

PLOTLOG for the Macintosh™

Version 1.0

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Introduction

PLOTLOG is designed to produce graphical displays associated with the models of item response theory (IRT), for use in item analysis and presentation. PLOTLOG draws trace lines (or item characteristic curves), item- and test-information functions, test characteristic curves, and the likelihood or posterior densities of item response patterns. The drawings appear (first of all) on the screen; they may be printed, or exported as files to other drawing programs for enhancement for use as presentation graphics. PLOTLOG is intended primarily as an ancillary program for use with MULTILOG; any of the wide variety of models that can be fitted to data using MULTILOG may be displayed with PLOTLOG. However, since item parameters may be entered from the keyboard, PLOTLOG may be used to provide graphical displays for IRT models fitted with other programs.

Creating graphics in PLOTLOG is a two-step process:

Step 1
Enter item parameters Before any plots may be drawn, PLOTLOG must have one or more items' parameters "in memory." Item parameters may be entered from the keyboard, using the **Add Item** menu, or by reading a MULTILOG or BILOG output file, using **Open...** under the **File** menu.

Step 2
Create plots After one or more items' parameters are "in memory," various plots may be drawn by selecting from the choices in the **Plot** menu.

While any of the graphics are on the screen, they may be printed by selecting **Print...** from the **File** menu, saved as a PICT file for subsequent editing by selecting **Save As...** under the **File** menu, or copied to the clipboard by selecting **Copy** under the **Edit** menu.

On the following pages, the use of the PLOTLOG menus is summarized.

The Menus

File	
New	N
Open...	O
Close	
Save	S
Save As...	
Page Setup...	
Print...	P
Quit	Q

New Selecting **New** erases all items in memory.

Open... Activates a standard dialog box to open a file. All TEXT files will be displayed, but PLOTLOG can successfully open only output files from MULTILOG or BILOG. These output files (.SAV files from MS-DOS or VAX VMS, or SAVE files from a VM/CMS, or IF.DAT files from BILOG) must be transferred to the Macintosh before PLOTLOG is run.¹ After a file is opened, the curves for all of the items in the file will be available in PLOTLOG's selection windows, identified by their numbers from 1 to however many. PLOTLOG does most of its computation when each item is entered; there is a substantial delay after opening a file before the watch cursor is replaced by the normal arrow.

Close Closes the current window; this is equivalent to clicking the "close box."

Save Same as **Save As...** (below).

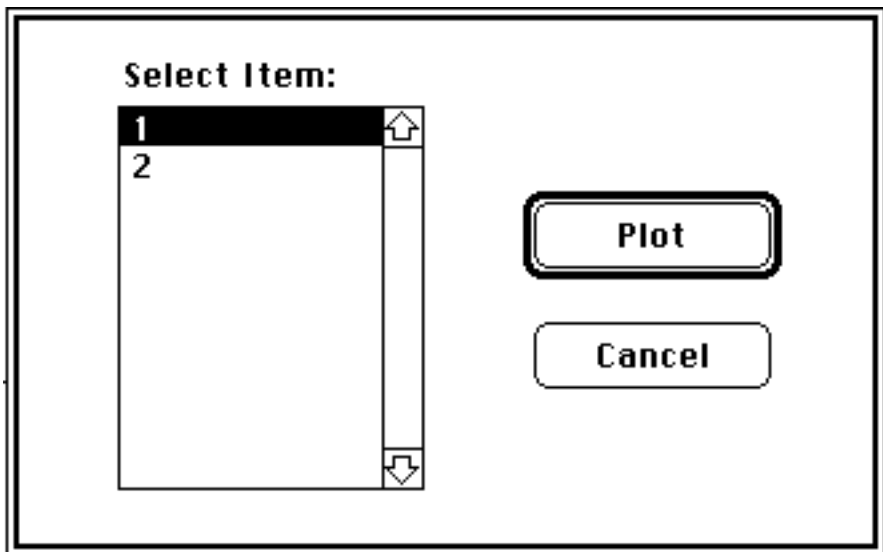
Save As... Activates a standard dialog box to save a file. PLOTLOG saves the image of the plot currently in the active window as a PICT file, which can be opened by common object-oriented drawing programs for subsequent editing.

Page Setup... Activates a standard dialog box to set printing attributes.

Print... Activates a standard dialog box to print the plot in the currently active window.

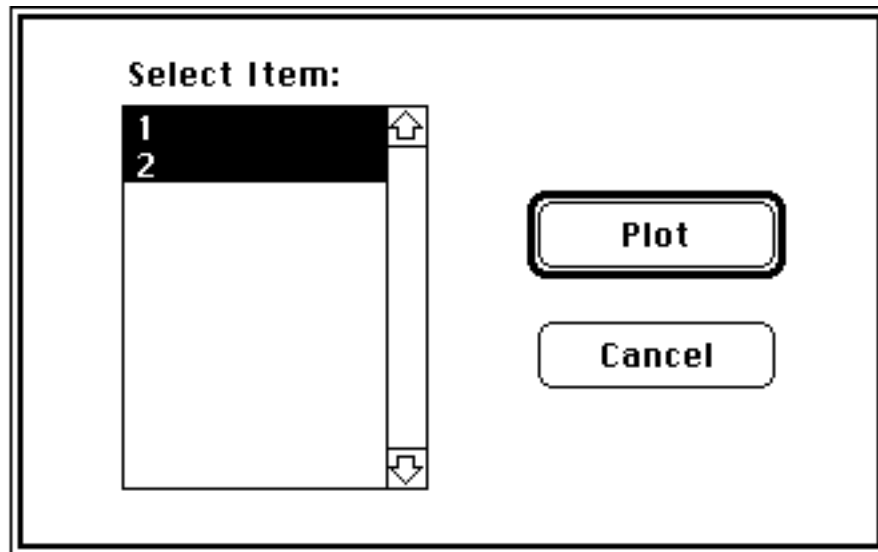
Quit Does just that.

¹MULTILOG or BILOG output files may be transferred from other systems to the Macintosh using FTP, Kermit, or any other file transfer system for ASCII (text only) files. Files from MS-DOS compatible personal computers may be transferred using a wide variety of

Edit**Undo** Z**Cut** K**Copy** C**Show Clipboard****Undo** (Currently inactivated.)**Cut** (Currently inactivated.)**Copy** Copies the contents of the currently active window to the clipboard.**Show Clipboard** (Currently inactivated.)**Plot****Trace Lines...****Information...****TCC****Posterior...****Selected...****Trace Lines...** Activates the dialog box illustrated below; selection of any of the item numbers in the list (by double-clicking the item number, or clicking the item number and then **Plot**) plots the item characteristic curve (for binary items) or all of the trace lines (for multiple alternative items).

commercially available communications or network software, as well as MS-DOS compatible disk drives for the Macintosh or Macintosh-compatible disk drives for MS-DOS machines.

Information... Activates the dialog box illustrated below; selection of any of the item numbers in the list (by double-clicking the item number, or clicking the item number and then **Plot**) plots the item's information function. Any subset of the items may be (drag or shift-click) selected; then the total (summed) information function for that set of items is displayed. Below, both items 1 and 2 are selected.



TCC Plots the test characteristic curve (TCC) for the complete set of items in memory. The TCC is the expected summed score as a function of θ . For binary items, it is computed with item scores of 0 and 1, so the range of the TCC is 0 to the number-of-items. For multiple alternative items, the item scores are assumed to run from 1 to the number of alternatives, so the range of the TCC is from the number-of-items to the total number-of-alternatives.

Posterior... Activates the dialog box illustrated at the right. In the box, enter (using the keyboard) a string of response-numbers, one number for each item currently in memory. For binary items, 2 is the positive (correct) response and 1 is the negative (incorrect) response. For graded or nominal items, the response

categories are numbered from 1 to however-many. For the multiple choice model, the alternatives are numbered from 2 to however-many-plus-one (category 1 is latent “don’t know”). To omit an item from the posterior, enter zero in that item’s position. Do not press <return> while entering item responses, or something very bad happens. If “**Likelihood only**” is selected, the product of the item trace lines (alone) is displayed. If “**Gaussian Population**” is selected, you may enter the mean and standard deviation in the obvious boxes. If “**Johnson Population**” is selected, enter the parameters in the four lowest boxes. The plot is scaled (by default) so that the maximum on the *y*-axis is equal to the ordinate of the maximum of the posterior; that number is usually small and unpleasant and is not displayed. To control scaling (e.g., to make comparable plots), you may enter a numerical value for the *y*-axis maximum in the box marked **Y-axis Maximum**.

Enter item responses, as numbers from 1 to the highest category, in order. Enter zero (0) to omit an item from the posterior.

Y-axis Maximum:

Likelihood only

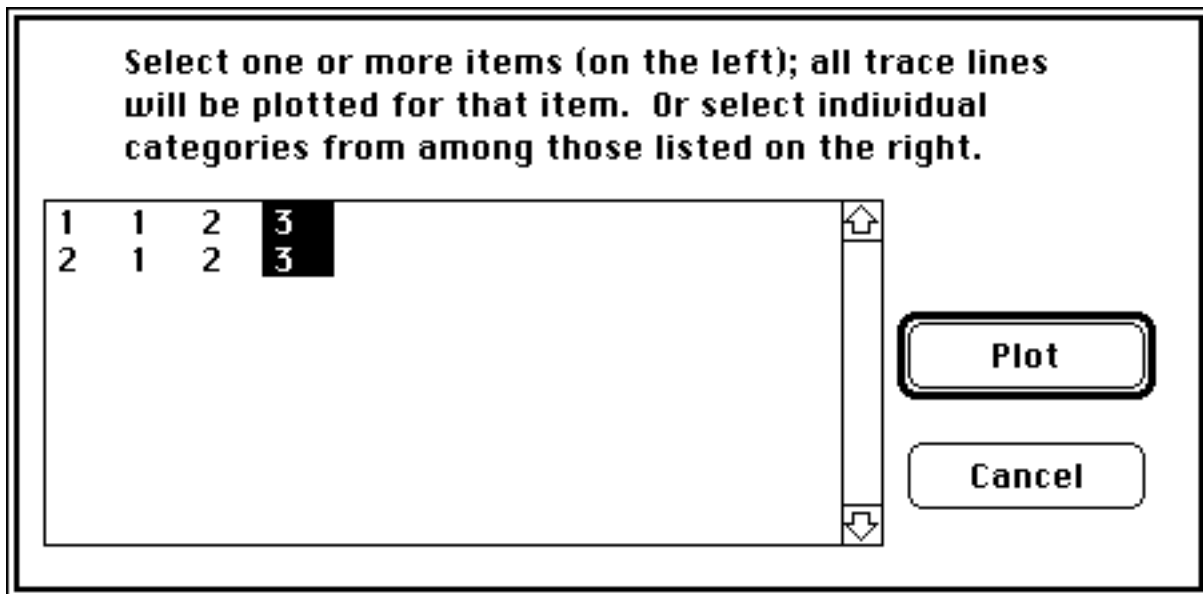
Gaussian Population—

Mean: **Std Dev:**

Johnson Population— **S(B)** **S(U)** **Lognormal**

gamma: **delta:** **lambda:** **xi:**

Selected... Activates the dialog box illustrated below. In the box, the numbers of the items currently in memory are displayed on the left margin, and the category-numbers for each item are displayed across the remainder of the list. You may select (click or shift-click) either (sets of) item numbers (in which case all of the selected items' trace lines are displayed) or (sets of) categories, in which case the selected trace lines are shown. Click **Plot** to see the curves. Only ten curves may be shown on a single plot; if more than ten curves are selected, only the first ten are plotted.



Add Item**2PL...****3PL...****Graded...****Nominal...****Multiple Choice...**

Each of these menu items activates a dialog box to add an item to the list currently available to be plotted; in the dialog box, the user is invited to enter parameters for the specified model. PLOTLOG does most of its computation when each item is entered; there may be a substantial delay after each item is entered before the watch cursor is replaced by the normal arrow.

2PL... For the two-parameter logistic model, enter the slope (**a**) and the threshold (**b**) in the dialog box, as illustrated below. The form of the model is $T = \{1 + \exp[-\mathbf{a}(x - \mathbf{b})]\}^{-1}$; note the absence of "1.7".

The dialog box is titled "Enter:". It contains two input fields: "a:" with the value "1.00" and "b:" with the value "0.00". To the right of these fields are two buttons: "OK" and "Cancel".

3PL... For the three-parameter logistic model, enter the slope (**a**), the threshold (**b**), and the lower asymptote (**c**) in the dialog box, as illustrated below. The form of the model is $T=c + (1 - c)\{1+\exp[-1.7a(x - b)]\}^{-1}$; note the presence of “1.7”.

Enter:

a:

b:

c:

Graded... For the graded logistic model, enter the slope (**a**) and the threshold (**b[k]**) parameters; the model is as documented in the *MULTILOG User's Guide*. Enter the correct number of categories if the value shown is not already correct (from the **Alternatives** menu).

Enter:

a:

b[1]:

b[2]:

b[3]:

b[4]:

b[5]:

b[6]:

b[7]:

b[8]:

b[9]:

Number of Categories:

Nominal... For the nominal model, enter the slope (**a[k]**) and intercept (**c[k]**) parameters; the model is as documented in the *MULTILOG User's Guide*. Enter the correct number of categories if the value shown is not already correct (from the **Alternatives** menu).

Enter:			
a[1]:	<input type="text"/>	c[1]:	<input type="text"/>
a[2]:	<input type="text"/>	c[2]:	<input type="text"/>
a[3]:	<input type="text"/>	c[3]:	<input type="text"/>
a[4]:	<input type="text"/>	c[4]:	<input type="text"/>
a[5]:	<input type="text"/>	c[5]:	<input type="text"/>
a[6]:	<input type="text"/>	c[6]:	<input type="text"/>
a[7]:	<input type="text"/>	c[7]:	<input type="text"/>
a[8]:	<input type="text"/>	c[8]:	<input type="text"/>
a[9]:	<input type="text"/>	c[9]:	<input type="text"/>

Number of Categories

Multiple Choice... For the multiple choice model, enter the slope (**a[k]**), intercept (**c[k]**), and guessing (**d[k]**) parameters; the model is as documented in the *MULTILOG User's Guide*. Enter the correct number of categories (number-of-alternatives plus one) if the value shown is not already correct (from the **Alternatives** menu).

Enter:			Number of Categories	<input type="text" value="2"/>
a[1]:	<input type="text"/>	c[1]:	<input type="text"/>	
a[2]:	<input type="text"/>	c[2]:	<input type="text"/>	d[1]: <input type="text"/>
a[3]:	<input type="text"/>	c[3]:	<input type="text"/>	d[2]: <input type="text"/>
a[4]:	<input type="text"/>	c[4]:	<input type="text"/>	d[3]: <input type="text"/>
a[5]:	<input type="text"/>	c[5]:	<input type="text"/>	d[4]: <input type="text"/>
a[6]:	<input type="text"/>	c[6]:	<input type="text"/>	d[5]: <input type="text"/>
a[7]:	<input type="text"/>	c[7]:	<input type="text"/>	d[6]: <input type="text"/>
				<input type="button" value="OK"/>
				<input type="button" value="Cancel"/>

Alternatives

- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

The checked entry under the **Alternatives** menu is the current default value for the number of categories when Graded, Nominal, or Multiple Choice items are added using the **Add Items** menu.

FontSize
10
12
14
18
24

The checked entry under the **FontSize** menu is the current default value for the axis labels.

Special
1 pt lines
2 pt lines
Bold
Envelope & M-line

1 pt lines When checked, the lines on the plot are drawn 1 point wide; this is good for most purposes (and printers).

2 pt lines When checked, the lines on the plot are drawn 2 points wide; this is useful for very large plots or low-quality printers, especially when used with **Bold**.

Bold When checked, all of the plot labels are in boldface; this is useful for very large plots or low-quality printers.

Envelope & M-line This option produces many of the plots described by D. Thissen & H. Wainer, "Confidence envelopes for item response theory," *Journal of Educational Statistics*, 1990, Volume 3, pp. 113-128; see that source for details on the computation. Selection of this menu entry activates the dialog box shown on the following page. The **Envelope & M-line** procedures are completely disconnected from all of the other plot-making capabilities of PLOTLOG. It is *not* possible to use the parameters entered elsewhere in the program to generate these plots.

Enter Parameters:

a: b: c:

1PL 2PL 3PL

M-lines Logistic Metric

Envelopes Normal Metric

N: Seed:

Envelope & M-line (continued) 95% confidence envelopes and *M*-line plots may be drawn only for the 1PL, 2PL, and 3PL models; and the parameters for those models must be entered in the dialog box shown above. The model is selected with the radio buttons marked **1PL**, **2PL**, and **3PL**. Regardless of the model selected, values must be entered for *all three* parameters (**a**, **b**, and **c**); for the 1PL and 2PL models enter **0.0** for **c**, and for the 2PL model enter **1.0** for **a** if the slope is otherwise unspecified. The radio buttons at the left-center of the dialog box select either 95% confidence envelope plots, or *M*-line plots that (approximately) fill the 95% envelope with randomly-generated curves (see Thissen & Wainer, 1990). The radio buttons marked **Logistic Metric** and **Normal Metric** determine whether the parameters are interpreted “using the 1.7” (**Normal**) or not (**Logistic**). The sample size is entered for **N**, and the “seed” for the random generation of *M*-line plots is entered in the **Seed** box.

Details, details...

BEWARE!

This version of the program has generally been fairly stable. However, like any Macintosh program, it may (unpredictably) cause complete system crashes. Use it with care. It appears to run under MultiFinder; but since the program may crash at any time (possibly taking the system with it), you are warned against having unsaved important material in other applications running simultaneously with PLOTLOG.

Test Information

The information curves plotted by PLOTLOG involve only the items. There is no way in the current version to include the information derived from the population distribution. If the population distribution is Gaussian with unit variance, the information from that source is uniformly 1.0, so in that event the information plotted by PLOTLOG is uniformly 1.0 less than the total test information for EAP or MAP scoring. If the population distribution is not Gaussian, it is not clear how to supply that information to PLOTLOG; that is why the population distribution is not considered in information curves at this time.

**Serious editing for
presentation
graphics**

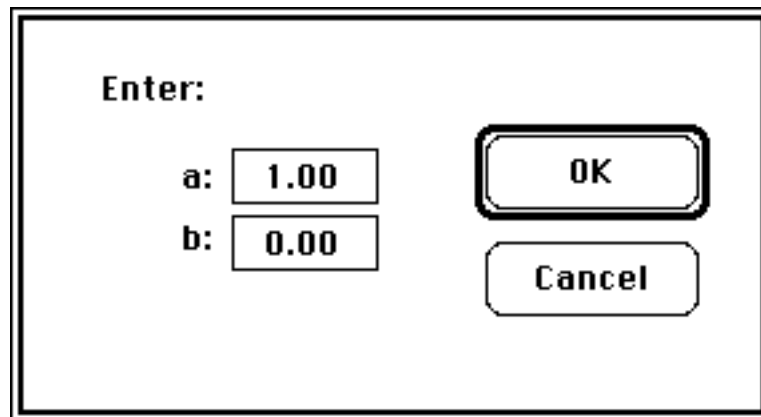
PLOTLOG will export its plots, either as PICT files or through the clipboard, to any of a wide variety of drawing programs, such as MacDraw, MacDraw II, Cricket Draw, or SuperPaint (to name a few of the more common). All of these programs exceed any drawing or formatting capabilities PLOTLOG could ever have; therefore PLOTLOG will never have any such features. To edit plots for use in publication or presentation, export the graphics to your favorite drawing program and “fix it up” there. For convenience, the curves generated by PLOTLOG are “polygons,” and they can be “smoothed” by drawing programs with the facilities to do so. Simply select the curves (or the entire graphic) in the drawing program and then select “smooth” from the appropriate menu. PLOTLOG does not “smooth” the curves; it plots only 28-straight-line-segment approximations. The 28-segment approximations look fairly curved on the screen or a dot matrix printer, but they may have noticeable discontinuities when printed on a laser printer.

An Example

How-to-make what became Figure 4.5 of *Computerized Adaptive Testing: A Primer*¹, using PLOTLOG and MacDraw; see page 21 for the result.

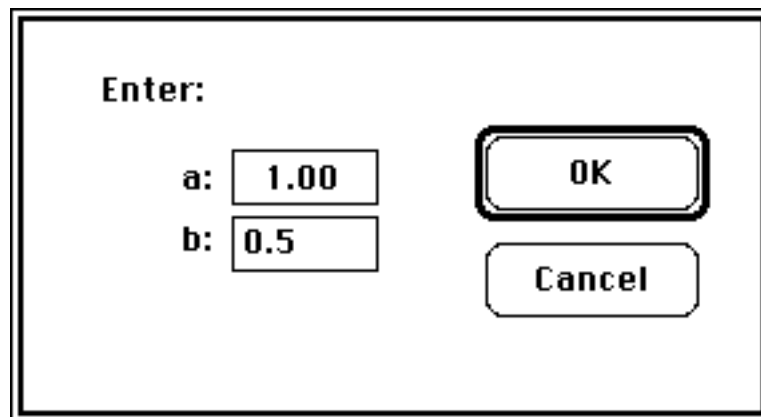
First, start PLOTLOG and use the **FontSize** menu to make the labels 18 points (big).

Then, enter the parameters for the two items that are to become **A** and **C**; we chose to make the slope 1.0 for both, with $b_A = 0.0$ and $b_C = 0.5$. To do this, select **2PL...** under the **AddItem** menu, and click **OK** in the following dialog box:



A dialog box with a double-line border. The text "Enter:" is at the top left. Below it are two input fields: "a:" followed by a box containing "1.00", and "b:" followed by a box containing "0.00". To the right of these fields are two buttons: "OK" (with a thick border) and "Cancel" (with a thin border).

Then, select **2PL...** again, and insert **0.5** in the box for **b**, and click **OK**:



A dialog box with a double-line border. The text "Enter:" is at the top left. Below it are two input fields: "a:" followed by a box containing "1.00", and "b:" followed by a box containing "0.5". To the right of these fields are two buttons: "OK" (with a thick border) and "Cancel" (with a thin border).

¹H. Wainer, N. Dorans, R. Flaugher, B. Green, R. Mislevy, L. Steinberg & D. Thissen (Eds.), (1990). *Computerized adaptive testing: A primer*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Now the two items are “in memory” and we are ready to start making pictures. The first one will be the standard normal for **N**; to make this one, select **Posterior...** under the **Plot** menu, and respond in the dialog box as follows:

Enter item responses, as numbers from 1 to the highest category, in order. Enter zero (0) to omit an item from the posterior.

00

Y-axis
Maximum: auto

Likelihood only
 Gaussian Population-
Mean: 0.0 Std Dev: 1.0

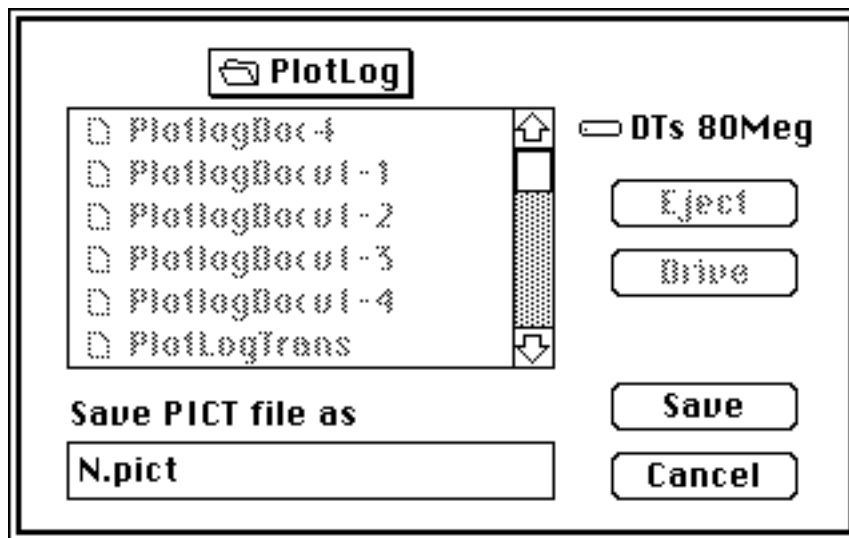
Johnson Population- **S(B)** S(U) Lognormal
gamma: 0.0 delta: 0.0 lambda: 0.0 xi: 0.0

Plot
Cancel

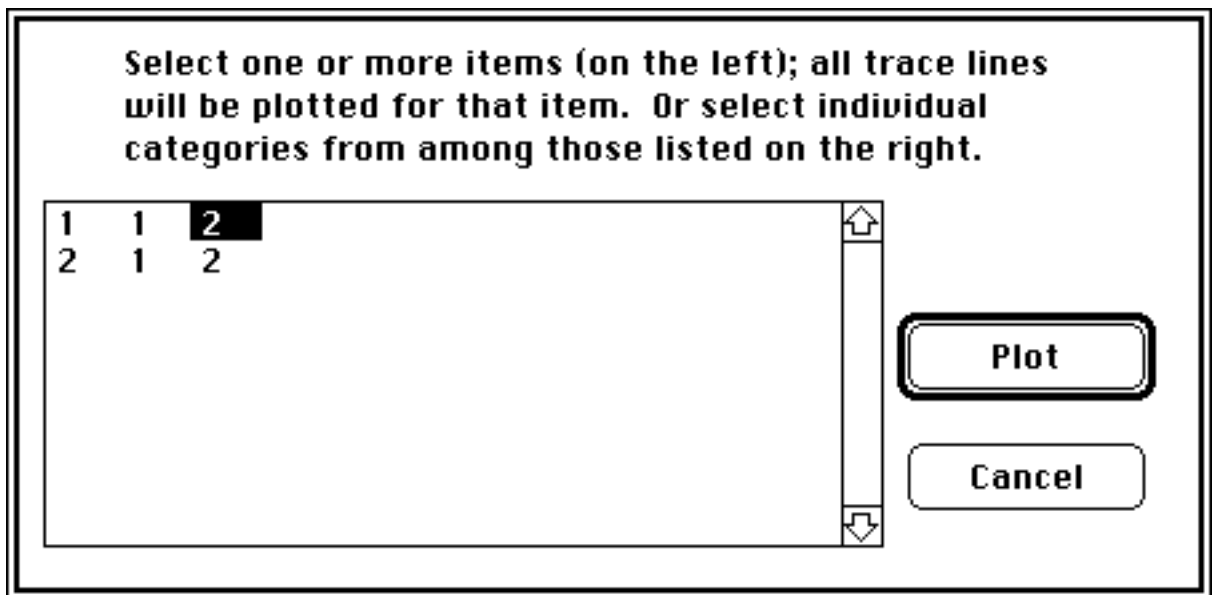
Note the entry of the two zeros in the responses-box; this makes the two items missing, so the posterior is the prior, which is $N(0,1)$. Click **Plot** and the picture appears.

It is best to resize the PLOTLOG drawing window at this point, so it is about 2.5 inches tall.

Then select **Save as...** under the **File** menu, to save the graphic as **N.pict** (for later use):



Now, we need to create the trace-line plot for **A**. The easiest way to do this is to use **Selected...** under the **Plot** menu, which gives this dialog box:



Next to item 1 (top row; remember, this is item **A**), click **2** (because that is "correct"), and then click **Plot**. The plot appears. While it is on the screen, select **Save as...** and save the graphic as **A.pict**, as above. Then repeat this process exactly to get the plot of the trace line for **C**, except in the dialog box like that immediately preceding, click **2** for item 2 (**C**, second row of the items-to-be-selected). Save that plot as **C.pict**.

Now we are ready to do the posterior. Select the **Posterior...** menu item under **Plot**, and the following dialog box appears; fill in **22** in the responses-box to indicate the posterior for “both correct.” Also, replace the word “**auto**” with “**1.0**” in the “**Y-axis Maximum**” box. Because the PLOTLOG-height of the original normal prior is 1.0, this makes the posterior come out the right-fraction-of-the-height of the original normal. If you leave it on “**auto**” the posterior will be as tall as the y-axis.

Enter item responses, as numbers from 1 to the highest category, in order. Enter zero (0) to omit an item from the posterior.

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Y-axis Maximum:

Likelihood only

Gaussian Population—

Mean: **Std Dev:**

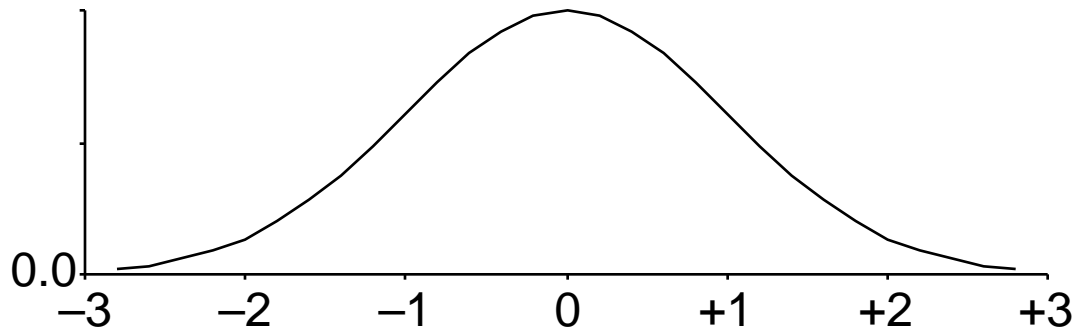
Johnson Population— S(B) S(U) Lognormal

gamma: **delta:** **lambda:** **xi:**

Click **Plot** and the graphic appears on the screen. Then **Save as... P.pict**, and **Quit** PLOTLOG.

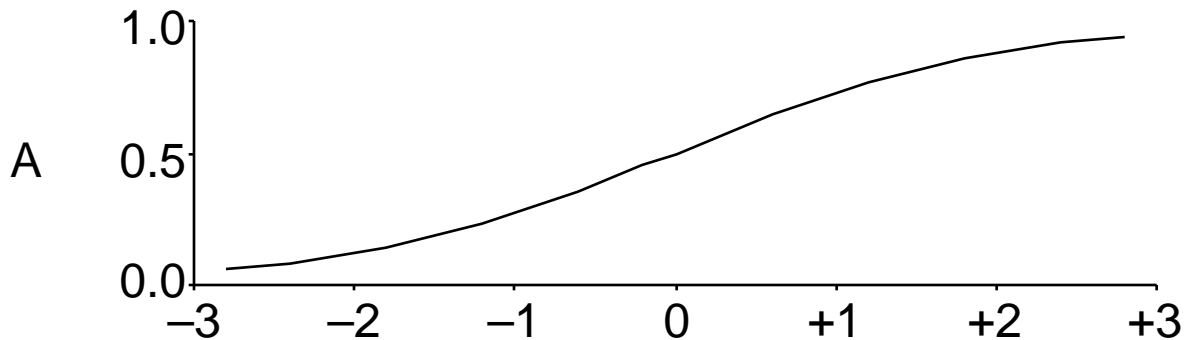
Now, start a drawing program; I used MacDraw. **Always, first: Turn Grid Off!** We are going to be doing a lot of “moving grouped things around” and if the snap-to-grid is on, the relative positions of all the elements will be thrown off by snapping to the nearest (invisible) grid line every time something moves. In MacDraw, the grid must be turned off each time a new file or window is opened, because it always defaults to be on.

Ok, now **Open... N.pict** (created previously in PLOTLOG). That file looks like this:



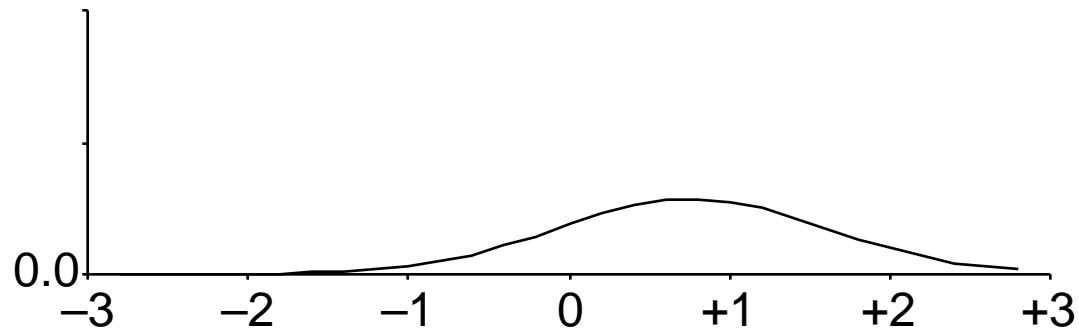
Delete the . **Save as...**, naming it **Figure4.5** (to title this window).


Now, **Open A.pict**; delete the , and replace the **T(x)** with **A**, after which it looks like this:



Then **Select All, Group** and **Copy** the whole thing to the Clipboard; and **Paste** it where it goes in **Figure4.5**. Repeat this process in the obvious way for **C.pict**.

Now open **P.pict**; it looks like this:



Leave the  on the bottom of this one, and repeat the maneuvers that place it on the bottom of **Figure4.5**.

Now, slide all four of the plots around in **Figure4.5** until their y-axes line up vertically and they are equally-spaced. Finish putting the labels in. When they are appropriately positioned (but not before!) select each of the four plots and **UnGroup** them. Then, **Select All** and choose “**Smooth**” from the **Edit** menu. This will “smooth” the four curves (replace the straight-line-segments with splines). Do this last, because after the curves are smoothed working with the MacDraw display gets really slow, as every time it scrolls it recomputes the splines.

Print it and it’s finished. The result is shown on the following page.

