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Conservative Dual-Criterion Method for Single-Case Research: A Guide for Visual Analysis of AB, ABAB, and Multiple-Baseline Designs

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Conservative Dual-Criterion Method for Single-Case Research: A Guide for Visual Analysis of AB, ABAB, and Multiple-Baseline Designs

Christopher M. Swoboda, Thomas R. Kratochwill, and Joel R. Levin

The purpose of this guide is to provide an overview of the *conservative dual-criterion (CDC) method* for improving visual analysis of graphed data in three classes of single-case design. The method was originally developed by Fisher, Kelley, and Lomas (2003) to improve visual analysis in AB single-case designs and has been used in at least one training study (Stewart, Carr, Brandt, & McHenry, 2007). We have extended the method to single-case designs not included in the original presentation by Fisher et al. (2003). The CDC method illustrated here provides guidelines for assessing an intervention by evaluating changes in various phases of single-case design experiments while taking into account various features of the graphed data. The CDC method is applied with the hope that multiple reviewers evaluating the same graph or series of graphs will reach the same conclusions regarding the pattern of data in the graphic display, thereby increasing the objectivity and interrater reliability of the visual decision-making process.

This guide assumes some background knowledge of single-case design and statistical analysis and some familiarity with resources on visual analysis of data (e.g., Franklin, Gorman, Beasley, & Allison, 1997; Parsonson & Baer, 1992; Tawney & Gast, 1984). But to provide a brief overview, single-case design includes the following characteristics:

- An individual "case" is the unit of intervention administration and data analysis (Kratochwill & Levin, 2010). A case may be a single participant or a cluster of participants (e.g., a classroom or a community).

- The case provides its own control for purposes of comparison. For example, the case's series of outcome variables are measured prior to the intervention and compared with measurements taken during and after the intervention.

- The outcome variable is measured repeatedly within and across different conditions or levels of the independent variable. These different conditions are referred to as *phases* (e.g., baseline phase, intervention phase; see Kratochwill et al., 2010, p. 2).

The current guide is designed to accompany a comprehensive review of the methodological, conceptual, and statistical aspects of visual analysis of data in single-case research (Kratochwill, Levin, & Swoboda, 2010). The guide is still under development, and some of the procedures it discusses are in need of empirical validation and refinement—tasks we are currently carrying out.

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Analysis of Single-Case Data

Overview

Single-case data (typically from either an individual or an aggregate such as a small group, classroom, or community) are often analyzed by graphing the outcomes on a session-by-session basis and then using a technique called *visual analysis* (Franklin et al., 1997; Horner & Spaulding, 2010; Kazdin, in press; Tawney & Gast, 1984). The researcher looks at the plotted data and compares the outcomes during the intervention sessions with the outcomes during sessions in which no intervention took place. In the simplest form of the single-case design, the AB design, a *baseline* is established by measuring the case several times during the A sessions (*A phase*) to determine what the measured behavior looks like before any intervention is performed. Once a baseline has been established, the researcher applies the intervention across several sessions while continuing to measure the outcome (*B phase*). The results from the B phase are then compared with those from the A phase to determine if change occurred from one phase to the next. Evidence for the reliability of the intervention effect is typically determined by a scientifically credible research design (reflecting what we have termed *methodological soundness*) that builds into the design structure both replication and an examination of outcomes that allows for valid documentation that an effect has occurred (termed *evidence credibility*; see Kratochwill & Levin, 2010). Various strategies for satisfying the methodological soundness criterion (including those incorporating some form of randomization into the design structure) are provided by Kratochwill and Levin (2010) but are beyond the scope of this paper.

The replication feature in single-case experimentation is addressed by one or more of the following design classes and associated procedures (see Horner et al., 2005):

- *ABAB designs:* Introduction and withdrawal (i.e., reversal) of the intervention;
- *Multiple-baseline designs:* Staggered introduction of the intervention across cases at different points in time; and
- *Alternating-treatment designs:* Iterative manipulation of the intervention across different observational phases (see Kratochwill et al., 2010, p. 3).

In this guide, we feature visual analysis procedures for the AB, ABAB, and multiple-baseline designs.

The What Works Clearinghouse (WWC; Kratochwill et al., 2010) has developed criteria for single-case designs that satisfy the methodological soundness criterion. Specifically, in a single-case research study the researcher must include “at least three attempts to demonstrate an intervention effect at three different points in time or with three different phase repetitions” (Kratochwill et al., 2010, p. 15; see also Horner & Spaulding, 2010). The three design classes listed above—(a) ABAB, (b) multiple-baseline, and (c) alternating-treatment designs—meet the WWC standard, as do some design variants not covered by this guide (e.g., changing criterion designs, combined single-case designs). Several designs do not meet the WWC standard, including AB and ABA designs, among others. The AB design is included in this guide simply to illustrate the application of Fisher et al.'s (2003) original CDC procedure and provide a useful springboard from which to extend that procedure to other designs.

The validity of visual analysis as a decision-making process is often challenged on the grounds that judgments about the relative success of interventions are subjective. The CDC method, outlined next, assists in overcoming the problem of subjectivity and the associated problem of low interrater reliability. By applying the CDC method correctly, researchers evaluating the same graph or series of graphs may reach the same conclusions regarding the evidence credibility, thereby increasing the objectivity and interrater reliability of the decision-making process.

CDC Method

Fisher et al. (2003) originally developed the CDC method to improve descriptive quantitative methods such as the *split-middle technique* (White & Haring, 1980) and the *percentage of nonoverlapping data method* (Scruggs, Mastropieri, & Casto, 1987) by increasing interrater reliability in traditional visual analysis. To apply the CDC method, one draws a line for level and a line for trend on the treatment graph using baseline data. The CDC method began as the dual-criterion (DC) method, but it was found that this approach did not appropriately control the rate of false positives (i.e., the Type I error rate) according to the inferential statistical test that Fisher et al. (2003) applied. However, by setting the level line and the trend line 0.25 standard deviations (SDs) further in the direction of the predicted treatment effect, Fisher et al. found that the CDC method adequately controlled for the rate of false positives and provided a conservative yet consistent method for analyzing single-case data.[1]

As noted, this guide extends the work of Fisher et al. (2003) by applying the CDC method to ABAB and multiple-baseline designs.[2] Visual analyses with and without the CDC method yield similar results in many situations. A major advantage of the CDC method, however, is that it evaluates and blends multiple sources of data to provide a consistent conclusion about *systematic* (as opposed to random) changes in the pattern of the data in a graphic display.

To take an example, in Figure 1 there are 10 data points in the treatment phase. According to Fisher et al. (Table 1), 8 of the data points must be above both the level line and the

[1] Unfortunately—as elaborated by Kratochwill, Levin, and Swoboda (2010)—just as visual analysts do not take into account the autocorrelated nature of single-case data, neither does the binomial test applied by Fisher et al. (2007) in their CDC method. In addition, Fisher et al.'s binomial test is actually two tests in one (*viz.*, a single test conducted in reference to both level and slope), and so the specific binomial probability incorporated into their test ($p = .5$) is not appropriate. At the same time, those authors have demonstrated that for a restricted set of simulation situations, the CDC procedure (with its more conservative additional 0.25 SD criterion) performs adequately with respect to Type I error rate control. The intent of this guide is to illustrate use of the CDC procedure as described by Fisher et al. and not to resolve the preceding issues. Consequently, we refrain from using the term *statistically significant* in the guide. We are in the process of reexamining the statistical properties of Fisher et al.'s CDC method in collaboration with John Ferron, adopting the *modified binomial test* approach of Onwuegbuzie, Levin, and Ferron (2005).

[2] The concerns expressed in the preceding footnote similarly apply to the CDC-method extensions (ABAB and multiple-baseline designs), inasmuch as they emerged as simple informal generalizations that are still in need of refinement and formal evaluation.

trend line to conclude that the treatment-phase change is systematic. Because all 10 data points in Figure 1 are above both lines, one can conclude that systematic change occurred from the baseline phase to the treatment phase.

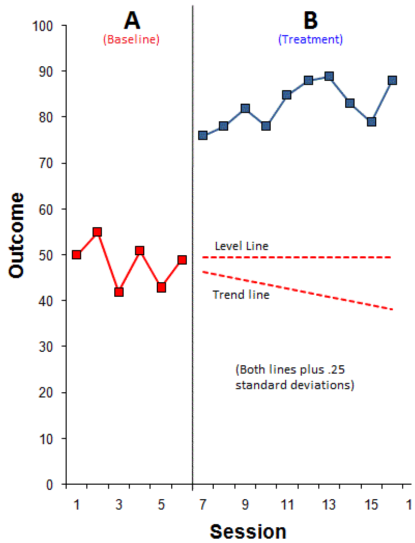


Figure 1. **AB graph showing an increase following treatment because 10 out of 10 treatment-phase points are above both lines (8 or more are needed).**

Table 1
Criteria for Concluding That the Treatment-Phase Change Is Systematic

No. of points in treatment phase	No. of points in predicted direction needed to conclude that there is systematic change
5	5
6–7	6
8	7
9–10	8
11–12	9
13	10
14	11
15–17	12
18–19	13
20–21	14
22–23	15

Note. **Adapted from "Visual Aids and Structured Criteria for Improving Visual Inspection and Interpretation of Single-Case Designs," by W. W. Fisher, M. E. Kelley, & J. E. Lomas, 2003, *Journal of Applied Behavior Analysis, 36*(3), p. 399.**

For each of three designs—AB, ABAB, and multiple baseline—this guide presents (a) a few basic examples, (b) a fourth example with context, and (c) an exercise (answers to the exercises are found in the appendix). In each instance, we use Fisher et al.'s (2003) criteria (Table 1) to determine the number of data points (representing outcome measures) needed to conclude that systematic change occurred from one phase to the next (but see Footnote 1). The CDC level and/or trend lines are provided when needed.

To summarize, Fisher et al.'s (2003) CDC method entails these four steps:

1. Count the number of data points in the treatment phase.
2. Look that number up in Table 1 to determine the number of points in the predicted direction of the treatment effect (i.e., either improvement or reduction in the outcome measure) needed to conclude that systematic change occurred.
3. Count the number of points in the treatment phase that are above *both* lines (or below both lines if the treatment is attempting to reduce the outcome measure).
4. If the number of data points from Step 3 is greater than or equal to the number required by Table 1 in Step 2, conclude that systematic change occurred from baseline to treatment. If not, conclude that there is not sufficient evidence of systematic change.[3]

AB Design

AB Example 1

For the CDC method, we count the number of points in the treatment phase (labeled B on the graph) that are above both the level line and trend line. In Figure 2, there are 10 points in the treatment phase. Using Table 1, we can again see that 8 points must be above both lines to conclude that systematic change occurred (specifically, that there was a change from the A phase to the B phase). Since 9 points are above the lines, we conclude that systematic change occurred, a conclusion consistent with that likely to be reached by a person using visual analysis.

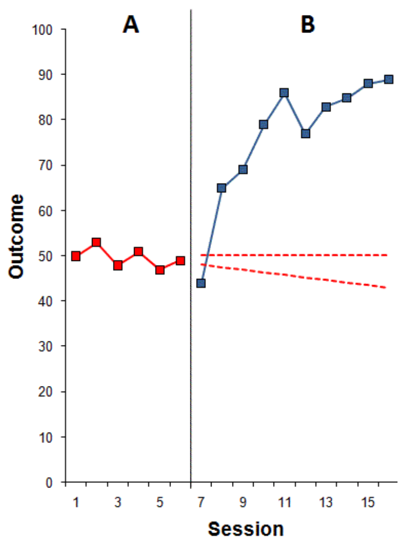


***Figure 2.* AB graph showing an increase following treatment because 9 out of 10 treatment-phase points are above both lines (8 or more are needed).**

[3] It is important to note that a formal data-analysis procedure such as the CDC method can be applied only to determine whether a systematic effect (in this case, a change) is present in the data; it cannot be used to attribute such an effect directly to the manipulated treatment. This is a methodological soundness consideration, which takes into account all the various factors related to the quality of the research design and the treatment implementation. For that reason, the conclusions in this guide's examples state only whether systematic change occurred from one experimental phase to the next and not whether the change was treatment-related.

AB Example 2

In the second AB example, a treatment is used to reduce the behavior in question. Applying the CDC method to Figure 3, we see that there are 8 treatment points but only 3 of them are below both lines. From Table 1, we find there need to be 7 points below both lines to conclude that systematic change occurred from the A phase to the B phase. Using the CDC method, we conclude that there is not adequate evidence of a systematic change.

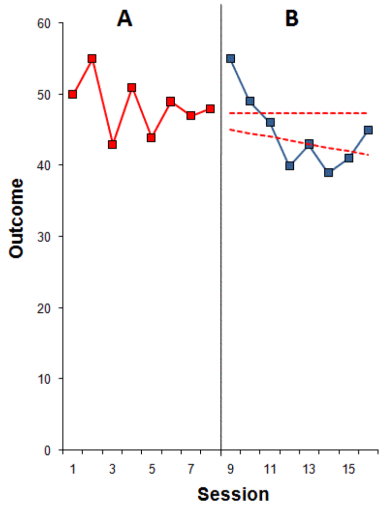


Figure 3. **AB graph showing no evidence of systematic change from the A phase to the B phase because only 3 out of 8 treatment-phase points are below both lines (7 or more are needed).**

AB Example 3

In the third AB example, a treatment is implemented to increase outcomes. In Figure 4, there are 11 points in the treatment phase, with none above the two lines. For evidence supporting a systematic change, 9 points need to be above both lines. Because no data points are above both lines, we conclude that there was no systematic change according to Fisher et al.'s (2003) CDC method and table. (Note that the adapted Table 1 is appropriate only for a 1-tailed test with a predicted direction for treatment.)

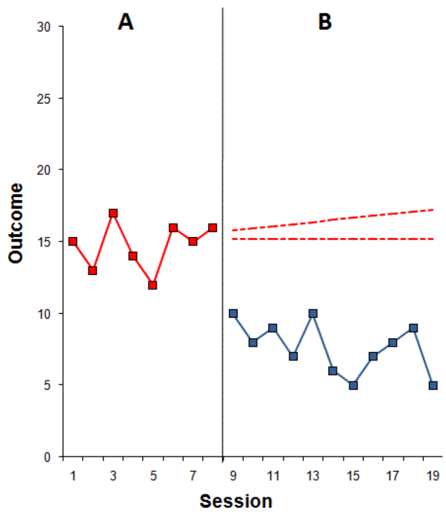


Figure 4. **AB graph showing no systematic change following treatment because 0 out of 11 treatment-phase points are above both lines (9 or more are needed).**

Contextualized AB Example

In this example, the data are from an AB study on the percentage of time a child conducted any peer relations with other children during one day's recess. The child was observed for 16 days. During the first 6 days, a baseline was established, and then a peer relations curriculum was administered for the final 10 days. Figure 5 shows the baseline and post-treatment data points.

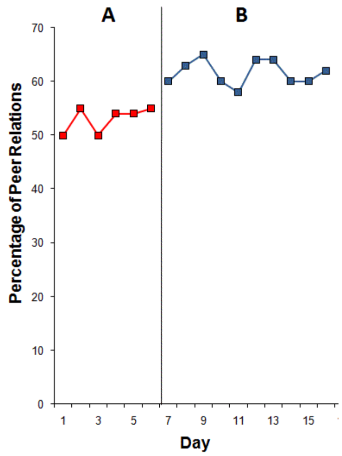


Figure 5. **Graph of percentage of peer relations during recess before and after curriculum.**

It is likely that different researchers asked to use visual analysis to analyze this graph would come to different conclusions about whether change occurred following introduction of the peer relations curriculum. With the CDC method, in contrast, a single decision is arrived at without the subjective judgments of the researcher.

In this example, the visual analyst would see that the *level* of the baseline phase is exceeded by every data point in the treatment phase. However, the visual analyst might not take into account the trend from the baseline phase. The CDC method evaluates both the level changes and the trend at baseline to determine whether systematic change occurred from one phase to the next. With 10 treatment data points in this example, Table 1 requires 8 or more to be above both lines. In the graph in Figure 6, only 6 treatment data points are above both lines. Thus, while change may have occurred, but it was not beyond what the trend line predicted. Using the CDC method, we conclude that there was no systematic change from the baseline to the treatment phase.

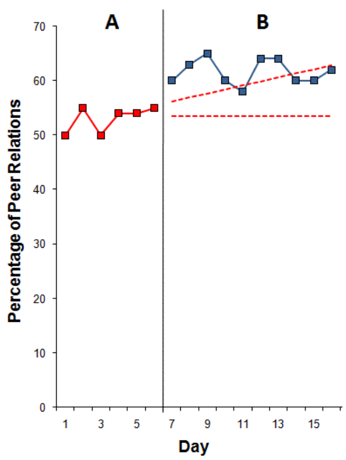


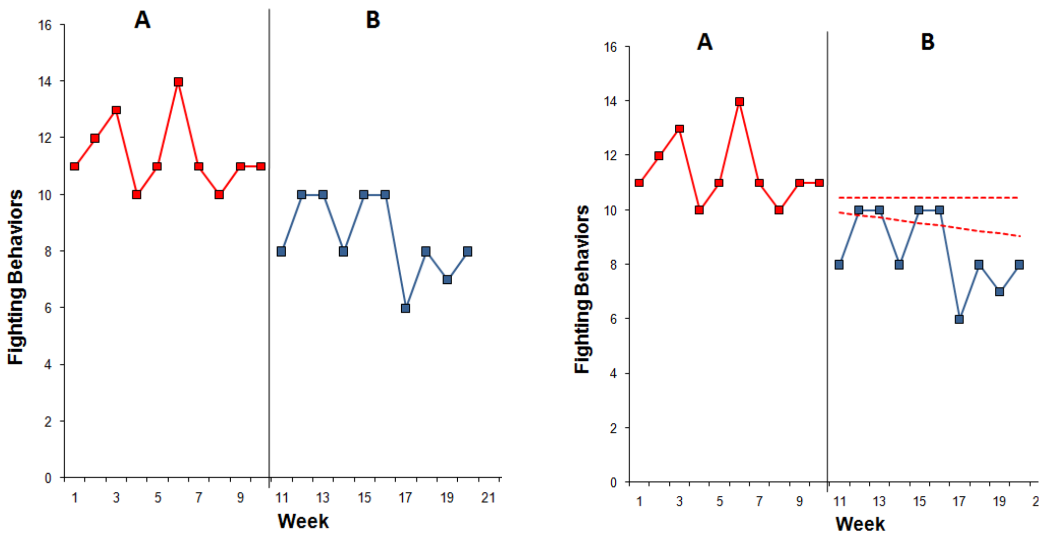
Figure 6. **Graph of percentage of peer relations during recess before and after curriculum with the CDC lines indicated.**

`AB Exercise

You are conducting research on the effectiveness of a new type of school reward system that awards elementary school students “reward slips” for every positive behavior exhibited. If the students collectively have enough slips at the end of the year, the whole school goes on a fun class trip. The reward system was enacted in response to increased fighting at recess and in the hallways, based on the hypothesis that the system would increase peer pressure not to fight and roughhouse and promote more socially appropriate behavior. The desired outcome for the intervention was a reduction in the number of fighting incidents leading to referrals to the principal’s office.

1. Visually examine the first set of A and B panels on the left of Exercise Figure 1 to decide whether there appears to be a change between phases of the design.

2. Now apply the CDC method to the second set of A and B panels on the right of Exercise Figure 1 and draw a conclusion.



Exercise Figure 1. **Left is a graph of fighting instances before and after implementing the reward system, and right is the same graph with the CDC lines inserted.**

ABAB Design

ABAB Example 1

In this example, the intervention is designed to reduce the outcome. In Figure 7, we break the ABAB into three AB designs—initial AB, BA, second AB—and then analyze each design separately. In the initial AB reduction treatment, we conclude that systematic change occurred because 10 of 10 data points are below both lines and only 8 are needed according to Table 1. The second reduction also indicates systematic change because 8 of 8 treatment points are below both lines and only 7 are needed. Finally, the BA reversal component checks to see if outcomes return to where they were when treatment is removed. There are 5 data points in the second A phase, and all 5 of them are above both lines (and, according to Table 1, all 5 are needed). Based on the CDC method, then, we conclude that all three AB designs show systematic change (initial reduction, return to baseline, replicated reduction; for additional consideration of this three-part approach, see Kratochwill & Levin, 2010).

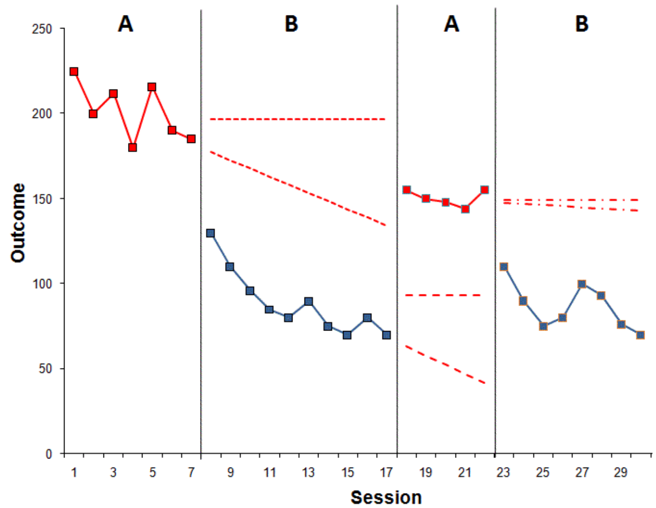


Figure 7. **ABAB graph showing systematic change across phases.**

ABAB Example 2

In the second ABAB example, the treatment is again designed to reduce the outcome. In Figure 8, we again break the ABAB into three AB designs (initial AB, BA, second AB) and then analyze them separately. The initial AB data pattern does not show systematic change because only 5 of 10 data points are below both lines, whereas 8 are needed according to Table 1. In the second AB pattern, only 4 of 8 treatment points are below both lines, as compared to the 7 that are needed, again leading to the conclusion that no systematic change occurred. Finally, the BA reversal component checks to see if outcomes return to where they were when treatment is removed. There are 5 data points in the second A phase, and only 1 of them is above both lines (all 5 are needed). Thus, there is not convincing evidence of change because none of the three AB tests meets the specified numerical criterion when the CDC method is applied.

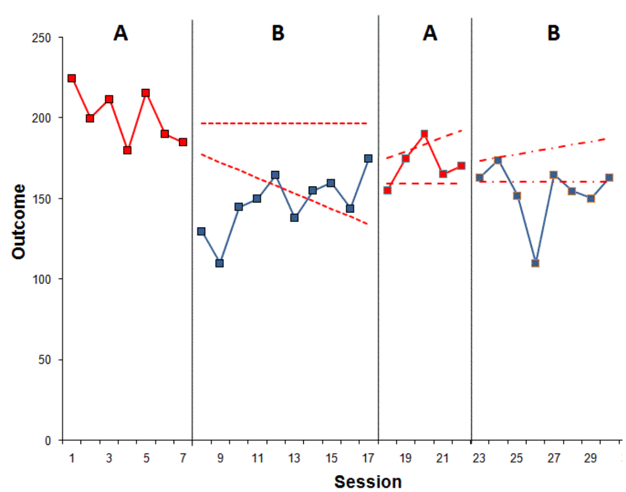


Figure 8. **ABAB graph showing no systematic change across phases.**

ABAB Example 3

In the third ABAB example (Figure 9), the treatment is designed to increase the outcome. In the initial AB data pattern, 6 of 6 points are above both lines, meeting the Table 1 criterion. In the second AB pattern, 6 of 6 treatment data points are above both lines, again meeting the criterion. Finally, the reversal (B to A) shows all 6 data points below both lines, yet again meeting the criterion. Because the initial treatment, the second (replication) treatment, and the reversal effects are all demonstrated, we conclude that systematic change occurred across phases.

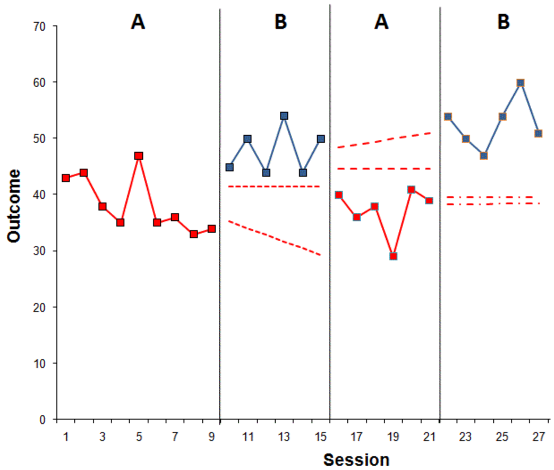


Figure 9. **ABAB graph showing systematic change across phases.**

Contextualized ABAB Example

In this example, the data are from an ABAB study of student performance on hard math problems as compared with easier problems. A fifth-grade teacher reported that a student was performing poorly on his in-class math problems, not because the problems were too difficult but because they were too easy (A phases). To verify her hypothesis, she gave the student much more difficult problems (B phases) to see how many the student could finish in class. The results are displayed in Figure 10.

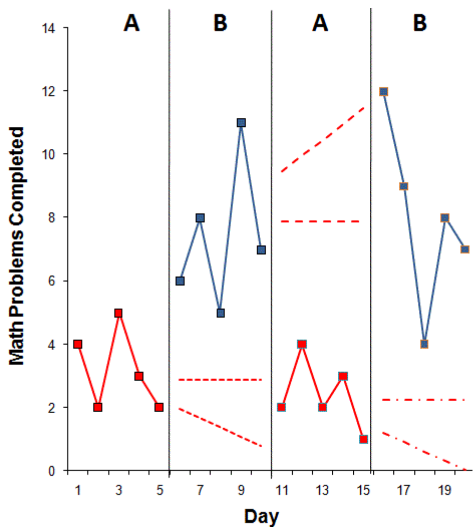


Figure 10. **ABAB graph showing easy math problems (A) and hard math problems (B) completed by a student.**

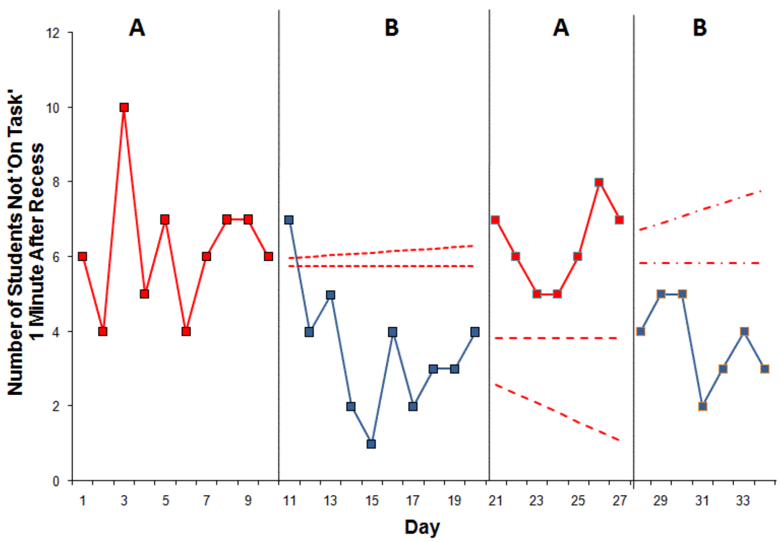
For the first AB comparison, all 5 of the treatment data points are above both lines, meeting the Table 1 criterion and providing evidence of systematic change. For the second AB comparison, all 5 of the treatment data points are also above both lines, again supporting a systematic phase-change conclusion. Finally, in the BA return-to-baseline comparison, all 5 treatment data points in the second A phase are below both lines, yet again suggesting that systematic change was documented. Because each of the three AB comparisons meets the CDC method's required numerical criterion, we conclude that there was systematic change between adjacent phases of the ABAB design.

ABAB Exercise

Every time a teacher's second-grade students go to recess, they come back unable to focus adequately for a sizeable amount of time. The teacher wants to try a new method of getting his students focused on their studies more quickly. He implements a reward system that gives students extra points if they are judged to be on task within one minute of returning to the classroom. To evaluate the reward system, he uses an ABAB design.

1. Visually examine the graph in Exercise Figure 2 and decide whether there is between-phase change in the amount of time it takes to get the class focused after recess.

2. Now apply the CDC method to make the same determination.



Exercise Figure 2. **ABAB graph showing number of students not on task after recess before (A) and after (B) implementation of the reward system.**

Multiple-Baseline Design

Multiple-Baseline Example 1

Multiple-baseline designs represent yet another class of single-case designs where visual analysis is typically used. These designs can be applied across participants, situations, or behaviors in a single individual or unit. These designs are structured as several AB designs, but with the intervention replicated in a staggered or lagged fashion. The results are then combined to make a decision about overall treatment effectiveness across the design units.

In the example in Figure 11, the researcher is applying the treatment in an attempt to increase the outcome. Individual A has 9 of 9 treatment-phase data points above both lines (8 are required by Table 1). For this individual, then, we conclude that systematic change occurred from the baseline to the treatment phase. In like fashion, we determine that the outcomes for each of the three other individuals similarly support systematic change from baseline to treatment, leading to the conclusion that there were increasing outcomes for all four individuals.

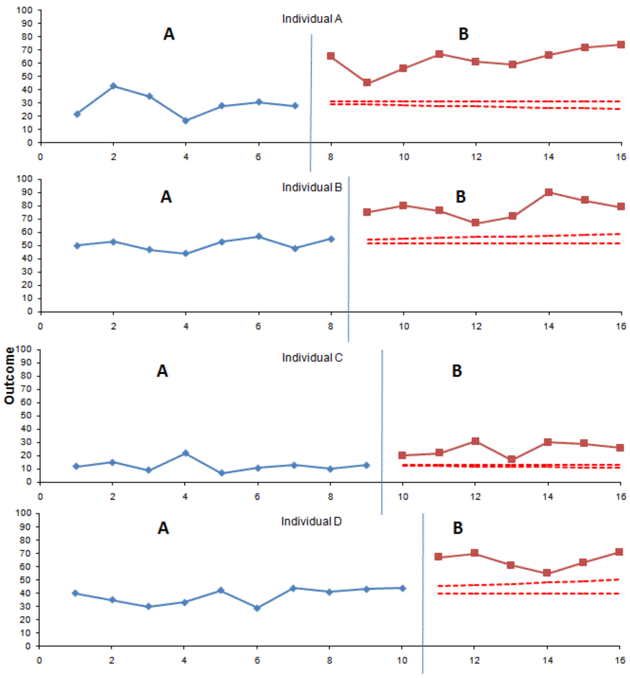


Figure 11. **Multiple-baseline graph showing systematic phase change across four individuals.**

Multiple-Baseline Example 2

In the second multiple-baseline example, the researcher is trying to reduce the outcome with treatment. Figure 12 depicts the graphs for the four individuals. Individual A shows evidence of a systematic change from baseline to treatment with 17 of 17 treatment data points below both lines (12 are needed). In contrast, Individuals B, C, and D do not show any systematic change from the baseline to the treatment phase. More important, Individuals B and C appear to have reduced baseline outcomes at around the same time the treatment intervention began for Individual A. This finding suggests the possibility of plausible explanations other than the treatment for the reduction in outcomes for some of the participants. Therefore, according to the CDC method, we conclude that no overall systematic change occurred in the outcomes of Individuals B–D.

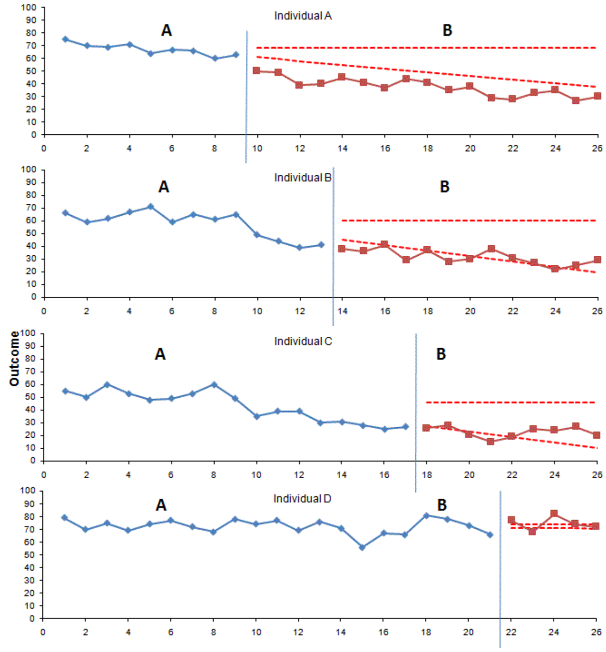


Figure 12. **Multiple-baseline graph showing no overall systematic change for three participants.**

Contextualized Multiple-Baseline Example

In this example, the data are from a multiple-baseline study of sharing among children. Sharing was identified as a problem for four children at a school. A sharing intervention was administered to the four children using a multiple-baseline design. Figure 13 shows the baseline and outcome data for the four children, with the level and trend lines not indicated. If we simply look at these graphs, we might well conclude that the intervention produced an increase in sharing behaviors.

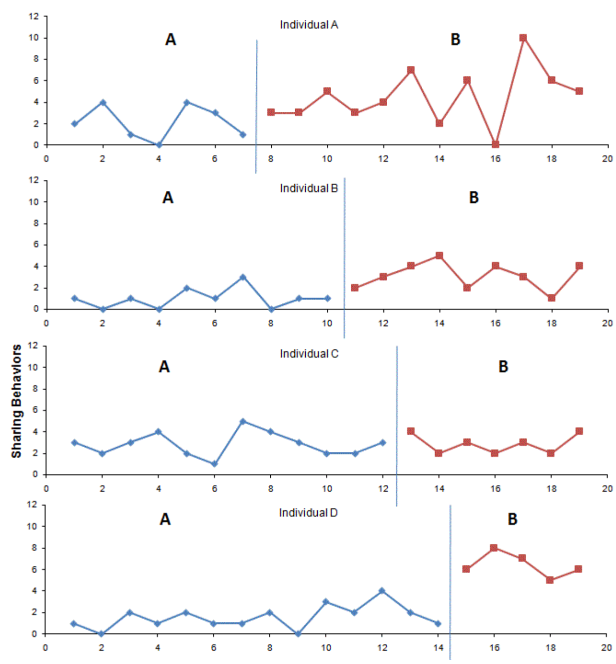


Figure 13. **Multiple-baseline graph showing outcomes for sharing behaviors across four participants with CDC lines not indicated.**

Next, we apply the CDC method to the same data (Figure 14). Individual A has 10 of 12 points above both lines, Individual B has 8 of 9 points above both lines, Individual C has 2 of 7 points above both lines, and Individual D has 5 of 5 points above both lines. Referring to Table 1 as before, we conclude that systematic change occurred from the baseline to the treatment phases for Individuals A, B, and D, but not for Individual C.

The conclusions the researcher draws from these data will depend on numerous issues, including whether the study meets the criteria for design structure and replication of the effect. This example met the design criterion by structuring replication into the experiment (i.e., there were “at least three attempts to demonstrate an intervention effect at three different points in time or with three different phase repetitions”; Kratochwill et al., 2010, p. 15), and it met the effect replication criterion for three out of four participants (Kratochwill et al., 2010). Given that these criteria were met, the outcomes in Figure 14 suggest that overall systematic change occurred.

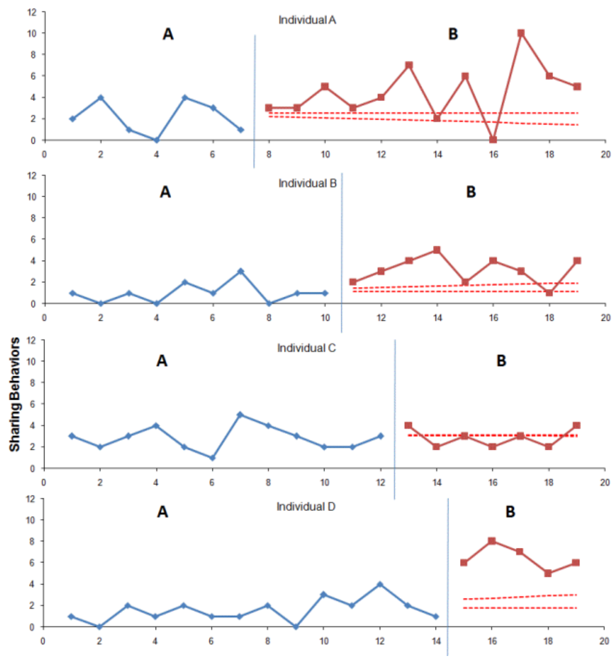
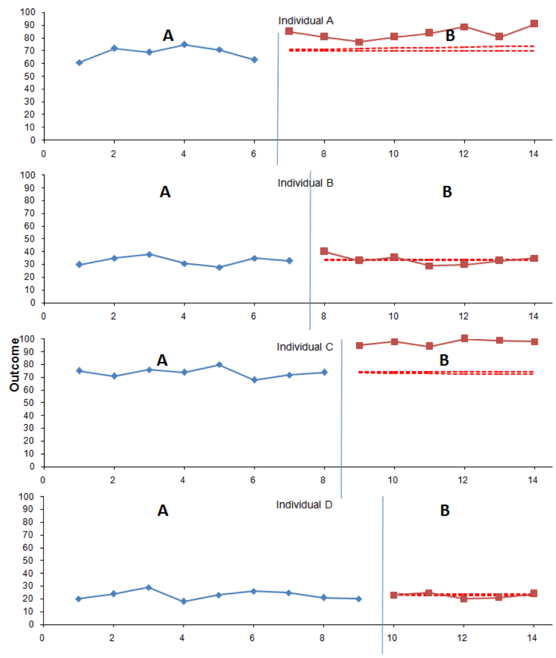


Figure 14. **Multiple-baseline graph showing outcomes for sharing behaviors across four participants with CDC lines indicated.**

Multiple-Baseline Exercise

A school psychologist is trying to increase the percentage of time during story time that a group of difficult students engages in appropriate (rather than disruptive) behavior. To do so, she introduces a new method of treatment.

1. Visually inspect the data in Exercise Figure 3 to decide whether there appears to be systematic change from baseline to treatment for each participant.



Exercise Figure 3. **Percentage of appropriate behavior during story time for four children before and after a treatment designed to reduce disruptive behavior.**

2. Now apply the CDC method and draw a conclusion. Note that the trend line and the mean line are the same for both Individual B and Individual D during the treatment phase.

Summary of Decision Rules

1. *AB designs.* Determine whether systematic change occurred from baseline to treatment by (a) counting the number of data points in the treatment phase that are above both CDC lines (or below, for a reduction treatment) and then (b) looking up the number required by Table 1 based on the total number of treatment points. If the number of points above both lines (or below in a reduction treatment) is greater than or equal to the number of points required by the table, then conclude that systematic change occurred from baseline to treatment (but not necessarily that the treatment was effective).

2. *ABAB designs.* Determine if systematic change occurred between adjacent phases by demonstrating (a) change in the series for both the first and second AB comparisons and (b) a return to baseline for the BA comparison. Unless all three of these results demonstrate that systematic change has occurred with the CDC method, conclusions about overall systematic change cannot begin to be established.

3. *Multiple-baseline designs.* Determine whether systematic change occurred from baseline to treatment for each individual in separate AB phase comparisons. Overall systematic change is established by replication of the effect with an agreed-upon number of participants to whom the CDC method has been applied.

Data Entry Tutorial

1. Open the provided Excel file[4] that corresponds to the design you are using (AB, ABAB, multiple baseline) and click on the Data tab. You should see the following:

ABAB analysis: Enter the data like below leaving bla

Session	A1	B1	A2	B2
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

Step 1

2. For this ABAB example, enter all of your baseline data points in Column A1. In the example, there are 6 baseline points.

3. Start the first treatment phase under the B1 column at the next session.

ABAB analysis: Enter the data like below leaving bla

Session	A1	B1	A2	B2
1	7			
2	10			
3	13			
4	11			
5	14			
6	17			
7		24		
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

Steps 2 + 3

[4] Please contact the authors for the Excel file to conduct these CDC methods.

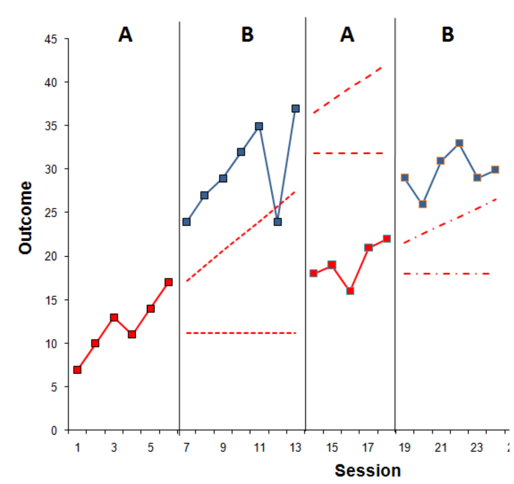
4. Continue filling in the remaining first treatment phase points in the B1 column. Enter the points in the A2 and B2 columns in a similar fashion. There will never be any overlapping data points in an AB or ABAB design.

ABAB analysis: Enter the data like below leaving blar

Session	A1	B1	A2	B2
1	7			
2	10			
3	13			
4	11			
5	14			
6	17			
7		24		
8		27		
9		29		
10		32		
11		35		
12		24		
13		37		
14			18	
15			19	
16			16	
17			21	
18			22	
19				29
20				26
21				31
22				33
23				29
24				30
25				

Step 4 (AB * ABAB designs)

5. Check the graph to see if everything came out correctly, by clicking on the Results tab. You may have to adjust the cosmetic aspects of the graph (e.g., phase lines and labels). Note that the example shown represents change across the comparison phases of the design.



Step 5 (AB * ABAB designs)

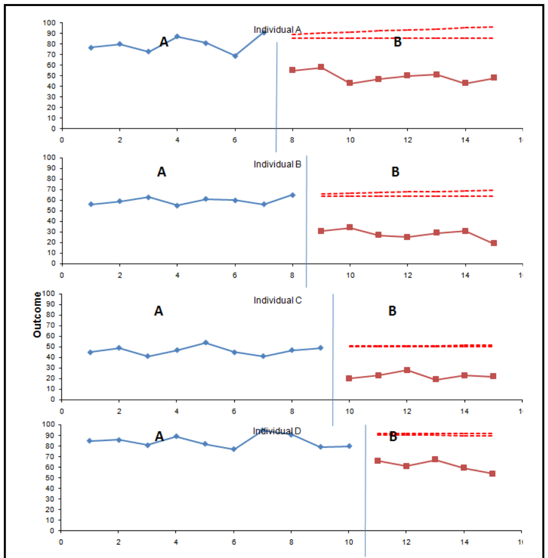
6. When using a multiple-baseline design, follow the above rules, except that each individual begins at Session 1.

MBL analysis: Enter the data like below leaving blank points without data

Session	A1	A2	B1	B2	C1	C2	D1	D2
1	77		56		45		85	
2	80		59		49		86	
3	73		63		41		81	
4	87		55		47		89	
5	81		61		54		82	
6	69		60		45		77	
7	91		56		41		95	
8		55	65		47		91	
9		58		31	49		79	
10		43		34		20	80	
11		47		27		23		66
12		50		25		28		61
13		51		29		19		67
14		43		31		23		59
15		48		19		22		54
16								
17								

Step 6 (Multiple Baseline Only)

7. The entered data result in the graph at right, demonstrating systematic overall change across participants in a reduction treatment.



Step 7 (Multiple Baseline Only)

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Appendix
Answers to the Exercises

AB Design

Exercise

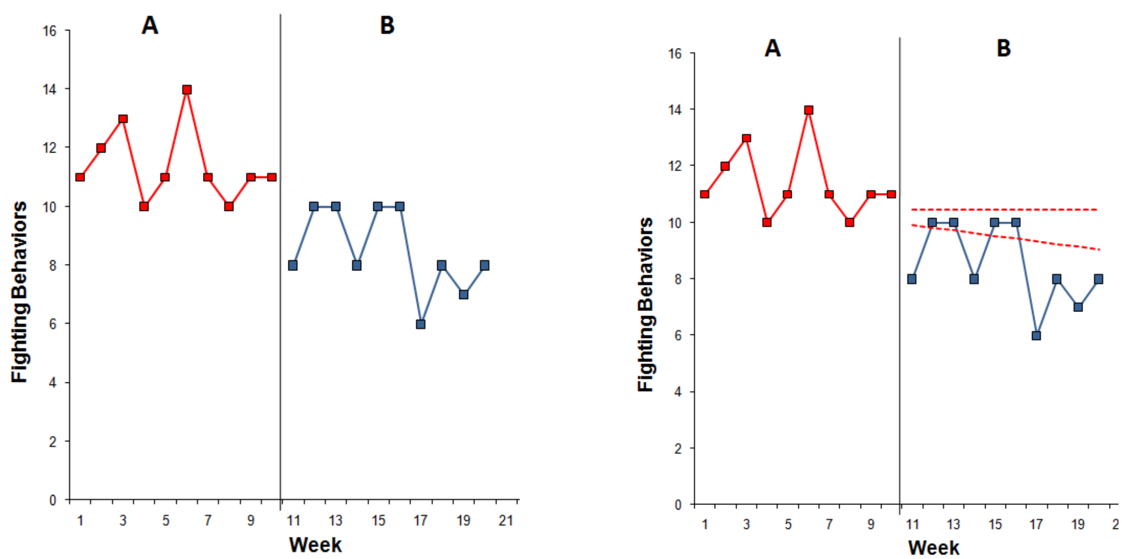
You are conducting research on the effectiveness of a new type of school reward system that awards elementary school students “reward slips” for every positive behavior exhibited. If the students collectively have enough slips at the end of the year, the whole school goes on a fun class trip. The reward system was enacted in response to increased fighting at recess and in the hallways, based on the hypothesis that the system would increase peer pressure not to fight and roughhouse and promote more socially appropriate behavior. The desired outcome for the intervention was a reduction in the number of fighting incidents leading to referrals to the principal’s office.

1. Visually examine the first set of A and B panels on the left of Exercise Figure 1 to decide whether there appears to be a change between phases of the design.

2. Now apply the CDC method to the second set of A and B panels on the right of Exercise Figure 1 and draw a conclusion.

Answer

Although the treatment may seem to be effective at first glance, the CDC method does not confirm treatment effectiveness because only 6 of 10 treatment data points are below both lines, and 8 or more are required by Table 1.



Exercise Figure 1. **Left is a graph of fighting instances before and after implementing the reward system, and right is the same graph with the CDC lines inserted.**

ABAB Design

Exercise

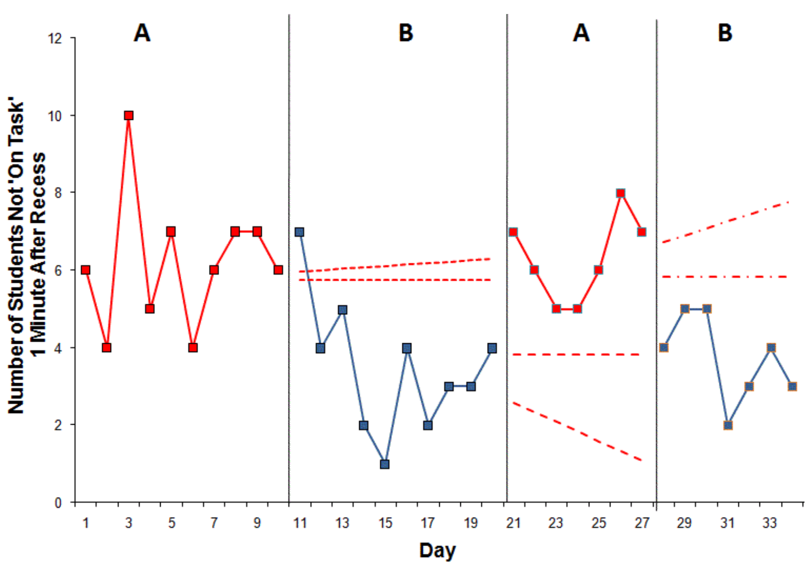
Every time a teacher's second-grade students go to recess, they come back unable to focus adequately for a sizeable amount of time. The teacher wants to try a new method of getting his students focused on their studies more quickly. He implements a reward system that gives students extra points if they are judged to be on task within one minute of returning to the classroom. To evaluate the reward system, he uses an ABAB design.

1. Visually examine the graph in Exercise Figure 2 and decide whether there is between-phase change in the amount of time it takes to get the class focused after recess.

2. Now apply the CDC method to make the same determination.

Answer

The first AB comparison shows a systematic change (reduction) because 9 of the 10 treatment phase data points are below both lines (and 8 are required). The second AB comparison also shows a systematic change (reduction) because 7 of the 7 treatment data points are below both lines (6 are required). Finally, in the BA return to baseline, systematic change is present because 7 of the 7 "treatment" data points are above both lines. Because all three comparisons meet the numerical criteria of Table 1, we determine by the CDC method that overall systematic change occurred between A and B phases.



Exercise Figure 2. **ABAB graph showing number of students not on task after recess before (A) and after (B) implementation of the reward system.**

Multiple-Baseline Design

Exercise

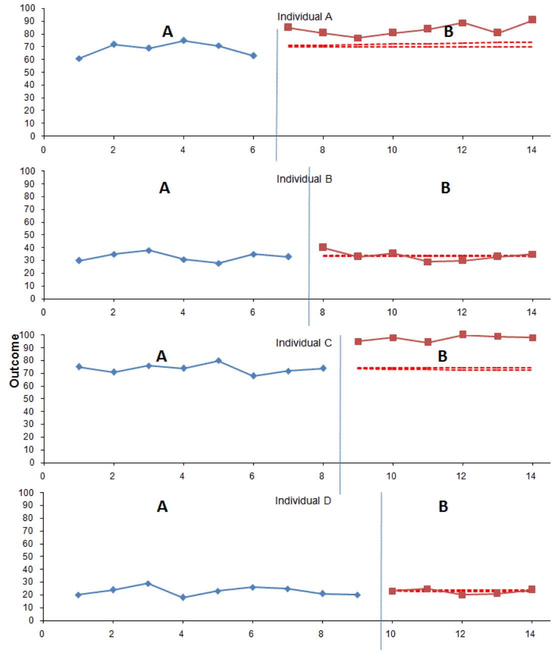
A school psychologist is trying to increase the percentage of time during story time that a group of difficult students engages in appropriate (rather than disruptive) behavior. To do so, she introduces a new method of treatment.

1. Visually inspect the data in Exercise Figure 3 to decide whether there appears to be systematic change from baseline to treatment for each participant.

2. Now apply the CDC method and draw a conclusion. Note that the trend line and the mean line are the same for both Individual B and Individual D during the treatment phase.

Answer

Although Individuals A and C exhibit systematic change according to the CDC method, Individuals B and D do not. Therefore, these data do not show evidence of replicating the treatment across all four participants. In this particular example, the school psychologist might hypothesize that the treatment is more effective for students with minor behavior problems (Individuals A and C, with their comparatively higher baseline levels) than for those with major behavior problems (Individuals B and D, with their comparatively lower baseline levels). To explore this hypothesis further, however, additional carefully controlled intervention experiments would need to be conducted.



Exercise Figure 3. **Percentage of appropriate behavior during story time for four children before and after a treatment designed to reduce disruptive behavior.**