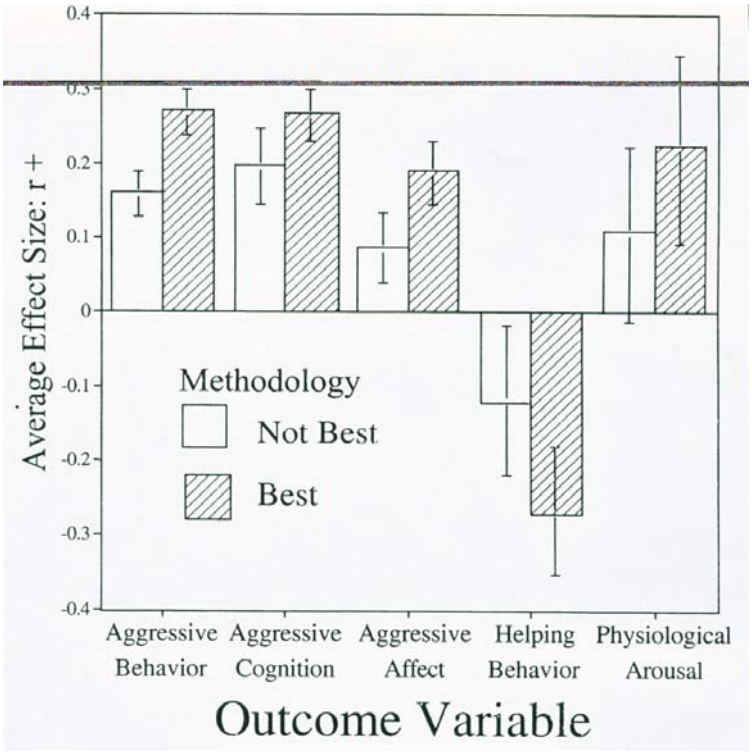
Topic #11

META-ANALYSIS

Meta-analysis can be described as a set of statistical methods for quantitatively aggregating the results of several primary studies to arrive at an overall summary statement or conclusion about the relationship between specified variables.

Effects of violent video games on a number of aggression-related dependent variables



Calculating the Effect Size Statistics (*d* or *r*)

- In meta-analysis, cumulating the effects across studies requires that outcomes from all studies be converted to a common metric. Two of the most common effect size statistics or metrics are *d* and *r*. For convenience, we shall focus on *d*.

- The *d* statistic provides a measure of the strength of a treatment or independent variable (e.g., different training methods). The effect size statistic, *d*, is the standardized difference between two means. Thus, in experimental designs, it represents the observed difference between the experimental and the control group in standard deviation units. A positive *d* value indicates that the experimental group performed better than the control group on the dependent variable. Conversely, a negative *d* value indicates that the control group performed better than the experimental group, and a zero *d* value indicates no difference between the groups. Thus, a *d* of .50 represents half a standardized difference between means.

- As shown in Formula 1, the *d* statistic is calculated as the difference between the means of the experimental (M_E) and control groups (M_C) divided by a measure of the variation.

$$d = \frac{M_E - M_C}{S_W} \tag{1}$$

- The measure of variation used in the above formula is S_W, which is the pooled, within-group standard deviation.

- For studies that report actual means and standard deviations for the experimental and control groups, effect sizes can be calculated directly using these statistics. For studies that report other statistics (e.g., correlations, *t* statistics, or univariate two-group *F* statistics), the appropriate conversion formulas can be used to convert them to *d*s.

Cumulating Effect Sizes Across Studies

- Mean sample-weighted effect sizes (*d*) can be calculated using Formula 2 below:

$$d = \frac{\sum diNi}{N_T} \tag{2}$$

where *d* is the mean effect size; d_i is the effect size for each study; N_i is the sample size for each study; and N_T is the total sample size across all studies. Sample weighting assigns studies with larger sample sizes more weight and reduces the effect of sampling error since sampling error generally decreases as the sample size increases.

- **EXAMPLE**

Study	Ne	Me	SDe	Nc	Mc	SDc	Ntot	Sw	d	dn
1	29	4.38	0.62	31	4.36	0.50	60	0.56	0.04	2.40
2	30	4.70	0.74	30	4.30	0.92	60	0.83	0.48	28.80
3	44	4.41	0.69	44	4.34	0.78	88	0.74	0.10	8.80
4	36	4.44	0.73	40	4.30	0.69	76	0.71	0.20	15.20
5	17	4.53	0.51	18	4.28	0.96	35	0.78	0.32	11.20
6	30	4.57	0.82	30	4.10	0.96	60	0.89	0.53	31.80
7	32	4.75	0.44	28	4.54	0.58	60	0.51	0.41	24.60
8	30	4.77	0.50	30	4.57	0.63	60	0.57	0.35	21.00
9	44	4.70	0.46	44	4.52	0.70	88	0.59	0.30	26.40
10	42	4.69	0.56	40	4.63	0.54	82	0.55	0.11	9.02
11	18	4.50	0.62	18	4.28	0.96	36	0.81	0.27	9.72
12	30	4.77	0.50	30	4.60	0.56	60	0.53	0.32	19.20
13	45	4.85	0.40	45	4.68	0.50	90	0.45	0.38	34.20
14	60	4.79	0.42	50	4.37	0.45	110	0.43	0.97	106.70
15	25	4.90	0.70	25	4.27	0.69	50	0.70	0.91	45.50
∑							1015			394.54

Ne & Nc = sample sizes of experimental and control groups, respectively
Me & Mc = mean of experimental and control groups, respectively
SDe & SDc = standard deviations of experimental and control groups, respectively
Ntot = total sample for specified study

$$d = \frac{\sum diNi}{N_T} \qquad d = \frac{394.54}{1015} \qquad d = 0.39$$

Advantages of meta-analysis

1. Controls for sampling error by assigning more weight to studies with larger samples and therefore, obtains more stable effect size estimates.

2. Focuses on the **magnitude** of effects instead of the statistical significance of effects; significance tests have recently been critiqued as being a major stumbling block to scientific progress in psychology, and the social sciences in general.

3. Uses a common metric to aggregate effect sizes across studies. Therefore, meta-analysis summarizes IV/DV effects across multiple studies to reach a population-level overall conclusion about specified effects.

4. Ability to summarize large volumes of literature.

5. Can be used to resolve conflicts between two or more bodies of literature by comparing effect sizes across them.

6. Ability to investigate relationships not investigated in original primary studies.

7. Investigate and find trends too subtle to identify with narrative reviews.

8. More standardized and relatively more objective.

Disadvantages of meta-analysis

1. Garbage in-garbage out.

2. Apples and oranges comparisons.

3. Number of primary studies available.

4. Selection of primary studies for inclusion.

5. File drawer problem.

6. Judgement calls.

NOTE. The following is just for your information. You are **NOT** expected to know this sequence of steps for the purposes of the exams.

Typical sequence of steps involved in implementing a meta–analysis

1. Topic selection—defining the research domain
2. Specifying the inclusion criteria
3. Searching for and locating relevant studies
4. Selecting the final set of studies
5. Extracting data and coding study characteristics
6. Deciding to keep separate or aggregate multiple data points (correlations or effect sizes) from the same article—independence and nonindependence of data points
7. Testing for and detecting outliers
8. Data analysis—calculating mean effect sizes, variability, and correcting for artifacts
9. Deciding to search for moderators
10. Selecting and testing for potential moderators
11. Interpreting results and making conclusions