

and first half-minute frequencies because they always began the timings by responding to the same sequence of items.

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**Editor's note:** When a precision teacher charts a 30-second frequency on the Standard Celeration Chart (SCC), using a 30-second counting period floor and a frequency finder, the count is automatically doubled. For example, a count of 10 correct responses in 30 seconds becomes 20 per minute on the SCC. If the charter remembers to mark the counting period floor, there need be no confusion between an actual frequency and a doubled count with an erroneous counting period.

### A MOLAR AND MOLECULAR ANALYSIS OF LOGARITHMICALLY CHARTED RUNNING DATA

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Conservative estimates now indicate that there are 30 million Americans who regularly run for the purpose of recreation and aerobic fitness. Most of these people begin with the simple goal of weight loss or to make the stairs at work less problematic. However simple their beginnings, many runners soon begin thinking of their first race. Next come attempts at racing longer distances, with quicker times. Later, a day or two per week of "speed work" is added to the weekly training regimen to increase the "quality" of workouts. This progress-orientation that seems a natural part of running is also evident in the practice of most runners in logging data regarding their runs.

Another sector in America's running community is made up of elite runners, the members of university track teams, or the "professional" runner who performs at the upper end of the running continuum. Like the serious fun runner, the elite athlete is always looking for a way to improve his or her training and racing performance, and is involved in logging of pertinent data.

Logarithmic charting of running data has been shown to be useful in determining the overall mileage base required for optimum performance at a specific distance (McCrudden, 1985). This article will show how Standard Celeration Charting techniques can be used to provide molar and molecular analyses of a running program, and thereby improve the runner's performance.

One of the early philosophies of the running boom was the L.S.D. (long slow distance) approach to both running and racing (Henderson, 1969, 1977). However, it has now been accepted that running faster in races is enhanced by variety in training, which includes some faster mileage. Even Henderson (1977) now recommends adding this higher quality mileage to the training regimen. Another vital factor in improved running, often neglected by both

elite and fun runners, is getting enough rest. Only by combining sufficient hard running and rest can a runner work toward the conditioning "peak", which enables the excellent race performance (Daws, 1978). The conditioning peak means that the runner's frequency of miles per minutes has increased and stabilized at its full potential on the day of the race. The runner can not maintain peak conditioning indefinitely, as he is likely to suffer from exhaustion, sickness, sore muscles, and other symptoms of being overworked. Thus, the runner does not want to peak too soon (weeks) before the race. Likewise, the runner does not want to enter a race with his frequency still significantly increasing, since this is indicative of not having achieved maximum potential.

It takes careful planning to reach the conditioning peak on the exact day of the race. Often, runners peak too soon before the race or are not quite at optimum condition on the race day. However, through a combination of molar and molecular analyses of the running program, it is possible for runners to reach the conditioning peak on time. Below is a description of how molar and molecular analyses can be applied to running programs to facilitate an excellent race performance.

### **Molecular Analysis**

Molecular analysis refers to the analysis of small, discrete data over short periods of time. A molecular analysis is made by plotting the frequency of miles run (miles over time). In this approach, the runner compares daily performance to his performance attained on the previous day or across days in the same week. Thus, the runner tries to increase his pace or distance over a short time period and may neglect to analyze his improvement over long periods. Likewise, the runner might compare his frequency from race to race. In this situation, the runner is comparing performance on two distinct days, but is failing to analyze all data (frequency points) before, after, and between races.

### **Molar Analysis**

Although many runners adhere to a molecular analysis of their running regimen, they frequently neglect the molar analysis. All too often, runners come under the control of the reinforcement provided by the addition of a few more miles in the running log. These data are rarely analyzed beyond simple weekly addition of total miles. However, in a molar analysis, the runner is concerned with trends across long periods of time. By plotting the frequencies daily over many months, a true measure of improvement can be detected. Through a molar analysis, the runner can determine if his frequencies are significantly increasing, decreasing, or stabilizing. This information is necessary in determining if the conditioning peak will occur on or near the scheduled day of the race.

Since it is frequently difficult to apply technology to different areas, an example of molecular and molar analysis of running, utilizing Standard Celeration Charting skills, is provided below. Data from one of the author's running logs were used so that a factual example could be made. Although most frequency dots were actual, a few were estimated because of factors such as a forgotten watch or a road that was closed.

## Method

### Procedure

The runner calculates his daily running frequency and records the data on the Standard Celeration Chart. Periodically, the runner selects a certified race which he would like to run. This selection is made months in advance so the runner can benefit from a molar analysis. After selecting the race in advance, the runner wants to insure peak performance on the race day. Thus the runner sets his dynamic aim approximately one week before the race and works towards this aim. The aim is set one week in advance so the runner can have an easy week directly preceding the race. This is necessary so the runner can begin storing carbohydrates in his system and saving his energy in anticipation of the race.

The runner continues to plot his running frequencies over the next few months and analyzes the celeration to insure adequate progress. If the runner continues to fall below his pre-determined celeration line, he will not reach his dynamic aim on the scheduled date. Thus, he must change his treatment phase by implementing a skill-building option. He can alter his practice environment by running with a partner whose frequency matches his aim. The runner can also alter the task by doing speed work or implementing a motivational strategy such as the setting of daily aims.

In addition to plotting daily frequencies, the runner also plots cumulative mileage for each week. Although this is not a frequency measure, it does aid the runner in seeing trends across larger units of time. Moreover, it serves as a reinforcer for the runner who enjoys seeing a written record of his increased mileage.

### Results

A graphic display of the runner's performance is represented in Chart 1. In analyzing the data in Chart 1, the runner sees several factors which are important to the running regimen. First, over a period of five months, daily frequencies increased from approximately .11 to .13 miles per minute. Second, as the frequencies increased, the race performance improved. Frequencies attained in marathon races were: .10 (marathon 1), .12 (marathon 2), and .13 (marathon 3). Third, the addition of speed work (training runs which include several miles of running at a pace higher than the expected race pace) appeared successful in increasing the runner's celeration.

### Discussion

Both molar and molecular analyses are important to a running regimen. A runner must select a race date months in advance, establish a dynamic aim, and watch trends in celeration across months. These are all components of a molar analysis.

The runner must also use a molecular analysis to determine if the dynamic aim is being reached. If the data fall below the aim for too many days, then an intervention strategy is necessary. A molecular approach provides the runner with information on when such intervention is necessary. By using Standard Celeration Charting techniques, the molar and molecular analyses become more structured. They provide the runner with an organized decision-making process for establishing aims and intervention strategies. Moreover, the analysis of the running data is easier when data are viewed on a chart



DAILY BEHAVIOR CHART (DCM-9EN)  
 8 CYCLE - 140 DAYS (20 WKS)  
 BEHAVIOR RESEARCH CO  
 BOX 3351 KANSAS CITY KANS 66103

CALENDAR WEEKS

26 Sep 82  
 DAY MO YR

24 Oct 82  
 DAY MO YR

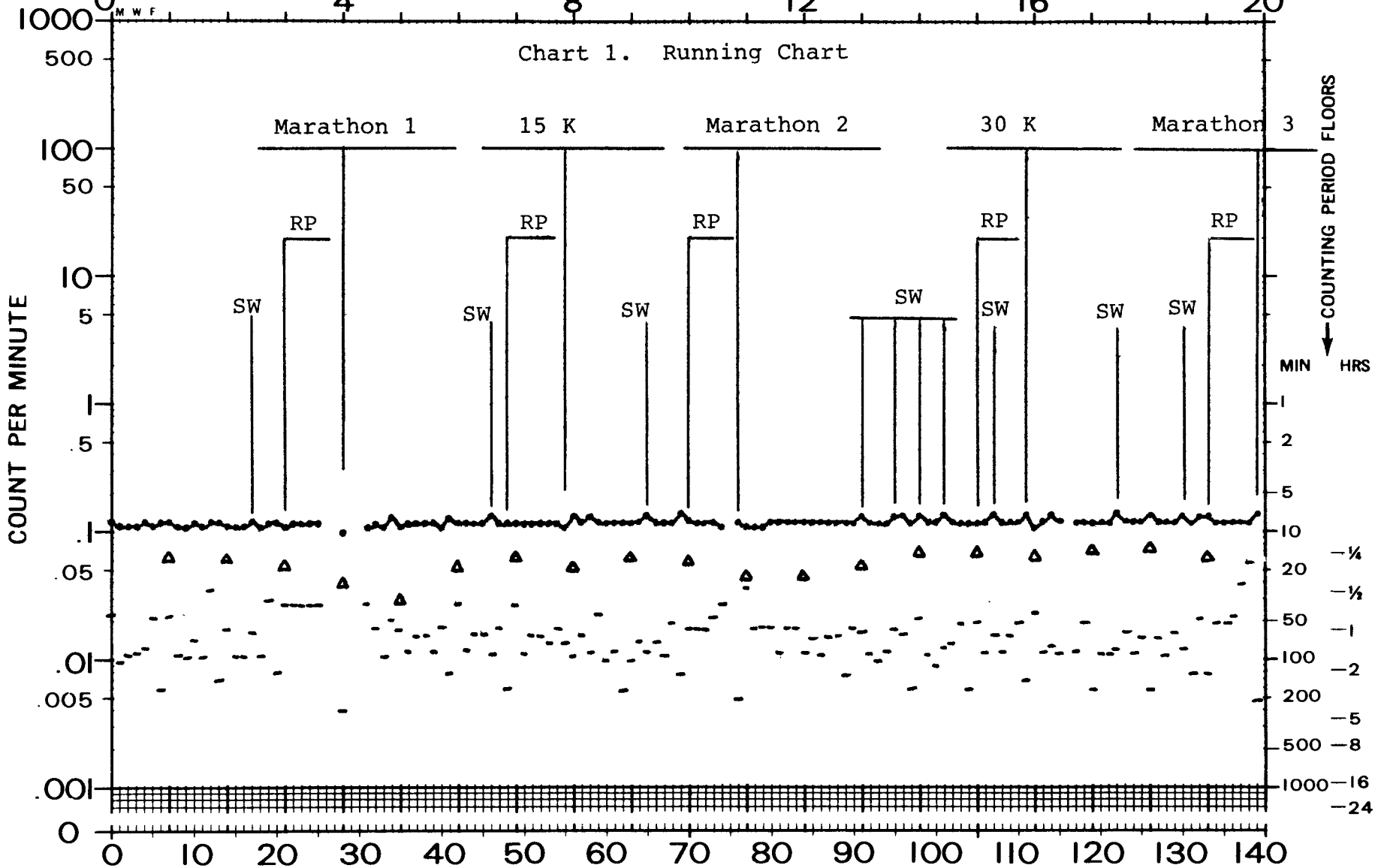
21 Nov 82  
 DAY MO YR

19 Dec 82  
 DAY MO YR

16 Jan 83  
 DAY MO YR

13 Feb 83  
 DAY MO YR

Chart 1. Running Chart



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SUCCESSIVE CALENDAR DAYS

J.J. 32 Runner runs miles  
 BEHAVIOR AGE COUNTED

SUPERVISOR ADVISER MANAGER  
 Δ=weekly mileage RP= rest phase

SW= speed work

rather in a table or log. By using these techniques, more runners can improve their running performances, and reduce the number of races for which they are improperly prepared.

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### PROBE SHEET CONSTRUCTION

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The use of probe sheets in Precision Teaching is a common occurrence. Most probe sheets contain a particular class of skills that a student is asked to perform. In this brief study, attention was given to the construction of the probe sheet.

Two students, ages 7 and 8, attending a school for the behaviorally disordered were given math probe sheets prepared by the Orange County Florida Precision Teaching Project. Student 1 worked on see-write sums 0 to 9 and 0 to 18. Student 2 worked on see-write answers to multiplication facts  $\times 0$  to 2 and 3-4.

On the probe sheet, the vertical area under the problems where the students were to write the answers was approximately  $14/16$  of an inch. This area was suspect as a cause for illegible numbers and slow student performance. The students in this study had attempted to write answers that would fill the entire space. During the study, a horizontal line was drawn under each row of problems so that the space between the bottom of the problems and the line was equal to that of standard  $5/16$  of an inch ruled paper.

Student performance on the ruled probe sheets was compared to that on the unruled ones. The students were not given any additional instructions and were asked to perform on the probe sheets as usual. Scoring criteria for number formation was derived from the Palmer Method (1979). Charts 1 and 2 display the performance of students 1 and 2 respectively. The first phase in each chart displays performance on the unruled probe sheets, while the second phase represents performance on the ruled ones. Table 1 shows the median accuracy ratio of the two students in each phase.