Suggestions for Presenting Multiple Baseline Analyses on Standard Celeration Charts

by

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This article considers benefits for the use of single case experimental designs with Precision Teaching. It also describes and illustrates the multiple baseline design and suggests ways to show the design on Standard Celeration Charts. The suggestions do not alter the integrity of the Standard Celeration Chart. They are compatible with established chart conventions used by Precision Teachers.

Science is concerned with describing and explaining events. Measurement alone can give an accurate and reliable description of events. Events are best explained, however, when the scientist changes the events at will (i.e., does something to turn the events on then off, on again and off again and so on). This type of manipulation explains events as a function of something else. It is the search for functional relationships (e.g., "cause and effect"). For example, reading fluency is functionally related to short repeated practice. We call such event manipulation experimental design.

The study of experimental design has a scholarly history within behavioral psychology and education. Skinner's (1956) article, "A Case History in Scientific Method" is a significant source on experimental design from the behavioral view. Sidman (1960) and Johnston and Pennypacker (1980) further refined the behavioral experimental tradition.

When researchers study human events, exact control over the environment is not possible, desired or even permitted. The lack of environmental control makes the task of discovering functional relationships more difficult. Accordingly, single-subject experimental designs have evolved that permit explanations of functional relationships in the absence of tight laboratory environmental control (Hersen & Barlow, 1976). The exhaustive review by Johnston and Pennypacker (1980) summarizes all known experimental design considerations in behavior analysis. They differentiate single-subject designs from group designs.

Single-subject experimental designs pertain to individual behavior. The single-subject designs do not infer from a group down to an individual. Control groups rarely appear in the analysis of behavior. Rather, in single-subject research, experimental control is assessed by comparing the behavior of an individual against his or her own behavior under a different condition. The base rate of some behavior is recorded prior to an event manipulation. The events manipulated are independent variables. The measure of the behavior is the dependent variable. In behavior analysis, frequency of behavior is the most sensitive, productive, and informative dependent variable yet discovered (Pennypacker, Koenig, & Lindsley, 1972). Once a base measure of the behavior is predictable, the independent variable is introduced. The independent variable might be, for example, a change in consequences following behavior. Or it could be a change in events that precede behavior. For example, a teacher could add response prompts to written materials (e.g., Skinner, 1957, pp. 253-259). Or further, a teacher could change instructional methods or curricula. After the independent variable is applied, the behavior continues to be recorded.

The behavior may change with the occurrence of the independent variable. Some may believe the behavior changed because of the independent variable. Such a conclusion warrants caution and restraint. Hersen and Barlow (1976) argue the behavior change could have occurred anyway, regardless of the event manipulation by the experimenter. Recall that many variables lie beyond the researcher's control in much of human research.

Measurement during baseline and intervention (i.e., independent variable) is insufficient for demonstrating a functional relationship. Several ways exist to proceed past this insufficiency. One method would remove the independent variable once the behavior changed. Then we would observe whether the behavior returns to its former base rate. If it does, there is more reason to believe that the independent variable was related to the behavior change in the first place. However, as we will describe, in many cases the reintroduction of baseline conditions may not be possible or desirable. A second method known as the multiple-baseline design could be used to demonstrate functional relationships. This design will be discussed in the remainder of this paper.

How does experimental design pertain to Precision Teaching? After all, teachers are not often considered scientists. They are not expected to demonstrate new functional relationships. Perhaps as a starting place, however, we believe teachers are in a unique position to make contributions to their profession as teacher-scientist. Greer (1986, May) said, teachers can become "strategic scientists" if outfitted with the tools that allow them to determine whether the changes they make in the classroom , teaching methods and materials, or curriculum are functionally related to the behavioral repertoires of their students. The teacher-scientists can contribute to the discovered knowledge of human behavior and the technology of teaching (Lindsley, 1990).

More broadly considered, some inclusion of Precision Teaching with experimental design, especially multiple baseline designs, has the following benefits:

(1) A more refined scientific rigor would become available to those interested in using Precision Teaching to expand our knowledge base and teaching technology. Although Precision Teaching's essential components (Standard Celeration Chart and frequency) already provide it with considerable rigor, Precision Teaching could be enhanced by multiple baseline designs.

(2) Greater integration could result between Precision Teaching (mostly educators) and applied behavior analysis (mostly Psychologists).

(3) Effects of working and sharing together could emerge. Applied behavior analysts may also use Standard Celeration Charting and frequency measurement if Precision Teachers demonstrate how the Chart can accommodate displays of experimental designs other than the ABAB (reversal) design (Tawney & Gast, 1984).

What Are Multiple Baseline Techniques?

Operation of the Multiple Baseline Design.
Multiple baseline designs have become the most frequently used experimental designs in applied behavior analysis (Cooper, Heron, & Heward, 1987). Baer, Wolf, and Risley (1968) first introduced and advanced multiple baseline designs as workable alternatives for the commonly used reversal (Baseline-1, Intervention-1, Baseline-2, Intervention-2) designs. The reversal design can present problems for teachers. Many school behaviors do not reverse in the second baseline condition. Other responses, such as aggressive behavior may not be suitable for reversal. Some teachers object to any reversal conditions. When these conditions are evident, the multiple baseline experimental design can be used, since this design does not need a reversal condition.

The multiple baseline design may be applied in three ways. First, a multiple baseline can be used across behaviors. This is an analysis of two or more different but similar behaviors of one student. Second, a multiple baseline can be applied across locations. This is an analysis of one student behavior occurring in at least two different locations. Finally, a multiple baseline can be taken across students. This is an analysis of one behavior of two or more students. In all three cases, the design is a set of baselines and interventions operating at the same time. But, the interventions are not introduced at the same time.

Multiple Baseline Across Behaviors Design.
With this design, the instructor measures at the same time two or more different behaviors of a given person. The independent variable is applied first on only one behavior following a baseline period. During this intervention, the other behaviors continue in baseline. After the behavior changes, the same teaching method is applied to the second behavior. Following behavior change of the second behavior, the teaching method is applied to the third behavior, and so on.

Multiple Baseline Across Locations Design.
In this design the instructor measures one behavior of one person in several different locations. Baselines are produced for each location. The locations, for example, could be home-school; lunchroom-playground; reading class - music class; morning-afternoon. Next, the teacher applies the intervention in only one of the locations. Meanwhile, baseline continues in the other locations. The same intervention may be applied in the second location. There are two conditions for deciding to apply it. First, the intervention is applied only after improvement in the first location. Second, the baseline celeration course in the second location should have remained unchanged.

Multiple Baseline Across Students Design.
In this design the teacher measures a single behavior of two or more individuals prior to intervention. That is, there is a baseline for each student. Next, the teacher implements the intervention for only one of the students. The other students are kept in baseline. Then, the intervention is used with another student following a behavior change

in the first student's behavior.

Figure 1 depicts a "stretch-to-fill" graphic prototype of a multiple baseline design. This is the type of figure typically seen in the applied behavior analysis literature.

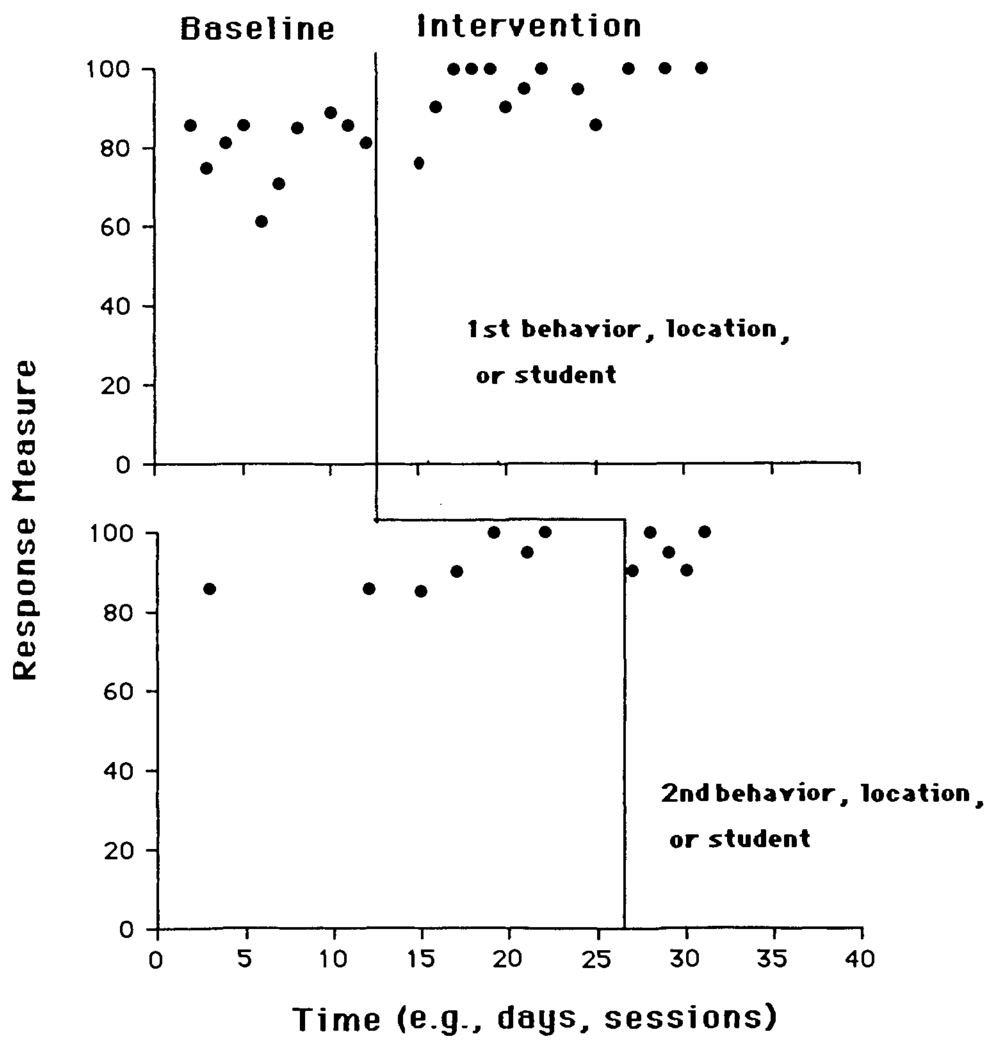
Consider the following points when using multiple baseline designs. First, when measuring two or more different behaviors of an individual, choose behaviors that are similar. For example, reading comprehension probably would make a more convincing second baseline for fluency of oral reading than frequency of sharing during cooperative play. The closer the similarity of behaviors among baselines, the more believable the succeeding functional relationship becomes. Second, begin data collection for all baselines close together in time. Starting all baselines on the same day at the same time is a sound policy.

Logic of the Multiple Baseline Experimental Design. Collecting baseline data establishes a basis for predicting future learning. The teacher may predict that learning will follow a similar Chart picture if no major changes occur during instruction or in the life of the student.

The remaining baselines confirm the first baseline prediction. Such confirmations occur only when these baselines remain unchanged. Moreover, these confirmations increase the believability that the behavior did not change due to variables uncontrolled by the teacher (i.e., did not occur "by chance").

Multiple baseline procedures provide for repetition of effect. A teaching method that produced only one effect would not be a major development. The important point is to demonstrate that the teaching method relates to the frequency of behavior. The staggered application of the intervention across behaviors, locations, or students makes repetition possible. As Sidman (1960) observed, the more times an effect is repeated, the greater the

FIGURE 1 Illustration of a multiple baseline design

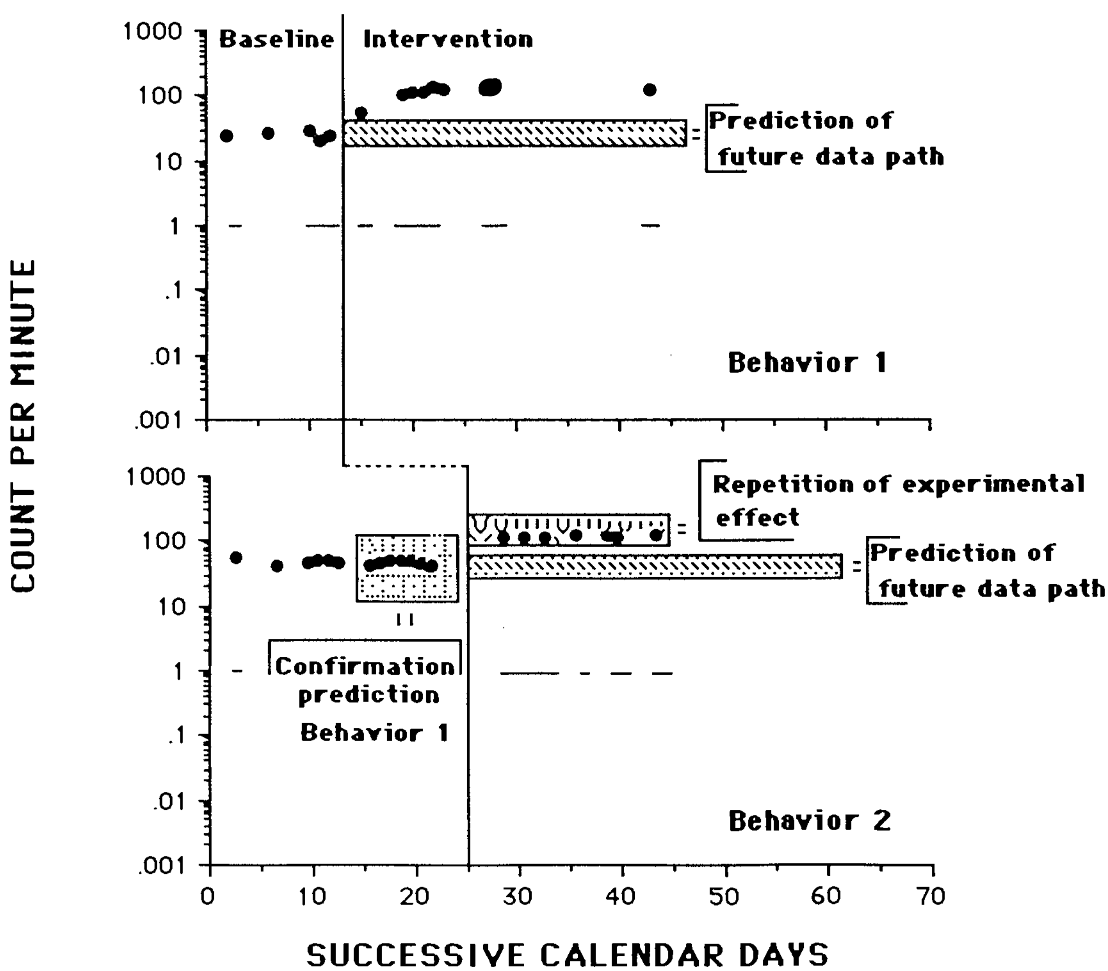


belief in a functional relationship. For instance, resulting behavior changes shown with six behaviors (or six locations, or six students) are more convincible than those shown with only two behaviors (or two locations, or two students).

Information from predictions, confirmations, and repetitions of effect are used to attribute a change in behavior to the teaching tactic. For example, if the intervention is applied to one behavior and affects not only that behavior but the other behaviors in baseline, we lose believability of a functional relationship. Similarly, if the first behavior changed, but the second and third behaviors remain unchanged when the intervention is applied to them, we also lose believability in a functional relationship. Figure 2 presents fictional data that illustrate prediction, confirmation, and repetition of effect with multiple baseline designs.

Presenting the Multiple Baseline Design on the Standard Celeration Chart. The Standard Celeration Chart is always used in Precision Teaching. It is also suited to present ABAB (reversal) experimental designs. However, as noted, reversal designs are not the most common in applied behavior analysis. Rather, multiple baseline designs are. The Standard Chart, unfortunately, does not lend itself to quick and easy display of multiple baselines on a single Chart paper. A number of conventions for displaying multiple baselines with the Standard Chart could be advanced. We suggest that the Precision Teaching community consider and use the following nine points. (Note: A Precision Teacher would handle these suggested conventions in conjunction with established charting conventions for the Standard Celeration Chart, e.g., McGreevy, 1981; White, 1986. Real data, presented in Charts 1 through 4, illustrate the suggestions we offer.)

FIGURE 2 Illustration of the use of prediction, confirmation, and repetition of effect with multiple baseline designs



Suggestions:

1) Vertical lines with arrow points at the end are used to separate conditions off the Chart grid (See Chart 1).

(2) A small vertical line at the end of the last condition line shows the last day of the analysis (See Chart 1).

(3) Include the number of baselines used and the order the intervention was applied to each baseline with the baseline label (See Chart 1). The note "(1 of 4)" means there are four baselines in the analysis and the baseline displayed on the Chart was the first to receive the intervention. "(2 of 3)" means that there are three baselines in the analysis, and the baseline shown on the Chart was the second to receive the intervention.

(4) Vertical lines with arrow points continue, beginning off the grid to the next Chart of the analysis (See Chart 2).

(5) A horizontal dashed line connecting the condition change line provides the number of calendar days this baseline is continued beyond the previous baseline (See Chart 2).

(6) If the multiple baseline design is across two or more behaviors, indicate the number of behaviors and the order of intervention under the Chart blank labeled "counted" [e.g., "(2 of 4)"]. (See Chart 2).

(7) If the multiple baseline design is across two or more locations, indicate the number of locations and order of intervention under the Chart blank that is labeled "Agency" [e.g., "(1 of 3)"]. List the different locations in the "Agency" blank (e.g., Central Elementary, resource room; Central Elementary, 3rd grade regular classroom; Central Elementary, band room).

(8) If the multiple baseline design is across the same behavior of two or more students, indicate the number of people and the order of intervention under the Chart blank labeled "Behaver" [e.g., "(2 of 3)"].

(9) The condition line for the last Chart of the analysis remains on the grid (See Chart 4).

Discussion

Multiple baseline designs permit a teacher to demonstrate a functional relationship between an instructional method and a behavior change. As such, the teacher could say why the behavior changed by relating it back to the event manipulation. This opens the door to further study of different aspects of the method, or other interventions. The overall result would be an inventory of what works and what does not work in education.

Our suggestions do not alter the basic integrity of the Standard Celeration Chart. This allegiance to Chart integrity played a critical role in the development of these suggestions. In its original form, the Standard Celeration Chart is not only scientifically powerful, it is a work of art. Tampering with its basic features leads to a "stretch-the-axes-to-fill-your-need" mentality and "bastard charts" (Pollard, 1988), as well as to weaker science.

Weak science does not find functional relationships very well, does not get us very far, and does not describe or explain very much.

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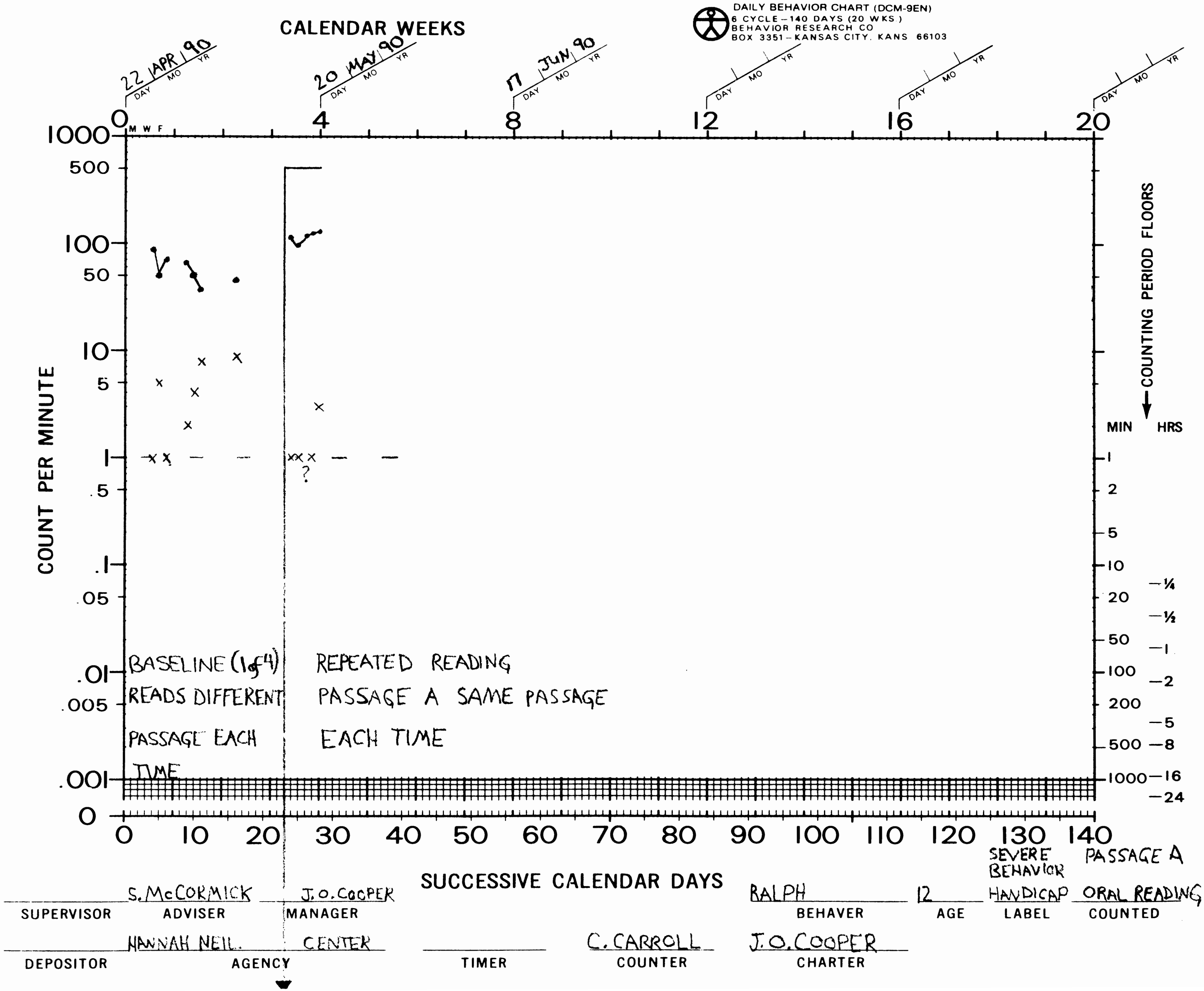
Chart 1


DAILY BEHAVIOR CHART (DCM-9EN)
6 CYCLE – 140 DAYS (20 WKS)
BEHAVIOR RESEARCH CO
BOX 3351 – KANSAS CITY, KANS 66103
CALENDAR WEEKS
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20 MAY 90
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Chart 2

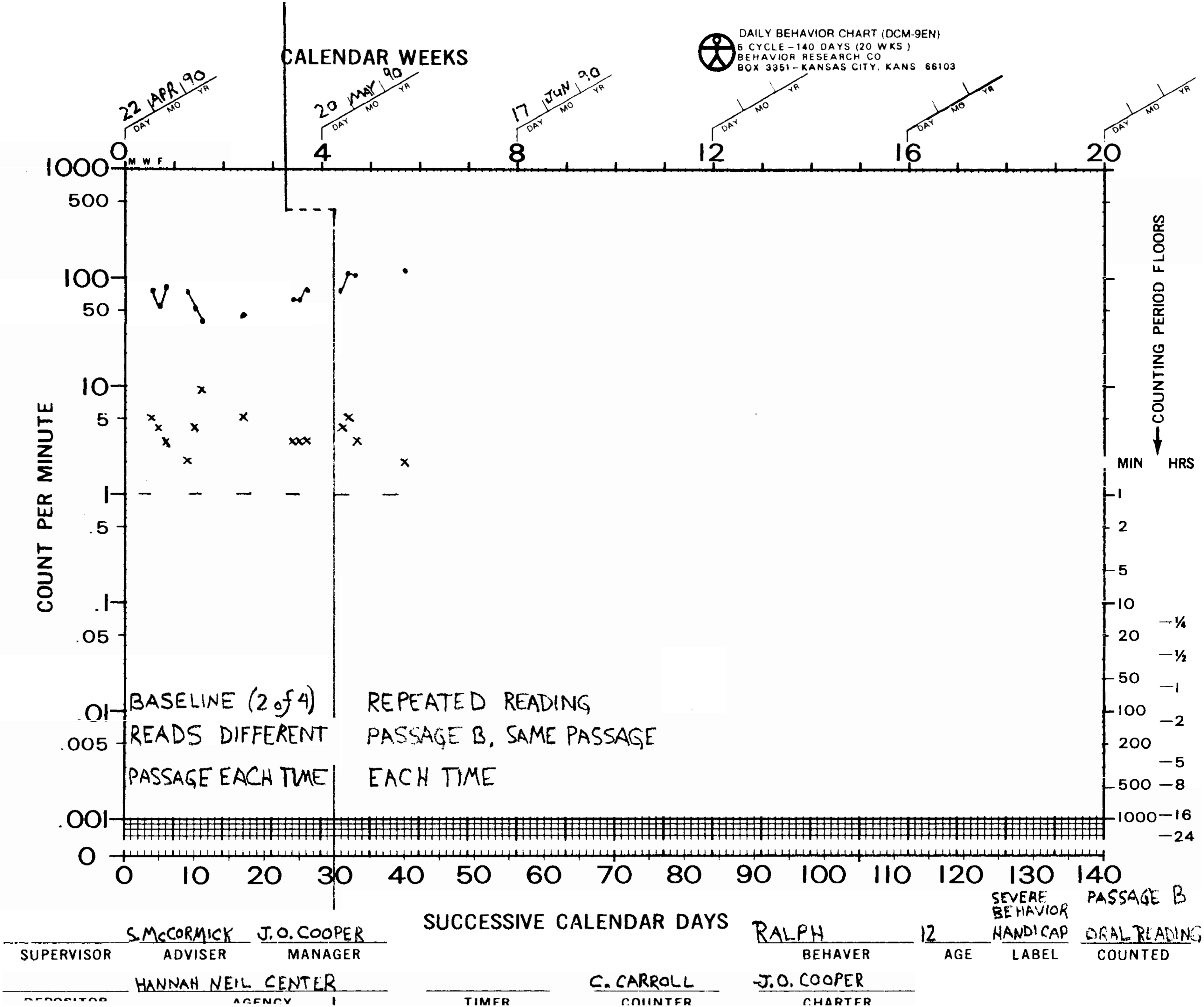

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Chart 3

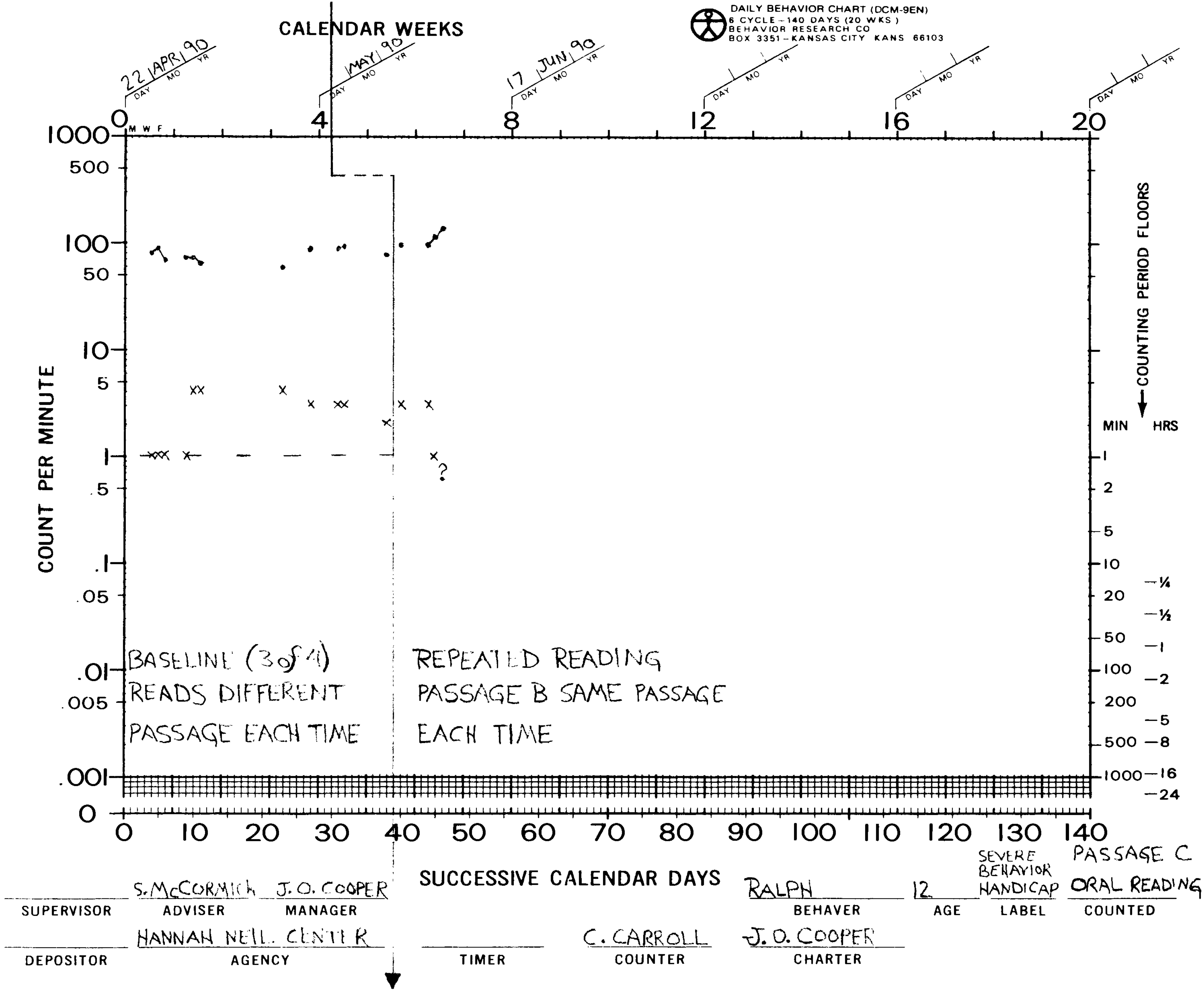

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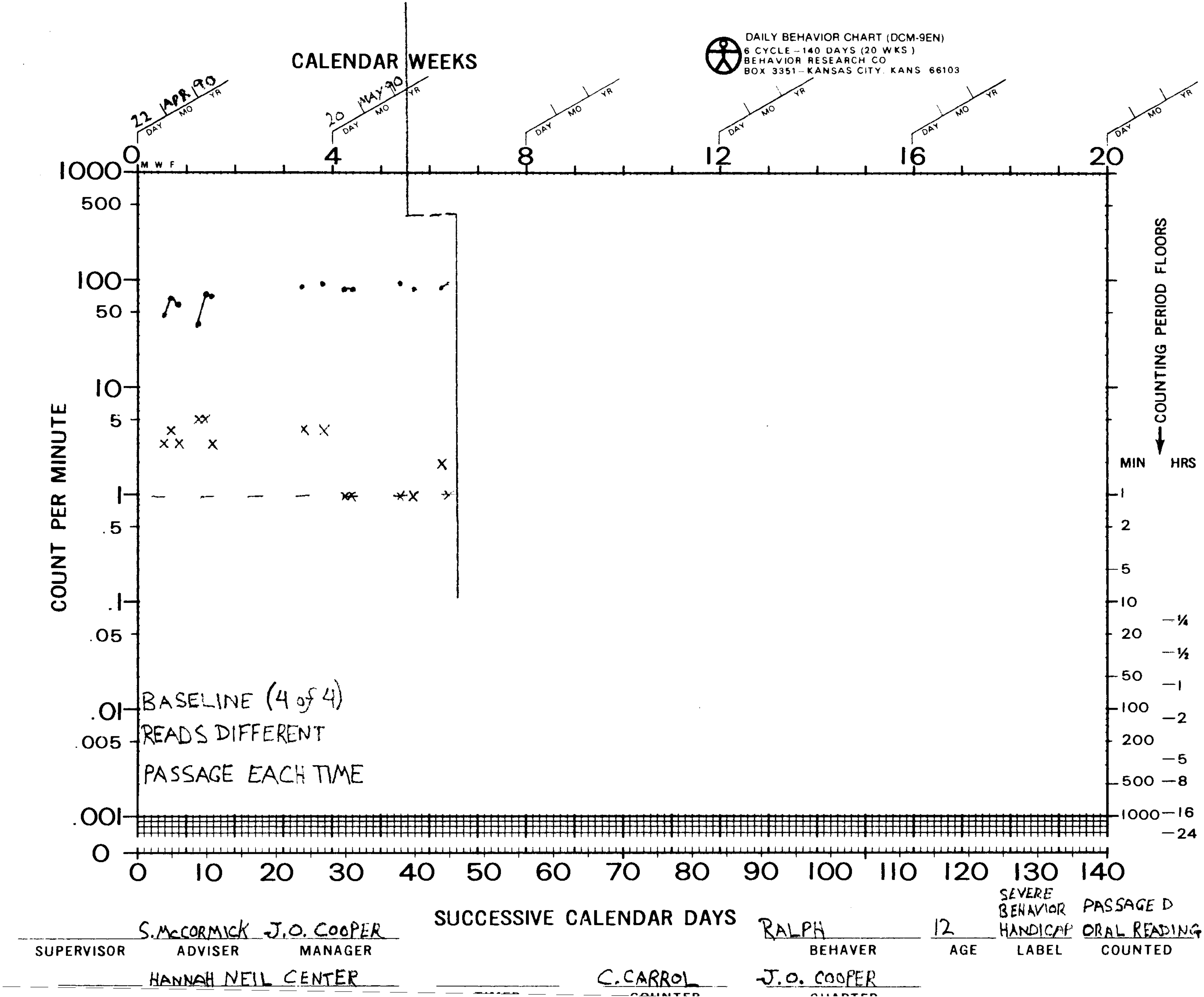
Chart 4



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