# ADDIS ABABA UNIVERSITY COLLEGE OF EDUCATION AND BEHAVIOURAL STUDIES DEPARTMENT OF EDUCATIONAL PLANNING AND MANAGEMENT

## Individual Assignment 1 For The Course Advanced Educational Research Methodology And Applied Statistics II (EdPM 868).


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# STATISTICAL EFFECT SIZE IN QUANTITATIVE RESEARCH:

# MEANING, TYPES AND MAGNITUDES

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# Abstract

*Effect sizes are quantitative estimates of the links established between variables in research studies. They can provide a basic summary of research findings that can be used to compare different studies or synthesize results from many studies. Effect sizes, as opposed to statistical significance (p values), demonstrate the strength of correlations independent of sample size. The most commonly used effect size families are the standardized mean difference family, the standardized regression coefficient family, and the odds ratio family. Both researchers and consumers must grasp what effect sizes are, why they are important, and how to quantify and assess them. This presentation, along with the other resources listed below, are intended to provide information for PhD students who do not yet have the necessary experience and competence for a variety of research situations.*

# Out line of the presentation

- 1. Introduction
- 2. Meaning of Effect Size
- 3. Types of Effect Size (Families)
- 4. Magnitudes of Effect Size
- 5. Summary
- 6. Concluding Comments
- 7. References

# Brainstorming Question

1. What is effect size in statistics? Describe them using a specific example.

# 1. Introduction for Effect Size

- The providing of information regarding the amount and direction of the difference between two groups or the link between two variables is referred to as effect size.
- An effect size can be defined as a change in means, a percentage, or a correlation.
- (Durlak, 2009)

# Introduction ....

- **Typically, researchers attempt to demonstrate that there is a difference between the groups they are examining or that the factors they are exploring are associated.**
- **This information is provided by effect sizes, which estimate how much difference there is between groups or how strong the association between variables is.**

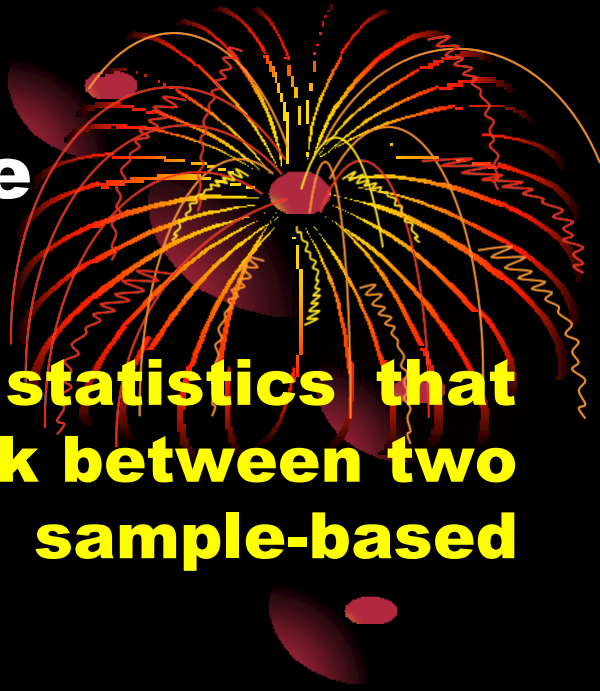
# Introduction.....

- In other words, effect sizes measure the quantity or intensity of research study findings.
- This is crucial information that cannot be gathered just by concentrating on a certain p-value, such as.05 (Levine, & Hullett, 2002).
- A p-value has no direct link with the magnitude of the impact.

# Intro ....

- A low, medium, or high p-value might indicate a low, medium, or high effect.
- Researchers favor bigger sample sizes because they boost confidence in the findings, but the issue here is that we cannot estimate the amount of an impact based just on statistical significance testing results.

# 2. The Meaning of Effect Size



- An effect size is a number in statistics that measures the strength of the link between two variables in a population, or a sample-based estimate of that amount.

- It might refer to the value of a statistic derived from a sample of data, the value of a parameter for a hypothetical population, or the equation that describes how statistics or parameters lead to the impact size value.
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# Relationship Between p-Values and the Magnitude of Effect

- A p-value determined in a research study is a function of both sample size and ES, and Thompson (2007) provided a compelling argument for why effects should be estimated regardless of their p-value.
- He presented the findings of ten research with varying sample sizes, just one of which had a p-value of.05.
- The ES for this single trial was 0.40. (an indication that the control group was superior to the experimental group).
- Thompson observed that if all attention was focused on the research that attained statistical significance, the only viable interpretation would revolve around its negative conclusion.
- The average ES estimated across all ten trials, on the other hand, was 0.28, which was statistically distinct from zero and would result in an entirely different conclusion.

# REMEMBER!!

**THE PROBLEM OF INTERPRETING AND COMPARING RESULTS FROM DIFFERENT STUDIES IS NOT SOLVED BY STATISTICAL SIGNIFICANCE ALONE.**

**(Hedges,2008).**

# Effect Sizes are Necessary

- The American Psychological Association Task Force on Statistical Inference suggested that researchers "always offer an ES estimate when presenting a p value."
- (italics added, Wilkinson and APA Task Force on Statistical Inference, 1999, p. 599) and went on to say that "... reporting and understanding ESs in the context of previously documented effects is vital to effective research."(p. 599)... from APA5 through APA7

# Effect Sizes are Necessary..con

- ESs were also emphasized in the fifth version of the APA Publication Manual (2001), which said, "For the reader to fully appreciate the relevance of your results, it is usually always required to give some index of ES or strength of association in your Results section."(p. 25).

# Effect Sizes are Necessary..con

- To summarize, adding and interpreting ESs should be considered as a crucial component of successful research rather than merely another editorial obstacle to clear for publishing.
- Effect sizes serve a vital role in that they aid in determining the overall impact of a study.

# 2. Types of Effect Size

- **There are three main effect size families .**

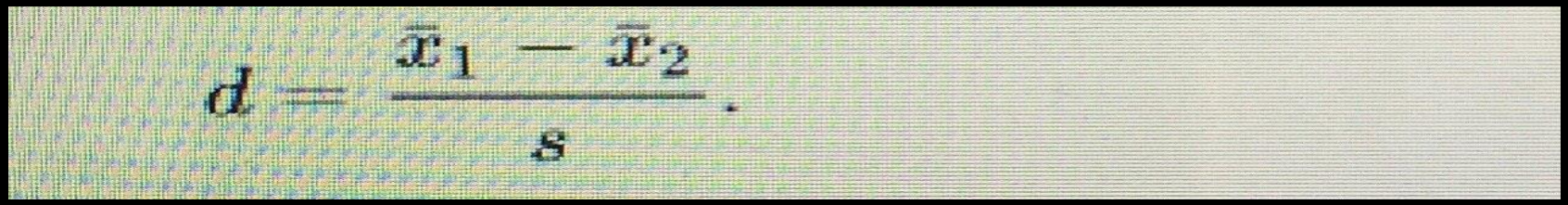
1. **Difference Effect Size Family(the d)**
2. **Correlation Effect Size Family (the r)**
3. **Odds Ratio Effect Size Family**

# 1. Difference Family: Effect sizes based on differences between means

- The raw effect size for a two-group comparison is automatically calculated as the difference between the two means.
- However, it is usual practice to standardize the impact size to assist interpretation.

# 1.1.Cohen's d

- Cohen (1977) proposed the effect size notion as a method for calculating statistical power.
- Cohen's d is defined as the difference between two means divided by the data's standard deviation, i.e.




- Where d= mean1- mean 2 divided by pooled Standard deviation

# Jacob Cohen

**(April 20, 1923 – January 20, 1998) was a statistician and psychologist best known for his research on statistical power and effect size.**

- While performing Cohen's d two things needs to be considered
- 1. Cohen's d= used when there are equal grouped sized

- Cohen's d= mean 1- mean 2

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  pooled standard deviation

- **Pooled Standard deviation**

- **P SD** $= \frac{\sqrt{SD\ 1\ ^2 + SD\ 2\ ^2}}{2}$
- **Cohen's d example**
- **Males** **Females**
- **Mean =0.528** **Mean =1.062**
- **SD=0.382** **SD= 0.339**
- **P SD** $= \frac{\sqrt{0.339\ ^2 + 0.382\ ^2}}{2}$
- **PSD= 0.361**

- Cohen's d= 1.062 ----0.528
-

0.31

D=1.479

- **2. Cohen's ds= used when there are unequal grouped sizes**

- **Cohen's d example**
- **Males** **Females**
- **Mean =0.528** **Mean =1.062**
- **SD=0.382** **SD= 0.339**
- **N=13** **n= 16**

- **Pooled SD=** $$\frac{\sqrt{(n1-1)x\ SD1^2+(n2-1)xSD2^2}}{n1\ +\ n2\ -2}$$

- $\frac{\sqrt{(16-1)x\ 0.339^2+(13-1)x0.382^2}}{16\ +\ 13\ -2}$
- **Pooled Sd= 0.359**

- **Cohen's D=** $\frac{1.062-0.528}{0.359}$
- **D=1.489**

# 1. 2 Glass' Δ

- Gene V. Glass provided an estimate of impact size based solely on the standard deviation of the second group in 1976.
- Glass stated that if various treatments were compared to the control group, it would be best to utilize only the standard deviation computed from the control group, so that effect sizes would not change under equal means and different variances.

- A pooled estimate is more exact under the right assumption of equal population variances.

$$\Delta = \frac{\bar{x}_1 - \bar{x}_2}{s_2}$$

# Gene V. Glass

# 2. Correlation Family: Effect sizes based on "variance explained"

These effect sizes estimate the proportion of an experiment's variance that is "explained" or "accounted for" by the model (Explained variation).

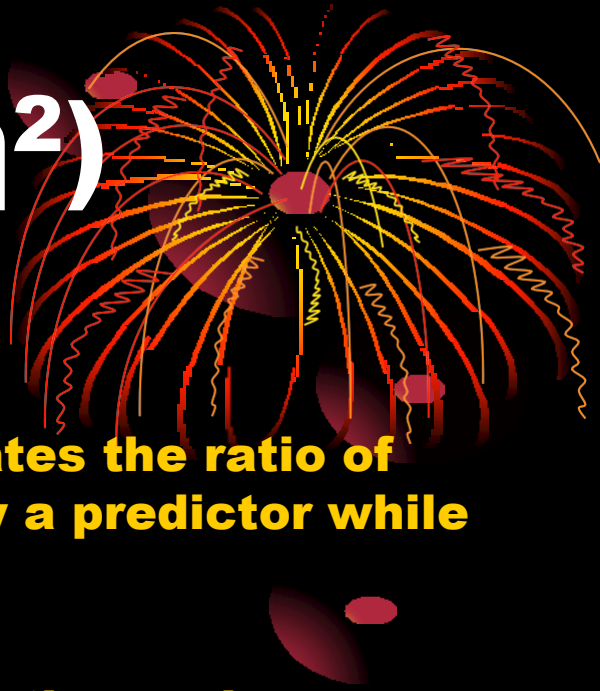
Explained variation is a statistic that assesses how well a mathematical model accounts for variation (dispersion) in a particular data set.

Variation is frequently measured as variance; the more precise phrase explained variance can then be employed.

# 2.1. Coefficient of determination (also referred to as $R^2$ or "$r$-squared")

- The square of the Pearson correlation r yields r2, which is a related effect size.
- This is a measure of the proportion of variance shared by the two variables in the case of paired data, and it ranges from 0 to 1.
- For example, with a r of 0.21, the coefficient of determination is 0.0441, indicating that 4.4 percent of the variance of one variable is shared by the other.

# 2.2 Eta-squared ($\eta^2$)



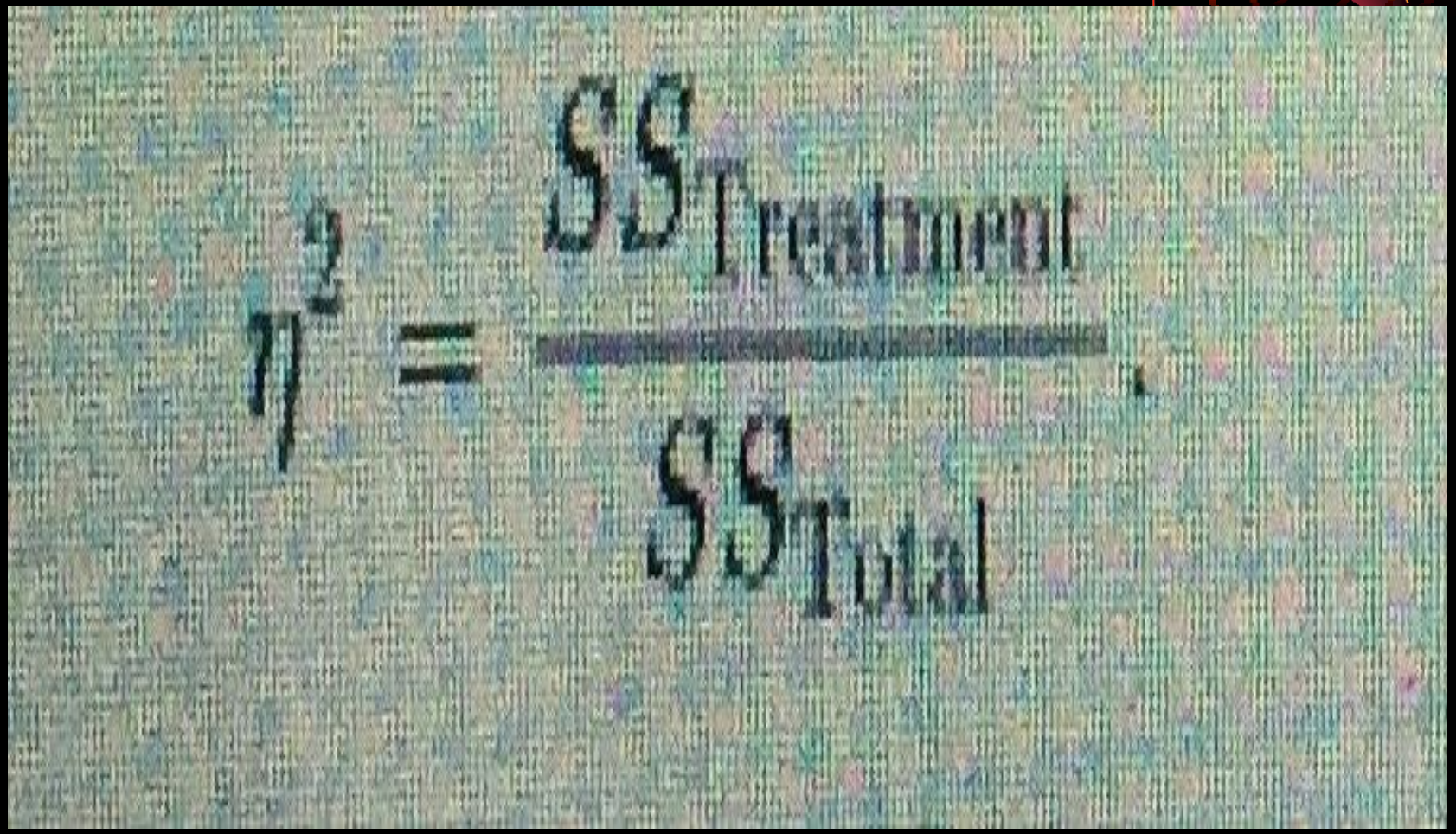
Eta-squared is comparable to r2 in that it indicates the ratio of variance explained in the dependent variable by a predictor while adjusting for other predictors.

Eta-squared is a skewed estimator of the population variance explained by the model (it estimates only the effect size in the sample).

This estimate has the same flaw as r2 in that each extra variable increases the value of 2.

Furthermore, because it measures the variance explained of the sample rather than the population, it will always overstate the effect size, while the bias decreases as the sample size increases.

# Eta-squared ($\eta^2$)....formula



# 3.Odds Ratio Effect Size Family

- **3.1. ODDS RATIO:**
- **Another important effect size is the odds ratio (OR).**
- **When the study issue focuses on the degree of relationship between two binary variables, it is acceptable.**
- **Consider a study on spelling skill, for example.**
- **In a control group, two students pass the class for every one who fails, resulting in a two-to-one chance of passing (or 2/1 = 2).**
- **Six pupils pass for every one who fails in the therapy group, hence the odds of passing are six to one (or 6/1 = 6).**
- **The effect size may be calculated by observing that the probabilities of passing are three times greater in the treatment group than in the control group (because 6 divided by 2 is 3).**
- **As a result, the odds ratio is 3.**

# 3.2 Relative risk

- The risk (probability) of an occurrence in relation to some independent variable is simply expressed as the relative risk (RR).
- This impact size metric varies from the odds ratio in that it compares probabilities rather than odds, yet it approaches the latter asymptotically for tiny probabilities.

# 4. Magnitudes of Effect Size

**Table 1** Values of Effect Sizes and Their Interpretation

| *Kind of Effect Size* | *Small* | *Medium* | *Large* |
|---|---|---|---|
| $r$ | .10 | .30 | .50 |
| $d$ | 0.20 | 0.50 | 0.80 |
| $\eta^2_p$ | .01 | .06 | .14 |
| $f^2$ | .02 | .15 | .35 |

*Source:* Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159. doi:10.1037/0033-2909.112.1.155

# CAUTION !!

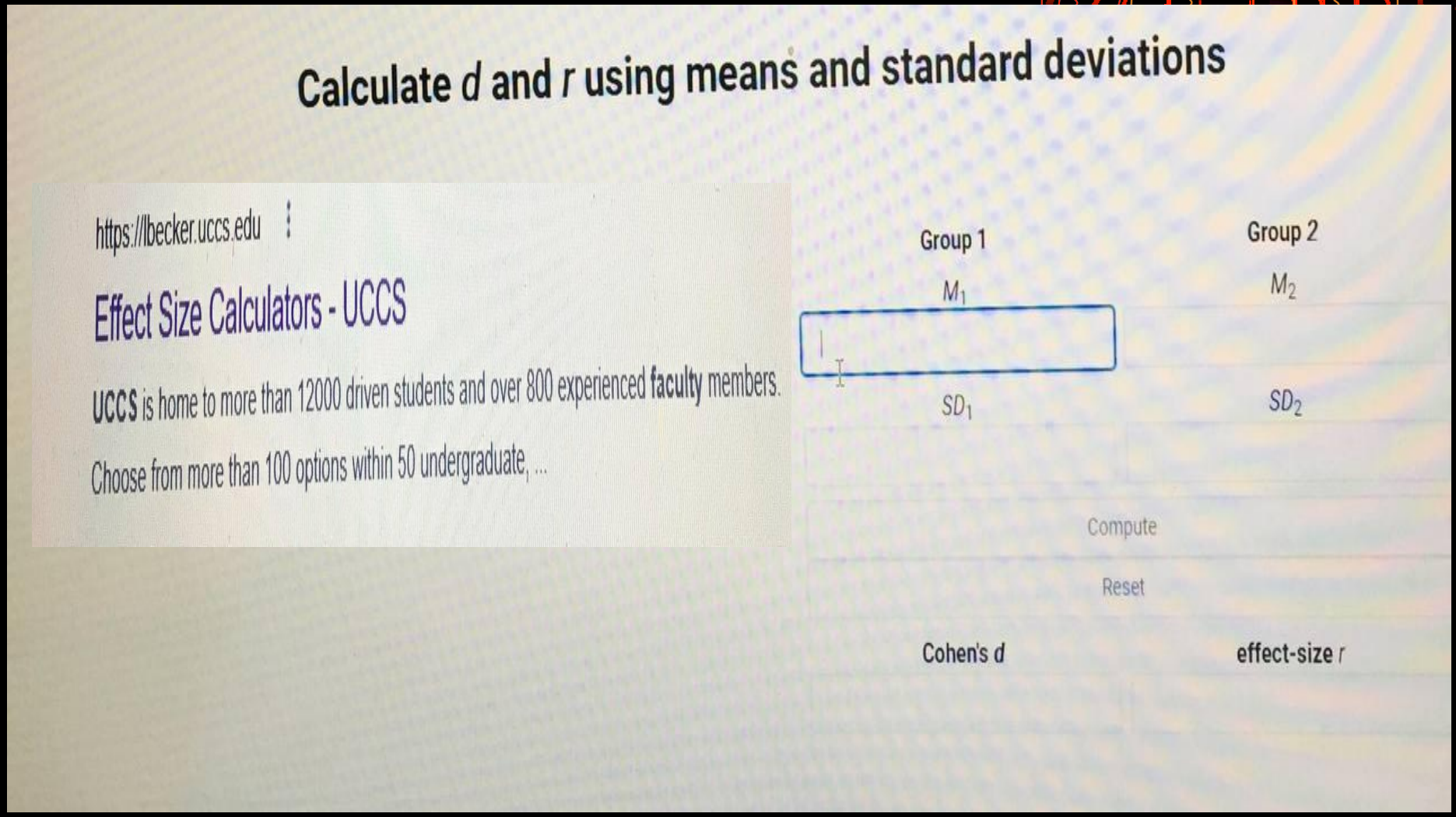
**Cohen did advise utilizing this rule of thumb with care.**
**In various contexts, the phrases "little" and "big" impacts might signify different things.**

**A "little" drop in suicide rates, for example, is significant, but a "small" weight loss may be insignificant.**

**He proposes consulting previous studies to determine how your findings fit into the larger picture.**

# Bonus: Online Effect Size Calculator

http://www.uccs.edu/~faculty/lbecker/



# 5. Summary

- Effect sizes are quantitative measures of the relationships established in research investigations between variables.

- They can give a general overview of study findings that can be used to compare different studies or synthesize outcomes across investigations.

- In contrast to statistical significance (p values), effect sizes show the strength of associations regardless of sample size.
- The standardized mean difference family, the standardized regression coefficient family, and the odds ratio family are the most commonly utilized effect size families.

# 6. Concluding Comments

- **It is critical for both researchers and consumers to understand what effect sizes are, why they are essential, and how to calculate and evaluate them.**

- **This presentation, along with the other materials given below, are meant to provide the information needed for numerous research circumstances for PhD candidates who do not yet have the appropriate background and expertise.**

# 7. References


- 1. Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science*, *1*(3), 98-101.
- 2. Durlak, J. A. (2009). How to select, calculate, and interpret effect sizes. *Journal of pediatric psychology*, *34*(9), 917-928.
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# THANK YOU !