Chapter 6: Constructing and Interpreting Graphic Displays of Behavioral Data
Chapter Focus Questions

• What are the benefits of graphic display and visual analysis of behavioral data?
• What are the fundamental properties of behavior change over time?
• What are the different visual formats for the graphic display of behavioral data? What are the relative strengths and limitations of each visual format?
• What are the basic parts of a properly constructed line graph?
• What is the purpose of visual analysis?
• How is a visual analysis of behavioral data conducted?
Direct and Repeated Measurement of Behavior

• Data
  – Medium with which the behavior analyst works
  – Results of measurement
  – Empirical basis for decision making
  – Plural
    • These data are
Direct and Repeated Measurement of Behavior

- Consecutive measures, over time
- Data series vs. graphic display

<table>
<thead>
<tr>
<th>Number Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition A</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>13</td>
</tr>
</tbody>
</table>

Percentage of correct responses
70, 72, 71, 87, 90, 85, 73
Graphic Display

Condition A

Condition B

Number correct

Sessions
Purpose & Benefits of Graphic Display

• Graphic displays
  – Primary function communication
  – Display relationships between dependent variable and independent variable
  – Summarization of data collected
  – Facilitates of accurate analyses
Purpose & Benefits of Graphic Display

• Benefits
  – Immediate access to record of behavior
  – Variations prompt exploration
  – Provides judgmental aid
    • Relatively easy to learn, no predetermined level for determining significance of change, no mathematical properties required
  – Conservative method
  – Encourages independent judgment & interpretation
  – Effective source of feedback
Fundamental Properties of Behavior Change

- Level
- Trend
- Variability
Types of Graphs Utilized in ABA

- Line graph
- Bar graphs
- Cumulative record
- Semilogarithmic charts
  - Standard Celeration Chart
- Scatterplots
Types of Graphs Utilized in ABA Line Graph

- Based on the Cartesian plane
  - Two-dimensional area formed by intersecting lines
  - Points on the plane represent relationships
    - Level of the dependent variable when the independent variable was in effect
  - Comparisons of data points reveals the presence or absence of changes in level, trend, and/or variability
Parts of a Line Graph

• Horizontal axis
• Vertical axis
• Condition change lines
• Condition labels
  – Phase and condition
• Data points
• Data path
• Figure Caption
Figure 5. Rates of hits during baseline and the blocking condition for Arlo.

- **Horizontal Axis (x-axis)**: Sessions
- **Vertical Axis (y-axis)**: Hits per minute
- **Condition Change Lines**
- **Data Path**
- **Data Points**
- **Condition Labels**
- **Figure Legend**

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Line Graph Variations

• Two or more dimensions of the same behavior
• Two or more different behaviors
• Measure of the same behavior under different conditions
• Changing values of the independent variable
• Same behavior of two or more participants
Types of Graphs Utilized in ABA

Bar Graph

- Based on the Cartesian plane
  - No distinct data points representing successive response measures through time
- Functions
  - Displaying and comparing discrete sets of data that ARE NOT related by a common underlying dimension by which the horizontal axis can be scaled (Example)
  - Visual summary of participant or group performance during different experimental conditions
- Provides efficient summary of data
  - DOES NOT allow for analysis of variability & trends in behavior
Sample Bar Graph

Baseline

Generalization/Maintenance

% Completion

% Accuracy

Percent Completion/Accuracy

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Types of Graphs Utilized in ABA
Cumulative Record

• Developed by Skinner
  – Primary means of data collection in EAB
  – Cumulative recorder
    • Experimental subject draws its own graph
  – Shows the number of responses on the ordinate against time on the abscissa
Types of Graphs Utilized in ABA
Cumulative Record

• Number of responses recorded and added to the total number of responses recorded during previous observations
  – Cumulative

• Y-Axis (vertical axis)
  – Represents the total number of responses recorded since the start of data collection
Types of Graphs Utilized in ABA
Cumulative Record

• Display
  – Total number of responses at any given point in time

• Relative rates of response
  – The steeper the slope, the higher the response rate
    • Overall response rate
    • Local response rate
Types of Graphs Utilized in ABA

Cumulative Record

- The steeper the slope, the higher the response rate

Cumulative Number Correct

Sessions
Types of Graphs Utilized in ABA Cumulative Record

• When to use cumulative graph over noncumulative graph
  – Progress toward a specific goal can be measured in *cumulative units*
    • *E.g.*, *Number of new words learned, quarters saved*
  – Graph is used as personal feedback
    • Total progress and relative rate of performance easily detected
  – Target behavior can only occur once per observation period
    • Yes/No
  – Intricate details between behavior & environmental variables are of interest
    • *E.g.*, *Within session analyses*
Equal-interval Graphs

- Distance between any two consecutive points on each axis is always the same
  - Increase/decrease in performance expressed by equal distances on the y-axis
  - Distance between sessions, days, etc. expressed by equal distance on the x-axis
Types of Graphs Utilized in ABA Semilogarithmic Charts

• Ratio or multiply-divide charts
  – One axis is scaled proportionally
  – Double response rate 4 to 8 same as 50 to 100

• All behavior changes of equal proportion are shown by equal vertical distances on the vertical axis
Types of Graphs Utilized in ABA

Standard Celeration Chart

- Developed by Ogden Lindsley
- Standardized method for
  - Charting & analyzing how frequency of behavior changes over time
Types of Graphs Utilized in ABA
Standard Celeration Chart


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Types of Graphs Utilized in ABA Standard Celeration Chart

• Four standard charts
  – Difference in scaling on horizontal axis
    • Daily chart (140 calendar days)
    • Weekly chart
    • Monthly chart
    • Yearly chart

• What’s standard about the standard celeration chart?
  – Consistent display of *celeration*
Types of Graphs Utilized in ABA
Standard Celeration Chart

• Celeration
  – Linear measure of frequency change across time
  – A factor by which frequency multiples or divides per unit of time
    • Acceleration – accelerating performance
    • Deceleration – decelerating performance

• Standard chart
  – Six, X 10 cycles (vertical axis)
    • 1 per 24 hrs
    • 1,000 per minute
  – Bottom left to top right corner
    • Slope of 34° - celeration value X2
Standard Celeration Chart & Precision Teaching

• Precision Teaching
  – Instructional decision-making system
  – Developed for use with standard celeration chart

• Position
  – Learning best measured as a change in response rate
  – Learning most often occurs through proportional changes in behavior
  – Past changes can predict future learning

• Chart uses estimations for most frequency values
Types of Graphs Utilized in ABA Scatterplot

• Shows relative distribution of individual measures in a data set
• Data points are unconnected
• Depicts changes in value on one axis correlated with changes in value on the other axis
• Patterns suggest certain relationships
  – Sometimes used to discover the temporal distribution of the target behavior
Types of Graphs Utilized in ABA Scatterplot

Constructing Line Graphs

• An effective graph presents data
  – Accurately
  – Completely
  – Clearly
  – Makes visual analysis as easy as possible
  – Does not create distortion or bias interpretation
Constructing Line Graphs
Drawing, scaling, & labeling axes

- Use a balanced ratio between the height and width of the axes
- Relative length of the vertical axis to horizontal axis
  - Suggestions
    - 5:8; 3:4; 1:1.6 ratio y-axis to x-axis
- Horizontal axis
  - Mark equal intervals
  - Left to right chronological succession of equal time periods or response opportunities
  - Use regularly spaced *tic marks*
Constructing Line Graphs
Drawing, scaling, & labeling axes

• Use a scale break to represent discontinuities in the progression of time

Regularly spaced tic marks
Constructing Line Graphs

Drawing, scaling, & labeling axes

• Scaling of vertical axis
  – Most significant feature of the graph
  – Mark the origin at zero
  – Mark the full range of values represented in the data set

**Good Practice**: Plot the data set against several different vertical axis scales – watch for distortion that may lead to inaccurate interpretations

  – If relatively small changes in performance are socially significant
    • Y-Axis should reflect a smaller range of values
Constructing Line Graphs
Labeling vertical axis

- Brief label, printed, centered to the left and parallel to the vertical axis
Constructing Line Graphs

Condition Change Lines

- Vertical lines
- Extend upward
- Indicate change in treatment or experimental condition
- Solid or dashed lines
  - Major changes – solid
  - Minor changes – dashed
  - Asterisks (*), arrows (→) or other symbols to indicate small changes
Constructing Line Graphs

Condition Change Labels

- Identify conditions in effect during each period of the experiment
- Centered above & between condition change lines
- Brief, but descriptive labels

Baseline  Blocking

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Constructing Line Graphs
Data Points & Data Paths

• Place each data point in the exact coordinate of the horizontal and vertical axis
  – If graphing by hand - use a graph paper with appropriately spaced grid lines
• Use bold, easily discernable symbols
  – Use a different symbol for each set of data
Constructing Line Graphs
Data Points & Data Paths

• Draw data paths using a straight line
  – The center of each data point in a given data set to the center of the next data point in the same set
Constructing Line Graphs

Data Points & Data Paths

• **DO NOT CONNECT DATA POINTS IF**…
  
  – Points fall on either side of a condition change line
  – A significant span of time passed and behavior was not measured
  – There was a discontinuity in time in the horizontal axis (e.g., school vacation)
    • Data were not collected, lost, etc.
  – It is follow-up or post-check data
    • Unless intersession time span same as original experiment
  – Data points fall beyond the values described by the vertical axis
Constructing Line Graphs
Data Points & Data Paths

• Use different styles of lines for multiple data paths on the same graph

• Clearly identify what each data path represents
  – Use arrows or a legend
Constructing Line Graphs
Figure Caption & Printing

• Figure caption
  – Printed below the graph
  – Concise, complete description of figure
    • Direct viewers attention to features of the graph that may be overlooked
      – E.g., scale changes
    • Describe the meaning of any added symbols
  
• Print graphs in one color - black
Constructing Graphs – Using Computer Software

• Use with caution
  – Check the range of scales available
  – Check the accuracy of data point plotting
  – Check the precision of data paths

• Further information
  – Carr & Burkholder (1998)
    • www.prenhall.com/cooper
Interpreting Graphically Displayed Behavioral Data

• Visual analysis
  – Did behavior change in a meaningful way?
    • If so, to what extent can that change in behavior be attributed to the independent variable?
  – Identification of
    • Variability
    • Level
    • Trend
Interpreting Graphically Displayed Behavioral Data

“It is impossible to interpret graphic data without being influenced by various characteristics of the graph itself.”

– Johnson & Pennypacker, 1993b, p. 320
Interpreting Graphically Displayed Behavioral Data

• Read the graph
  – Figure caption
  – Condition & axis labels
  – Location of numerical value & relative significance of scale breaks

• Visually track each data path
  – Are data paths properly connected?
  – Is the graph distorted?
Interpreting Graphically Displayed Behavioral Data

• Visual analysis
  – Within conditions
    • Number of data points
    • Nature & extent of variability in the data
    • Absolute & relative level of the behavioral measure
    • Direction & degree of any trends in the data
Interpreting Graphically Displayed Behavioral Data

• **Visual analysis**
  – Between conditions
    • Level
      – Mean or median level lines
    • Trend
    • Stability/Variability
      – Across similar conditions
Interpreting Graphically Displayed Behavioral Data

• Level
  – Value on the vertical axis around which a series of data points converge

• Stability
  • When data points fall at or near a specific level

• Mean or median lines
  • Added to represent overall average or typical performance
  • Use with caution - can obscure important variability
Interpreting Graphically Displayed Behavioral Data

• Trend
  – Overall direction taken by the data path
    • Direction
      – Increasing, decreasing, or zero trend
    • Degree
      – Gradual or steep
    • Extent of variability
  – Trend line or line of progress
    • Freehand, least-squares regression equation, or split-middle line of progress
Interpreting Graphically Displayed Behavioral Data

• Variability/Stability
  – Frequency and degree to which multiple measures of behavior yield different outcomes
  • High degree of variability
    – Little or no control over the factors influencing behavior