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|  |  | | | One-Way ANOVA Workflow | | | | | | | | |  |  |
|  |  | | | |  | |  | | |  | |  | |  |
|  | Evaluate potential violation of assumptions | | | | | | | | | | | | |  |
|  |  | | | |  | | | | | | |  | |  |
|  | Independence (a matter of research design; no statistical evaluation required) | | | | | | |  | | | Violated? Choose another statistic and stop. | | |  |
|  |  | | | |  | | | | | | |  | |  |
|  | DV as continuous (a matter of research design; no statistical evaluation required) | | | | | | |  | | | Violated? Choose another statistic and stop. | | |  |
|  |  | | | |  | | | | | | |  | |  |
|  | Normality: | | | | | |  | | |  | |  | |  |
|  |  | | Skew: Values < 3.0 ok | | | |  | | |  | Violated? If cell sizes are reasonably large (e.g., at last 15) and balanced, ANOVA is a relatively robust option. | | |  |
|  |  | | Kurtosis: Values < 8 ok | | | |  | | |  |  |
|  |  | | Shapiro Wilk’s: Want a non-significant *p* value | | | |  | | |  |  |
|  |  | | | |  | |  | | |  | |  | |  |
|  | Homogeneity of variance | | | |  | |  | | |  | |  | |  |
|  |  | | Levene’s test: Want a non-significant *p* value | | | |  | | |  | Violated? Use Welch’s one-way for the omnibus | | |  |
|  |  | |  | | | |  | | |  | |  | |  |
|  |  | | | | Compute the Omnibus ANOVA + effect size) | | | | | | |  | |  |
|  |  | | | |  | |  | | |  | |  | |  |
|  | **Significant** | | | |  | |  | | |  | Not-significant: stop | | |  |
|  |  | | | |  | |  | | |  | |  | |  |
| Post-hoc comparisons (all possible) | | Planned contrasts  (*k* – 1) | | | | Polynomial tends (linear, quadratic, or otherwise curvilinear | | |  |  | |  | |  |
|  |  | | | |  | |  | | |  | |  | |  |
| Manage Type I error w LSD or Bonferroni |  | | | |  | |  | | |  | |  | |  |

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|  | | |  | | | | Two-Way ANOVA Workflow | | | | | | | | | | | |  | | |  | | |
|  | | | | | | Evaluate potential violation of assumptions | | | | | | | | | | | | | |  | | | | |
|  | | |  | | |  | | | | | | | | | | | | | |  | |  | | |
|  | Independence (a matter of research design) | | | | | | | | | | | | |  | Violated? Stop and choose another statistical tool. | | | | | | | | |  |
|  | | |  | | |  | | | | | | | | | | | | | |  | |  | | |
|  | DV as continuous (a matter of research design | | | | | | | | | | |  | | | Violated? Stop and choose another statistical tool. | | | | | | | | |  |
|  | | |  | | |  | | | | | | | | | | | | | |  | |  | | |
|  | DV normally distributed for each of the populations (cells) | | | | | | | | | | | |  | | | | | | |  | |  | | |
|  | | Skew: Values < 3.0 ok | | | | | | | |  | | | | | Violated? If cell sizes are reasonably large (e.g., at last 15) and balanced, ANOVA is a relatively robust option. | | | | | | | | |  |
|  | | Kurtosis: Values < 8 ok | | | | | | | |  | | | | |
|  | | Shapiro Wilk’s (applied to residuals from the ANOVA model): Want a non-significant *p* value | | | | | | | |  | | | | |
|  | | |  | | |  | |  | |  | | | | | | | | | |  | |  | | |
|  | Homogeneity of variance for each of the populations (cells) | | | | | | | | |  | | | | | | | | | |  | |  | | |
|  | | | Levene’s test: Want a non-significant *p* value | | | | | | |  | | | | | Violated? See if one of the other SS Types is more appropriate for evaluating any ANOVAs used | | | | | | | |  | |
|  | | |  |  | | | |  | |  | | | | | | | | | |  | |  | | |
|  | | |  | | | Compute the Omnibus ANOVA (es: η2) | | | | | | | | | | | | | |  | |  | | |
|  | | |  | | |  | |  | |  | | | | | | | | | |  | |  | | |
|  | | | INTERACTION EFFECT  Interaction, *p* < .05  (ignore main effects)  es: η2ok for ANOVAs | | | | |  | | NO SIGNIFICANCE  Factor A, B, & Interaction *.* > .05  Stop! | | | | | |  | MAIN EFFECTS ONLY  Factor A and/or B, *p* < .05  Interaction, *p* > .05  es: η2ok for ANOVAs | | | | |  | | |
|  | | |  | | |  | |  | |  | | | | | | | | | |  | |  | | |
| Simple Main Effects for Factor A w/i all levels of Factor B | | | | | Simple Main Effects for Factor B w/i all levels of Factor A | | | |  | | Post-hoc comparisons | | | | | | | Planned contrasts | | | Polynomial tends (linear, curvilinear) | | | |
| Post hoc comps  OR planned contrasts  OR polynomial.  Same as in purple boxes on left. | | | | | Post hoc comps  OR planned contrasts  OR polynomial.  Same as in purple boxes on left. | | | |  | | Type I: LSD if only 3 comps; Holm’s if >3 and mod control; Bonferonni if >3 and strict control | | | | | | | Type I: α ÷ #contrasts | | | Type I: leave at original level | | | |

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| One-Way Repeated Measures ANOVA Workflow | | | | | | | | | | | | | | |
|  | | |  | | |  | |  | |  | |  | |  |
|  | | | Evaluate potential violation of assumptions | | | | | | | | | |  | |
|  | | |  | | |  | | | | | |  | |  |
|  | The cases represent a random sample from the population and there is **no dependency** in the scores ***between*** subjects | | | | | | | |  | | Violated? Choose another statistic and stop. | | |  |
|  | | |  | | |  | | | | | |  | |  |
|  | DV as **continuous** (a matter of research design; no statistical evaluation required) | | | | | | | |  | | Violated? Choose another statistic and stop. | | |  |
|  | | |  | | |  | | | | | |  | |  |
|  | **Normality** (for each level of the within-subjects factor): | | | | | | |  | |  | |  | |  |
|  | | Skew: Values < 3.0 ok | | | | | |  | |  | Violated? If cell sizes are reasonably large (e.g., at last 15) and balanced, ANOVA is a relatively robust option. | | |  |
|  | | Kurtosis: Values < 8 ok | | | | | |  | |  |  |
|  | | Shapiro Wilk’s: Want a non-significant *p* value | | | | | |  | |  |  |
|  | |  | | | |  | |  | |  | |  | |  |
|  | **Sphericity**: population variances of differences scores b/t any 2 levels are the same | | | | | | |  | |  | |  | |  |
|  | | Mauchly’s: Want a non-significant *p* value | | | | | |  | |  | Violated? Greenhouse Geiser or Huynh-Feldt correction; or use a multivariate method | | |  |
|  | | |  |  | | | |  | |  | |  | |  |
|  | | |  | | | Compute the Omnibus ANOVA + effect size) | | | | | |  | |  |
|  | | |  | | |  | |  | |  | |  | |  |
|  | | | **Significant** | | |  | |  | |  | Not-significant: stop | | |  |
|  | | |  | | |  | |  | |  | |  | |  |
| Post-hoc comparisons (all possible) | | | | | Planned contrasts  (*k* – 1) | | Polynomial tends (linear, quadratic, or otherwise curvilinear | | |  | |  | |  |
|  | | |  | | |  | |  | |  | |  | |  |
| Manage Type I error w LSD or Bonferonni | | |  | | |  | |  | |  | |  | |  |

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|  | | | | | | | Mixed Design ANOVA Workflow | | | | | | | | |  | | | | | |
|  | | | | | | Evaluate potential violation of assumptions | | | | | | | | | | |  | | | | |
|  | | | |  | |  | | | | | | | | | | |  | |  | | |
|  | DV as continuous (a matter of research design) | | | | | | | | | |  | Violated? Stop and choose another statistical tool. | | | | | | | | |  |
|  | No significant outliers | | | | | | | | | |  | Violated? Consider truncating or transforming. | | | | | | | | |  |
|  | DV normally distributed for each of the populations (cells) | | | | | | | | | |  | | | | | |  | |  | | |
|  | | | Skew: Values < 3.0 ok; Kurtosis: Values < 8 ok  No outliers, boxplots, outlier analysis | | | | | | | |  | Violated? If cell sizes are reasonably large (e.g., at last 15) and balanced, ANOVA is a relatively robust option. | | | | | | | | |  |
|  | | | Shapiro Wilk’s (applied to residuals from the ANOVA model): Want a non-significant *p* value | | | | | | | |  |
|  | | | QQ plots | | | | | | | |  |
|  | Homogeneity of variance for each of the populations (cells); Levene’s test, want *p* > .05 | | | | | | | | | |  | Violated? See if one of the other SS Types is more appropriate for evaluating any ANOVAs used | | | | | | | |  | |
|  | | Homogeneity of covariance matrix; Box’s, want *p* > .05 | | | | | | | | |  | Violated? Box’s M is sensitive to sample size. Just take a note and interpret in light of other output. | | | | | | | |  | |
|  | | **Sphericity assumption**: population variances of differences scores b/t any 2 levels are the same. Want Mauchly’s *p* > .05 | | | | | | | | |  | Violated? Use output adjusted (Greenhouse Geyser, Huynh-Feldt) output. Or switch to multivariate or linear mixed effects approaches. | | | | | | | |  | |
|  | | | |  | | Compute the Omnibus ANOVA (es: η2) | | | | | | | | | | |  | |  | | |
|  | | | | INTERACTION EFFECT  Interaction, *p* < .05  (ignore main effects)  es: η2ok for ANOVAs | | | |  | | | NO SIGNIFICANCE  Factor A, B, & Interaction *.* > .05  Stop! | |  | MAIN EFFECTS ONLY  Factor A and/or B, *p* < .05  Interaction, *p* > .05  es: η2ok for ANOVAs | | | | |  | | |
| Simple Main Effects for Factor A w/i all levels of Factor B | | | | | Simple Main Effects for Factor B w/i all levels of Factor A | | | |  | Post-hoc comparisons | | | | | Planned contrasts | | | Polynomial tends (linear, curvilinear) | | | |
| Post hoc comps  OR planned contrasts  OR polynomial.  Same as in purple boxes on left. | | | | | Post hoc comps  OR planned contrasts  OR polynomial.  Same as in purple boxes on left. | | | |  | Type I: LSD if only 3 comps; Holm’s if >3 and mod control; Bonferonni if >3 and strict control | | | | | Type I: α ÷ #contrasts | | | Type I: leave at original level | | | |

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|  | | | One-Way ANCOVA Workflow | | | | | | | | |  | |  |
| Evaluate potential violation of assumptions | | | | | | | | | | | | | |  |
|  |  | | | |  | | |  | | | | | |  |
| Cases are a random sample of the population and the scores on the DV are independent of each other, | | | | | | | |  | Violated? Choose another statistic and stop. | | | | |  |
|  |  | | | |  | | |  | | | | | |  |
| *Linearity:* The covariate is linearly related to the dependent variable within all levels of the factor (IV). | | | | | | | |  | Violated? Depending on the relationship between DV/COV, treating the covariate as a moderator (in regression) may be more appropriate. | | | | |  |
|  | Examine scatterplot of Cov/DV wi groups | | | | | | |  |  |
| *Homogeneity of regression slopes*. The slopes relating the COV to the DV are equivalent across levels of the factor. | | | | | | | |  |  |
|  | Interaction term of COV\*IV to DV should be NS. | | | | | | |  |  | | | | |  |
| *Normality.* The DV is normally distributed in the population for any specific value of the covariate and for any one level of a factor. | | | | | | | |  | Violated? If cell sizes are reasonably large (e.g., at last 15) and balanced, ANOVA is a relatively robust option. | | | | |  |
|  | Shapiro Wilk test applied to residuals from the model should be NS. | | | | | | |  | Transformations, truncating outliers, deleting cases, or ignoring/noting the issues are possible solutions. | | | | |  |
| No outliers | | | | | | |
| *Homogeneity of variance.* The variances of the DV for the conditional distributions (i.e., every combination of the values of the covariate and levels of the factor) are equal. | | | | | | | |  | | | | | | |
|  |  | Levene’s test: Want a non-significant *p* value | | | | | |  | Violated? Consider a more robust test for omnibus and SS Type III | | | | |  |
|  |  |  | | | | |  | | |  |  | | |  |
|  |  | Compute the Omnibus ANOVA + effect size) | | | | | | | | | | |  |  |
|  |  | | | |  | |  | | |  |  | | |  |
|  | **Significant** | | | |  | |  | | |  | Not-significant: stop | | |  |
|  |  | | | |  | |  | | |  |  | | |  |
| Post-hoc comparisons (all possible) | | | | Planned contrasts  (*k* – 1) | | Polynomial tends (linear, quadratic, or otherwise curvilinear | | | | |  | | |  |
| Manage Type I error w LSD or Bonferonni | | | |  |  | |  | | |  |  | | |  |