Meta-Analysis

A statistical method for cumulating studies

Why is Meta-Analysis Better Than Traditional Reviews?

Correlation Between Intelligence and Job Performance

Study	N	Validity	p
Sparks & Lewis (2007)	23	.26	NS
Hicks & McPhee (2006)	20	.28	NS
Underwood & Bice (2005)	30	.25	NS
Barrino & DeGarmo (2004)	25	.30	NS
Studdard & Aiken (2003)	40	.27	NS
Clarkson & Guarini (2002)	28	.29	NS

Correlation Between Intelligence and Job Performance

Study	N	Validity	p
Carson & Severinson (1967)	430	.28	.001
Letterman & Shaffer (1985)	30	.05	NS
Leno & Eubanks (1995)	225	.30	.001
O'Brien & Weinberg (1992)	40	.07	NS

Meta-Analysis Steps

- Obtain relevant studies
- Convert test statistics into effect sizes
- Compute mean effect size
- Correct effect sizes for sources of error
- Determine if effect size is significant
- Determine if effect can be generalized or if there are moderators

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Finding Studies

- Establish time frame for studies
- Sources
  - Journals
  - Dissertations
  - Theses
  - Technical reports
 - Conference presentations
  - File cabinet data

Finding Studies
Methods

- Search Engines
  - Infotrac
  - PsychInfo
  - Lexis-Nexis
  - Factiva
  - World Cat
  - Google Scholar
- Internet
- Bibliographies from studies
- Phone calls
- List serve calls for help

Finding Studies
Deciding Which Studies to Use

- Must be empirical
- Must have the appropriate statistic to convert to an 'r' or a 'd'
- Must have complete set of information
- Must be accurate
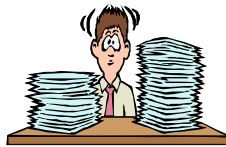
Converting Test Statistics into Effect Sizes

- Two common effect sizes
  - Correlation (r)
  - Difference (d)
- Conversion Types
  - Directly using means
    $$(M_{exp} - M_{control}) \div SD_{overall}$$
  - Formulas to convert t, F, X^2, r, and d

Study	Training	No Training	SD	D
Cruise (1993)	6.3	4.1	2.2	1.0
Reeves (1994)	5.1	4.8	1.4	.21
Gibson (1993)	8.2	6.3	3.5	.54
Pitt (2003)	7.3	7.1	1.5	.13
Washington (1994)	6.9	7.4	2.9	-.17

Let's Practice!

Study	Therapy	No Therapy	SD	D
Connery (1962)	7.0	4.9	3.2	
Lazenby (1969)	5.8	5.7	1.9	
Moore (1973)	4.1	4.1	3.5	
Dalton (1987)	6.7	6.9	1.5	
Brosnan (1995)	3.1	3.8	2.6	
Craig (2006)	4.7	4.6	1.0	

Statistic to Be Converted	Formula for Transformation to r
t	$r = \sqrt{\dfrac{t^2}{t^2 + df}}$
F	$r = \sqrt{\dfrac{F}{F + df\,(\text{error})}}$
χ^2	$r = \sqrt{\dfrac{\chi^2}{n}}$
d	$r = \dfrac{d}{\sqrt{d^2 + 4}}$
z	$r = \sqrt{\dfrac{z^2}{N}}$

Statistic to Be Converted	Formula for Transformation to d
t	$d = \dfrac{2t}{\sqrt{df}}$
F	$d = \dfrac{2\sqrt{F}}{\sqrt{df\,(\text{error})}}$
r	$d = \dfrac{2r}{\sqrt{1 - r^2}}$

Statistic to Be Converted	Formula for Transformation to r
t	$r = \sqrt{\dfrac{t^2}{t^2 + df}}$
F	$r = \sqrt{\dfrac{F}{F + df\,(\text{error})}}$
χ^2	$r = \sqrt{\dfrac{\chi^2}{n}}$
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Statistic to Be Converted	Formula for Transformation to d
t	$d = \dfrac{2t}{\sqrt{df}}$
F	$d = \dfrac{2\sqrt{F}}{\sqrt{df\,(\text{error})}}$
r	$d = \dfrac{2r}{\sqrt{1 - r^2}}$

Let's Practice!

Statistic	r	d
$t(98) = 2.63$		
$F(1,65) = 3.45$		
X^2 (n=90) = 8.78		
r=.30		

Cumulating Effect Sizes

Study	Correlation	N	N*r
Bullock (1999)	.10	43	4.30
Peiffer (1998)	.33	206	67.98
Ryan (1998)	.42	320	134.40
Lopez (2000)	.63	24	15.12
Hunt (1995)	.35	189	66.15
Total	**.37**	**782**	**287.95**

Let's Practice!

Study	Correlation	N	N*r
Holyfield (1999)	.18	150	
Getty (1998)	.25	90	
Van Gough (1998)	.30	200	
Friend (2000)	.09	50	
Roman (1987)	.15	100	
Countryman	.27	250	
Total			

Correcting Correlations for Common Sources of Error

- Test unreliability
- Criterion unreliability
- Restriction of range

$$r_{xx,\,yy} = \frac{r_{xy}}{\sqrt{r_{xx}}\,\sqrt{r_{yy}}}$$

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$$r_{xx,\,yy} = \frac{.30}{\sqrt{.90}\,\sqrt{.50}}$$

Validity = .30
Test reliability = .90
Criterion reliability = .50

$$r_{xx,\,yy} = \frac{.30}{(.95)(.71)}$$

$$r_{xx,\,yy} = .447$$

Let's Practice!

- Example 1
  - Validity = .10
  - Test reliability = .75
  - Criterion reliability = .80

- Example 2
  - Validity = .20
  - Test reliability = .95
  - Criterion reliability = .90

$$r_{xx, yy} = \frac{r_{xy}}{\sqrt{r_{xx}}\sqrt{r_{yy}}}$$ **Example 1**

> Validity = .10
> Test reliability = .75
> Criterion reliability = .80

$$r_{xx, yy} = \frac{.10}{\sqrt{.75}\sqrt{.80}}$$

$$r_{xx, yy} = \frac{.10}{(.87)(.89)}$$

$$r_{xx, yy} = .129$$

$$r_{xx, yy} = \frac{r_{xy}}{\sqrt{r_{xx}}\sqrt{r_{yy}}}$$ **Example 2**

> Validity = .20
> Test reliability = .95
> Criterion reliability = .90

$$r_{xx, yy} = \frac{.20}{\sqrt{.95}\sqrt{.90}}$$

$$r_{xx, yy} = \frac{.20}{(.97)(.95)}$$

$$r_{xx, yy} = .217$$

Interpreting Meta-Analysis Results

Scope of the Meta-Analysis

- Number of Studies
  - Number of studies
  - Number of actual data points (k)
  - Allowing more than one data point per study
- Sample size
  - Number of participants (n)

The Effect Size

- Correlations
  - Observed mean correlation (r)
    - Weighted by sample size
    - Unweighted
  - Corrected correlation - rho (ρ)
    - Criterion reliability
    - Predictor reliability
    - Range restriction
- Difference scores
  - d
  - Z

Statistical Significance

- Confidence Intervals
  - Uncorrected correlation
  - Calculated using standard error
  - Significant if interval does not contain zero
  - Common intervals are 95%, 90%, and 80%
- Credibility Intervals
  - Corrected correlation
  - Calculated using standard deviation

Can We Generalize Results?

- Size of confidence and credibility interval
- 75% sampling error rule
- Statistical tests (all use chi-square distributions)
  - Chi-square (X^2)
  - Homogeneity Test (H_T)
  - Q_W

Interpreting Meta-Analysis Results

Police Education				95% Conf Int			90% Cred Int			
Criteria	K	N	r	L	U	ρ	L	U	SE %	Q_w
Academy Grades	32	6,153	.26	.24	.29	.38	.38	.38	100	19.78
Commendations	24	6,737	-.03	-.11	.04	-.04	-.30	.21	21	111.3*
Supervisor Ratings	54	9,120	.17	.12	.21	.28	.16	.40	80	67.52

Interpreting Meta-Analysis Results

Cognitive Ability				95% Conf Int			90% Cred Int			
Criteria	K	N	r	L	U	ρ	L	U	SE %	Q_w
Academy Grades	61	14,437	.41	.33	.48	.62	.47	.78	78	77.82
Absenteeism	5	1,402	-.03	-.08	.02	-.05	-.05	-.05	100	2.11
Discipline	13	4,854	-.06	-.12	.00	-.11	-.36	.18	26%	49.9*

Roth, BeVier, Switzer, & Shippmann (1996)

GPA & Work Performance	K	N	r	ρ	80% L	80% U	SE%
Overall	71	13,984	.16	.35	.30	.41	54%
Education Level							
Bachelor's	49	9,458	.16	.36	.30	.42	66%
Master's	4	446	.23	.50	.31	.56	100%
Doctorate	6	1,755	.07	.15	.08	.25	100%

Roth, BeVier, Switzer, & Shippmann (1996)

GPA & Work Performance	K	N	r	$r_{rxx,yy,rr}$	80% L	80% U	SE%
Overall	71	13,984	.16	.35	.30	.41	54%
Years since graduation							
1 year	13	1,288	.23	.49	.40	.62	89%
2-5 years	11	1,562	.15	.33	.23	.48	80%
6+ years	4	866	.05	.12	.00	.41	59%

Stem and Leaf Diagrams

Stem	Leaf
.0	7
.1	479
.2	00111145588999
.3	001245589999
.4	9
.5	
.6	0

.07	.29
.14	.29
.17	.29
.19	.30
.20	.30
.20	.31
.21	.32
.21	.34
.21	.35
.21	.35
.24	.38
.25	.39
.25	.39
.28	.39
.28	.39
	.49
	.60

Let's Practice!

Stem	Leaf
.0	
.1	
.2	
.3	
.4	
.5	
.6	

.00	.16
.00	.17
.01	.17
.04	.17
.05	.19
.05	.20
.06	.22
.08	.23
.09	.24
.09	.27
.09	.28
.11	.29
.11	.30
.11	.33
.12	.34
.13	.41
.15	.42

Meta-Analyzer Exercise
Validity of Cognitive Ability

Study	N	Correlation	Study Decade
Bishop	18	0.88	1950s
Davis	25	0.64	1950s
Estevez	62	0.20	1980s
Hall	68	0.00	1980s
Lawford	23	0.61	1950s
Lowe	64	0.27	1980s
Martin	17	0.78	1950s
McCarthy	62	0.36	1980s
Moore	62	0.18	1980s
Nelson	59	0.00	1980s
Ringwald	68	0.31	1980s
Sheedy	62	0.20	1980s
Sinatra	15	0.82	1950s