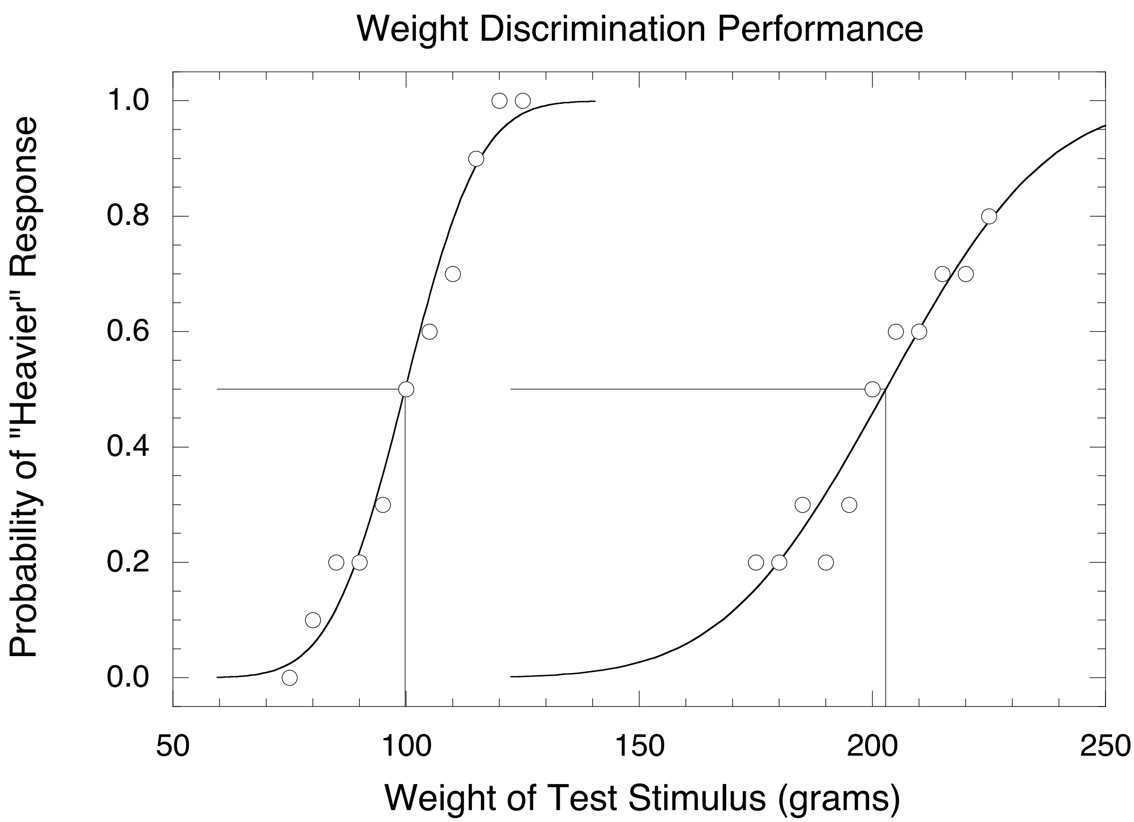
Psychology of Perception

Psychology 4165, Summer 2006

Laboratory 1

Weight Discrimination



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Lab 1: Weight Discrimination

Introduction

Classical methods of psychophysics involve the measurement of two types of sensory thresholds: the absolute threshold, RL (*Reiz Limen*), the weakest stimulus that is *just* detectable, and the difference threshold, DL (*Differenz Limen*), the smallest stimulus increment that is *just* detectable (also called the Just-Noticeable Difference, the JND). Gustav Theodor Fechner (1801–1887), in *Elemente der Psychophysik* (Fechner, 1860) introduced three psychophysical methods for measuring absolute and difference (JND) thresholds: the method of adjustment; the method of limits; the method of constant stimuli. The purpose of this exercise is to give you experience with the measurement and computation of the JND for lifted weights using the method of constant stimuli and to test the predictions of Weber's Law (see below).

Experiment

You will determine difference thresholds for weight discrimination using the method of constant stimuli for two different standard weights: 100 and 200 grams. One of the foundations of psychophysics is Weber's Law. It states that the difference limen is a constant proportion of the standard:

$$\frac{\Delta I}{I} = k \qquad \text{Weber's Law}$$

In this experiment you will test the hypothesis that Weber's constant is the same for two different standard weights, thus validating Weber's Law.

Procedure

In the method of constant stimuli, a standard stimulus is compared a number of times with other fixed stimuli of slightly different magnitude. When the difference between the standard and the comparison stimulus is large, the subject nearly always can correctly choose the heavier of the two weights. When the difference is small, errors are often made. The difference threshold is the transition point between differences large enough to be easily detected and those too small to be detected.

Each of you will serve as subject, experimenter, and data recorder. You will use the method of constant stimuli to measure your ability to discriminate small differences in weight using two standard weights: 100 grams and 200 grams. Since there are two different standard weight conditions there are two possible testing orders. You should test yourself in the order assigned to you.

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Testing Orders

Order No	1st	2nd
1	100	200
2	200	100

The experimenter (E) presents a pair of weights (the standard and one of the test weights listed on the data sheet) to the observer (O). He/she arranges a support for the preferred arm of the subject or observer (O) so that his/her hand will extend over one weight. By flexion of the wrist O should be able to pick up the weight that E has placed in the appropriate position. O should lift the standard weight first (100 or 200 grams) and then the test weight and judge whether the test weight was heavier or lighter than the standard. The person recording the data needs to know the actual weight of the test weight. If the test weight was judged heavier than the standard, a "+" should be recorded on the data sheet. If the test weight was judged lighter, a "-" should be recorded. The 11 test weights should be scrambled on the table and presented in a "random" order. After all 11 are presented the experimenter should shuffle them again and repeat the presentation of each test weight.

Ideally O should be blindfolded, or at least turn his/her face away so that he/she gets no visual cue as to which weight is presented. E then gives O the necessary instructions:

1. "When I say, 'Now,' lift the standard weight which is directly below your hand, using a wrist motion. Notice its weight, return it to the table, and lift your hand again. When I repeat, 'Now,' do the same with the second weight."

2. "Report whether or not the test (second) weight seems **heavier** than the standard weight. **Do not give 'equal' judgments**. Guess if you are not certain."

3. E should present the weights in pairs, placing first the standard weight (either 100 or 200 grams, as appropriate) and then a test weight directly below O's hand. E should try to develop a regular rhythm. Stimuli should be presented for 1–2 sec. duration, separated by an equal period of time. The intervals between pairs should be longer. Allow the subject to rest from time to time. At least 10 presentations of each test stimulus should be made. The order of the test weights should be randomized.

Data Tabulation and Analysis

1. Transfer the frequency of "heavier" and "lighter" judgments for each test weight from your data sheet to the summary sheet at the end of this handout. Compute the total of heavier and lighter judgments and then compute the

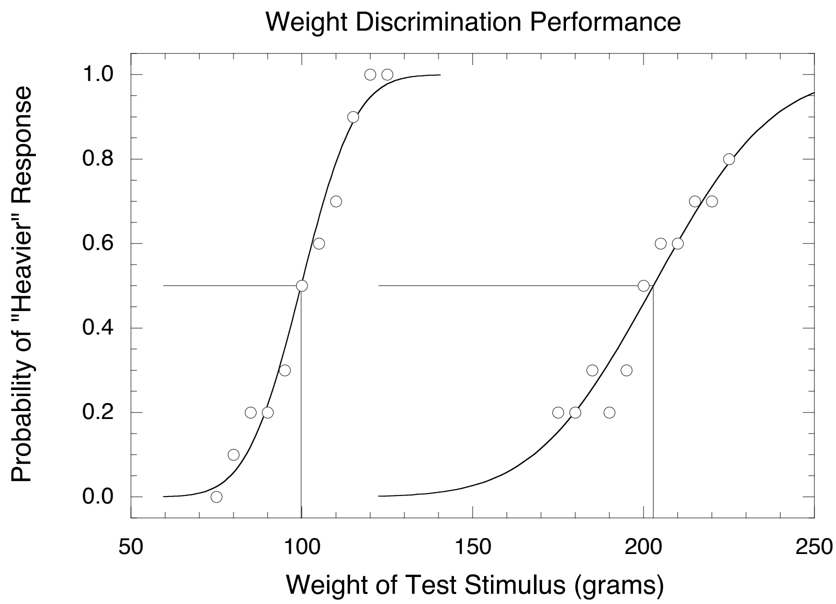
probability of making a heavier judgment.

2. Next you will use the computer program **PsychoFit** to fit a smooth, S-shaped psychometric function (Gaussian Integral Function) to your data. Open the template data file "PsychoFitDataTemplate.txt" by double-clicking on it and replace the last two data columns with your own data (frequency of heavier and lighter judgments). Edit the two title lines to include your own name. When you are finished, choose SaveAs… from the File menu and save the file as a ***Text File*** with your own name (e.g., HarveyData.txt). Do not use spaces in the file name.

3. Double-click on the PsychoFit application and type the name of your data file when the program asks you. The data file should be in the same folder as the PsychoFit program. You may give a carriage return in place of an output file name. The program will then ask for four pieces of information: type *n* in response to the first three and 0 (zero) to the fourth. The program will use a maximum-likelihood curve-fitting technique to find the best-fitting Gaussian integral psychometric function for your data.

4. The results of the analysis will appear in a window. Print this window to save the results. Of the fitted parameters, alpha and beta are directly relevant. Alpha is the point of subjective equality (PSE) and beta is the reciprocal of the just noticeable difference (JND).

5. Using KaleidaGraph, plot both your data and the best-fitting psychometric function. PsychoFit creates a text file containing all the plotting information you need. The file is called xxx_GaussianPF.txt, where xxx is the name of your data file. Import the data into KaleidaGraph using the Import command from the File menu. To make the plot, select Line in the submenu Linear under the Gallery main menu item. A dialog box will appear asking you to select variables to plot. Choose log stimulus (not stimulus) for the x-axis, and probability, probability (Gaussian), and markers for the y-axis. The horizontal axis, the abscissa, should cover the range from 50 to 250 grams. The vertical axis, the ordinate, plots the probability of judging the test stimulus "heavier" than the standard. It should cover the range from -0.05 to 1.05. Your graph should look something like this:



6. **The JND**: There are two ways to estimate the JND. One way is to compute the reciprocal of the steepness of the best-fitting psychometric function. The steepness is given by the parameter beta. So the steeper the function, the smaller the JND. Computed this way, one JND is equivalent to one standard deviation of the Gaussian distribution underlying the psychometric function. The second, equivalent method, is to use the difference, in grams, between the weight corresponding to the 0.84 point on the ordinate, and the weight corresponding to the 0.16 point on the ordinate divided by 2.0. You can find these points on your curves by using the "gun sight" tool in KaleidaGraph.

   Compute the Weber fraction for the 100 and the 200 gram standard by dividing the appropriate JND by the corresponding standard weight. Is the Weber fraction constant?

7. **The PSE**: The point of subjective equality (PSE), is the stimulus which is psychologically equal to the standard. This point is given by the parameter *alpha* from the curve fitting and is the stimulus weight that gives a "heavier" response probability of 0.5. You can also estimate the PSE by taking the average of the weights at 0.84 and 0.16 points on the psychometric function. In a situation where no constant errors operated, the PSE should equal the standard. The discrepancy between the physical midpoint of the series (the standard) and the psychological midpoint of the series (PSE) is defined as the constant error (CE):

$$CE = PSE - SW$$

where SW is the Standard Weight. A negative CE means that the first stimulus of a pair seems less than it "actually" is. When this error can be attributed to the time elapsing between the first and second stimuli of a pair this is called the time error.

8. **Hypothesis Testing**: We will assemble your individual data into a single data file that will be available for the next lab meeting. Test the hypothesis, using the R statistical analysis program, that the value of the Weber fraction is the same for 100 grams as for 200 grams. The appropriate analysis is a repeated measures analysis of variance.

Lab Report

Your lab report should be brief and contain five sections: cover sheet, introduction, methods, results, and discussion. These sections should conform to the American Psychological Association (APA) style (American Psychological Association, 2001) as described in Chapter 13 of the Martin textbook (Martin, 2004). The results section should have the graph described above and a table giving the PSE and JND for the 100 and 200 gram conditions. Do your results support Weber's Law?

The report is due at the beginning of the lab meeting **(12 & 13 June 2006**). Late labs will receive a grade of zero. All lab reports must be prepared with a word processor. This lab report is worth 30 points.

References

American Psychological Association. (2001). *Publication manual of the American Psychological Association* (5th ed.). Washington, DC: American Psychological Association.

Fechner, G. T. (1860). *Elemente der Psychophysik*. Leipzig, Germany: Breitkopf and Härtel.

Martin, D. W. (2004). *Doing psychology experiments* (6th ed.). Pacific Grove, CA: Brooks/Cole Publishing.

Lab 1: Weight Discrimination

Method of Constant Stimuli Data Sheet — 100 gram Standard											
Trial No.	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**	**115**	**120**	**125**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
Frequency of Test "Heavier"											
Frequency of Test "Lighter"											

Note: The judgment of the observer should be which weight (Test or Standard) is heavier.

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Method of Constant Stimuli Data Sheet — 200 gram Standard											
Trial No.	**175**	**180**	**185**	**190**	**195**	**200**	**205**	**210**	**215**	**220**	**225**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
Frequency of Test "Heavier"											
Frequency of Test "Lighter"											

Note: The judgment of the observer should be which weight (Test or Standard) is heavier.

Lab 1: Weight Discrimination

Data Summary Sheet

Weight in grams	No. Heavier than Standard	No. Lighter than Standard	Total No. of Judgments	Probability Heavier
75				
80				
85				
90				
95				
100				
105				
110				
115				
120				
125				
175				
180				
185				
190				
195				
200				
205				
210				
215				
220				
225				

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Curve-Fitting Summary from PsychoFit

		Alpha		Beta		Badness-of-Fit (χ^2)	
Name	Order	100 g	200 g	100 g	200 g	100 g	200 g

Please transfer your results above to the master data sheet for the class and we will prepare a master file with everyone's data for analysis next meeting. Your name will not appear on the master file.

Lab 1: Weight Discrimination

Using R for Lab 1 Analysis

The commands below are the minimum required to compute a mixed design (one between subjects factor (order) and one within factor (standard). You might have to download the data file (lab1data.txt) from the server. Ask us for help if the file is not on the desktop.

The general strategy with any data analysis is to first examine the data graphically and then do a formal statistical test of hypotheses. The commands below are the minimum required to compute a mixed design (one between subjects factor (order) and one within factor (standard)

Step 1: Set the working directory to the folder where data file "lab1_data.txt" is located.

Choose **Change Working Directory** under the **Misc** menu.

Step 2: Read data into R and store it in a data frame (here called df):

df <- read.delim("lab1_data.txt")

Step 3: Make the variables available outside the data frame

attach(df)

Step 4: Calculate just noticeable difference (JND) for each subject:

df$jnd <- 1 / pf_beta

(notice that because "pf_beta" is a column of numbers, the calculation is performed on each value in the column. The result is a new column of numbers equaling the JND for each subject. By identifying the new column as df$jnd, we are adding this column to df.)

Step 5: Calculate Weber's Constant (k) for each subject:

df$k <- df$jnd / w_standard

Step 6: Specify standard weight as a factor in our design:

df$w_standard <- factor (w_standard)

Step 7: Make the newly added columns available to the workspace:

detach (df)
attach (df)

Step 8: Write out a summary of the variables in the data frame:

summary(df)

Step 9: Make a strip chart of the data
stripchart(k ~ w_standard, method = "jitter", jitter = 0.03, xlab = "Weber's k", ylab = "Standard Weight")

Step 10: Make a box plot of the data:
boxplot(k ~ w_standard, data=df, xlab="Standard Weight", ylab="Weber's k")

Step 11: Compute the repeated measures ANOVA and store the results in object a:
a <- aov(k ~ (w_standard * st_order) + Error(w_subj/(w_standard)), data = df)

Step 12: print a summary of the analysis of variance
summary(a)

Step 13: Print a table of means:
print(model.tables(a,"means"))