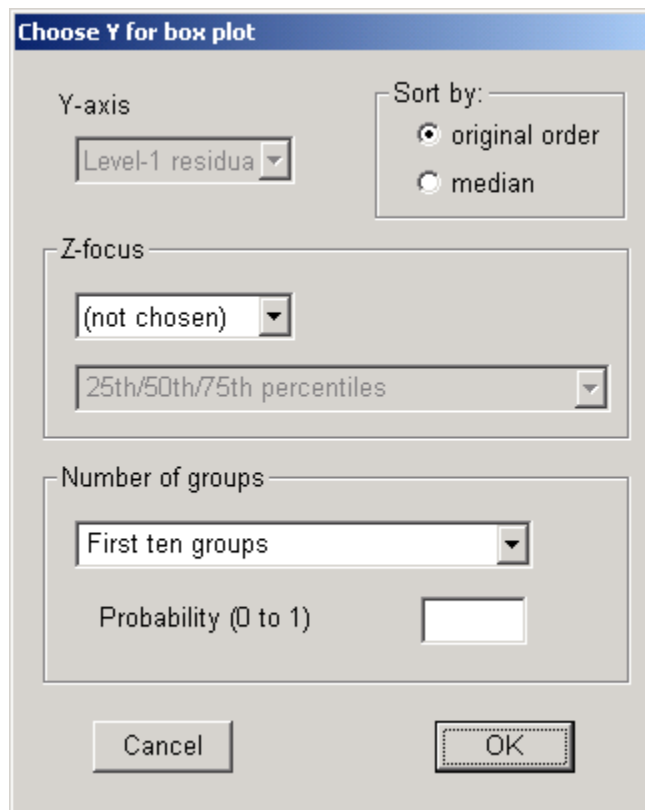


## Level-1 residual box-and-whisker plots

In addition to plotting predicted values for individual level-2 units using level-1 equations, users can also examine the distributions of the level-1 errors or residuals. The plots allow users to graphically examine the assumptions about the level-1 residuals and to identify cases for which the model provides a particularly poor fit. We continue to use VOCAB.MDM to illustrate this graphing procedure.

### To prepare level-1 residual box-and-whisker plots

1. After the model is run, select **Graph Equations...Level-1 box whisker** from the **File** menu, which will give us the following dialog box.



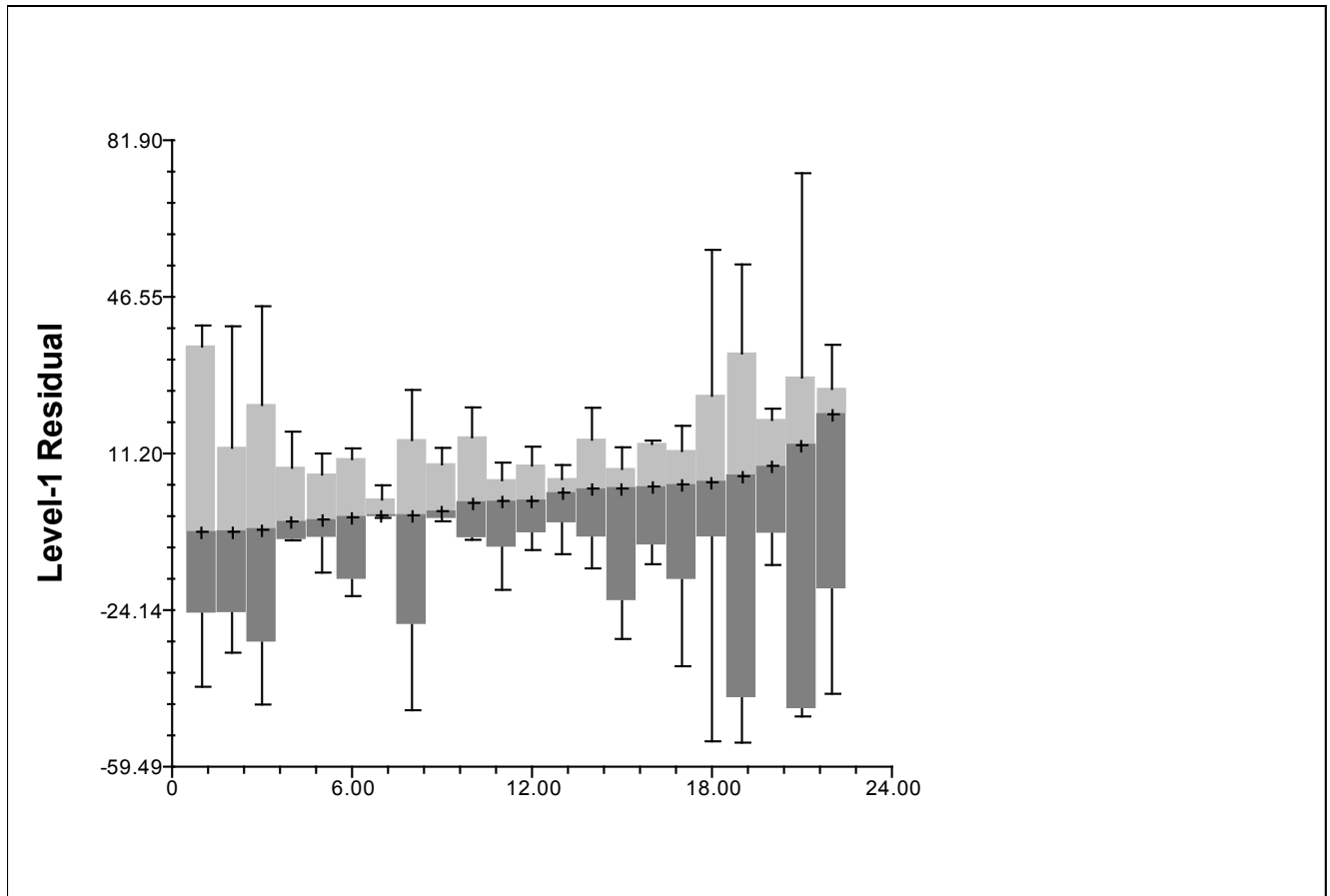
The dialog box titled "Choose Y for box plot" contains the following elements:

- Y-axis:** A dropdown menu with "Level-1 residua" selected.
- Sort by:** Two radio buttons: "original order" (selected) and "median".
- Z-focus:** A dropdown menu with "(not chosen)" selected, and a text input field containing "25th/50th/75th percentiles".
- Number of groups:** A dropdown menu with "First ten groups" selected, and a text input field for "Probability (0 to 1)".
- Buttons:** "Cancel" and "OK" buttons at the bottom.

Figure 27 Choose Y for box plot dialog box

Note that the variable for Y-axis, level-1 residual has been pre-selected.

2. Select **All groups (n=22)** in the **Number of groups** to include all the 22 children in the display.
3. Click the selection button for **median** in the **Sort by** section to arrange the plots by median order.
4. Click **OK**. The following graph will appear.



**Figure 28** Box-and-whisker plots of the level-1 residuals

The box-and-whisker plots provide side-by-side graphical summaries of the level-1 residuals for each level-2 units. The plots suggest that the underlying model assumptions may not be tenable. First, quite a number of the distributions are highly asymmetric, such as the last one from the left. Thus, the normality assumption may not hold. There seems to be heterogeneity of variance as well, judging from the wide disparities in the box lengths. The non-constant residual spread may suggest an omission of important effects from the model. However, there are no extreme values or outliers in any of the 22 plots. Note that this graphical analysis of level-1 residuals does not pool the residuals across level-2 units. In addition, WHLM has a statistical test for evaluating the adequacy of the homogeneity of level-1 variance assumption

(See *Hierarchical Linear Models* pp. 263-267 for a discussion of the examination of assumptions about level-1 random effects.)

5. (Optional) Users can look at the EB estimates for any child by clicking on the corresponding box-and-whisker plot.
6. (Optional) Users can choose to include a level-2 classification variable when examining the level-1 residuals.