Brakes Assembled" is a *y*-axis label that indicates the work output of a person who puts together bicycle brakes.

Research Designs

When people conduct research in behavior modification, they use research designs that include more complex types of graphs. The purpose of a research design is to determine whether the treatment (independent variable) was responsible for the observed change in the target behavior (dependent variable) and to rule out the possibility that extraneous variables caused the behavior to change. In research an *independent variable* is what the researcher manipulates to produce a change in the target behavior. The target behavior is called the *dependent variable*. An extraneous variable, also called a confounding variable, is any event that the researcher did not plan that may have affected the behavior. For a person with a problem, it may be enough to know that the behavior changed for the better after using behavior modification procedures. However, a researcher also wants to demonstrate that the behavior modification procedure is what caused the behavior to change.

When a researcher shows that a behavior modification procedure causes a target behavior to change, the researcher is demonstrating a **functional relationship** between the procedure and the target behavior. In other words, the researcher demonstrates that the behavior changes as a function of the procedure. A functional relationship is established if a target behavior changes when an independent variable is manipulated (a procedure is implemented), while all other variables are held constant, and the process is replicated or repeated one or more times and the behavior changes each time. A behavior modification researcher uses a research design to demonstrate a functional relationship. A research design involves both treatment implementation and replication. If the behavior changes each time the procedure is implemented and only when the procedure is implemented, a functional relationship is demonstrated. In this case, we would say that the researcher has demonstrated experimental control over the target behavior. It is unlikely that an extraneous variable caused the behavior change if it changed only when the treatment was implemented. This section reviews research designs used in behavior modification (for further information on behavior modification research designs see Bailey, 1977; Barlow & Hersen, 1984; Hayes, Barlow, & Nelson-Gray, 1999; Poling & Grossett, 1986).

A-B Design

The simplest type of design used in behavior modification has just two phases: baseline and treatment. This is called an **A-B design,** where A = baseline and B = treatment. A-B designs are illustrated in Figures 3-1, 3-7, 3-8b, and 3-10. By means of an A-B design, we can compare baseline and treatment to determine whether the behavior changed in the expected way after treatment. However, the A-B design does not demonstrate a functional relationship because treatment is not implemented a second time. Therefore, the A-B design is not a true research design; it does not rule out the possibility that an extraneous variable was responsible for the behavior change. For example, although the mouth-biting behavior decreased when the competing response treatment was implemented in Figure 3-1, it is possible that some other event (extraneous variable) occurred at the same time as treatment was implemented. In that case, the decrease in mouth-biting may have resulted from the other event or a combination of treatment and the other event. For example, the person may have seen a TV show about controlling nervous habits and learned from that how to control her mouth-biting. Because the A-B design does not rule out other causes, it is rarely used by behavior modification researchers. It is most often used in applied, nonresearch situations, in which people are more interested in demonstrating that behavior change has occurred than in proving that the behavior modification procedure caused the behavior change. You probably would use an A-B graph in a self-management project to show whether your behavior changed after you implemented a behavior modification procedure.

A-B-A-B Reversal Design

The **A-B-A-B reversal design** is an extension of the simple A-B design (where A = baseline and B = treatment). In the A-B-A-B design, baseline and treatment phases are implemented twice. It is called a reversal design because after the first treatment phase, the researcher removes the treatment and reverses back to baseline. This second baseline is followed by replication of the treatment. Figure 3-11 illustrates an A-B-A-B design.

The A-B-A-B graph in Figure 3-11 shows the effect of a teacher's demands on the aggressive behavior of an adolescent with mental retardation named Bob. Carr and his colleagues (Carr, Newsom, & Binkoff, 1980) studied the influence of demands on Bob's aggressive behavior by alternating phases in which teachers made frequent demands with phases in which teachers made no demands. In Figure 3-11 you can see that the behavior changed three times. In the baseline phase ("Demands"), the aggressive behavior occurred frequently. When the treatment phase ("No Demands") was first implemented, the behavior decreased. When the second "Demands" phase occurred, the behavior returned to its level during the first "Demands" phase. Finally, when the "No Demands" phase was implemented a second time, the behavior decreased again. The fact that the behavior changed three times, and only when the phase changed, is evidence that the change in demands (rather than some extraneous variable) caused the behavior change. When the demands were turned on and off each time, the behavior changed accordingly. It is highly unlikely that an extraneous variable was turned on and off at exactly the same time as the demands, so it is highly unlikely that any other variable except the independent variable (change in demands) caused the behavior change.

A number of considerations must be taken into account in deciding whether to use the A-B-A-B research design. First, it may not be ethical to remove the treatment in the second baseline if the behavior is dangerous (for example, self-injurious behavior). Second, you must be fairly certain that the level of the behavior will reverse when treatment is withdrawn. If the behavior fails to change when the treatment is withdrawn, a functional relationship is not demonstrated. Another consideration is whether you can actually remove the treatment after it is implemented. For example, if the treatment is a teaching procedure and the subject learns a new behavior, you cannot take away the learning that took place. For a more detailed discussion of considerations

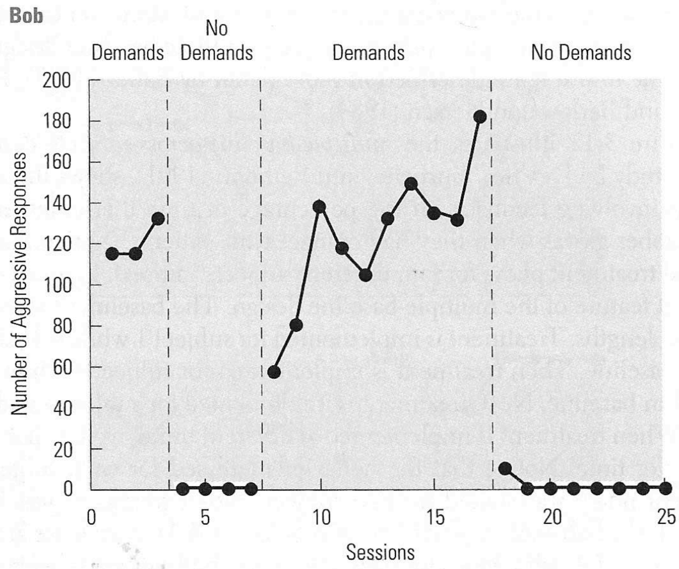

FIGURE 3-11 This A-B-A-B graph (from the study by Carr, Newsom, & Binkoff, 1980) shows the frequency of aggressive behaviors by an adolescent with mental retardation during baseline phases involving demands (A) and treatment phases involving no demands (B).

in the use of the A-B-A-B design, see Bailey (1977), Bailey and Burch (2002), and Barlow and Hersen (1984).

Multiple-Baseline Design

There are three types of multiple-baseline designs.

- In a **multiple-baseline-across-subjects design,** there is a baseline and a treatment phase for the same target behavior of two or more different subjects.
- In a **multiple-baseline-across-behaviors design,** there is a baseline and treatment phase for two or more different behaviors of the same subject.
- In a **multiple-baseline-across-settings design,** there is a baseline and treatment phase for two or more settings in which the same behavior of the same subject is measured.

Remember that the A-B-A-B design can also have two baseline phases and two treatment phases, but both baseline and treatment phases occur for the same behavior of the same subject in the same setting. With the multiple-baseline design, the different baseline and treatment phases occur for different subjects, or for different behaviors, or in different settings.

A multiple-baseline design may be used when you are interested in the same target behavior exhibited by multiple subjects, when you have targeted more than one behavior of the same subject, or when you are measuring a subject's behavior across two or more settings. A multiple-baseline design is useful when you cannot use an A-B-A-B design for the reasons listed previously. The multiple-baseline design and the appropriate time to use it are described in more detail by Bailey (1977), Bailey and Burch (2002), and Barlow and Hersen (1984).

Figure 3-12 illustrates the *multiple-baseline-across-subjects design.* This graph, from a study by DeVries, Burnette, and Redmon (1991), shows the effect of an intervention involving feedback on the percentage of time that emergency room nurses wore rubber gloves when they had contact with patients. Notice that there is a baseline and treatment phase for four different subjects (nurses). Figure 3-12 also illustrates a critical feature of the multiple-baseline design: The baselines for each subject are of different lengths. Treatment is implemented for subject 1 while subjects 2, 3, and 4 are still in baseline. Then treatment is implemented for subject 2 while subjects 3 and 4 are still in baseline. Next, treatment is implemented for subject 3 and, finally, for subject 4. When treatment is implemented at different times, we say that treatment is staggered over time. Notice that the behavior increased for each subject only after the treatment phase was started for that subject. When treatment was implemented for subject 1, the behavior increased, but the behavior did not increase at that time for subjects 2, 3, and 4, who were still in baseline and had not yet received treatment. The fact that the behavior changed for each subject only after treatment started is evidence that the treatment, rather than an extraneous variable, caused the behavior change. It is highly unlikely that an extraneous variable would happen to occur at exactly the same time that treatment started for each of the four subjects.

A *multiple-baseline-across-behaviors design* is illustrated in Figure 3-13. This graph, from a study by Franco, Christoff, Crimmins, and Kelly (1983), shows the effect of treatment (social skills training) on four different social behaviors of a shy adolescent: asking questions, acknowledging other people's comments, making eye contact, and showing affect (e.g., smiling). Notice in this graph that treatment is staggered across the four behaviors and that each of the behaviors changes only after treatment is implemented for that particular behavior. Because each of the four behaviors changed only after treatment was implemented for that behavior, the researchers demonstrated that treatment, rather than some extraneous variable, was responsible for the behavior change.

A graph used in a *multiple-baseline-across-settings design* would look like those in Figures 3-12 and 3-13. The difference is that in a multiple-baseline-across-settings graph, the same behavior of the same subject is being recorded in baseline and treatment phases in two or more different settings, and treatment is staggered across the settings.

Draw a graph of a multiple-baseline-across-settings design with hypothetical data. Be sure to include all six components of a complete graph. Assume that you have recorded the disruptive behavior of a student in two different classrooms using an interval recording system. Include baseline and treatment across two settings in the graph.

The graph in Figure 3-14, from a study by Dunlap, Kern-Dunlap, Clarke, and Robbins (1991), shows the percentage of intervals of disruptive behavior by a student during baseline and treatment (revised curriculum) in two settings, the morning and afternoon classrooms. It also shows follow-up, in which the researchers collected data

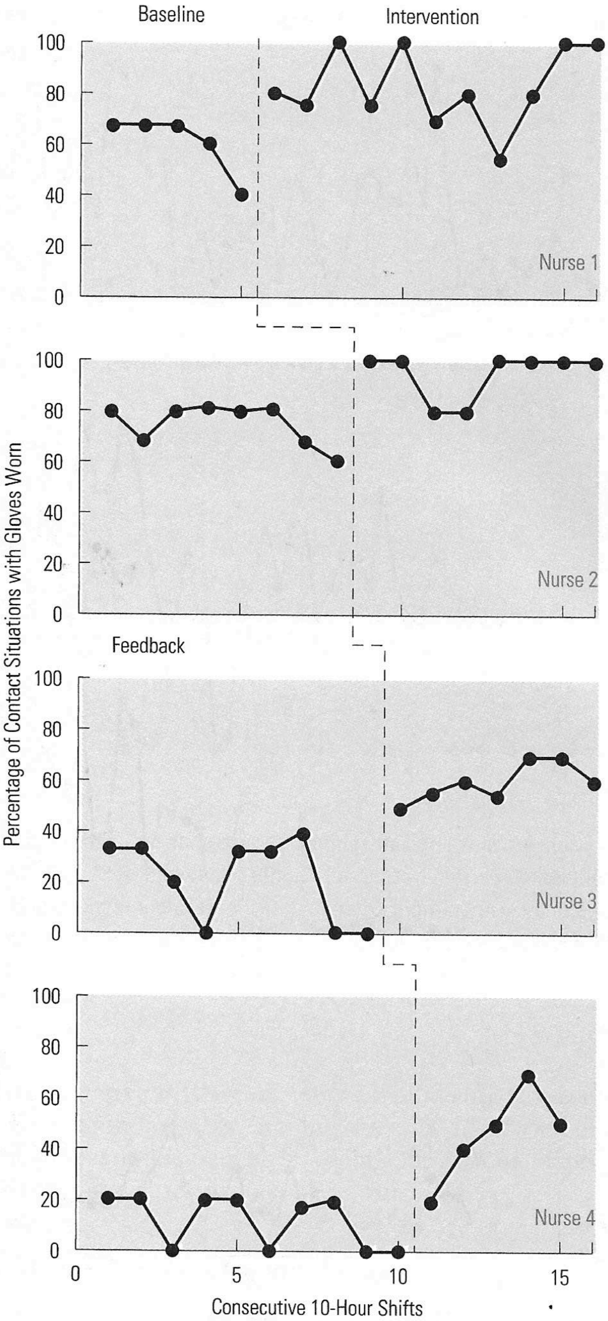

FIGURE 3-12 This multiple-baseline-across-subjects graph (from the study by DeVries, Burnette, & Redmon, 1991) shows the percentage of time that four emergency room nurses wear rubber gloves when they have contact with patients. The intervention, which involves feedback from their supervisor, is staggered over time and results in an increase in the behavior for each of the four nurses.

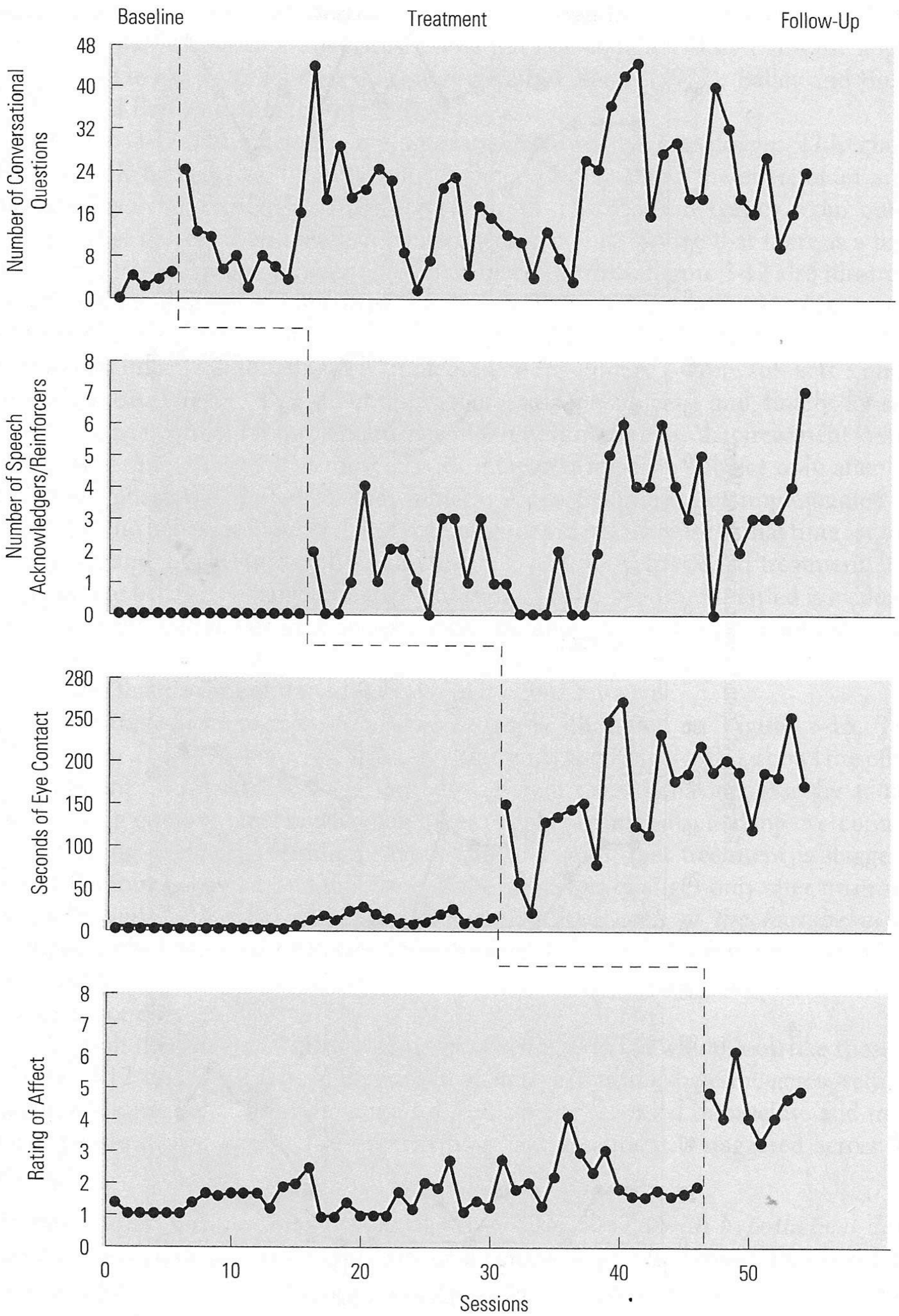

Figure 3-13 This multiple-baseline-across-behaviors graph (from the study by Franco, Christoff, Crimmins, & Kelly, 1983) shows four social behaviors exhibited by a shy adolescent. A social skills training intervention is applied to each of these four behaviors, and each behavior increases when the intervention is applied to it.

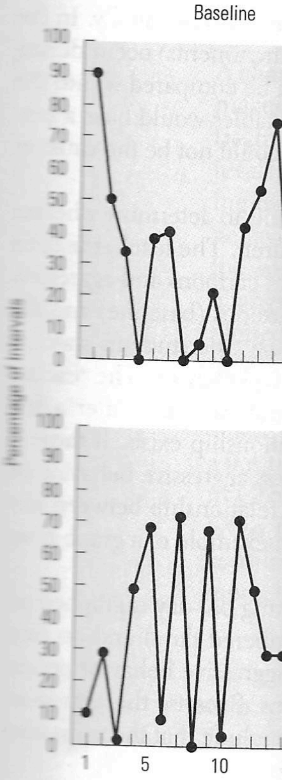

Figure 3-14 This multi
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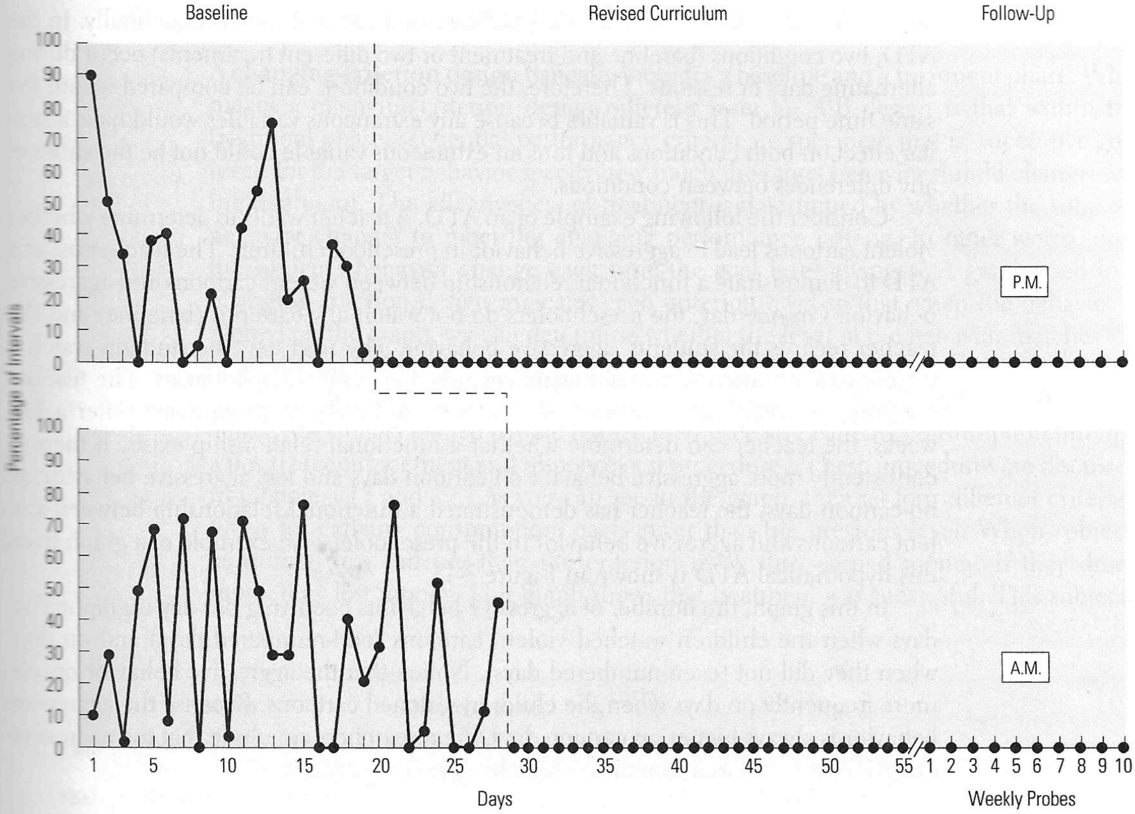

FIGURE 3-14 This multiple-baseline-across-settings design (from the study by Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991) shows the effect of a revised curriculum on the disruptive behavior of an adolescent in a classroom setting in the morning (A.M.) and another classroom setting in the afternoon (P.M.). The authors used interval recording and put the percentage of intervals of disruptive behavior on the graph.

once a week for 10 weeks. Notice that treatment was implemented first in one setting and then in the other, and the student's disruptive behavior changed only after treatment was implemented in each setting. Your graph of a multiple-baseline-across-settings design would look like Figure 3-14.

Alternating-Treatments Design

The **alternating-treatments design (ATD)**, also called a multielement design, differs from the research designs just reviewed in that baseline and treatment conditions (or two treatment conditions) are conducted in rapid succession and compared with each other. For example, treatment is implemented on one day, baseline the next day, treatment the next day, baseline the next day, and so on. In the A-B, A-B-A-B, or multiple-baseline designs, a treatment phase occurs after a baseline phase has been implemented for a period of time; in other words, baseline and treatment occur sequentially. In the ATD, two conditions (baseline and treatment or two different treatments) occur during alternating days or sessions. Therefore, the two conditions can be compared within the same time period. This is valuable because any extraneous variables would have a similar effect on both conditions and thus an extraneous variable could not be the cause of any differences between conditions.

Consider the following example of an ATD. A teacher wants to determine whether violent cartoons lead to aggressive behavior in preschool children. The teacher uses an ATD to demonstrate a functional relationship between violent cartoons and aggressive behavior. On one day, the preschoolers do not watch any cartoons (baseline) and the teacher records the students' aggressive behavior. The next day, the students watch a violent cartoon and the teacher again records their aggressive behavior. The teacher continues to alternate a day with no cartoons and a day with cartoons. After a few weeks, the teacher can determine whether a functional relationship exists. If there is consistently more aggressive behavior on cartoon days and less aggressive behavior on no-cartoon days, the teacher has demonstrated a functional relationship between violent cartoons and aggressive behavior in the preschoolers. An example of a graph from this hypothetical ATD is shown in Figure 3-15.

In this graph, the number of aggressive behaviors occurring per day is graphed on days when the children watched violent cartoons (odd-numbered days) and on days when they did not (even-numbered days). Notice that the aggressive behavior occurs more frequently on days when the children watched cartoons. Because the aggressive behavior is always higher on cartoon days, the researchers conclude that the aggressive behavior occurred as a function of watching violent cartoons.

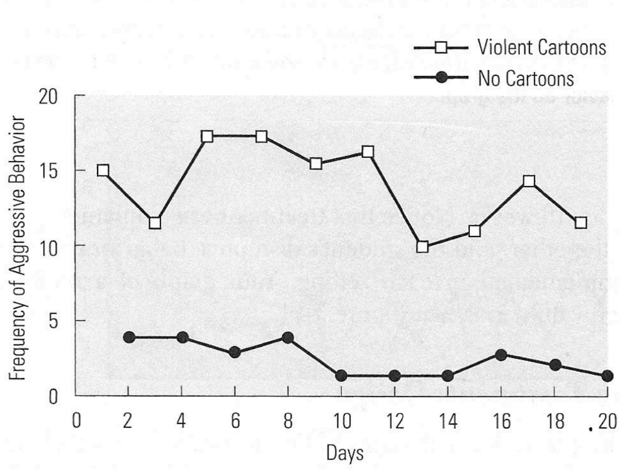

FIGURE 3-15 This alternating-treatments design shows the frequency of aggressive behavior on days when children watched violent cartoons compared to days when they did not watch cartoons. The level of the aggressive behavior is higher on days with violent cartoons than on days with no cartoons.

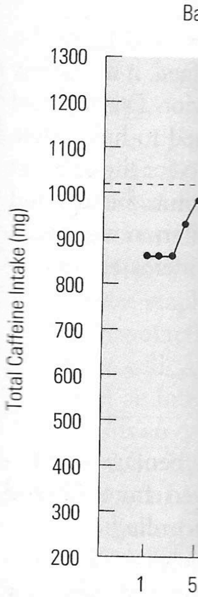

FIGURE 3-16

Changing-Criterion Design

A **changing-criterion design** typically includes a baseline and a treatment phase. What makes a changing-criterion design different from an A-B design is that within the treatment phase, sequential performance criteria are specified; that is, successive goal levels for the target behavior specify how much the target behavior should change during treatment. The effectiveness of treatment is determined by whether the subject's behavior changes to meet the changing performance criteria. In other words, does the subject's behavior change each time the goal level changes? A graph used in a changing-criterion design indicates each criterion level so that when the behavior is plotted on the graph, we can determine whether the level of the behavior matches the criterion level.

Consider the graph in Figure 3-16, from a study by Foxx and Rubinoff (1979). These researchers helped people reduce their excessive caffeine consumption through a positive reinforcement and response cost procedure. (These procedures are discussed in Chapters 15 and 17.) As you can see in the graph, they set four different criterion levels for caffeine consumption, each lower than the previous level. When subjects consumed less caffeine than the criterion level, they earned money. If they drank more, they lost money. This graph shows that treatment was successful: This subject's

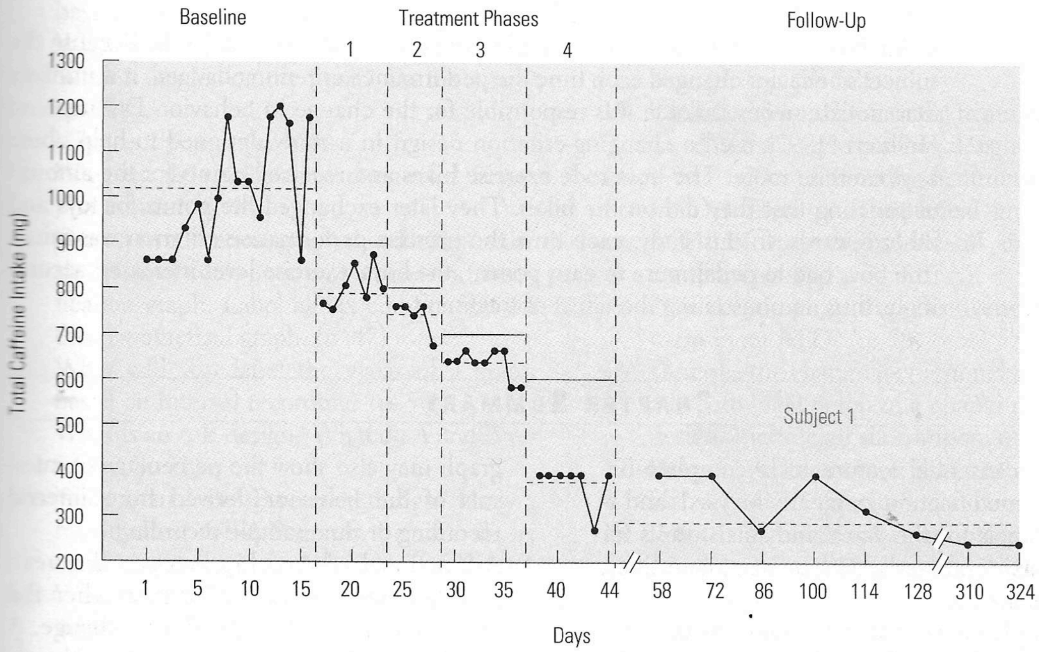

FIGURE 3-16 This changing-criterion graph is from a study by Foxx and Rubinoff (1979). They found that caffeine consumption decreased to a level below the criterion each time the criterion was lowered. The solid horizontal bars in treatment phases 1–4 are the criterion lines. The dashed lines show the mean level of the behavior in each phase.