**Problem statement**

The distribution of effect sizes is relatively unstudied, as most assume they match the distribution of the test statistic. Therefore, *d* values are often calculated with *t* tests because the formulas are mathematically similar (as *d* usually is only a transform of *t* by removing the square root of *N*). However, several researchers have shown that the distribution of *d* is not normal, and actually follows a non-central *t* distribution, even as the central limit theorem approximates normal for the sampling distribution of *t*.

This study focuses on several related measures of variance overlap that are traditionally paired with ANOVA (linear models). Previous research has two implications: 1) the calculation of confidence intervals should not be based on the normal approximation, and 2) meta-analytic techniques that require the estimate of the variance of the effect size sampling distribution are unexplored for this statistic.

**Method**

* Simulated 1000 multivariate normal datasets for each of the following combinations of variables.
* Variables (1,152 combinations):
  + Sample size: values range from 20 to 110 increasing by units of 6.
  + Levels: 3, 4, 5, 6
  + SD/variance/effect size: 5 (small), 3 (medium), 1 (large)
  + Correlation between levels: 0, .10, .30, .50, .70, .90
* For each simulated data set, we calculated the following ANOVAs:
  + One way between subjects, assuming levels were separate groups of people.
  + One way repeated measures, assuming levels were the same people.
  + Created a second ‘fake’ variable for two way ANOVAs:
    - Two way between subjects, assuming all levels were independent.
    - Two way repeated measures, assuming all levels were related.
    - Two way mixed design, analyzing the important factor as repeated measures.
* For each of these tests, we calculated the traditional *F* statistics as described below:

One way between subjects ANOVA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | SS | df | MS | F |
| A |  | a – 1 |  |  |
| S/A |  |  |  |  |
| T |  | N – 1 |  |  |

One way repeated measures ANOVA

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Between  Comparison | Source | SS | df | MS | F |
| A | A |  | a – 1 |  |  |
| S/A | S |  | n – 1 |  |  |
| AXS | S/A – S | (a – 1)(n – 1) |  |  |
| T | T |  | an – 1 |  |  |

Term Definition:

* A and B are the independent variables, effects.
* S/A is the error term, residual for between subjects.
* AXS is the error term, residual for within subjects
* T is the total variance.

Symbol definition:

* a = number of levels.
* N = total sample size.
* n = sample size.
* I = individual participant number.
* J = group number.
* Y = dependent variable score.
* T = grand mean.
* Bar = average.
* With these statistics, we calculated eta, generalized eta, omega, and all partial statistics for two way designs using the following formulas:

|  |  |  |  |
| --- | --- | --- | --- |
| ANOVA Design | Full Epsilon Squared | Full Omega Squared | Partial Omega Squared |
| 1-way Between |  |  | NA |
| 2-way Between |  |  |  |
| 1-way Within |  |  | NA |
| 2-way Within |  |  |  |
| 2-way Mixed |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| ANOVA Design | Generalized Eta Squared | Full Eta Squared | Partial Eta Squared |
| 1-way Between |  |  |  |
| 2-way Between |  |  |  |
| 1-way Within |  |  |  |
| 2-way Within |  |  |  |
| 2-way Mixed |  |  |  |

**Questions:**

1. Are there significant differences in the means of the effect size across conditions?
   1. Yes, it’s complicated.
2. Are there significant differences in the SDs of the effect size across conditions?
   1. Yes, it’s complicated.
3. Is there significant bias in estimated effect across conditions?
4. What distribution do the effect sizes approximate across conditions?
   1. FES: Beta
   2. FOS: Beta
   3. GES: Beta
   4. PES: Beta
   5. POS: Beta
5. Can we find a formula that best estimates sampling variance for these effect sizes?

|  |  |  |
| --- | --- | --- |
|  | PDF | CDF |
| *F*-distribution |  |  |
|  | Variance |  |

Epsilon

