Effect sizes and measurement-comparability for meta-analysis of single-case research

James E. Pustejovsky

Northwestern University
(but soon to be at University of Texas at Austin)

pusto@u.northwestern.edu

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Meta-analysis of single-case research

- Summarizing results from multiple cases in a study
- Summarizing results from multiple studies
- Comparing results across variations in intervention, participant characteristics
- Means for identifying evidence-based practices/programs
- Improving external validity

MANY proposed effect size metrics

- Non-overlap metrics
  - Percentage of non-overlapping data (Scruggs, Mastropieri, & Castro, 1987)
  - Percentage of all non-overlapping data (Parker, Hagan-Burke, & Vannest, 2007)
  - Percentage exceeding median (Ma, 2006)
  - Non-overlap of all pairs (Parker & Vannest, 2009)
  - Improvement rate difference (Parker, Vannest, & Brown, 2009)
  - Tau-U (Parker, Vannest, Davis, & Sauber, 2011)

- Parametric effect sizes
  - Standardized mean difference (Busk & Serlin, 1992)
  - R-squared metrics (Center, Skiba & Casey, 1985; Allison & Gorman, 1993; Faith, Allison, Franklin, & Gorman, 1996; Beretvas & Chung, 2008)

- Hierarchical linear models
  - Van den Noortgate & Onghena (2003a, 2003b, 2007, 2008)
  - Hedges, Pustejovsky, & Shadish (2012)
  - Shadish, Kyse, & Rindskopf (2013)

Effect size desiderata

1. Should measure magnitude of treatment effect/ functional relation
   - Should not depend strongly on other procedural details of the study

2. Should include some measure of precision/uncertainty
   - Standard error
   - Confidence interval

3. Should be comparable across different methods of measuring the same construct

Shogren, et al. (2004)

The effect of choice-making as an intervention for problem behavior

- 13 single-case studies
- 32 unique cases

Measurement procedure	# Cases
Event counting	3
Continuous recording	5
Momentary time sampling	1
Interval recording	19
Other	4

Measures of percentage change

- Mean baseline reduction (Campbell, 2004; Campbell & Herzinger, 2010)
- Suppression index (Hershberger, et al., 1999; Marquis et al., 2000)

$$MBR = \left(\frac{\bar{y}_B}{\bar{y}_A} - 1 \right) \times 100\%$$

where

- $\bar{y}_A$ is the mean outcome in phase A (baseline)
- $\bar{y}_B$ is the mean outcome in phase B (treatment)

Log-Response Ratios

- Hedges, Gurevitch, & Curtis (1999)
- Natural-log scale used due to better statistical properties

$$lRR = \ln\left(\frac{\bar{y}^{B}}{\bar{y}^{A}}\right)$$

- Can be transformed into *MBR*/percentage change measure

$$MBR = \left[\exp\left(lRR\right) - 1\right] \times 100\%$$

Log-Response Ratios (continued)

- Standard error (SE)

$$\mathrm{SE}\left(lRR\right) \approx \sqrt{\frac{s_A^2}{n_A \bar{y}_A^2} + \frac{s_B^2}{n_B \bar{y}_B^2}}$$

where

- s_A^2 is the sample variance in phase A
- n_A is the number of measurements in phase A
- s_B^2 is the sample variance in phase B
- n_B is the number of measurements in phase B

Approximate 95% confidence intervals

- For the log-response ratio:

$$Lower = lRR - 2 \times \mathrm{SE}\left(lRR\right)$$

$$Upper = lRR + 2 \times \mathrm{SE}\left(lRR\right)$$

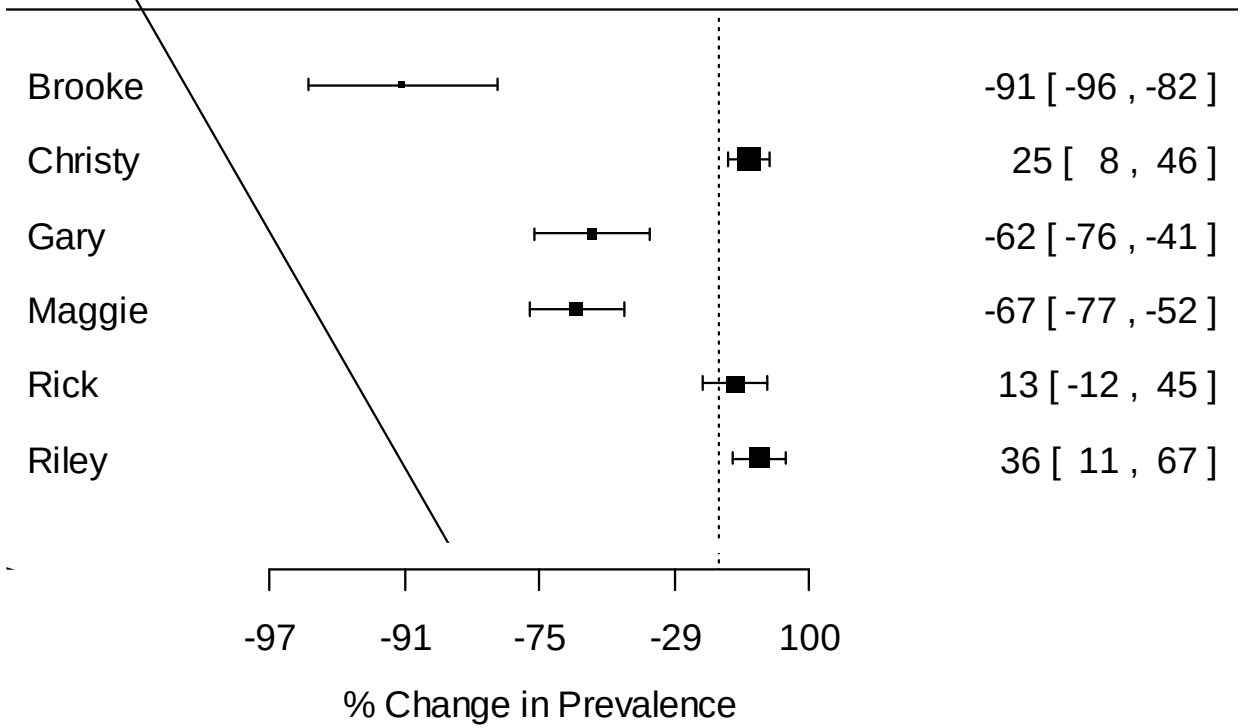
- For *MBR*/percentage change:

$$Lower = \left[\exp\left(lRR - 2 \times \mathrm{SE}\left(lRR\right)\right) - 1\right] \times 100\%$$

$$Upper = \left[\exp\left(lRR + 2 \times \mathrm{SE}\left(lRR\right)\right) - 1\right] \times 100\%$$

Romaniuk, et al. (2002)

The influence of activity choice on problem behaviors maintained by escape versus attention.[1]



1. *JABA*, *35*(4).

Measurement comparability

- When the average length (duration) of behavior does not change between phases, the response ratio based on frequency counting is equivalent to the response ratio based on continuous recording/MTS.

- For interval recording methods, further assumptions about average duration of behavior are needed in order to make direct comparisons to frequency counting or continuous recording data.

Handling interval recording data

- Scenario 1
  - average event durations are greater than some known value
- Scenario 2
  - most inter-event times are larger than the interval length
  - the average event durations are short
- Scenario 3
  - average event duration is unaffected by the treatment
  - inter-event times are exponentially distributed

Key Take-Aways

- For outcomes that are based on direct observation of behavior, consider using the log-response ratio.
- Use log-scale for calculating standard errors and for meta-analysis.
- Transform into percentage change (MBR) for easy interpretation.
- Pay careful attention to how outcomes are measured.

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