subject to subject would make the data more "noisy," increasing the variability of RT. (See the List of Analyses and Variables above for a report of variables that were blocked, random, or counterbalanced.)

2. Shepard and Metzler (1971) found the same basic pattern of results with their three-dimensional figures, even when they were rotated in "depth." RT was a linear function of degree of rotation, whether the rotation was in depth or in the picture plane.

3. The speed of rotation can be measured roughly by taking the time difference between 0 degrees and 180 degrees and dividing by the 180 degrees of rotation. Shepard and Metzler's figure for their "picture-plane" pairs indicates a speed of about 52 degrees per second. Unlike the abstract forms used in this experiment, Shepard and Metzler used three-dimensional forms projected onto a two-dimensional (2D) surface, which may be more complex to rotate mentally. Rotation is usually about 300 degrees per second for the figures used in this experiment.

4. While people certainly differ in their ability to use imagery, and presumably in the clarity of their images, it is vey difficult to assess this accurately. The method of "trained introspection" used by early psychologists properly fell into disrepute, precisely because there was no way to verify the observations of each individual.