Quantifying Intervention Effectiveness in Single-Case Research Designs

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Outline

• Visual analysis of results
• Overview of effect sizes developed for ABA
• Non-overlap of all pairs (NAP)
• Example exercise
• Applications in ABA studies
• Appendix: Parametric effect sizes
Figure adapted from Pierce & Cheney (2004)
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Shortcomings of Visual Analysis

• Subjective/unreliable
• Useful only in immediate context
  – Cannot directly compare efficacy across similar published studies
  – Cannot conduct meta-analysis
• Increasingly does not meet evidence-based grant requirements (e.g., Whitehurst, 2004; for a review, see Parker et al., 2011)
Effect Size Quantifies Visual Analysis

• The question is: How large of a change is there across two conditions of interest?
• Applies to reversal and multiple baseline designs
• For any effect size: compare two sets of datapoints (e.g., baseline and post-intervention)
Percent of Non-Overlapping Data

Figure adapted from Parker & Vannest (2009)
Percent of Non-Overlapping Data
Percent of Non-Overlapping Data

N = 10

PND Method
Percent of Non-Overlapping Data

- All relatively large effects are “the same”
- Any variability can be due to outlying observations in baseline

- Difficult to distinguish between published studies
  - Scientific progress impeded
  - Client behavior may not improve
Percent Exceeding Median
Percent Exceeding Median

- Improvement over PND
- But, medium to large effects are all “the same”

- Difficult to distinguish between published studies
  - Scientific progress impeded
  - Client behavior may not improve
Non-Overlap of All Pairs
Non-Overlap of All Pairs

• NAP = number of comparison pairs showing no overlap, divided by total number of comparisons
• In other words, percent of non-overlapping data between baseline and treatment phases

• Major theoretical advantage: A comprehensive test of all possible sources of data overlap (all baseline versus all treatment datapoint comparisons)
• Major numerical advantage: Interpretability
  – Value of 1 indicates perfect improvement
  – Value of 0.5 indicates no change
  – Value of 0 indicates perfect reduction
### Calculating NAP

1. For each Phase A (baseline) datapoint:
   - add 1 for each Phase B (intervention) datapoint that exceeds it
   - Add 0.5 for each Phase B datapoint that ties
   - Add 0 for each Phase B datapoint that is less than it

2. Add up all values for all Phase A datapoints from step 1
   - In this example, there are $10 \times 11 = 110$ values

3. Divide sum from step 2 by total number of comparisons
   - In this example, there are $10 \times 11 = 110$ values

<table>
<thead>
<tr>
<th>Phase A (n = 10)</th>
<th>Phase B (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
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<tr>
<td>3</td>
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106/110 = 0.96 = 96% of intervention data do not overlap with baseline data
Multiple Definitions of “Change”

• Change *compared to what?*
  – A1 → B1 → A2 → B2
    • Can compare A1 to B1, A2, or B2
    • Can compare B1 to B2
    • Etc.
  – It all depends on what comparison(s) is(are) logically relevant in terms of the hypothesis

• Change in which direction?
  – Sometimes “non-overlap” in one direction indicates improvement, other times reduction
  – If goal is to increase rate of a behavior, higher scores in Phase B indicate non-overlap (and vice versa)
Multiple Baseline Applications

• Across subjects
  – Examine degree of similarity of % NAP across subjects
  – That is, is there a consistent effect across subjects?

• Across stimulus conditions
  – Examine degree of similarity of % NAP across contexts
  – Examine whether change generalizes to other contexts.
    That is, is there any change in other contexts at the time of
    introducing intervention for target context?

• Across behaviors
  – Examine degree of similarity of % NAP across behaviors
  – Examine whether change generalizes to other behaviors
Cohen’s $d$ and Hedges’s $g$

Cohen’s $d$ for equal number of observations in both phases:

$$d = \frac{M_E - M_C}{\text{Sample SD pooled}} \times \left( \frac{N - 3}{N - 2.25} \right) \times \sqrt{\frac{N - 2}{N}}$$

Sample SD pooled = $\sqrt{\frac{[(SD_E)^2 + (SD_C)^2]}{2}}$

Hedges’s $g$ for unequal number of observations across phases:

$$g = \frac{M_E - M_C}{SD \text{ pooled}} \times \left( \frac{N - 3}{N - 2.25} \right) \times \sqrt{\frac{N - 2}{N}}$$

SD pooled = $\sqrt{\frac{[(SD_E)^2(n_E - 1)] + [(SD_C)^2(n_C - 1)]}{n_E + n_C - 2}}$

Durlak (2009)
References


Thank You!
Questions?

Presentation available on NCADE YouTube channel
• On YouTube, search for “NCADE”
• Should be the first link, titled “NCADE The Chicago School of Professional Psychology”

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