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Notes

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2. The case study described herein was developed by Robert W. Grossman in a White awareness workshop sponsored by a grant from the Upjohn Company.
3. We thank three reviewers for their helpful comments.
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A Classroom Demonstration of Single-Subject Research Designs

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This article provides a brief overview of single-subject designs and describes a classroom demonstration useful in teaching these designs to undergraduate psychology majors. Using a reversal design as a methodological frame, students collect repeated measures of their own behavior, and they graph and visually interpret the data.

When conducting experimental research, social scientists most often use group designs to assess behavior change (Kantowitz, Roediger, & Elmes, 1994). Likewise, psychology classes and textbooks in experimental design focus almost exclusively on group research. An alternative to the analysis of group data is the single-subject design (Baer, Wolf, & Risley, 1968; Krishef, 1991). A group design often requires many subjects to achieve adequate power and identify statistically significant differences between group means. Alternatively, a single-subject design can require only one subject and is often useful when large numbers of subjects sharing similar features are unavailable. Whereas group designs identify statistical differences between or within two or more groups of subjects, single-subject research exercises its power through examining changes in subjects' responding over time across experimental conditions. For instance, a reversal design demonstrates experimental control by repeatedly presenting and withdrawing a treatment (i.e., independent variable). When an effective treatment is repeatedly presented and withdrawn, responding should change accordingly. In this procedure, rather than using statistical tests of significance, the data are graphed and visually inspected for substantial change across conditions (e.g., from baseline to treatment).

Researchers have used single-subject designs to study various phenomena, including disruptive and learning behavior in school settings (e.g., Birnbrauer, Wolf, Kidder, & Tague, 1965), recycling and littering in community settings (e.g., Austin, Hatfield, Grindle, & Bailey, 1993), occupational safety (e.g., Austin, Kessler, Riccobono, & Bailey, 1996), work productivity and quality (e.g., Gowen & Jennings, 1990), clinical disorders (e.g., Carr & Bailey, 1996; Knox, Albano, & Barlow, 1996), and the habilitation and treatment of individuals with developmental disabilities (e.g., Vollmer, Marcus, & Ringdahl, 1995).

There are many variations of single-subject designs, including multiple baseline, multiple probe, withdrawal, changing criteria, multielement (or alternating treatments), and reversal designs (Cooper, Heron, & Heward, 1987; Iwata et al., 1989). Because the reversal design is the most widely used and often provides the most compelling and believable results, this demonstration focuses on the use of the reversal design to evaluate intrasubject changes.

Sometimes referred to as the baseline–treatment–reversal design (i.e., A–B–A or return to baseline), the reversal design demonstrates the functional control, or causal status, of the independent variable or variables by showing an obvious on–off relation between the independent and dependent variables. This relation is sometimes referred to as a "water-faucet" effect because presentation of the independent variable turns "on" the behavior (i.e., the dependent variable changes in the expected direction) and removal of the independent variable turns "off" the behavior (i.e., the dependent variable returns to approximately baseline level).

The purpose of this demonstration is to teach undergraduate psychology students about single-subject methodology by having them collect repeated measures of their own behavior during the three phases of a reversal design.

Method

Begin by presenting your class with adequate information, via lecture or otherwise, on the theory and applications of single-subject methodology (including the graphing of behavioral data). Once students understand the basic concepts (e.g., baseline and reversal) and techniques (e.g., line graphs) involved, the demonstration can begin. Instruct students that the demonstration will require them to engage in physical exercise for 15 separate 20-s periods. Any student who is unable to exercise or is uncomfortable about exercising should be allowed to use another student's data for the final analysis. Inform students that they will be using a reversal design to study the effects of physical exercise on their pulse rate. In addition, they will take repeated measures of their pulse rate to ensure that the difference between conditions is not artifactual. Provide them with a data sheet that has five spaces for data (five per condition).

Ensure that all students can adequately record their own pulse. The pulse can be obtained by placing the index and middle fingers of the left hand over the carotid artery in the neck (on the right side) or over the right side of the right wrist

(palm up). After students practice taking their own pulse, you can provide them with the details of the demonstration.

The independent variable is 20 s of exercise (jumping jacks). The dependent variable is frequency of pulse beats during a 1-min interval. During the baseline condition, students should be cued to start recording their pulse. You should have a stopwatch to time the intervals. After 1 min has passed, have students record the number of pulse beats for that interval on their data sheets. This number represents the first baseline data point. Have students repeat this recording process for another 4 min, yielding a total of five baseline data points.

During the treatment phase of the demonstration, instruct students to stand up and begin jumping jacks for 20 s. After the exercise period, have them sit down and record their pulse for 1 min. After 1 min, have them record the number of pulse beats on their data sheets. This number represents the first treatment data point. Instruct students to repeat this exercise–recording process four more times, yielding a total of five treatment data points. For the reversal condition, have students repeat the baseline procedure until they have obtained five data points.

Finally, instruct each student to make a line graph of all 15 data points, including vertical lines separating the three conditions. Graphing may be facilitated by providing a graph sheet with preprinted axes. After students graph the data, have them raise their hands if the exercise increased their pulse rate. Next, have students raise their hands if there was no change or if they experienced a decrease in heart rate. Most students should have experienced an increase in pulse rate as a result of the exercise. You can use this discussion time to share some of the finer points of single-subject methodology. For example, you may discuss how this independent–dependent variable relation could be tested with a multiple-baseline design using delayed exercise start times for some students. In addition, you can discuss how the aforementioned other single-subject designs can be used to study this relation and others. Another possible avenue of discussion is the utility of repeated measures in data analysis and their assistance in locating extraneous sources of variability and reducing the probability of making Type I errors.

Results

We conducted the demonstration with 14 students in an undergraduate psychology laboratory in research methodology. Students had previously heard a lecture on single-subject designs. All graphs showed substantial changes in pulse rate as a result of the exercise as well as a successful reversal. Figure 1 illustrates representative graphs from three students.

Student Opinions and Evaluations

We solicited student opinions about the utility of the demonstration immediately after completing it. There were no negative comments about the demonstration. Comments included the following: "I thought it worked rather well. It was hands-on, and you could actually see the changes." "It was a great way to demonstrate the A–B–A design." "Overall, I thought the lab was very informative." "I thought the lab was useful. It made the concept of single-subject design more clear, and made the class more interesting." "I think it was a good idea because it took something that we could easily manipulate and measure." "I think that the single-subject design involving exercise was a great idea in reflecting the reversal design. Results were quick, obvious, and understandable."

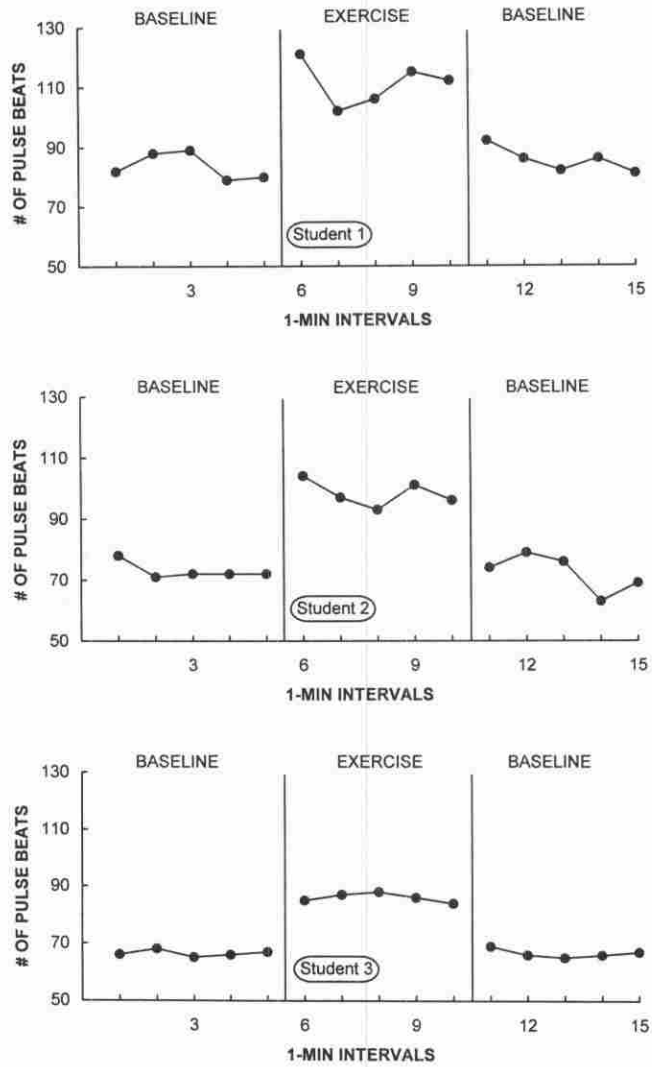

Figure 1. Representative line graphs of pulse-rate data from three students.

Discussion

Tell the class that the demonstration covered only the most rudimentary aspects of single-subject methodology. Another crucial point is that, although the demonstration conditions were changed after five trials, single-subject methodology is based on the foundation that conditions be changed only when data are stable and do not exhibit linear trends that may confound the interpretation of subsequent data. The demonstration could be improved by using a phase-change criterion to illustrate steady-state responding before experimental conditions are changed. Furthermore, the methodological rigor of this procedure could be enhanced through the use of

interobserver agreement measures for the dependent variable (see Carr, Taylor, & Austin, 1995).

This simple demonstration can be helpful in teaching students about single-subject designs because it provides opportunities to study their own behavior during different experimental conditions. The students collect, graph, and visually interpret their own data, which allows them to perform many of the practical behaviors necessary in using single-subject designs. The demonstration can be completed in less than 30 min and should be a useful addition to instruction on experimental research methods.

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Notes

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Hindsight Bias and the Simpson Trial: Use in Introductory Psychology

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The Simpson criminal trial provided an excellent opportunity to illustrate the hindsight bias, the tendency to exaggerate one's ability to have foreseen the outcome of an event after learning the outcome. As hypothesized, introductory psychology students who estimated their prediction of the outcome of the trial post verdict were more accurate than students who predicted the outcome pre verdict. In this article, I illustrate how the hindsight bias can be demonstrated in the classroom and how it can highlight the need for the scientific method in psychology.

In introductory psychology, providing a rationale for psychology as the scientific study of behavior is critical. Many students enter their first psychology course with "folk" theories of behavior, and they see psychology as simply intuitive and commonsensical. To help students appreciate the need for the scientific method in the study of behavior, teachers can discuss cognitive biases, such as the overconfidence phenomenon, the confirmation bias, and the hindsight bias (Myers, 1995; Wood, 1984). The focus of this article is how to demonstrate the hindsight bias in the classroom and how it illustrates critical points about psychological science.

The *hindsight bias* is a tendency to exaggerate one's ability to have foreseen the outcome of an event, after learning the outcome. More simply, on learning the outcome of an event, individuals may claim that they "knew it all along." For instance, Leary (1982) had participants estimate prior to or after an election the percentage of votes candidates would receive. Consistent with a hindsight bias, ratings made after the election were more accurate than ratings made before the election. Similarly, more accurate hindsight versus foresight judgments have been observed with the outcome of football games, medical diagnoses, and legal decisions (Hawkins & Hastie, 1990). Such events, with discrete outcomes, provide an excellent opportunity to illustrate the hindsight bias.

The recent adjudication in the Simpson criminal trial also provided an excellent opportunity to illustrate the hindsight bias and to provide an active-learning experience about cognitive biases. In October 1995, Simpson was found not guilty of murdering Nicole Brown Simpson and Ronald Goldman. Consistent with the hindsight bias, I predicted that participants who estimated the outcome of the trial postverdict would be more accurate (i.e., more likely to indicate that Simpson was not guilty) than participants who made preverdict judgments.

Method

Participants

Three classes of introductory psychology students participated (N = 66). One class (n = 24) made preverdict