Confidence Interval

Let us first compute a confidence interval on the difference between conditions. The general formula for a confidence interval on a contrast of two means is

$$CI_{.95} = (\bar{X}_i - \bar{X}_j) \pm t_{.05} s_{\bar{X}_i - \bar{X}_j}$$

or, if we let ψ_j represent the value of the contrast, where $\psi_j = \Sigma a_j \bar{X}_j$, then

$$CI_{.95} = (\psi_j) \pm t_{.05} s_{\bar{X}_i - \bar{X}_j}$$

For a confidence interval $s_{\bar{X}_i - \bar{X}_j}$ is the standard error of the contrast, and can be computed as $s_{\bar{X}_i - \bar{X}_j} = \sqrt{MS_{error}\left(\frac{\Sigma a_j^2}{n_j}\right)} = \sqrt{MS_{error}\left(\frac{2}{n}\right)}$ when we have equal sample sizes.

Then

$$CI_{.95} = (-1(10) + 1(29) \pm 2.03\sqrt{32.00(\frac{2}{n})} = (-1(10) + 1(29) \pm 2.03\sqrt{8}$$
$$= 19 \pm 2.03(2.828) = 19 \pm 5.74$$
$$13.26 \le \mu_1 - \mu_2 \le 24.74$$

The probability is .95 that an interval formed as I have formed this one will include the true difference between the population means.

Effect Size

Things are a bit different when we come to effect sizes because our goal is somewhat different. For confidence limits we used the standard error of the contrast in our computation. But with effect sizes we have a choice of what to use to standardize the difference between means. One alternative would be to use the standard error of the contrast as we did with confidence intervals. However it is difficult to say what such an effect size would mean in terms of our experience. That statistic would deal more with stability of the difference than its magnitude.

Another alternative would be to take the square root of MS_{error} because that represents the square root of the variance within each group. Kline (2004) recommends this approach. This denominator would be $\sqrt{32} = 5.657$.

Another alternative would be to take the square root of the average sample variance of the two groups in question, perhaps weighted by sample size if the groups are uneven. In this case it would be $\sqrt{\frac{26.32 + 37.95}{2}} = \sqrt{32.135} = 5.669$. Assuming that we have something close to homogeneity of variance this will be close to the square root of MS_{error}, though it will be based on fewer degrees of freedom.

Finally, I could consider one of the groups to be a control group and use its standard deviation as my error term. Here, I might argue that M-M is sort of a control group because the conditions don't change on trial 4. In this case I would let $s_{error} = 5.13$.

My general preference would be to base my estimate on the average of the variances of the groups in question. If there is heterogeneity of variance across the groups, then this would be a more representative estimate for the contrast we are examining. If the variances are homogeneous across all five groups, then the average of the groups in question won't deviate much from the average of the variances of all five groups, so I haven't lost much. Others might take a different view.

We have just seen that the confidence interval on the difference between Mc-M and M-M is $13.26 \leq (\mu_{Mc\text{-}M} - \mu_{m\text{-}m}) \leq 24.74$. Both limits are on the same side of 0, reflecting the fact that the difference was statistically significant. However, the dependent variable here is the length of time before the animal starts to lick its paws, and I don't suppose that any of us have a strong intuitive understanding of what a long or short interval is for this case. A difference of at least thirteen seconds seems pretty long, but I would like some better understanding of what is happening. One way to compute that would be to calculate an effect size on the difference between these means.