Homework 4

ANOVA

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1 Effect Size

1.1 Sample Size and Number of Groups from Summary Statistics

$df_{between} = k - 1$, so $2 = k - 1$ and $3 = k$. There are 3 groups.

$df_{within} = N - k$, so $21 = N - 3$ giving $24 = N$. The overall sample size is 24.

Since the design is balanced, and there are 3 groups, the per-group sample size is $24/3 = 8$.

1.2 Effect Sizes

```
eta.squared <- function(ss_between, ss_within){
  return(ss_between / (ss_between + ss_within))
}

omega.hat <- function(ss_between, ss_within, ms_within, k){
  numerator <- ss_between - (k - 1)*ms_within
  denominator <- (ss_between + ss_within) + ms_within
  return(numerator/denominator)
}

r.squared.adjusted <- function(N, k, eta_squared){
  return(1 - ((N-1)/(N-k))*(1-eta_squared))
}

eta_squared <- eta.squared(660.3, 1107)
cat("Eta Squared:", eta_squared, end="\n")
```

```
Eta Squared: 0.3736208
```

```
cat("Omega Hat Squared:", omega.hat(660.3, 1107, 52.7, 3), end="\n")
```

```
Omega Hat Squared: 0.3048901
```

```
cat("Adjusted R Squared:", r.squared.adjusted(24, 3, eta_squared))
```

```
Adjusted R Squared: 0.3139656
```

2 Power Analysis

```
library("WebPower")
```

2.1 Power to detect Omega Squared .15

WebPower needs effect size in terms of f, which is related to ω^2 by $f = \sqrt{\frac{\omega^2}{1-\omega^2}}$

```
f <- sqrt(0.15 / (1 - 0.15))
# n is the overall sample size, so 10*4
wp.anova(k=4, n=40, f=f)
```

```
Power for One-way ANOVA

    k  n        f alpha     power
    4 40 0.420084  0.05 0.5428697

NOTE: n is the total sample size (overall)
URL: http://psychstat.org/anova
```

2.2 Minimum per-group sample size

```
wp.anova(k=4, f=.4, power=.8)
```

```
Power for One-way ANOVA

    k        n   f alpha power
    4 72.17047 0.4  0.05   0.8

NOTE: n is the total sample size (overall)
URL: http://psychstat.org/anova
```

The minimum per-group sample size to detect an effect size of $f = .4$ is $\lceil \frac{72.17047}{4} \rceil = 19$.

If we are comfortable rounding down a smidge, a per-group sample size of 18 would be fine as well.

3 Contrast

3.1 Given sample size

f is related to d by $f = \frac{d}{\sqrt{k \sum_i c_i^2}}$, so $f = \frac{.5}{\sqrt{5(1/4+1/4+1/9+1/9+1/9)}}$, which reduces to $f = \frac{.5}{\sqrt{5(1/2+3/9)}}$ and $f = \frac{.5}{\sqrt{5(15/18)}}$, so $f = .244949$

```
wp.anova(k=5, n=25, f=0.244949, type="two.sided")
```

```
Power for One-way ANOVA

    k  n        f alpha     power
    5 25 0.244949  0.05 0.2146277

NOTE: n is the total sample size (contrast, two.sided)
URL: http://psychstat.org/anova
```

The power is .2146, which is quite low.

3.2 Given power

```
wp.anova(k=5, f=0.244949, power=0.8, type="two.sided")
```

```
Power for One-way ANOVA

    k        n        f alpha power
    5 132.8083 0.244949  0.05   0.8

NOTE: n is the total sample size (contrast, two.sided)
URL: http://psychstat.org/anova
```

The minimum per-group sample size to detect an effect size of $f = .25$ is $\lceil \frac{132.9}{5} \rceil = 27$.