

# Practice Evaluation

Analysis of Single Subject  
Research Design

# 1. Visual Analysis

# Visual Analysis

- The most basic method of analyzing data from SSRD
- Method- Visual inspection of patterns in the data
- 1<sup>st</sup>- Drawing a graph
- 2<sup>nd</sup>-Presenting some definitions of visual patterns
- 3<sup>rd</sup> - Describing the major patterns and interpreting

# Limitation

- Difficult to interpret the ambiguous patterns
- Can be biased
- Autocorrelation- refers to the degree of correlation of the same variables between two successive time intervals.

# How to Prepare Graphs-1

- **Graphs can be constructed using Microsoft Excel**
- **Things to do when graphing data:**
  - Use thicker lines to form the vertical and horizontal axes than the lines used to connect data points
  - Use black ink only
  - Use actual data points (solid or open black circles)
  - Separate phases using a dashed vertical line
  - Label each phase with an intelligible title
  - Use abbreviations sparingly
  - If vertical axis has zero point, elevate it slightly above horizontal axis so data points do not rest on it
  - Make graph big enough to be easily read

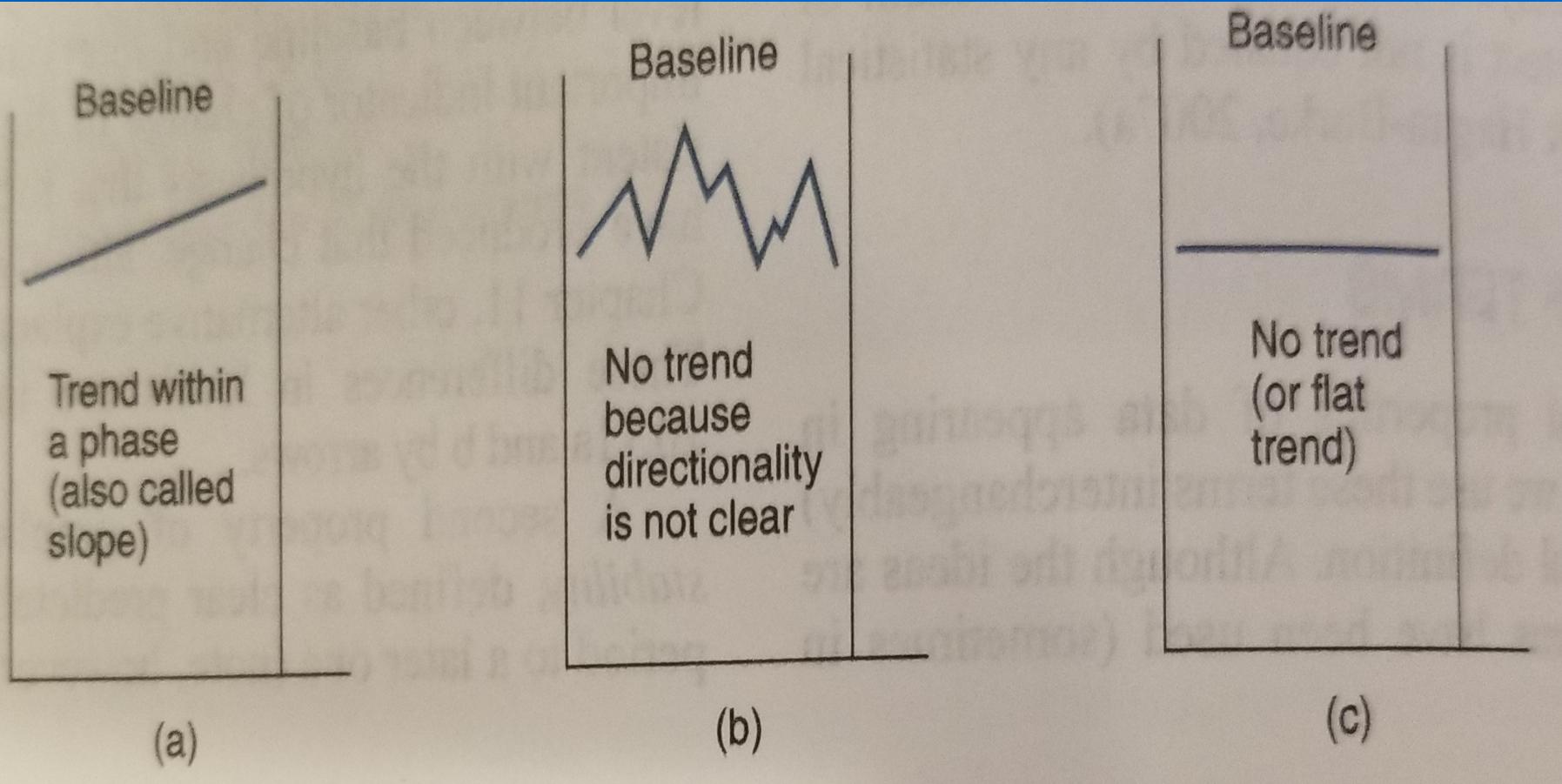
# How to Prepare Graphs-2

- Things not to do:

- Do not use colored ink or shades of gray
- Do not format using computer's 3D features
- If submitting to journal, do not place the figure caption on the figure itself. Use a separate figure caption page
- Do not have top or right border on graph
- Do not use horizontal lines running from the vertical axis across graph
- Do not connect data points between phases
- The *Journal of Applied Behavior Analysis* publishes guidelines for preparation of SSRD graphs

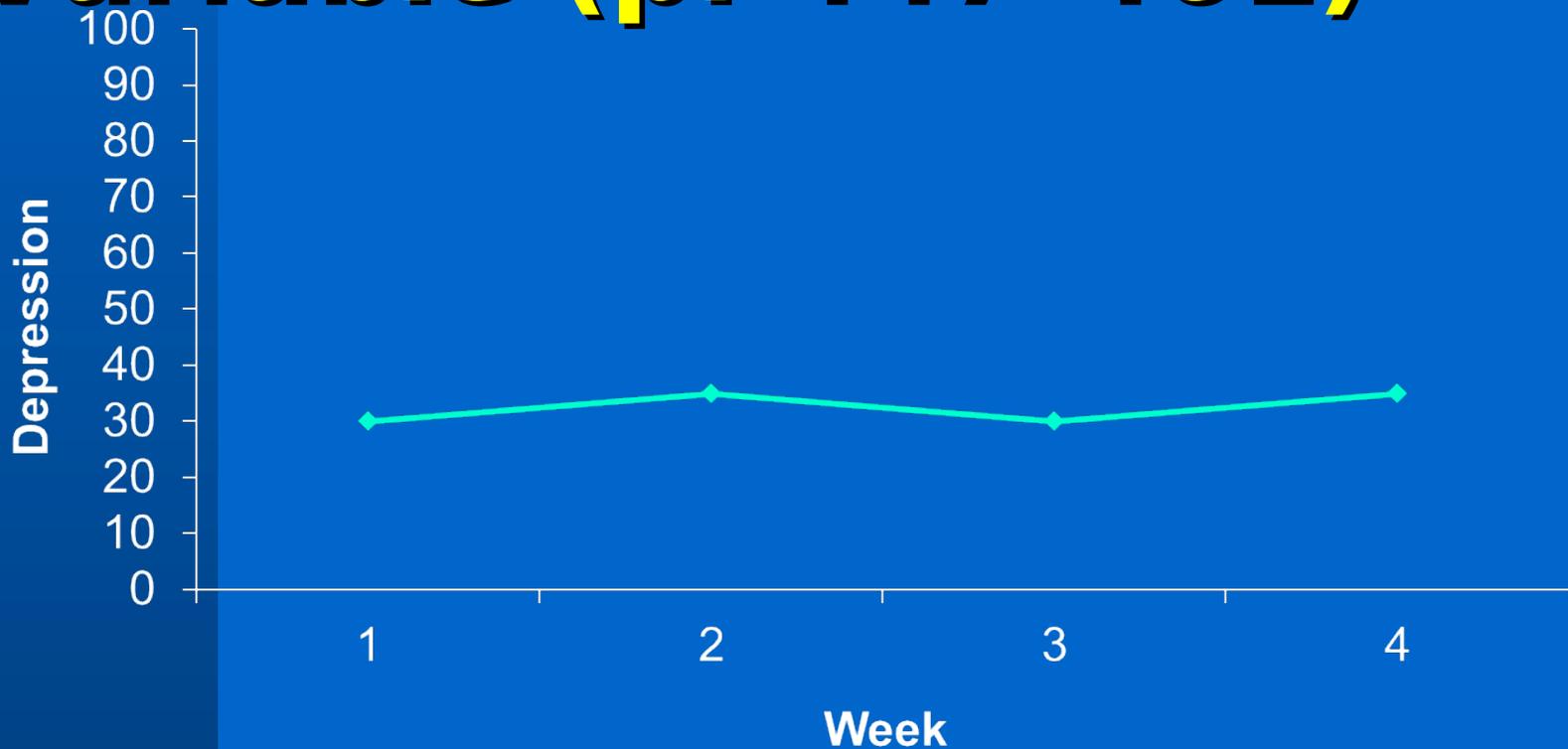
<https://www.youtube.com/watch?v=QQTnyohsEG4>

# Trend in SSRD Graph



# Graph: Flat Line (no trend)

Predictable and Not Variable (p. 447-461)



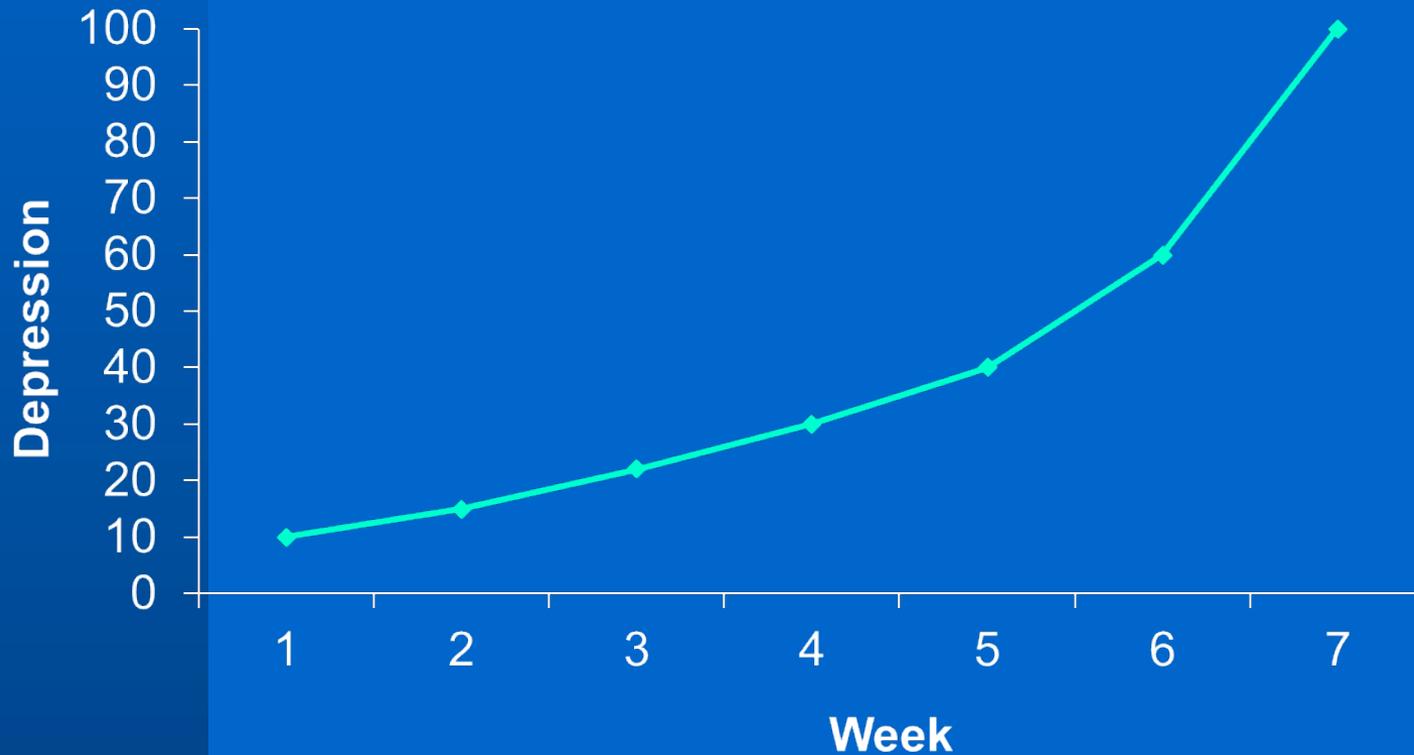
# Graph: Variable Flat Line Predictable and Variable (p. 447-461)



# Graph: Linear Trend Predictable and Variable (p. 447-461)



# Graph: Curvilinear Trend Predictable and Not Variable



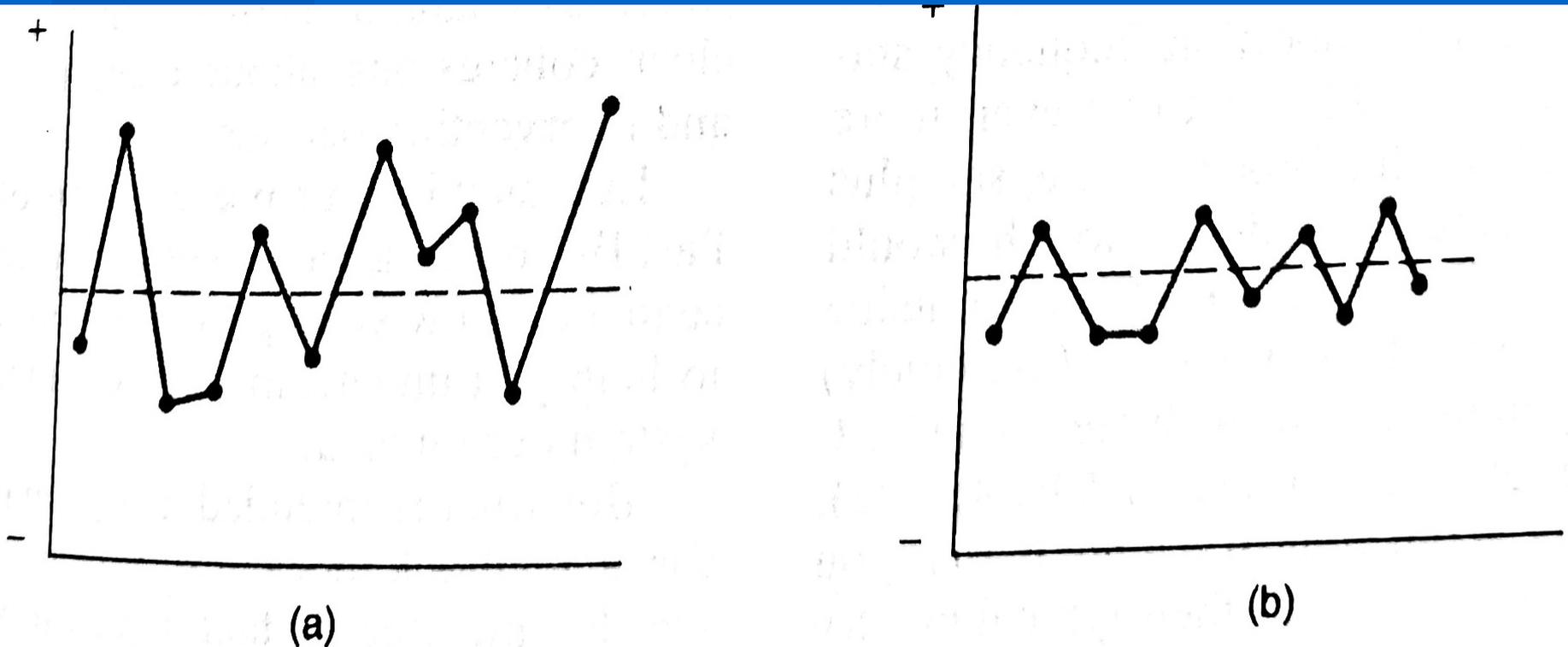
# Graph: Cyclic Predictable and Variable



# Graph: No Patten Not Predictable but Variable

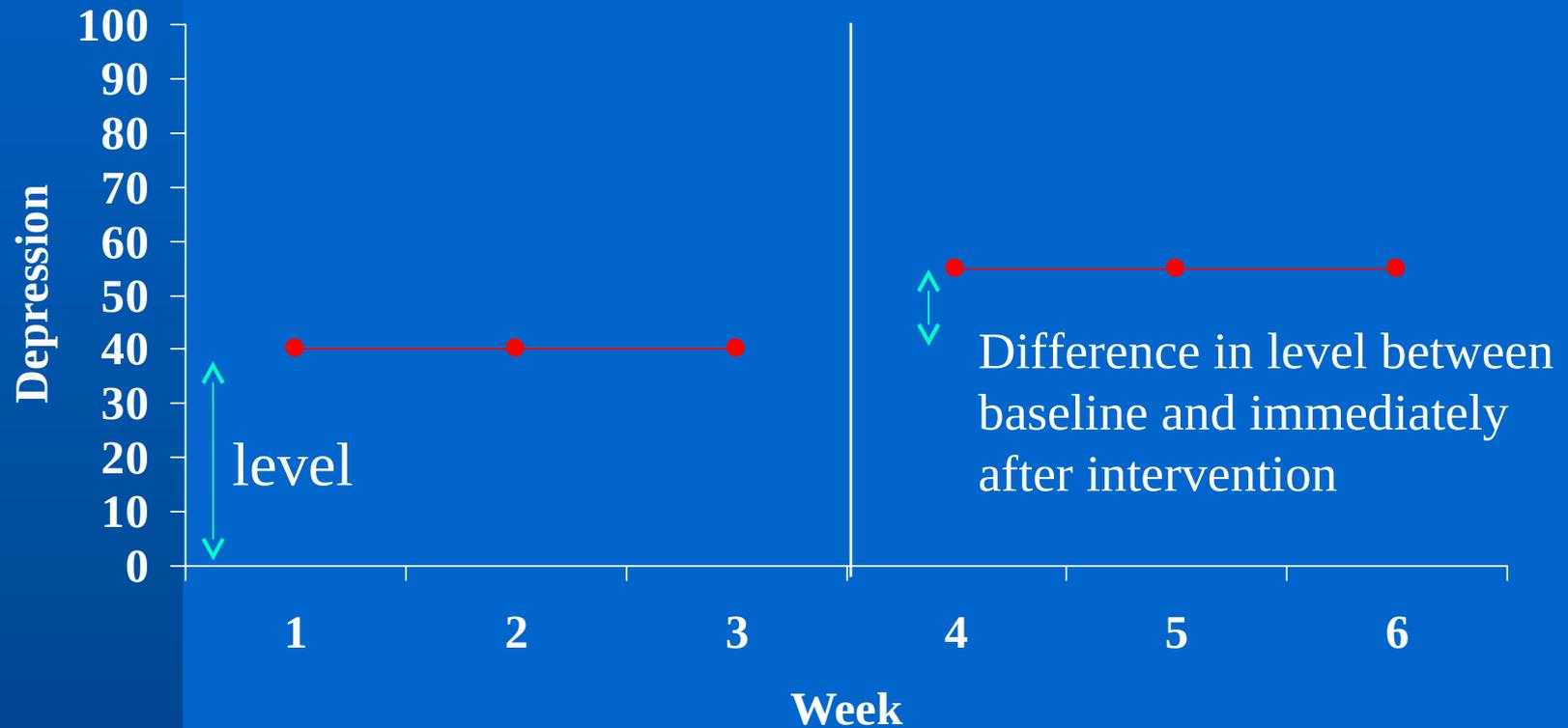


# Same Mean, but Differ in Variability

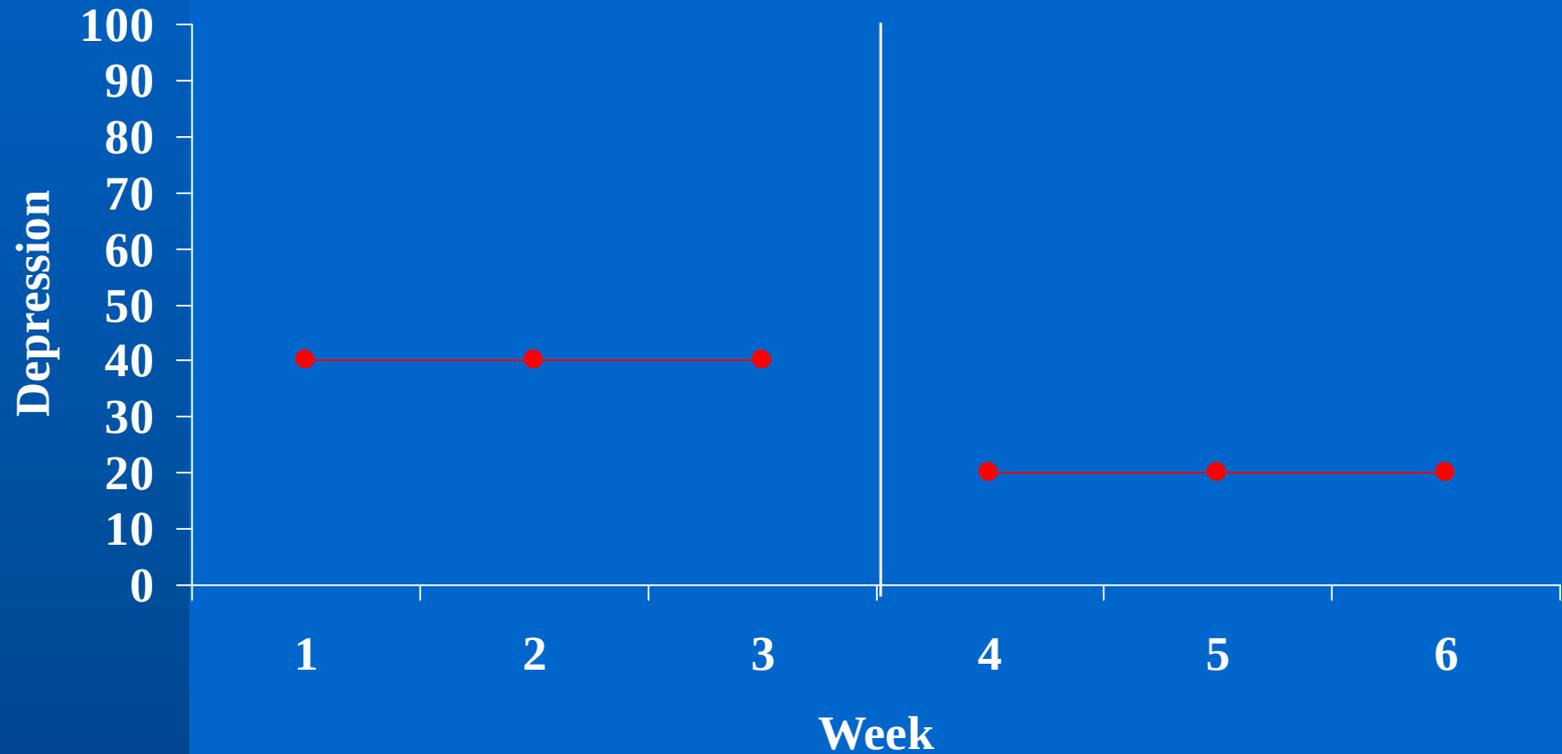


**FIGURE 20.10** Illustrations of mean lines drawn on baseline data that differ in variability.

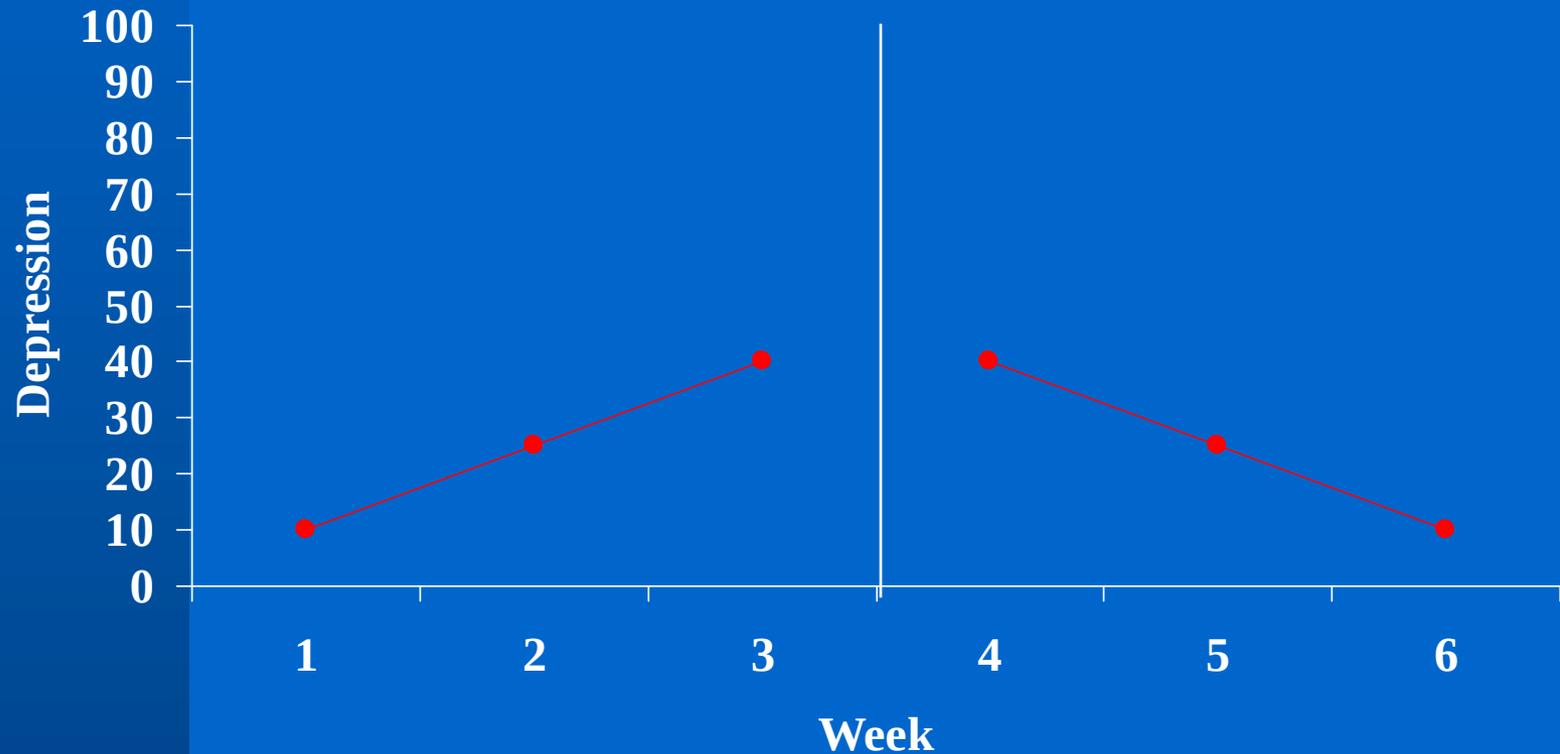
# Difference in Level: Deterioration



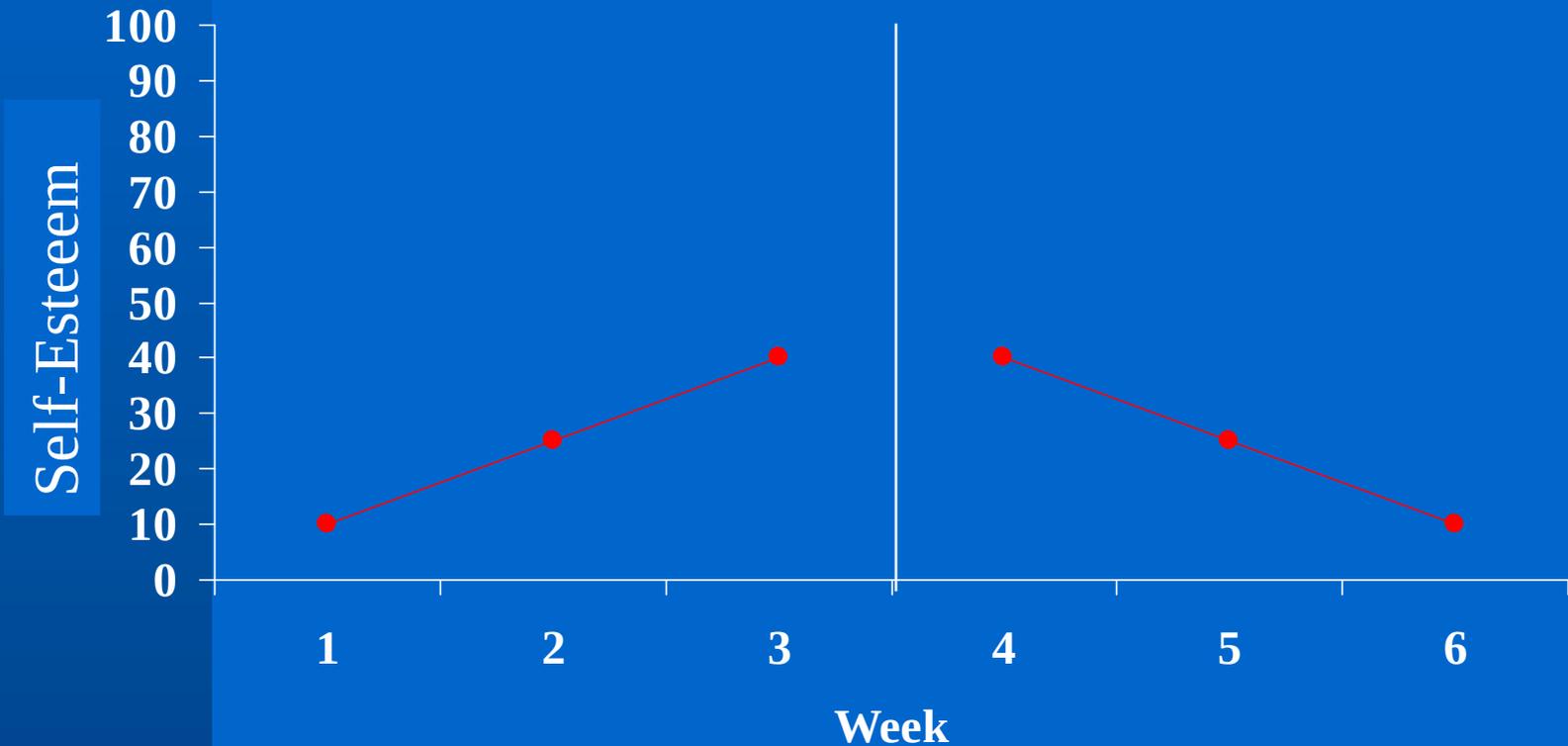
# Difference in Level: Improvement



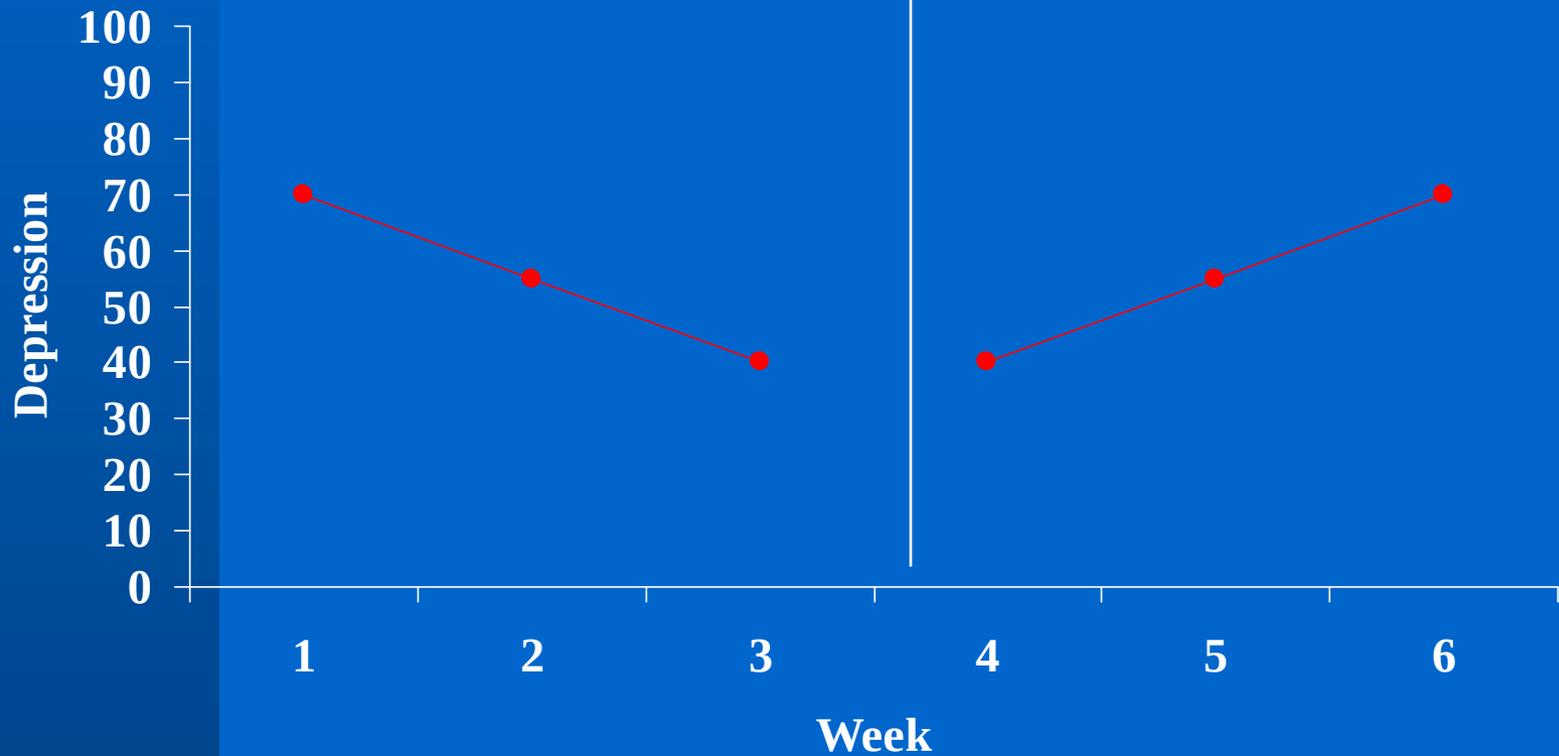
# Difference in Trend: Improvement



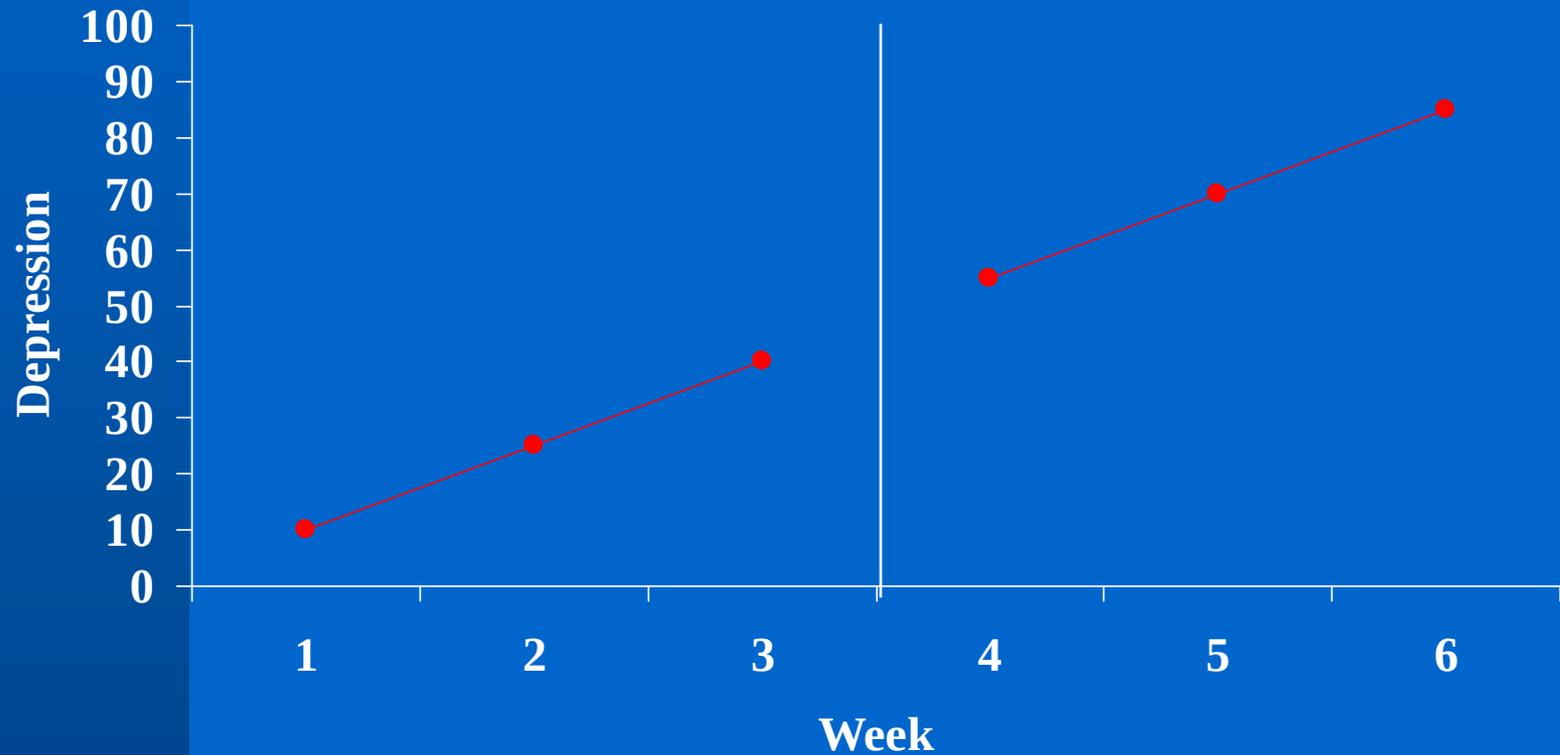
# Difference in Trend: Deterioration



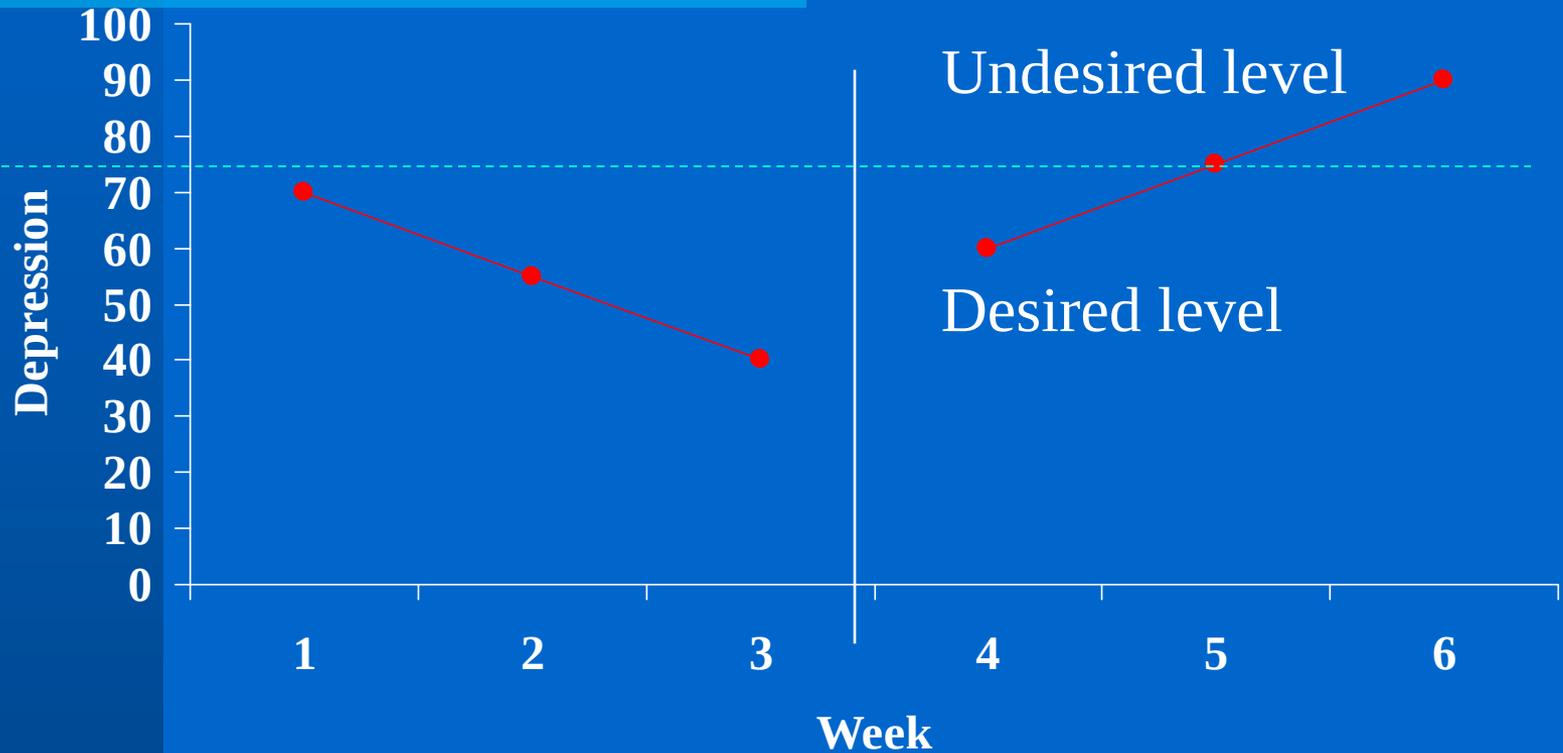
# Difference in Trend: Deterioration



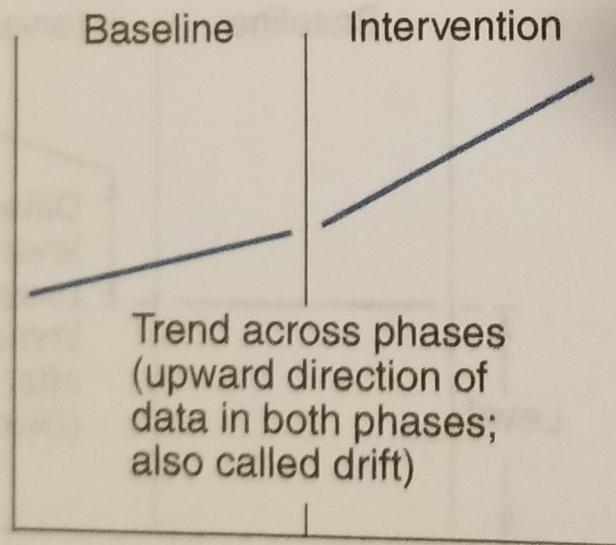
# No Difference in Trend



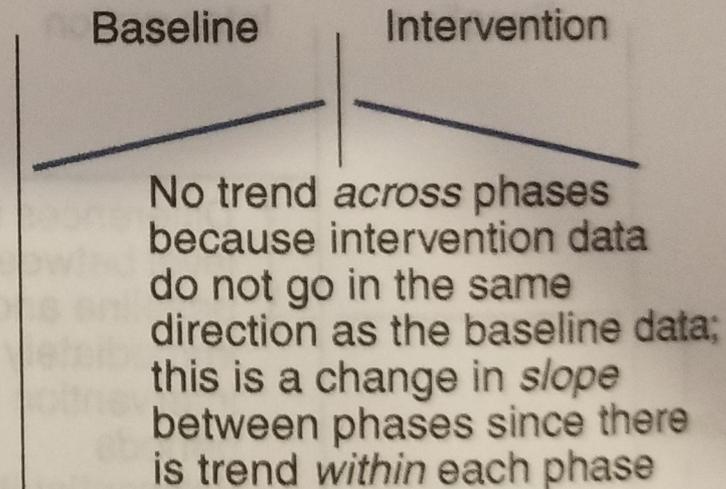
# Difference in Level & Trend: Deterioration



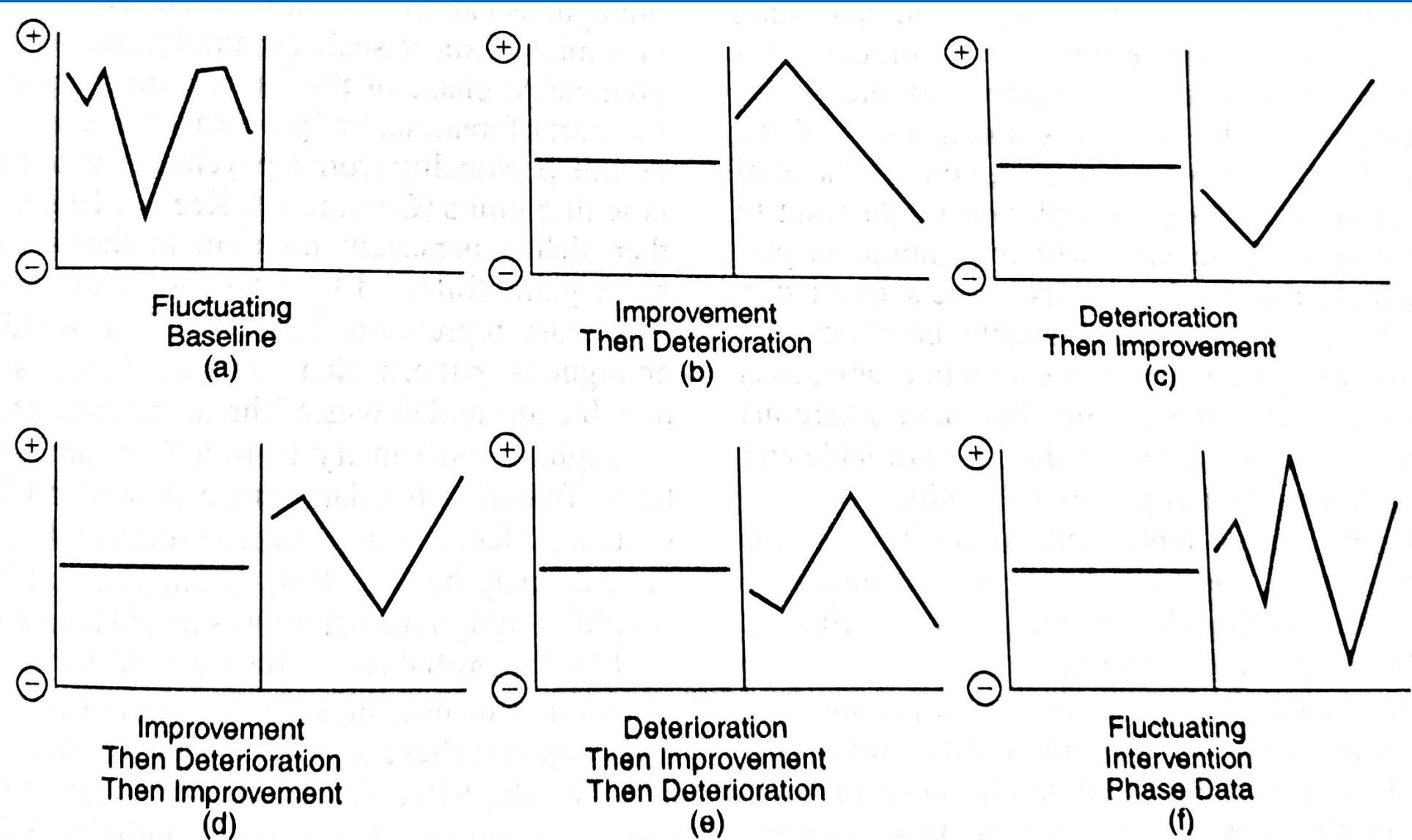
# Illustrations of Trends within a Phase (Slope) and Across Phase (Drift)



(d)



(e)

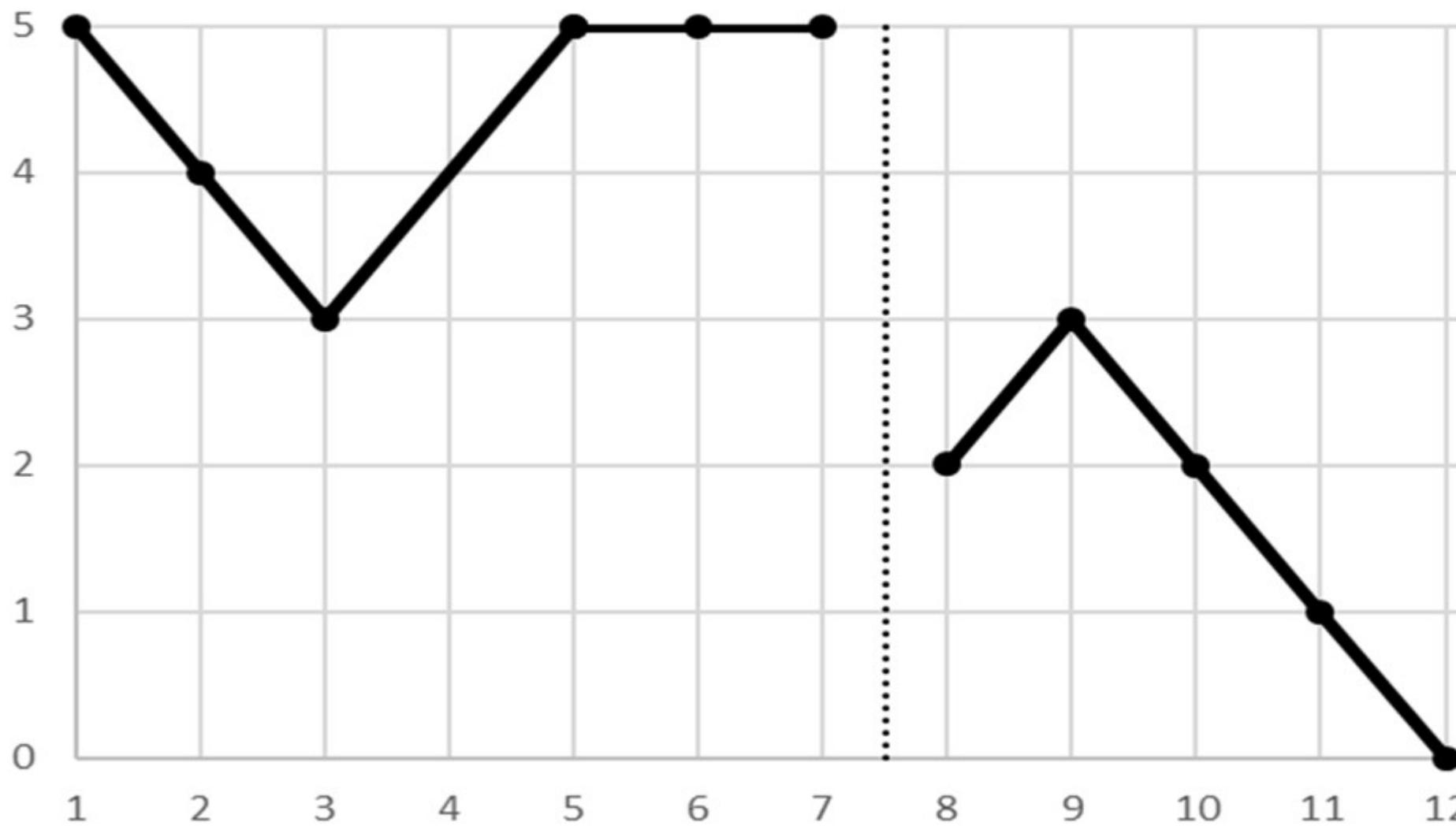


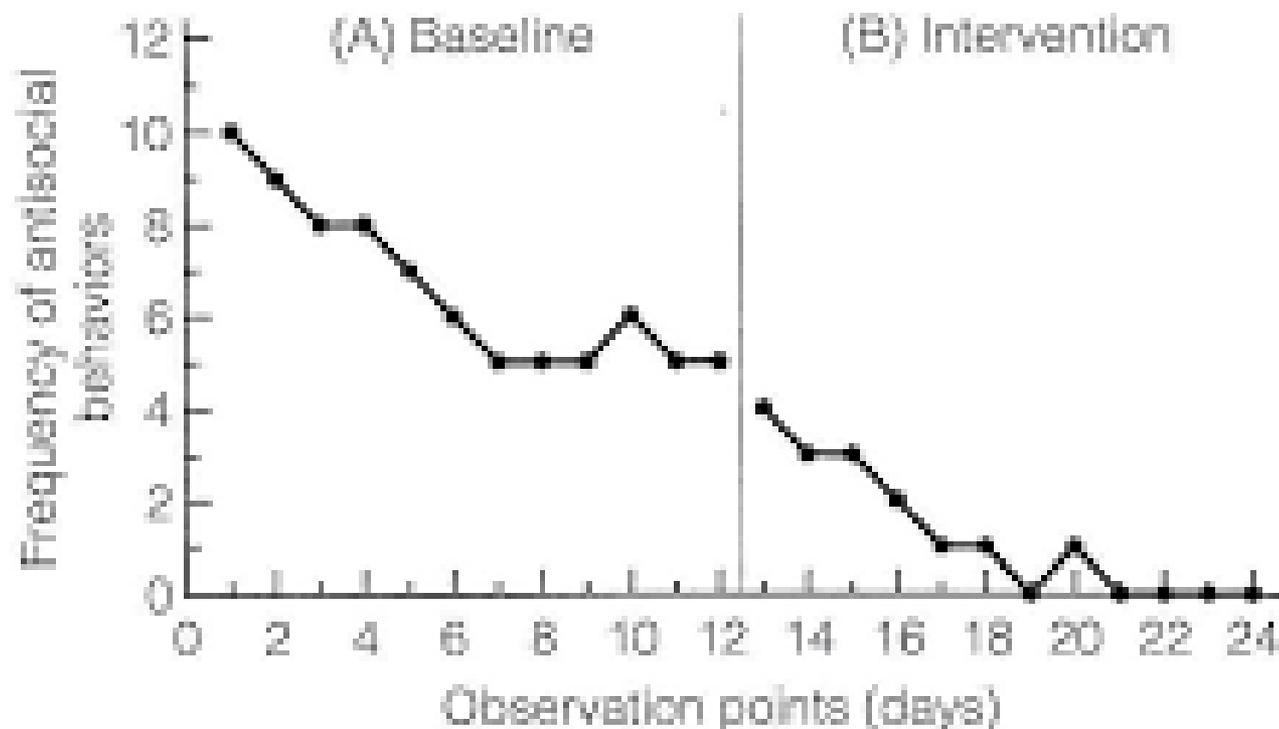
**FIGURE 20.13** Examples of ambiguous data patterns.

# Anger outburst

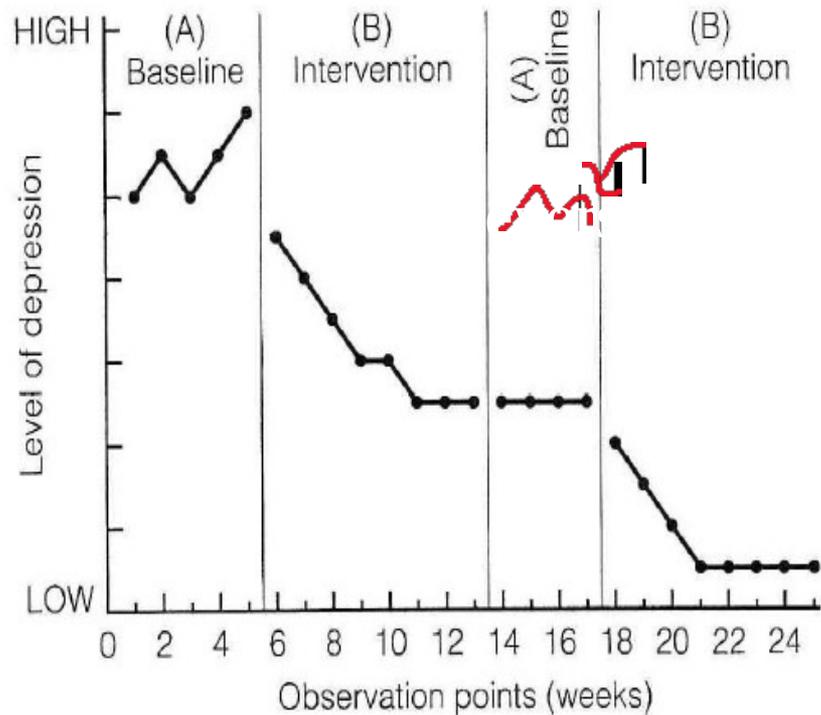
Baseline

Intervention

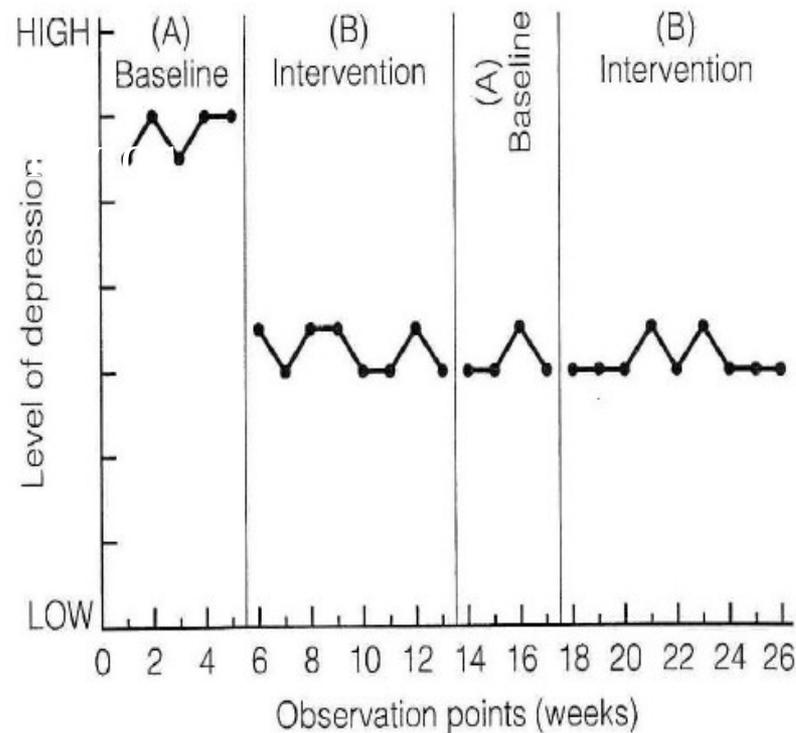




**Figure 14-5** Graph of Hypothetical Outcome after Extending a Baseline with an Improving Trend (AB Design)



**Figure 14-8** Graph of Hypothetical Outcome of ABAB Design Supporting Intervention Efficacy Despite Failure to Obtain a Reversal during Second Baseline



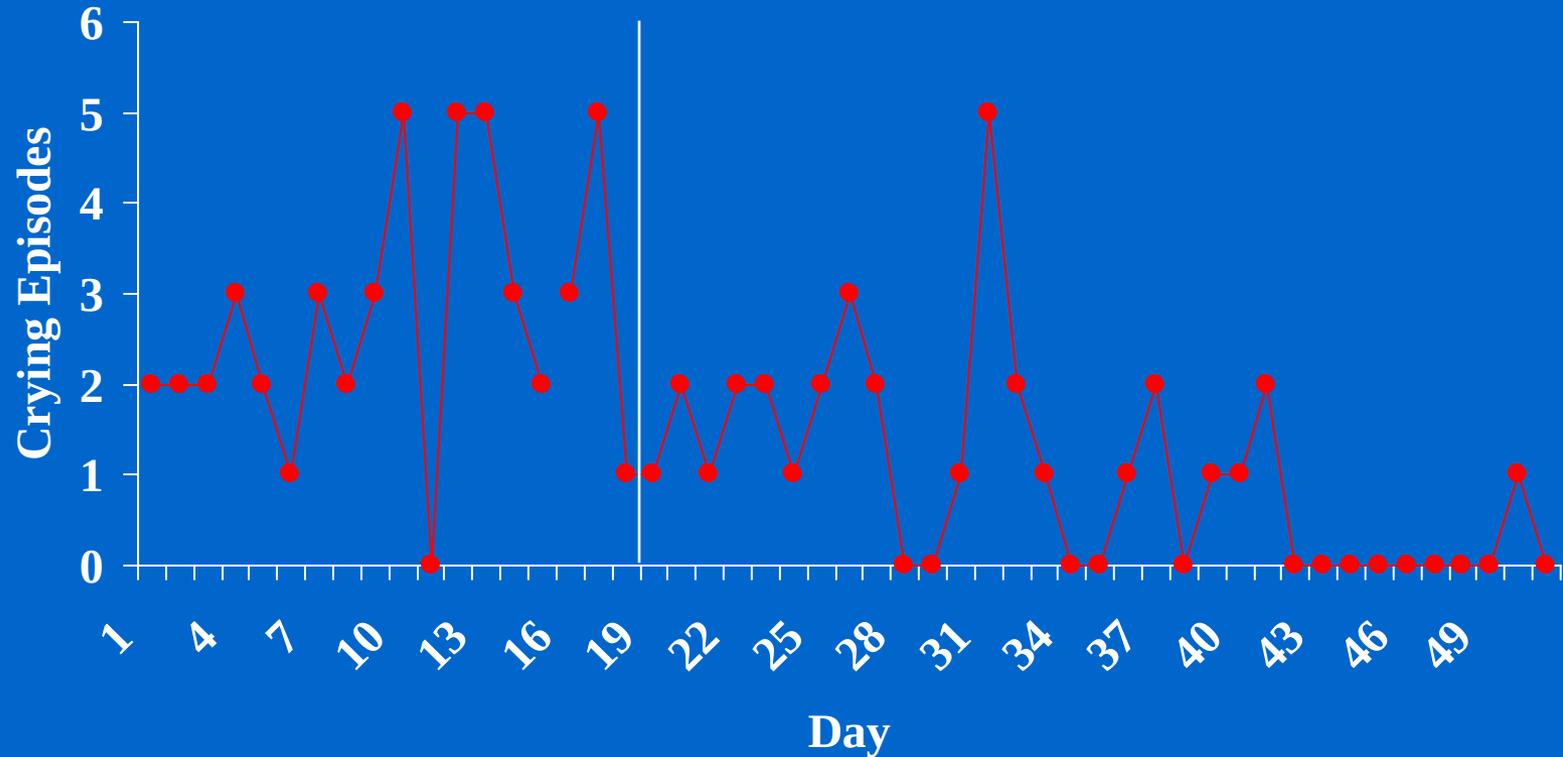
**Figure 14-9** Graph of Hypothetical Outcome of ABAB Design with Unclear Results

## 2. Descriptive Analysis

1) Reporting Measures of Central Tendency

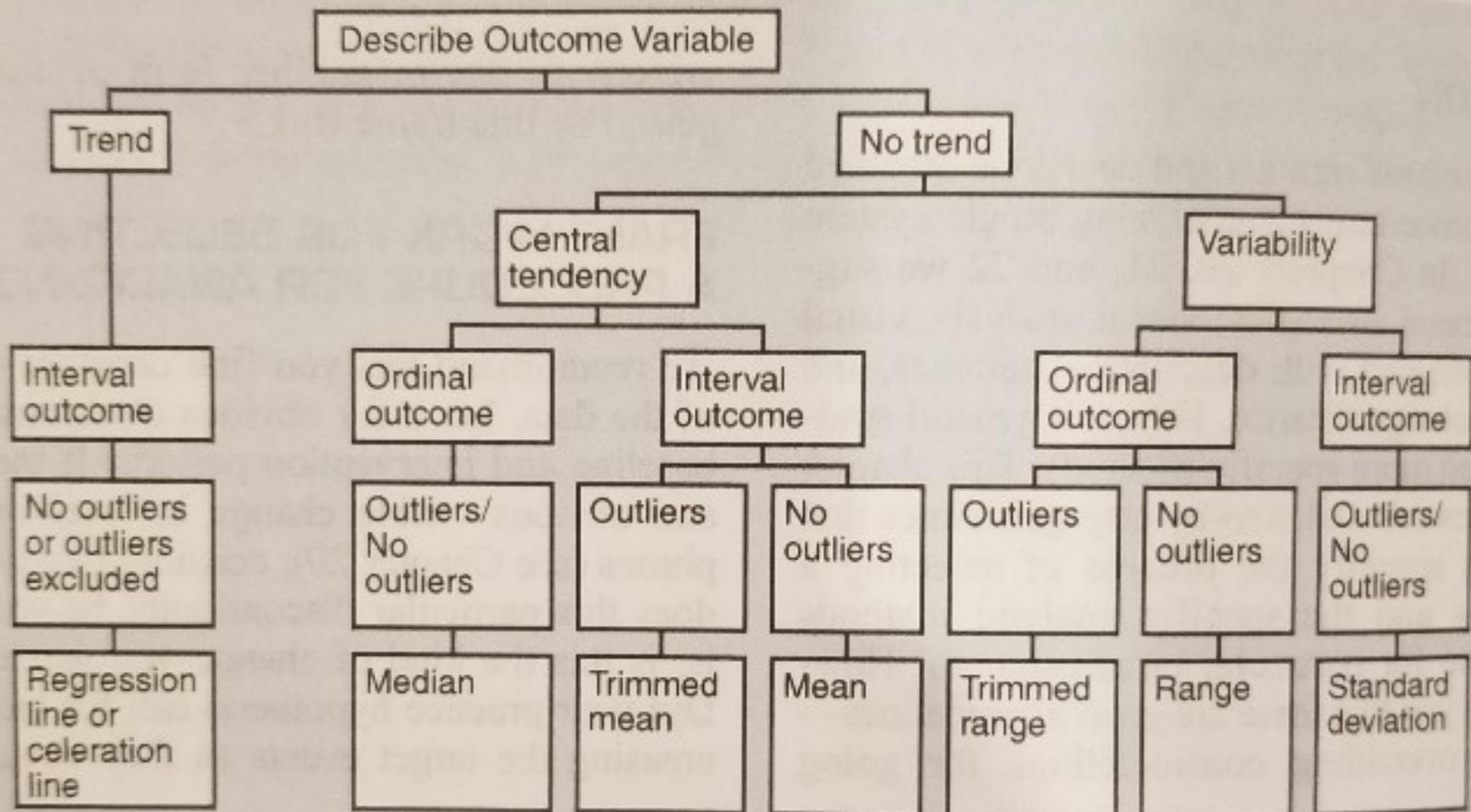
2) Reporting Measures of Variation

# Daily Frequency of Crying



# Selecting Descriptive Statistics

- See Figure 24.1
- Considerations
  - Trend
  - Level of measurement of outcome variable
  - Presence of outliers



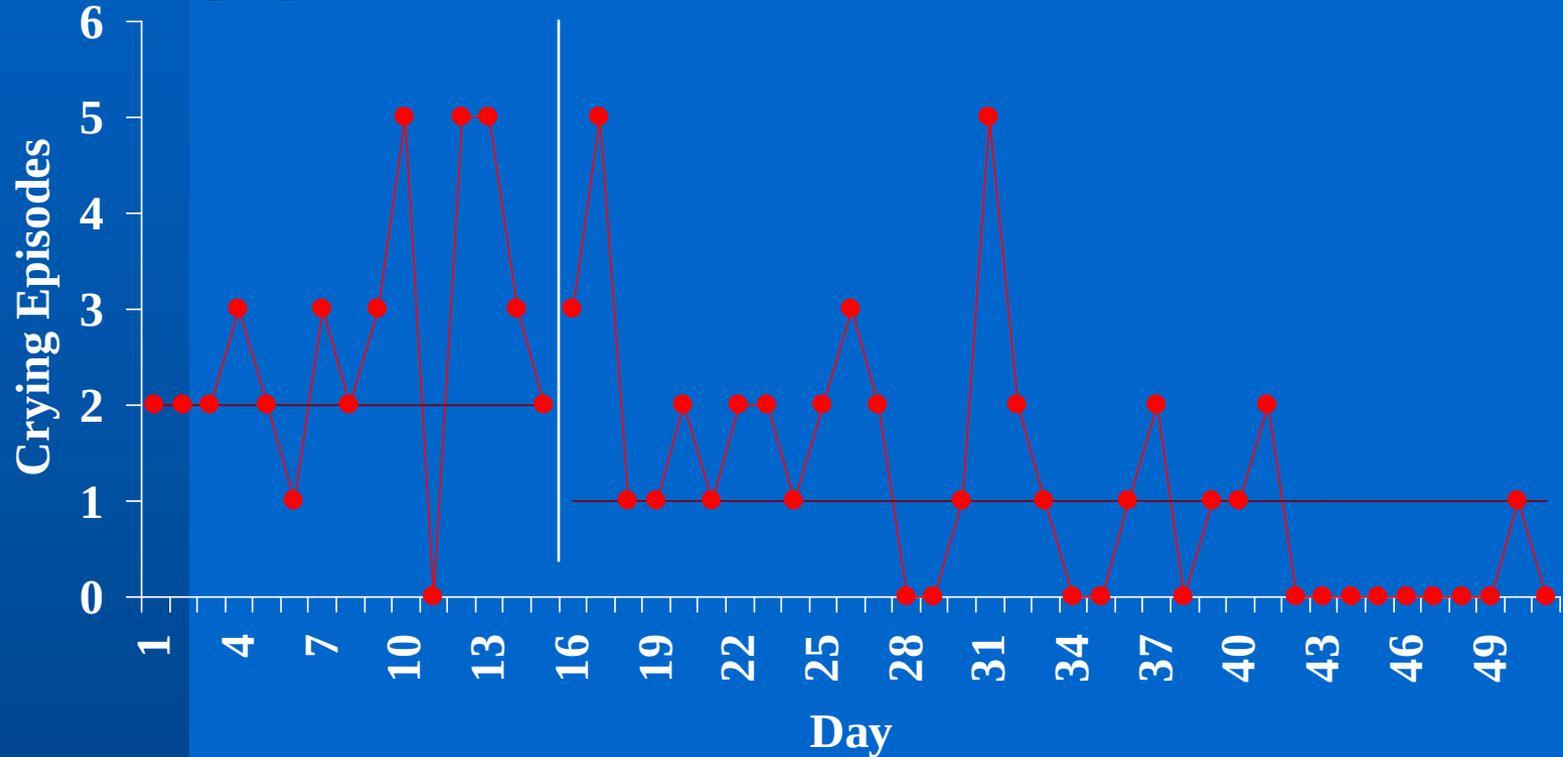
**FIGURE 24.1** Selecting statistics to describe an outcome variable.

# 1) Measures of Central Tendency

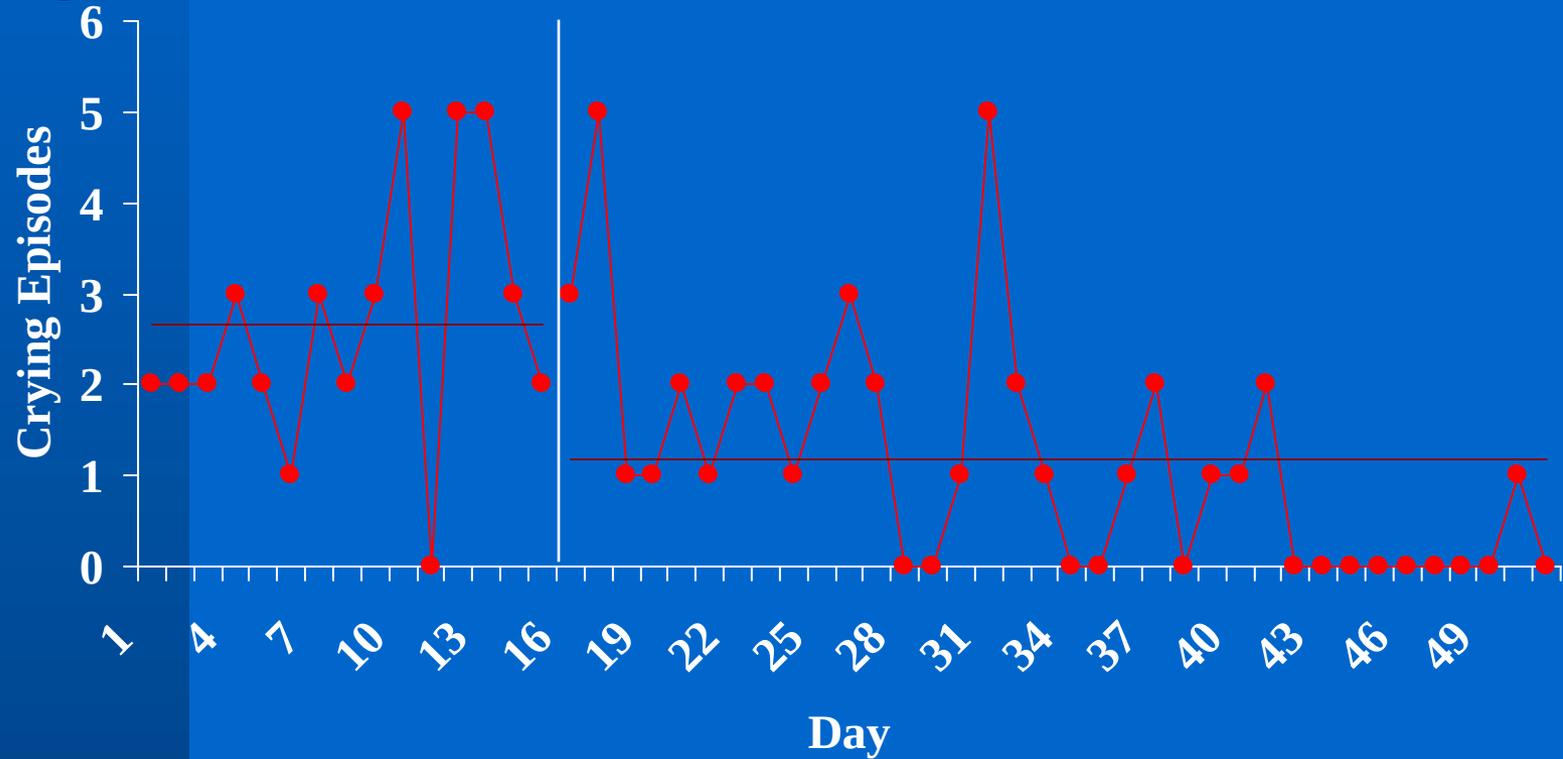
**Measures of central tendency indicate the typical value of a set of scores**

- Median
  - Ordinal data, interval data with influential outliers
- Mean
  - Interval data, no influential outliers
- Trimmed mean
  - Interval data, influential outliers
    - Order data from highest to lowest, trim highest 10% of data points and lowest 10% of data points, compute mean with remaining data

# Daily Frequency of Crying With Median Lines



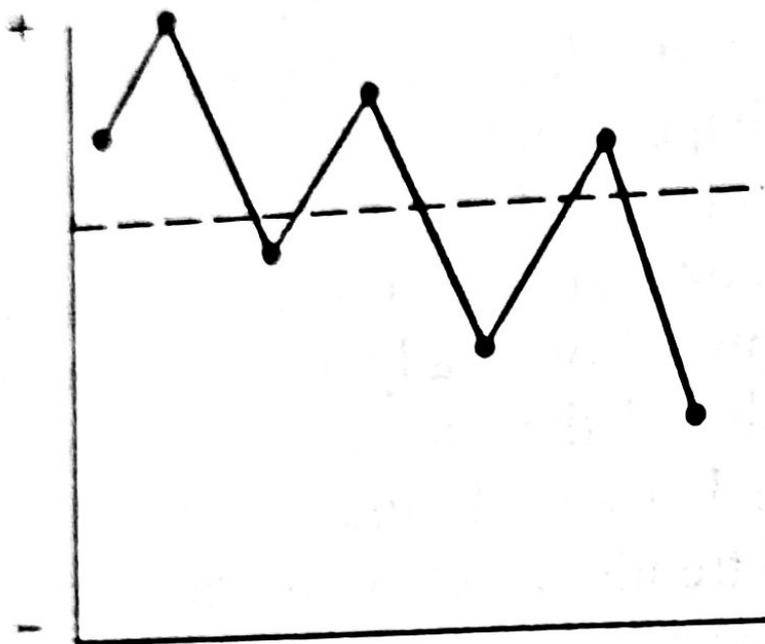
# Daily Frequency of Crying With Mean Lines for



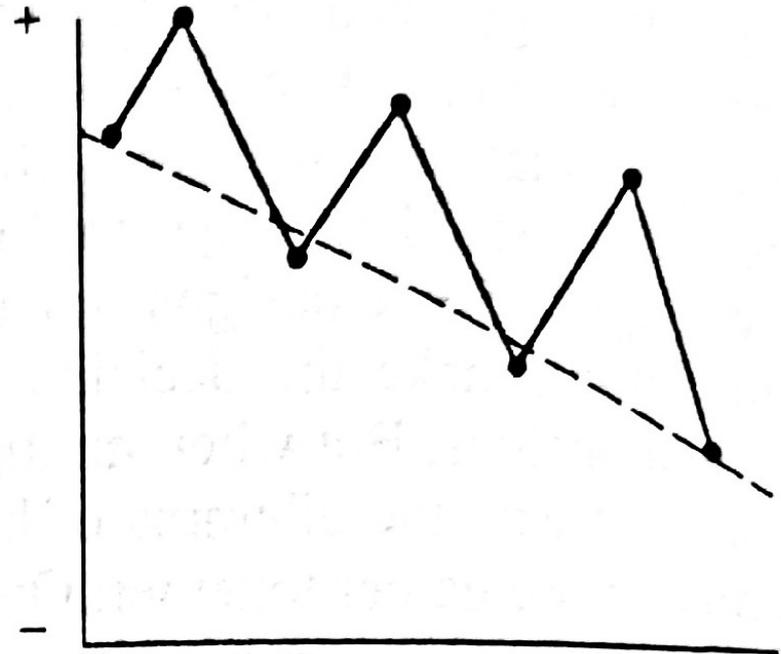
# Trend

- Average rate of increase or decrease over time
- **Technically, reporting central tendency are not recommended for data exhibiting a trend, but regression line**
- For the assignment, however, I want you to include that you would report central tendency regardless of the existence of trend in baseline or intervention

# Mean Line VS. Trend Line



(a)

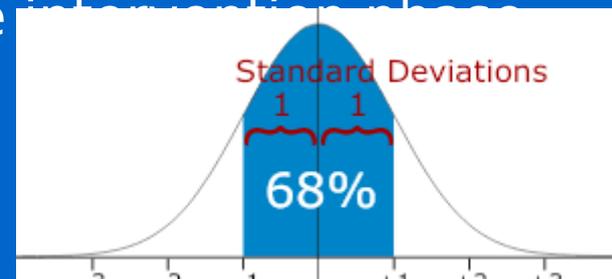


(b)

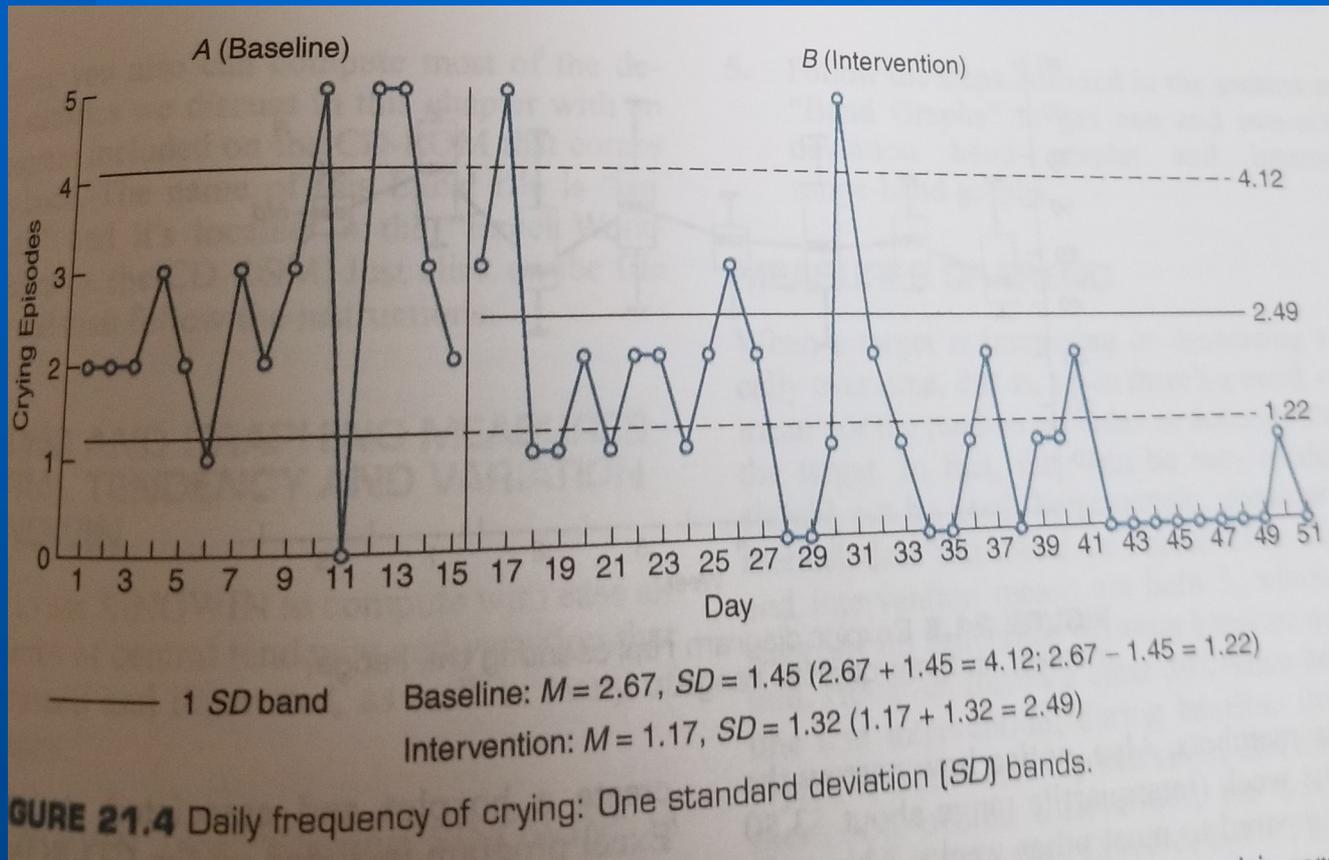
**FIGURE 20.11** Illustrations of a mean line (a) and a trend line (b) with the same target event data.

## 2) Measure of Variation

- Variation is the degree to which data deviate from the overall pattern of data (e.g., mean)
- Range- difference between the highest and the lowest value in a set of score
- Standard deviation-indicate the average amount by which the scores in a given distribution deviate from the mean of the distribution
  - Making plot lines representing the baseline mean  $\pm 1$  sd's and project these into the intervention outcomes ("typical" pattern)



# Reporting Descriptive Data in a Figure



# Let's practice

- Make a graph, mean, and SD

## 2. Inferential Statistical Analysis of SSRD-

# Null Hypotheses ( $H_0$ )

- Statement of no difference between phases
- Rejection provides support for an alternative hypothesis

Example.

- Frequencies of crying in baseline and Intervention are not different.

# Alternative (Evaluation) Hypotheses ( $H_1$ )

- Difference between phases

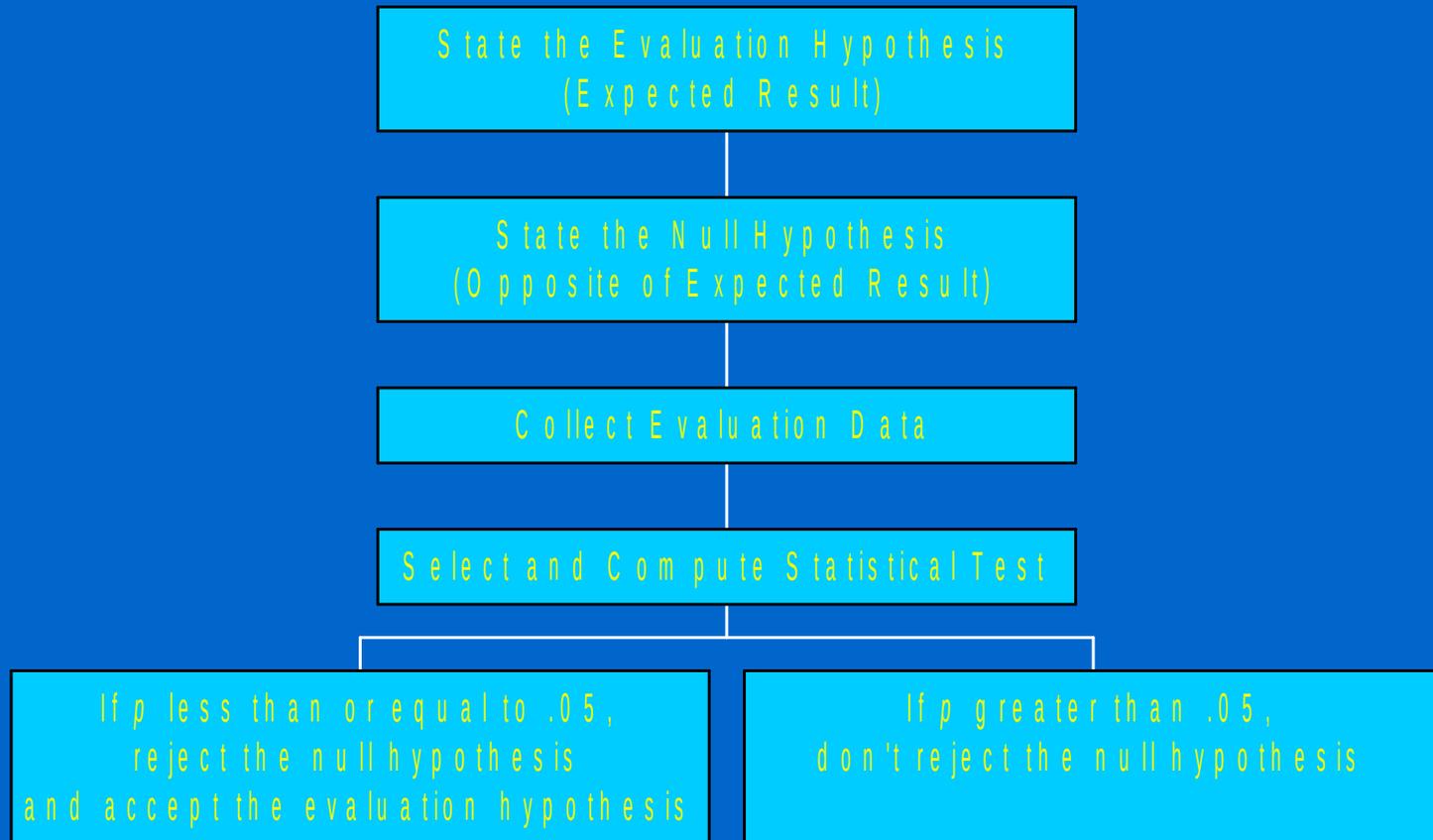
Example.

- Participation in CBT will show difference in Frequencies of crying between baseline and Intervention.
- The baseline mean is greater than the mean score of PHQ-9 in CBT intervention.

# Basic Concept in Inferential Statistics: Statistical Significance

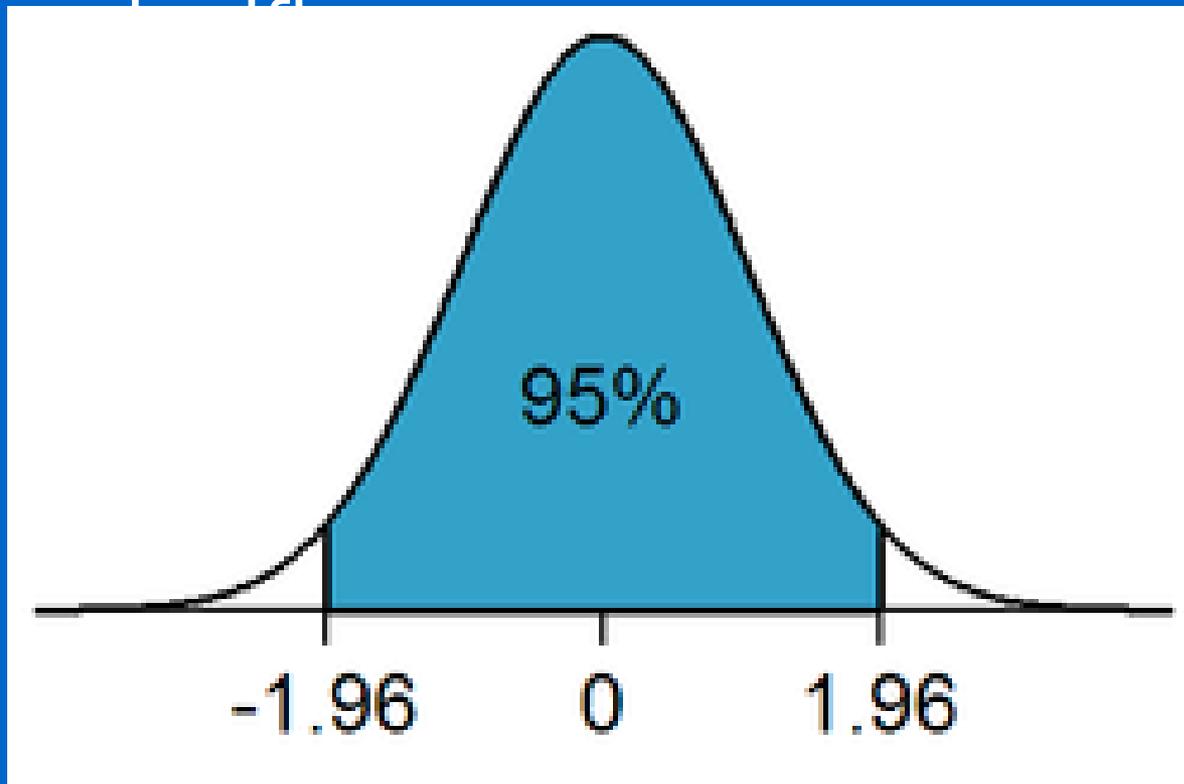
- Outcome that permits:
  - Rejection of the null hypothesis
  - Acceptance of the evaluation hypothesis
    - i.e., alternative hypothesis

# Hypothesis Testing Process



# Significance Level ( $\alpha$ )

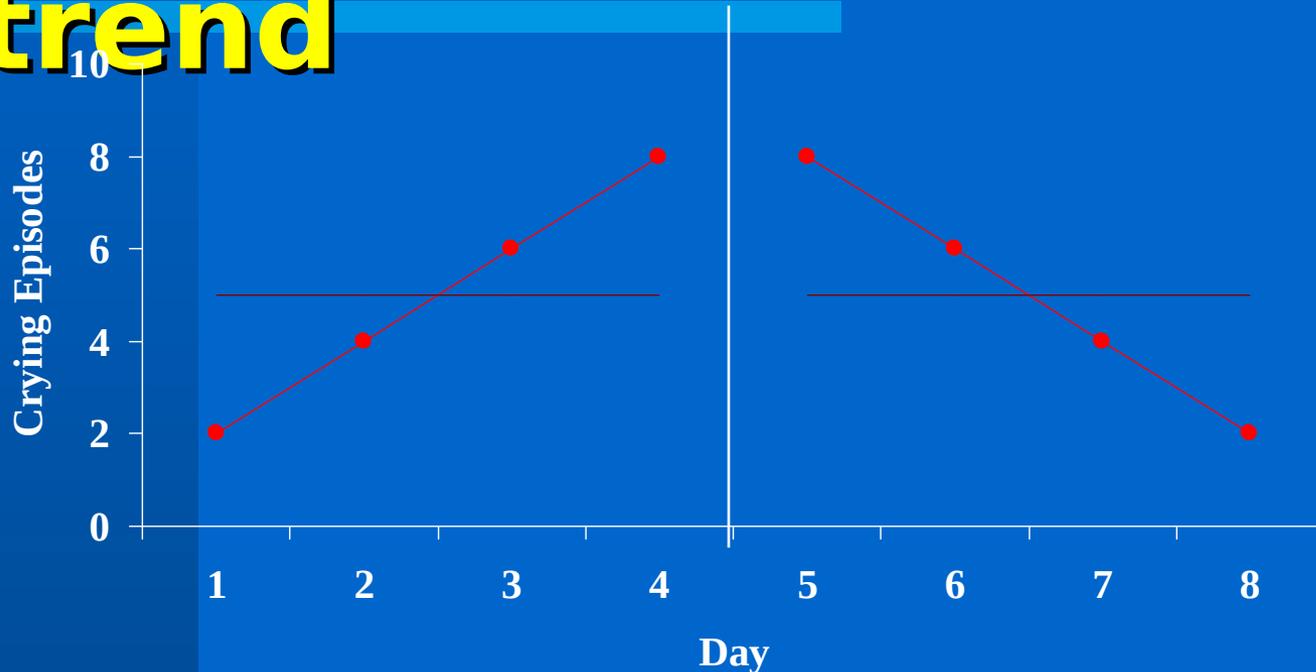
- Typically set at .05
  - Most significance tests are carried out using the .05, or 5%, level of



# Factors that Increase Statistical Power

- More reliable measure
- More reliable implementation of intervention
- More powerful statistical test
- Larger alpha (e.g., .10 instead of .05)
- More observations

# Data with Mean Lines, Showing a perfect trend



If there is a perfect trend in either baseline or intervention data, inferential statistical analyses are not recommended. HOWEVER, Chi-Square test can be used.

# Statistical Process Control (SPC) Charts

- X-mR-chart
  - X-moving-Range-chart
- C-chart
  - Count-chart

# X-mR-chart

- Assume that you have measures of 4, 6, 3, and 5, and you will get the following differences  $(4-6)=2$ ;  $(6-3)=3$ ;  $(3-5) = 2$

- Mean

$$4 + 6 + 3 + 5 = 18. \quad 18/4 = 4.5$$

- Calculate the mean of the Individual Moving Ranges (MR)

$$2 + 3 + 2 = 7. \quad 7/3 = 2.333$$

- Calculate the upper & Lower control Limits

$$\text{UCL} = \text{sample mean} + 3 * \text{MR mean} / d_2 =$$

$$4.5 + (3 * 2.333 / d_2)$$

$$\text{LCL} = \text{sample mean} - 3 * \text{MR mean} / d_2 =$$

$$4.5 - (3 * 2.333 / d_2)$$

$d_2$  can be found from a table of control chart constants

Given the SAME sample data, and a table of control chart constants, what would be the Upper Control Limit and Lower Control Limit measure for the corresponding X-bar chart?

Sample	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$
1	30	37	26	25	32
2	40	32	29	28	25
3	33	27	30	38	36
4	25	28	37	32	37

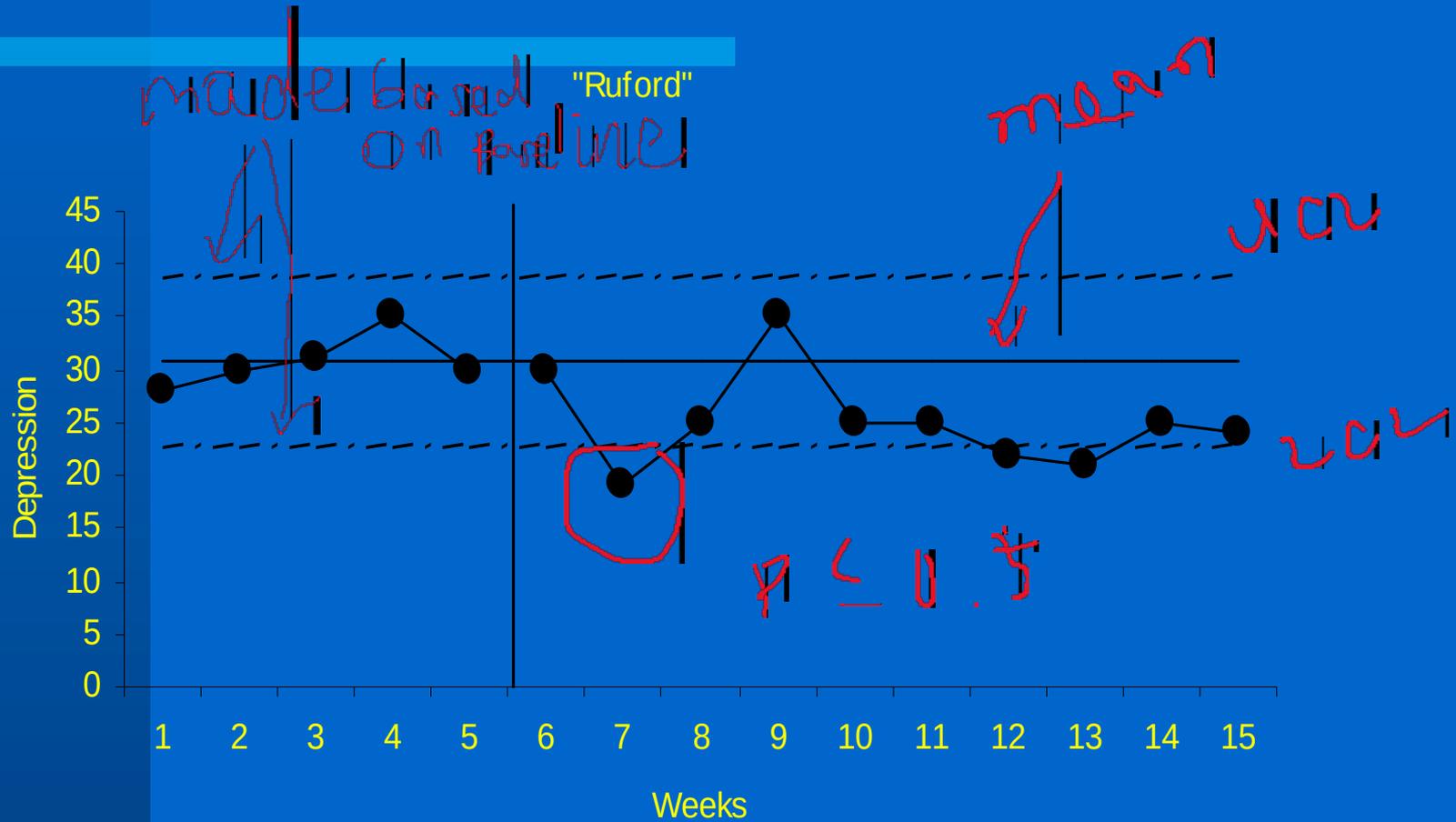
$n$	$d_2$	$c_4$	$A_2$	$D_3$	$D_4$	$A_3$	$B_3$	$B_4$
2	1.128	0.7979	1.880	*	3.267	2.659	*	3.267
3	1.693	0.8862	1.023	*	2.575	1.954	*	2.568
4	2.059	0.9213	0.729	*	2.282	1.628	*	2.266
5	2.326	0.9400	0.577	*	2.115	1.427	*	2.089
6	2.534	0.9515	0.483	*	2.004	1.287	0.030	1.970
7	2.704	0.9594	0.419	0.076	1.924	1.182	0.118	1.882
8	2.847	0.9650	0.373	0.136	1.864	1.099	0.185	1.815
9	2.970	0.9693	0.337	0.184	1.816	1.032	0.239	1.761
10	3.078	0.9727	0.308	0.223	1.777	0.975	0.284	1.716
11	3.173	0.9754	0.285	0.256	1.744	0.927	0.321	1.679
12	3.258	0.9776	0.266	0.283	1.717	0.886	0.354	1.646
13	3.336	0.9794	0.249	0.307	1.693	0.850	0.382	1.618
14	3.407	0.9810	0.235	0.328	1.672	0.817	0.406	1.594
15	3.472	0.9823	0.223	0.347	1.653	0.789	0.428	1.572
16	3.532	0.9835	0.212	0.363	1.637	0.763	0.448	1.552
17	3.588	0.9845	0.203	0.378	1.622	0.739	0.466	1.534
18	3.640	0.9854	0.194	0.391	1.608	0.718	0.482	1.518
19	3.689	0.9862	0.187	0.403	1.597	0.698	0.497	1.503
20	3.735	0.9869	0.180	0.415	1.585	0.680	0.510	1.490
21	3.778	0.9876	0.173	0.425	1.575	0.663	0.523	1.477
22	3.819	0.9882	0.167	0.434	1.566	0.647	0.534	1.466

- 40.46 and 22.24
- 38.56 and 24.14
- 41.28 and 22.66
- 42.87 and 19.83

# X-mR-chart (cont'd)

- If one intervention data point falls outside of these lines there has been a statistically significant change (the probability of this is  $\leq .05$ , i.e.,  $p \leq .05$ )
- Interval level outcome variable
- Should not be used when there is a trend during baseline

# X-mR-chart

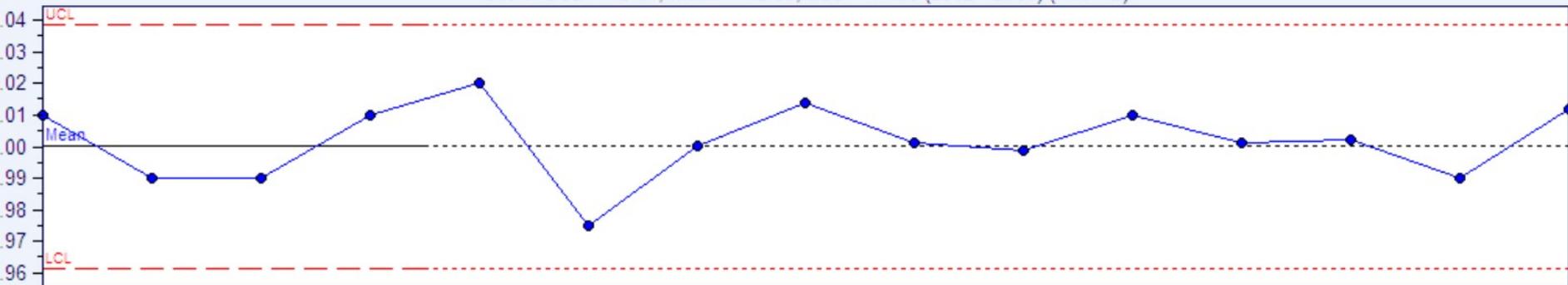


Calculated in the query (WeightFull - WeightEmpty)

2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316
12.010	11.990	11.990	12.010	12.020	11.975	12.000	12.014	12.001	11.999	12.010	12.001	12.002	11.990	12.000
	0.02	0.00	0.02	0.01	0.05	0.03	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.00

### Individuals

Set 1: UCL = 12.04, Mean = 12.00, LCL = 11.96 (2302 - 2305) (mR = 2)



### Moving Range (2)

Set 1: UCL = 0.04, Mean = 0.01, LCL = none (2302 - 2305) (mR = 2)



# ***t*-test**

- Use the *t*-statistic to compare differences in the means between phases.
- test the null hypothesis that the intervention mean equals the baseline mean (baseline mean represents “typical” pattern)
- If  $p \leq .05$  reject the null
- If  $p > .05$ , don't reject the null

# ***t*-test (cont'd)**

- Interval level outcome variable
- Should not be used when there is a trend in either baseline or intervention
- Number of data points should be more than 30 in each phase

# T-test

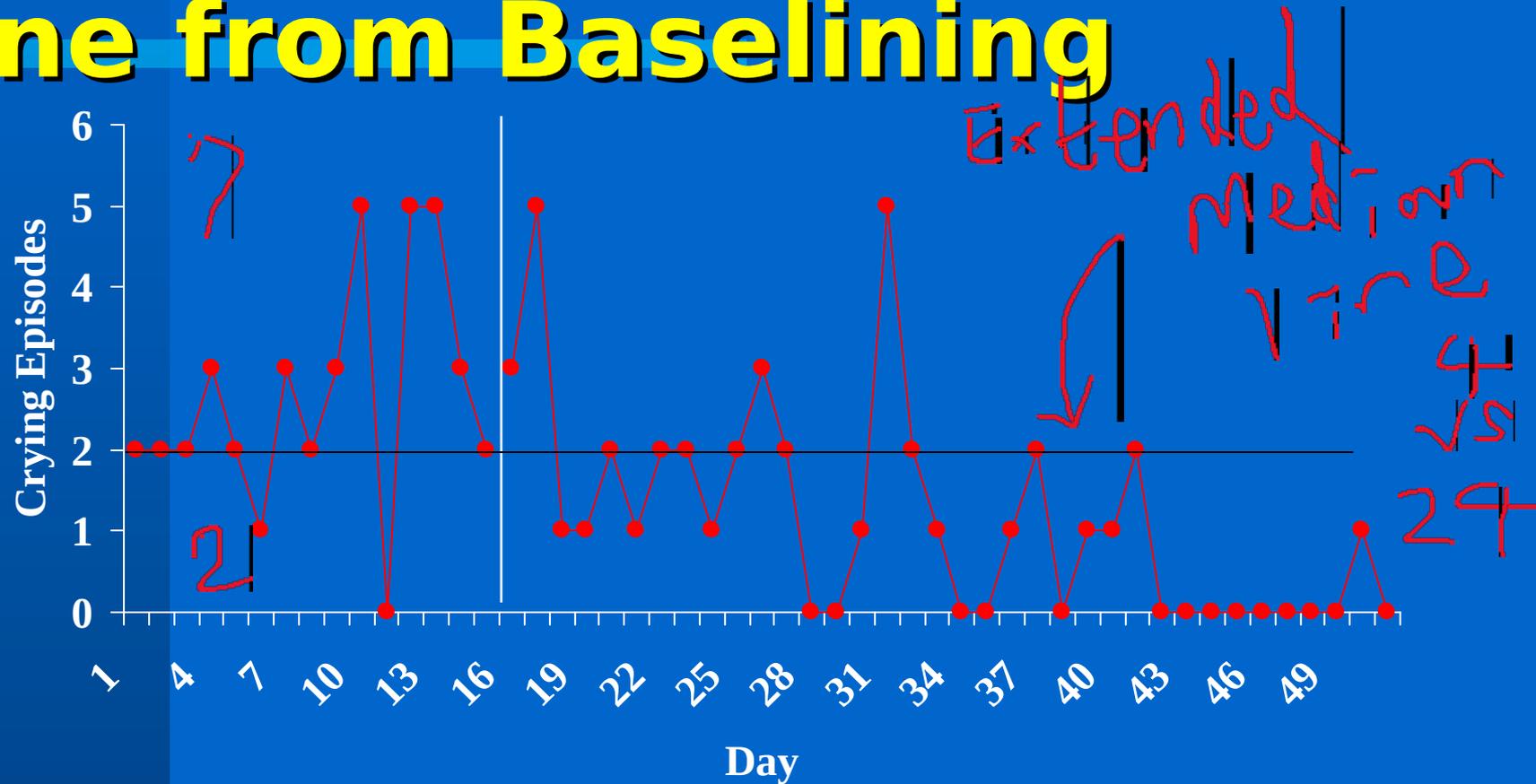
- T-test: compares the **difference** in the means of the dependent variable (ordinal, interval, and ratio) of two groups

	Baeline	Intervention	
Item	Mean(SD)	Mean(SD)	t-value
Self-Esteem	14.27 (12.49)	24.58 (9.42)	-8.00***

# Chi-Square

- Compute and plot a baseline median and extend into the intervention phase (“typical” pattern)
- Use the chi-square statistic to test the null hypothesis that the number of intervention observations above (or below) the line equals the number of baseline observations above (or below) the line

# Daily Frequency of Crying with Extended Median Line from Baseline



# Chi-Square (cont'd)

- If  $p \leq .05$  reject the null
- If  $p > .05$ , don't reject the null
- Interval or ordinal level outcome variable
- Can be used both with or without trend during baseline
- Requires an adequate sample size with expected frequencies in all four cells greater than five

# Not Recommending Statistical Tests for SSRD

- Using inferential statistical tests from SSRD data is not recommended.
  - 1) Many of recommended statistical tests are based on the usual assumptions of parametric analysis ( e.g., equality of variances, normally distributed data, independent data). SSRD's small number of data points will cause problems. In other words, SSRDs by their very nature contradict the most crucial assumption of parametric test
  - 1) Increased chance of Type 2 error occurs (missing a “true” difference when one exists).