Single Case Research Designs

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Today’s Agenda

• Introductions
• What are SCDs?
  – Rationale for use and the types of research questions we can answer
• Salient features of SCD
  – Quality standards
• Visual analysis of Graphs
  – Examples
• Overview of different types of SCDs
  – Multiple probe, reversal designs, alternating treatment
What are Single-Case Designs

- Derived from the field of behavior analysis (Baer et al., 1968)
- Used to study human behavior
  - Predominately within education and related fields, but that is changing
- Individuals are the unit of analysis
  - All variables are consistent except the independent variable (e.g., instructional strategy)
  - Experimental control demonstrated by changes in behavior
- Main goal: demonstrate causal relation between introduction of a manipulated independent variable (i.e., intervention) that causes a change in the dependent variable (i.e., outcome)
  - Called a functional relation

Why use SCD?

- Used in applied and clinical settings
- Small sample size
  - Low incidence disorders/behaviors
- Unable to have cross matched groups
- Useful when withholding treatment would be unethical
- Methodologies demonstrate high levels of experimental control
Questions that SCD Answer

• Is there a causal relationship between introduction of IV on DV?
• Is the intervention effective?
• Are there other interventions that are more effective?
• Are there parts of an intervention package that are more or less effective?
• Do outcomes of intervention maintain over time or generalize across different settings, people or materials?

The Importance of Generalization

• Generalization is the phase of learning where a person can apply the newly learned skill in different settings, situations, and materials
  – Within education, we can’t say a person “learned” something if they cannot generalize
  – Example: driving a car

• Because of the small sample size, studies must address generalization or else “so what”
  – Established through generalization probes across conditions
  – Indicated by different types of data points (e.g., circles, triangles)
Salient features of SCD

- Participants
  - The individual “case” or cluster of “cases”
  - Unit of intervention and data analysis
- Baseline
  - At least 5 data points within each phase
- Intervention
  - Staggered across different points in time
  - Manipulated across different phases
- Data Analysis - visual analysis on graph
  - Trends - increasing or decreasing slope
  - Level - mean for data within a phase
  - Variability - how much the data fluctuates

Level

- Level represents the mean of all data points (y-axis values) in that phase
- Often a change in level and/or trend indicate the robust change in behavior you expect to see following introduction of intervention
  - Called immediacy of effect

(Cooper et al., 2020)
Trend

- Dotted line represents the “trend line”
- A & B have no slope or trend  
  - Need to collect more data
- C & D both show increasing trends
- E & F both show decreasing trends
- What does G show?
- What does H show?

Variability

- Standard rule: The less data points fluctuate, the better
- If data are variable, it indicates the need to collect more data
- A & B shows low variability
- C shows some variability but also steady trends at the beginning and end of data path
- D shows a steady trend, but high levels of variability

(Cooper et al., 2020)
Understanding Visual Analysis

Phase line separating Baseline and Intervention

Data points do not connect across phase lines

What is the trend of the CAI Intervention data?

Prediction, Verification, Replication

- How SCDs control for threats to internal validity
  - Prediction- anticipated outcome
  - Verification- impact on data when intervention is removed or added
  - Replication- repeated effect of intervention
    - Requires three consistent demonstrations of effect and/or at three different points in time
    - Trends in data points (increase or decreasing; changes in level for data path)
Prediction, Verification, and Replication on the Graph

Look Fors:
- Stable or decreasing trend prior to intervention
- Baseline data on other tiers remains unchanged when Penny enters intervention (same for Sheldon as Leonard enters)
- Leonard enters once Penny shows change in level; Sheldon enters once Leonard shows same change

SCD Standards

1. Are there predictable baseline patterns?
   - Steady trends? High variability?
2. Are there at least 5 data points within each phase?
   - Is there a series prior to introduction to intervention?
3. Are there patterns within phases?
   - Trend, level, variability
   - Prediction, verification, replication
4. Was there an immediacy of effect when comparing adjacent phases?
   - If so, was that change (e.g., level and trend) predicted?
5. Are there at least three demonstrations of effect at different points in time?

Kratochwill, et al. 2010
Let’s analyze....

![Graph showing data analysis for different participants over sessions.](image)

Let’s analyze....

![Graph showing data analysis for different participants over sessions.](image)
DIFFERENT SCR DESIGNS

• There are various different types of designs and variations of those designs, but three are most common
  – Multiple baseline/probe designs
  – Reversal designs
  – Alternating treatment designs

Remember, the goal of the presentation is to walk away knowing if SCD can answer your research question(s)......
Multiple Baseline/Probe Designs

- Multiple baseline - collect probe data every session
- Multiple baseline - collect probe data every X session
  - Most common design
- Good for behaviors that cannot be unlearned
  - Instructional interventions (e.g., learning to read)
- Multiple probe is most beneficial to limit potential for memorization
  - Students on the spectrum
- Potential replication across different skills or across different participants or both
- Allows for component analysis
  - Comparison across different phases

Multiple Probe Graph

- No less than 3 tiers on the graph
- Functional relation is demonstrated by level and trend
- Introduction of intervention is staggered in time
- At least 2 phases, potential more
- Look for generalization probes across all phases
Multiple Probe Example

Smith et al., 2012

Is CAI effective for teaching science vocabulary

What do you see?
- Trend, Level, Variability
- Prediction, Verification, Replication

Is there a functional relation?

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Multiple Probe Example (component analysis)

Smith et al. (2013)

Same intervention with video added to the CAI intervention

What do you see?
- Trend, Level, Variability
- Prediction, Verification, Replication

Is there a functional relation?
Reversal Designs

• Strongest design to demonstrate “experimental control”
  – Only 1 IV
• Can only use for a behavior that can be unlearned or where the intervention can truly be removed
  – Shouldn’t be used when withdrawing the intervention is problematic
• Particularly useful for interventions focused on addressing challenging behavior
  – The use of check in/check out intervention to decrease noncompliance

Reversal Graph

• Functional Relation is demonstrated by separation in level and trend between phases
• Graphs only have 1 tier, but many phases
• Generalization happens across settings and people
Reversal Example

Donaldson & Vollmer (2011)

Comparing fixed-duration timeout and Release contingency timeout

What do you see?
Trend, Level, Variability Prediction, Verification, Replication

Is there a functional relation?

Alternating Treatment Designs

- Used when you want to compare different treatments
  - Multiple Ivs
  - Must randomize implementation of IVs
- Can be used when doing nothing or withdrawing the intervention is unethical
  - Different types of aggression
Alternating Treatment Graphs

- Graphs may have one tier, but multiple data paths within phases
- Graphs may have multiple tiers, with two phases
- Functional relation is demonstrated by slope, trend, and separation between the IV data paths

Alternating Treatment Example

Hua et al., 2020
Comparing randomized read-ask-paraphrase (RAP) and RAP with vocab instruction

What do you see?
Trend, Level, Variability
Prediction, Verification, Replication

Is there a functional relation?
References


• What Works Clearinghouse
  – Single-Case Design Technical Documentation