PSY Users' Guide: Contents

Getting Started

Getting started. PSY constructs raw and standardized confidence intervals on contrasts in designs with one or more Between (group) factor(s) and/or one or more Within (repeated measures) factor(s). PSY requires an *input file,* which can be constructed within the program or as a text file with a word processor or text editor. The input file must contain data under the heading [Data], and at least one set of contrast coefficients: a set of integer coefficients referring to groups (under the heading [BetweenContrasts] or [BContrasts]) and/or a set of integer coefficients referring to (repeated) measurements (under the heading [WithinContrasts] or [WContrasts]). Each row of data must refer to a single case (subject, participant). The first column of data must be a group membership variable with values of 1, 2, 3, …, *in that order.* (If there is only one group, each row of data must begin with 1 as the value of this group membership variable.) The remaining columns should contain scores on a single dependent variable, one score for each measurement occasion.

Examples

Example 1: Three groups (two treatments and a control); $n_1 = 2$, $n_2 = 3$, $n_3 = 3$, no repeats; two Between contrasts.

```
[Data]
1 32
1 29
2 25
2 30
2 19
3 13
3 17
3 12
[BContrasts]
1  1 –2 Ts – C
1 –1  0 T1 – T2
```

Contrast labels (optional) can have up to 12 characters.

Example 2: One group (n = 5), four measurements (pretest, posttest, first follow-up, second follow-up); four Within contrasts

```
[Data]
1 6 20 19 15
1 8 19 19 22
1 4 15 17 15
1 8 21 17 12
1 3 12 10  7
[WContrasts]
-1  1  0  0 Post-Pre
 0  2 -1 -1 Post-FUs
 0  0  1 -1 FU1-FU2
-1  0  0  1 FU2-Pre
```

Example 3: 2 × (3) design; $n_1 = n_2 = 4$

```
[Data]
1 51 72 70
1 45 62 69
1 60 83 79
1 57 71 73
2 59 48 58
2 44 50 49
2 53 49 47
2 53 56 50
[BContrasts]
1 -1 B
[WContrasts]
-2  1  1 W1
 0  1 -1 W2
```

When there is at least one contrast of each type (B and W), PSY generates a complete set of B × W product interaction contrasts (BW1 and BW2 in this case).

Input & Output

To construct the input file within PSY, double-click the PSY icon. A blank screen will appear with a menu bar at the top. Select **File → New**. A screen will appear including the following in square brackets:
[Data]
[BetweenContrasts]
[WithinContrasts].
Type in whatever is required under the relevant headings, save the input file (optional) after selecting **File → Save as …** , and click the green *Run Analysis* button.

You will then see the *Analysis Options* screen, containing a range of options relating to confidence intervals. If you ignore these options, and accept the defaults, PSY will produce 95% individual confidence intervals on planned contrasts. When you have selected the options you prefer, click *OK*. You should now see the output on the screen. To save the output to a file, select **File → Save as …** . To send the output to a printer, select **File → Print …** .

To use an existing input file, select **File → Open**

Analysis Options: General

The *Analysis Options* screen allows you to control the type and level of confidence intervals produced on contrasts, and the scaling of contrast coefficients. The default option produces a 95% *individual* (non-simultaneous) confidence interval on the *mean difference* version of each contrast. These intervals are valid only for contrasts defined independently of the data.

Anything you enter as a *Title* (optional) will appear as a heading in the output.

If you wish to change the *Confidence Level* for confidence intervals from 95% (corresponding to a noncoverage error rate of .05) to some other value (not less than 70%), type (or use the buttons to select) the required value.

Confidence Intervals: Individual

A set of *individual* 100(1 - α)% confidence intervals on planned contrasts controls the noncoverage error rate at α for each contrast in the set, thereby producing a familywise error rate which is greater than α.

Confidence Intervals: Simultaneous

Options under the *Confidence Intervals* heading allow you to specify *simultaneous* confidence intervals of various kinds, or to provide PSY with the critical constants required to construct special confidence intervals. Given the standard distributional assumptions, the *Bonferroni t* and *Post hoc* options control the *familywise* noncoverage error rate at the nominated confidence level (95% by default), for one or all of three families of contrasts:

- the family of all Between-subjects (B) main effect contrasts
- the family of all Within-subjects (W) main effect contrasts
- the family of all Between × Within (BW) interaction contrasts.

The families defined by PSY are consistent with standard (but usually implicit) definitions of families in single-factor ANOVA (for either Between-subjects or Within-subjects designs), and in two-factor ANOVA with one between-subjects factor and one within-subjects factor.

Confidence Intervals: Bonferroni *t*

Bonferroni t intervals are usually narrower (more precise) than post hoc or maximum root intervals, but are valid only if contrasts within families are defined independently of the data.

Confidence Intervals: Post hoc

Post hoc intervals control the familywise error rate whether or not contrasts within families are defined independently of the data. The *Scheffé* method is used to construct intervals for B main effect contrasts. A *MANOVA* method is used otherwise (*Hotelling's* T^2 for W main effect contrasts, *Roy's gcr* method for BW interaction contrasts).

Confidence Intervals: Advanced Options

The remaining options under the *Confidence Intervals* heading are intended for advanced users. The *Maximum root* method makes use of Boik's *smr* (studentized maximum root) distribution, and can be useful for the analysis of balanced two-factor between-subjects designs. The parameters *p* and *q* refer to the degrees of freedom for the main effects in such a design.

The *User-supplied Critical Constants* option can be used to instruct PSY to construct confidence intervals of the form

$$\text{(Upper or Lower)Limit} = \text{value} \pm \text{CC} \times \text{SE}$$

where *CC* (the critical constant) is provided by the user, and the statistics *value* (contrast sample value) and *SE* (estimated standard error) are calculated by PSY. Users who wish to control the familywise error rates for families of contrasts not recognized by PSY (such as families including simple effects, or families appropriate for designs with multiple between-subjects and/or multiple within-subjects factors) may find it convenient to provide PSY with appropriate CCs. If you need critical values of *t*, *F*, *gcr* or *smr* distributions to calculate CCs for confidence intervals, use the *Probability Calculator* before running the analysis.

Scaling Options: Mean Differences

Scaling Options allow you to change the scale of contrast coefficients so that each contrast can be expressed as a *mean difference* contrast (a difference between the means of two subsets of means), or in a form appropriate for the interpretation of a first-order or higher-order product interaction contrast. Contrast coefficient scaling has no effect on contrast sums of squares or on test statistics, so if you are interested in using confidence intervals *only* to carry out significance tests (by seeing whether zero is or is not inside an interval), then you may as well use the default. Correct scaling is critical for the correct interpretation of contrast values as effect sizes, and of confidence intervals on contrast values. The default option (mean difference contrasts) is appropriate for the analysis of most single factor designs (trend analysis being the most obvious exception). If the design has one between-subjects and one within-subjects factor, the default option produces mean difference scaling for main effect contrasts, and expresses each Between $\times$ Within (BW) interaction contrast as a Between mean difference in a Within mean difference. This scaling is generally appropriate for main and interaction effect contrasts in two-factor designs.

Rescaled contrast coefficients are printed in the output immediately above tables of confidence intervals. If you do not want the coefficients to be rescaled, select the *No Rescaling* option.

Scaling Options: Interaction Contrasts

Designs with more than one factor of a particular type (Between or Within) will generally require more than one run through PSY to produce appropriately scaled confidence intervals for all contrasts. In general, mean difference scaling is appropriate for *simple* and *main* effect contrasts. (Appropriately scaled *individual* confidence intervals on all such contrasts can be constructed in one run; more than one run may be required for the construction of appropriately scaled *simultaneous* confidence intervals.) The scaling of interaction contrasts depends (or should depend) on the *order* of the interaction. The *Interaction Contrasts* option allows you to specify a scaling appropriate for Between × Between contrasts of a given order (a two-factor interaction involving only Between factors is of order 1) and/or a scaling appropriate for Within × Within contrasts of a given order (a three-factor interaction involving only Within factors is of order 2). The default order (0) is appropriate for main effect mean difference contrasts. Any higher-order Between × Within contrast defined by PSY will be scaled appropriately if the Between and Within contrasts on which it is based are both scaled appropriately.

Interaction Contrasts Example

Example: Data from a 2 × 3 × (4) design (two Between factors, called here U and V; one Within factor; 6 groups, 4 measurements per subject) are submitted to PSY with 3 Between main effect contrasts (U, V1 and V2), 2 Between product interaction contrasts (UV1 and UV2), and 3 Within contrasts (W1, W2 and W3). The user provides coefficients for the 5 Between contrasts (U, V1, V2, UV1 and UV2) and the 3 Within contrasts. PSY defines 15 Between × Within product interaction contrasts [9 first-order (double) interaction contrasts UW1, UW2, UW3, V1W1, V1W2, V1W3, V2W1, V2W2 and V2W3 and 6 second-order (triple) interaction contrasts UV1W1, UV1W2, UV1W3, UV2W1, UV2W2 and UV2W3]. A PSY run with all default options in place will produce 95% individual confidence intervals for all 23 contrasts, with the 8 user-defined contrasts scaled as mean difference contrasts, and the 15 PSY-defined BW contrasts scaled as first-order interaction contrasts. The main effect contrasts U, V1, V2, W1, W2 and W3 will be scaled appropriately, as will the (PSY-defined) first-order Between × Within interaction contrasts derived from them (UW1, UW2, UW3, V1W1, V1W2, V1W3, V2W1, V2W2 and V2W3). User-defined Between × Between interaction contrasts (UV1 and UV2) will be scaled inappropriately, if the user wishes to interpret each of these contrasts as a mean difference in a mean difference (perhaps a difference between two effect sizes). Higher-order interaction contrasts based on these contrasts (namely UV1W1, UV1W2, UV1W3, UV2W1, UV2W2 and UV2W3) will also be scaled inappropriately, if the user wishes to interpret each as a mean difference in the magnitude of a properly scaled first-order interaction. After the first PSY run is completed, pressing the *Run Analysis* button brings up the *Analysis Options* screen again, and the user should select *Interaction Contrasts*, Between order = 1, retaining the Within order default option of 0. In the second run all Between contrasts will be scaled as first-order interaction contrasts, so the contrasts UV1 and UV2 will be scaled appropriately, as will the second-order Between × Within contrasts UV1W1, UV1W2, UV1W3, UV2W1, UV2W2 and UV2W3.

Probability Calculator

The *Probability Calculator* provides *critical values* (given α and degrees of freedom) or *p values* (given an obtained value and degrees of freedom) for four probability distributions [*t*, *F*, *gcr* (Roy's greatest characteristic root θ) and *smr* (Boik's studentized maximum root)]. Critical values can be used to determine critical constants for the construction of non-standard confidence intervals (confidence interval critical constants depend on, but are not always identical to, critical values of probability distributions). *Bonferroni-adjusted* critical values can be obtained by specifying *k,* the value by which the nominated (familywise) α is to be divided. All critical values are appropriate for two-sided confidence intervals (or two-tailed tests).

All *p* values refer to the area in the upper tail of the relevant distribution. This means that *p* values given for the *t* distribution (but not for the *F*, *gcr* or *smr* distributions) are the values associated with one-tailed tests. Double the obtained *p* value if you want the value associated with a two-tailed *t* test.