If I assume I have complete knowledge of anything, including the thing I am most expert in, then I risk preventing myself (and others) from learning more about the things I care about.

Author's Note:

The father of Precision Teaching and the Standard Celeration Chart (SCC), is Dr. Ogden Lindsley. During the 1960's and in the decades following, Dr. Lindsley and his colleagues produced mountains of research, and spent enormous amounts of time and effort to develop and refine a standardized display for behavior—the SCC (Graf & Lindsley, 2002). Since I learned of the SCC in 2000, I have had great respect for it, and have used it extensively to graph academic and non-academic data in many settings (homes, schools, personal data, etc.).

Moreover, in my quest to become a board certified behavior analyst, I was content to discover that it was required for people to learn about the SCC, since the SCC would be on the board certification exam. However, about a decade after being introduced to the SCC, I was deeply disheartened to learn that it would be taken off of the board certification exam. That is, it would no longer be a requirement to learn the SCC in order to become certified in behavior analysis--once the new (4^{th} ed.) exam was to be administered (BACB, 2012). There has been much speculation about why the SCC disappeared from the 4^{th} edition certification exam and task list; though whatever the reason(s), I did not see that as a good sign for the SCC, precision teaching, and all the work that Dr. Lindsley and his many colleagues had done. It wasn't long before I set out to discover why some people avoid using the SCC; I was curious to see if there was anything I could do (beyond calling for better teaching strategies) to help reduce some of the barriers to its implementation. Thus, my motivation to improve upon the already perfect chart had begun, and so I attempted to make a standard display that is more user-friendly, while preserving some of the excellent technical aspects of the SCC that could support the would-be standard.

Initially, I started changing little pieces here and there of the SCC, but the more I worked on the original, the more I felt a need to completely start over. I felt there were many things that could be improved for greater usability. Thus, though the Stand Behavior Graph (SBG) and the vast majority of the procedures it utilizes are heavily influenced by all of the great founding work of Lindsley and colleagues, I started over and built the SBG from the ground up with a Microsoft excel and word program, carefully considering and reconsidering each aspect. I based the SBG on what I personally wanted in a standard graphic display. What did I take from the SCC? What is different? This is all described in the appendix of this book, in a point-by-point comparison. Have I conducted any controlled research that proves the SBG is superior to charts like the SCC? No, I haven't yet. However, if someone were interested in gathering data for a comparison, I would think a fair test would involve taking a set of data that represents *several* dimensions of behavior (e.g., rate, duration, and latency), randomize the order of data point presentation to a person trained in graphing, and observe how long it takes the person to correctly find, read, and write a randomized set of data on both the SCC and the SBG.

For readers who do not know about the SCC, or are not sure why I mention it on the opening page, please rest assured this book is still geared for you. You will NOT be required to learn the SCC to understand what's going on in my book about the SBG. However, I refer to the SCC, and credit it as the foundation of the SBG (and most of the analytic concepts that surround it), and encourage you to learn more about the SCC, and the research behind it by visiting the following websites: www.celeration.org, www.behaviorresearchcompany.com, and http://precisionteaching.pbworks.com. Note: this book and its contents are not affiliated with or endorsed by the websites mentioned, or any entity that sells or promotes the SCC.

Ultimately, the SCC and the SBG are mostly compatible, but it is up to each individual to decide which they prefer. Some may even choose to use both! Of course, I so strongly believe in the SBG that I wrote a book about it; the SBG is what I now prefer to use for graphing my own behavior and that of my clients. Thus, I encourage everyone to give it a try!

The Quick Start Guide for the Quarter Year, Daily, Standard Behavior Graph[1]

While reading this Quick Start Guide, it is recommended that the user have a sheet of *Quarter Year, Daily,* Standard Behavior Graph paper in front of them for easy reference. Free excel version and printable copies of the Quarter Year, Daily, SBG can be found at the following website: www.standardbehaviorgraph.com.

Vertical Grid Lines: The vertical blue and green lines are all day lines. The thick blue vertical lines that start each week are Monday lines, and the vertical green lines represent the other days of the week (Tuesday – Sunday). There are 13 full weeks on the Quarter Year, Daily: SBG, and 92 days. There is a blank for the date above the 1st, 5th, 9th, and 13th week for syncing with real calendar time.

Horizontal Grid Lines: The horizontal green and blue lines, stacked from bottom to top, have values that go from just under .001 to just over 1,000, and represent the range of nearly all measurable human behavior in a day. These lines are not equally spaced because they are on a log scale. Those unfamiliar with log scales, should become more comfortable by quickly saying aloud the value of each horizontal line from the bottom to the top.

A Rhyme for Counting[2]: To help one become familiar with the horizontal line values, try the following rhyme: "*The numbers with a "1"--- from low to high — are what you count from --- and what you count by.*" For example, close to the bottom of the Y-axis scale is the number .001 (it has a 1 in it), which means if you start from that blue .001 line, the next horizontal green line up from it is .002 (as labeled), and the next line up from that is .003, then .004, then .005, etc. In other words, you're counting from .001 by .001's until you get to the next cycle, or line marked with a 1 in it (e.g., .01). For another example, find the number 100 on the Y-axis. Notice It also has a 1 in it, so if you start at the blue 100 line, then you'll count up the from the 100 line by 100's (as described by the rhyme). The next horizontal green line up from the 100 line is 200 (as labeled), then the next line up is 300, then 400, 500, 600, etc.

Data can also be plotted in-between the horizontal lines too. For example, if a data point was half way between the 10 line and the 20 line, its value would be about 15. If a data point were placed just a hair under the 20 line, its value would be about 19.

[1] Most of the ideas in this entire quick start guide have been derived from the SCC (which is the work of Dr. O. Lindsley and colleagues). To facilitate the purpose of a "*quick* start," specific references are included throughout the body of this book following the quick start guide.
[2] A Similar rhyme from which this one was derived can be found on Dr. M. Maloney's (2012) website : www.maloneymethod.com.

Rate: When one is plotting the dimension of behavior known as “rate,” one must plot the quotient of the following ratio: *number of events / recording time in minutes*. For example, if 100 responses were counted while observing for 50 minutes on Monday, then the rate is plotted with a “•” on the horizontal 2 per min line where it intersects with that Monday line (100 / 50 = 2). The primary Y-axis scale (along the left side of the SBG) marks and labels the values for rate. On the other hand, the secondary Y-axis scale (along the right side of the SBG) marks and labels all values that are for duration and latency.

Duration or Latency: When one is plotting dimensions of behavior such as “duration” or “latency,” one must directly plot the time value in minutes. For example, if a response lasts for 10 minutes, then the duration is plotted with a “□“ on the 10 min line. The secondary Y-axis scale (along the right side of the SBG) has common values of minutes also put in terms of hours and seconds in parentheses for a quick reference. Latency is plotted with a “/”.

Converting hours or seconds to minutes: To convert hours to minutes, multiply the hours by 60 (e.g., 5 hours = 300 minutes). To convert seconds to minutes, one only needs to divide the seconds by 60 (e.g. 30 second = .5 minutes). Moreover, if a response does not begin until after 30 seconds since the cue to begin was delivered, we’d plot that 30 second latency on the .5 line (with a forward slash “/”), because 30 seconds = .5 minutes.

Recording Time: The duration of time spent recording a behavior is marked with a “^”. Recording times and floors are two separate marks on the SBG (this is to be distinguished from the SCC convention it was derived from: using a “record floor,” in which a single mark represents both the rate floor and the recording time). The recording time and rate floor are always the same distance from the light red “1” line on the SBG, but the recording time and rate floor are symmetrically placed on opposite sides of the 1 line.

Floors: A floor is plotted with a “_” and indicates where measured values greater than zero cannot go below. A floor can be for rates, durations, latencies, IRTs, and even percentage data. If the floor is for a rate, then an observer can find the value by answering the question “What would the rate value be if I counted only 1 instance of the behavior during my observation time?” E.g., if one observed for 50 minutes, then to find the RATE floor, just take 1/50 to get the rate floor’s value (.02 per min), then plot a floor “_” on the .02 per min level. If one does not count any instances of behavior during the recording time of 50 minutes, i.e., if one counts *zero* instances of the behavior, then one should put a dot just below that floor.

The floors for latency and duration are more up to the discretion of the observer, and depend upon the degree of precise measurement that is practical and necessary for the behavior being recorded. Common floors for duration and latency might range as high as 1 minute, or as low at one-tenth of a second.

Percentage Data: If one must display percentage data, he or she should still use a Standard Behavior Graph. Make double horizontal lines at the 1 line (for the floor) and the 100 line (for the ceiling), and plot the data between the two sets of double lines. Place a large percentage symbol above the ceiling to make it extra clear it is a display of *percentage* data. A zero percent value would go just below the double line at the light red 1 line.

Finding Values and Plotting Data : A calculator may be useful to determine values. However, a piece of regular old scrap paper, or the *range finder* may become a faster method for experienced users. See chapters 3, 5, and 10 for more detail.

For readers used to plotting on the SCC (Standard Celeration Chart):

The SBG's grid lines are more widely spaced than the SCC's, but the angle of a X2 celeration line on the Daily Per Min, SCC is about the same as a X2 Standard Value Trend line on the Quarter Year, Daily SBG: approximately 34 degrees. All of the angles of other trend line values or celeration line values are also the same between the SBG and the SCC.

In accordance with the International Organization for Standardization (ISO, 2004), and the common practice of calling the first day of the week "Monday" in business and school, the thick blue vertical lines on the SBG are *Monday* lines (not Sunday lines).

The SBG separates the recording time from the rate floor such that they are represented with two separate marks (^ and -). The SCC combines the rate floor with the recording time, so that the "record floor" is represented with just one mark (-) . The SBG's visual separation of these concepts emphasizes an important relationship between the behavior being observed, and the behavior of observing behavior!

The y-axis scale to the right is normal on the SBG: the numbers get larger as you move UP the scale. On the SCC's y-axis to the right, the numbers get larger as you move DOWN the scale because the SCC uses a reciprocal axis for duration and latency.

The Standard Behavior Graph

Standardized Graphing Made Easy

Chad E. L. Kinney

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Preface and Acknowledgements:

The Standard Behavior Graphs in this guidebook are innovations created by Chad Kinney in 2011 and 2012. Along with these graphs came a need to develop new terms and procedures that surround the newly proposed standard. Inspired by Dr. Ogden Lindsley's notion of "working terms," (Lindsley, 1991; Graf & Lindsley, 2002) this guidebook has all of its experimental terms and procedures presented in **green ink** within the glossary. Furthermore, many experimental terms in the glossary have a short note to guide the reader regarding the author's reasoning for that working term.

I offer my sincere gratitude to Dr. H.S. Pennypacker, my "chart parent," for introducing me to ABA, precision teaching, the SCC, and the amazing folks at Morningside Academy. Though the SCC was conceived and developed circa 1967 by Ogden Lindsley (Graff & Lindsley, 2002)—and without Dr. Lindsley's founding work this book and SBG could not have been made--it was the *Handbook of the Standard Celeration Chart,* by Pennypacker, Gutierrez, & Lindsley (2003), that had the most direct influence on the design and flow of this guidebook for the SBG.

Also, I deeply thank Dr. J. Martinez-Diaz for inspiring me to obtain an M.S. and certification in ABA, supporting my continuing professional development, and hiring me to teach ABA (and the SCC) to those seeking certification in ABA.

Next, I thank all of the major contributors to the *SCListserv* (precision teaching listserv) for responding to my many (sometimes impertinent) questions and comments with mountains of critical feedback that shaped my thinking about a new standard (and special thanks to those who emailed me off the list with words of kindness and encouragement). I fully believe the SBG (and this guidebook) is very compatible with the SCC, despite the obvious differences. Moreover, the SBG would not even begin to exist if it were not for the decades of hard work that went into refining, researching, and promoting the SCC (the SBG's predecessor).

Many thanks also go to the parents and students who continue fluently graphing their own performance on the Quarter Year, Daily and the 100 Minute SBGs. Your data is a true guide, showing us how the SBG can be a practical and powerful tool.

Additionally, a great deal of thanks goes to Carlos Zuluaga (a studious teacher of the SCC), for offering his valuable feedback and encouragement after reading this book. Moreover, Carlos is the creator of a highly useful Excel spreadsheet version of the SBG!

Finally, I would like thank my wife, Katie, for helping me find the courage to hold a firm stance in the public arena, regardless of its immediate popularity. She is my rock, and I doubt I would have completed this project without her support.

Table of Contents:

Forward:

If you are a behavior analyst who understands the importance of standard measurement in science, Chad Kinney's Standard Behavior Graph could be the option for you.

In this guidebook, Chad provides a complete description of the Standard Behavior Graph and provides yet another compelling argument for why standard measurement is essential in the study of behavior. This book is a powerful resource for professionals who are interested in changing behavior, and are concerned with the empirical evaluation of interventions.

I hope that you find inspiration in Chad Kinney's work , and that the knowledge you gain through reading this guide will allow you to continue making significant improvements in the lives of the individuals you serve.

Carlos A. Zuluaga, MS, BCBA

Introduction: The Importance of Standardization.

"The power of the Standard Celeration Chart derives from the fact that it is standard and universal" (Pennypacker, Gutierrez, and Lindsley, 2003).

The ability to make valid comparisons is at the heart of all science. While custom-made graphs, with non-standard axes and features, often facilitate the interpretation of scientific data, they generally miss out on the advantages that standardization can bring (Johnston & Pennypacker, 1980). Standardization of graphic displays primarily has the advantage of ensuring consistency between different sets of data; such consistency can allow for the interpretation of data to be more precise, more accurate, and more quickly communicated (Datchuk & Kubina, 2011). Moreover, standardized graphic displays can guard against unintentional distortions of data (e.g., via improperly labeled or scaled axes) that may impair accurate interpretation (McGreevy, 2007). Ultimately, standardization of graphical displays enhances ones ability to make valid scientific comparisons—even between data sets that are of vastly different quantities (Pennypacker et al., 2003).

This book is a guide that shows how to use a standardized graphical display known as the Standard Behavior Graph (SBG). The type of SBG that is shown on the front cover is the "Quarter Year, Daily."   It is the primary SBG in a growing family of Standard Behavior Graphs that have been designed to enhance the study of the behavior of organisms—especially *human* organisms.   The SBG shown and discussed in Appendix D is the "100 Minute, Minutely." Unfortunately, the SBG's predecessor, the Standard Celeration Chart (SCC) mentioned in the quote above, can not be fully discussed here, because it is beyond the scope of this book; however, point-by-point comparisons between the SCC and the SBG are given in Appendix A.

One thing that makes the Standard Behavior Graph (SBG) a so-called *standard* is its "Standard Values" (see chapter 3).   *Standard Values* may be applied to nearly any data point or set of data points displayed on an SBG. For instance, on a single SBG the following can be consistently compared, and quickly communicated: (1) rates, latencies, and durations of behavior (2) reversal, multi-element, multiple baseline, and other within-subject research designs, (3) exact calendar dates of pinpointed behaviors in particular settings, and (4) precise measurement of changes in the trend, level, and variability in any dimension of behavior.

One reason the SBG is a *good* standard is that its logarithmic axis allows for the sensitive display and quick comparison of nearly any quantity of any behavior on *one* graph—even the variability in data sets of vastly different quantities can be sensitively compared on a single graph with a logarithmic ("equal ratio scale") axis (Johnston & Pennypacker, 1980; Pennypacker et al., 2003).

To illustrate the power of being able to quickly and accurately compare data patterns on the same graph, the reader is asked to graph the following five raw data entries on the regular-grid graph-paper above; please label your axes as you wish:

Session Number	**Date**	**Total Number of Responses**	**Total Number of Response Opportunities**	**Total Minutes of Recording Time**
Session 1	10/08/2012	100	Unknown	50 minutes
Session 2	10/09/2012	60	Unknown	20 minutes
Session 3	10/10/2012	20	Unknown	10 minutes
Session 4	10/11/2012	40	Unknown	10 minutes
Session 5	10/12/2012	30	Unknown	10 minutes

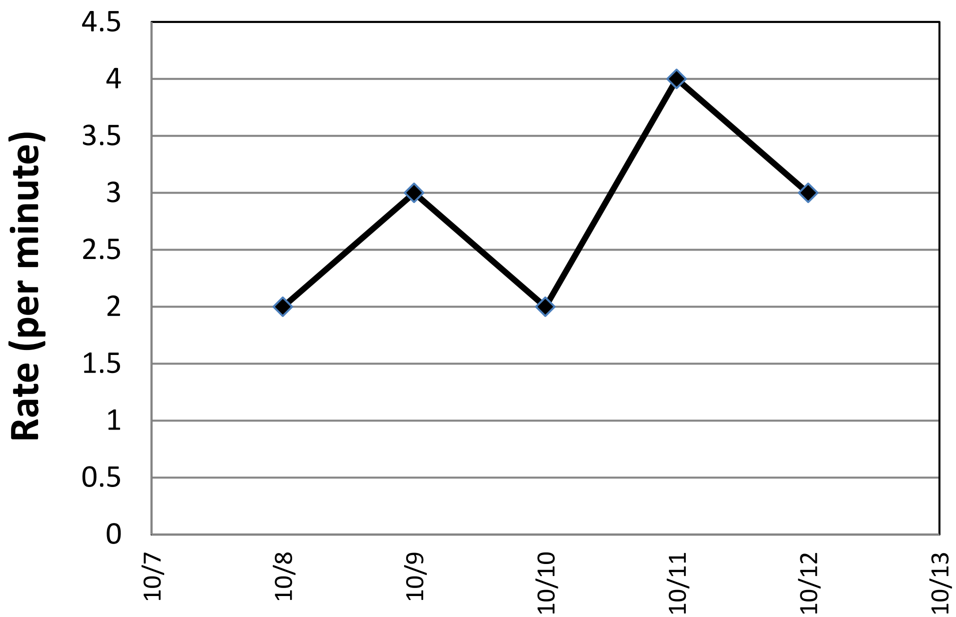
How did you label your axes? Did your X-axis have sessions or dates in continuous time? Did your Y-axis represent total raw count or converted rate values? By what increments did the values on the y-axis increase (e.g., 1's, 5's, 10's, etc.)? Next, try adding the five data entries below on the graph you just made. Please notice what you do to the graph to make all the data fit.

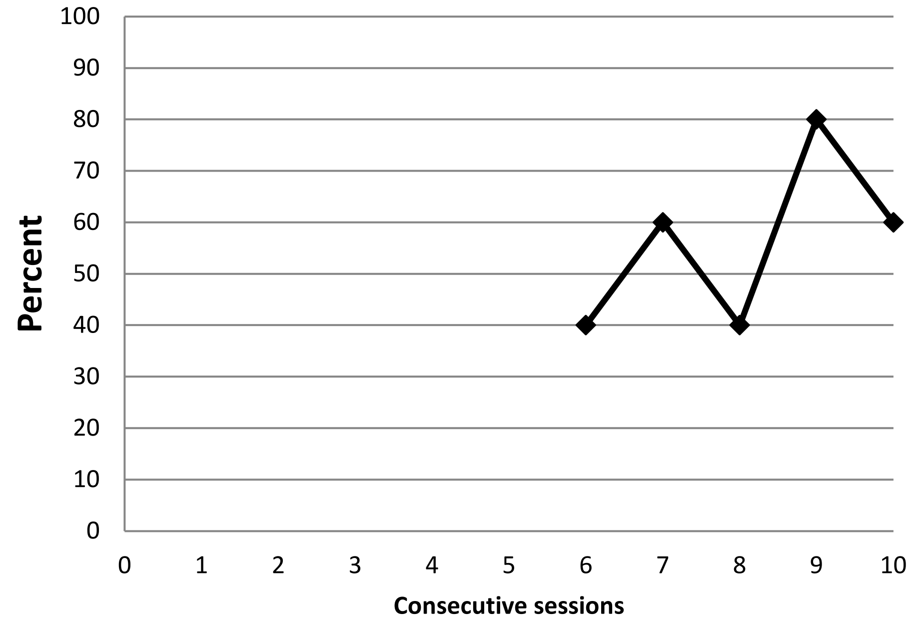
Session Number	**Date**	**Total Number of Responses**	**Total Number of Response Opportunities**	**Total Minutes of Recording Time**
Session 6	11/05/2012	40	100	2 minutes
Session 7	11/06/2012	60	100	2 minutes
Session 8	11/07/2012	40	100	2 minutes
Session 9	11/08/2012	80	100	2 minutes
Session 10	11/09/2012	60	100	2 minutes

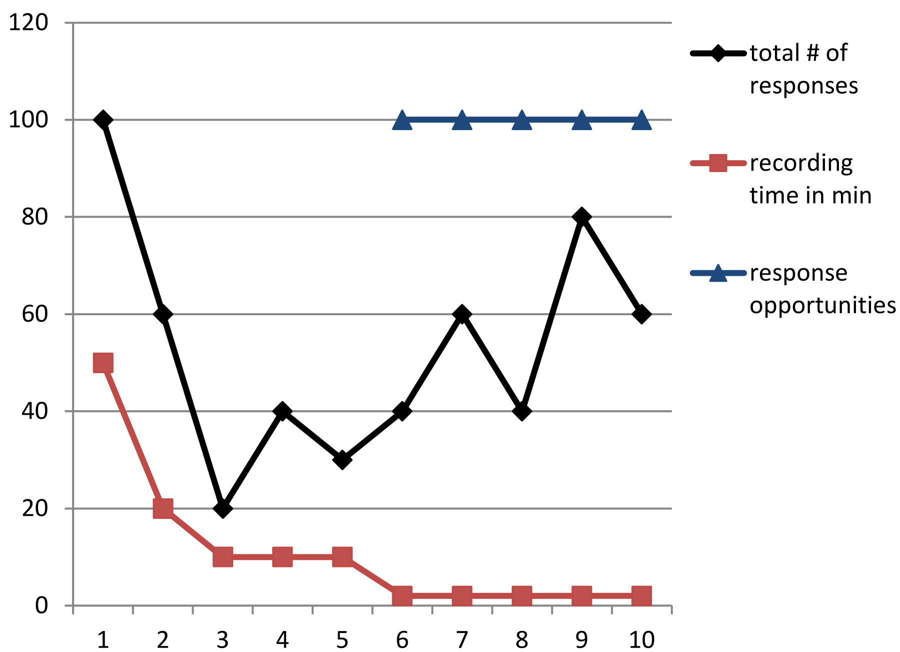
A second blank sheet of graph paper is given above in the event that the reader determines that the 2nd set of data points (sessions 6 – 10) requires its own separate graph because it will not fit well on the same graph as the 1st set of data points. However, if the reader attempts to put all of the data upon a single graph, then he or she may have made an indefinite number of decisions regarding how to alter the X and Y axes so that all of the data could be accurately displayed. If one were to try to fit all the data points given on the same graph, then how would they need to re-label their axes? Should their X-axis have sessions or actual dates in continuous time? Should their Y-axis represent total raw count or converted rate values? Or should percentages be represented by the Y-axis? By what increments should the values on the y-axis increase (e.g., 1's, 5's, 10's, etc.)? Should there be a double Y-axis?

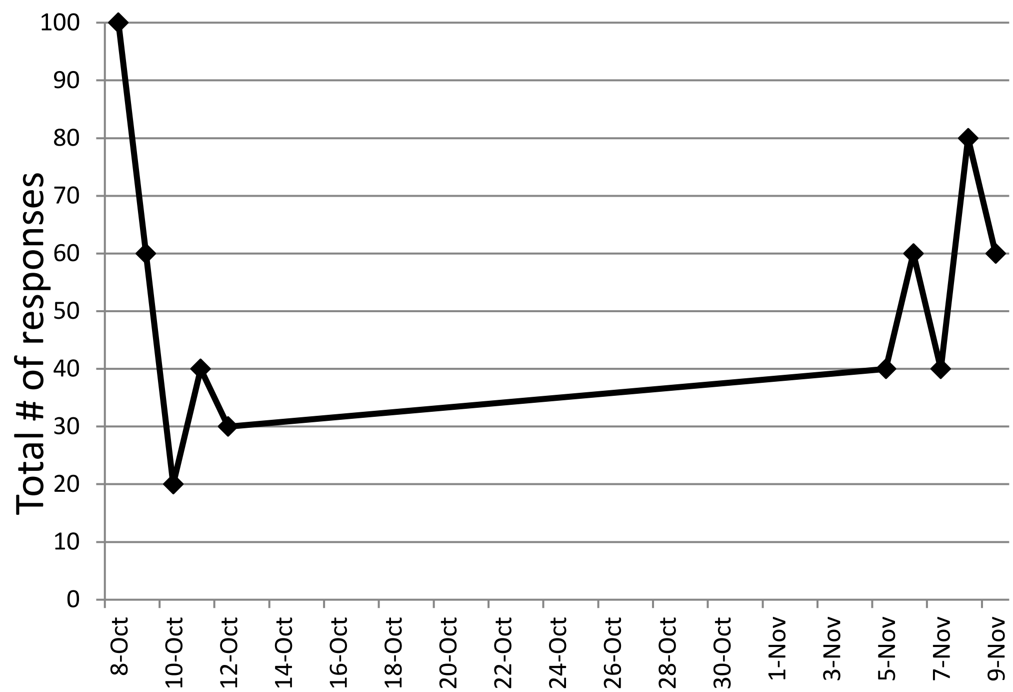
There are no absolute correct answers to the questions above (though there may be incorrect answers!). In fact, there may be *many* acceptable ways to graph the *exact same set* of data points.

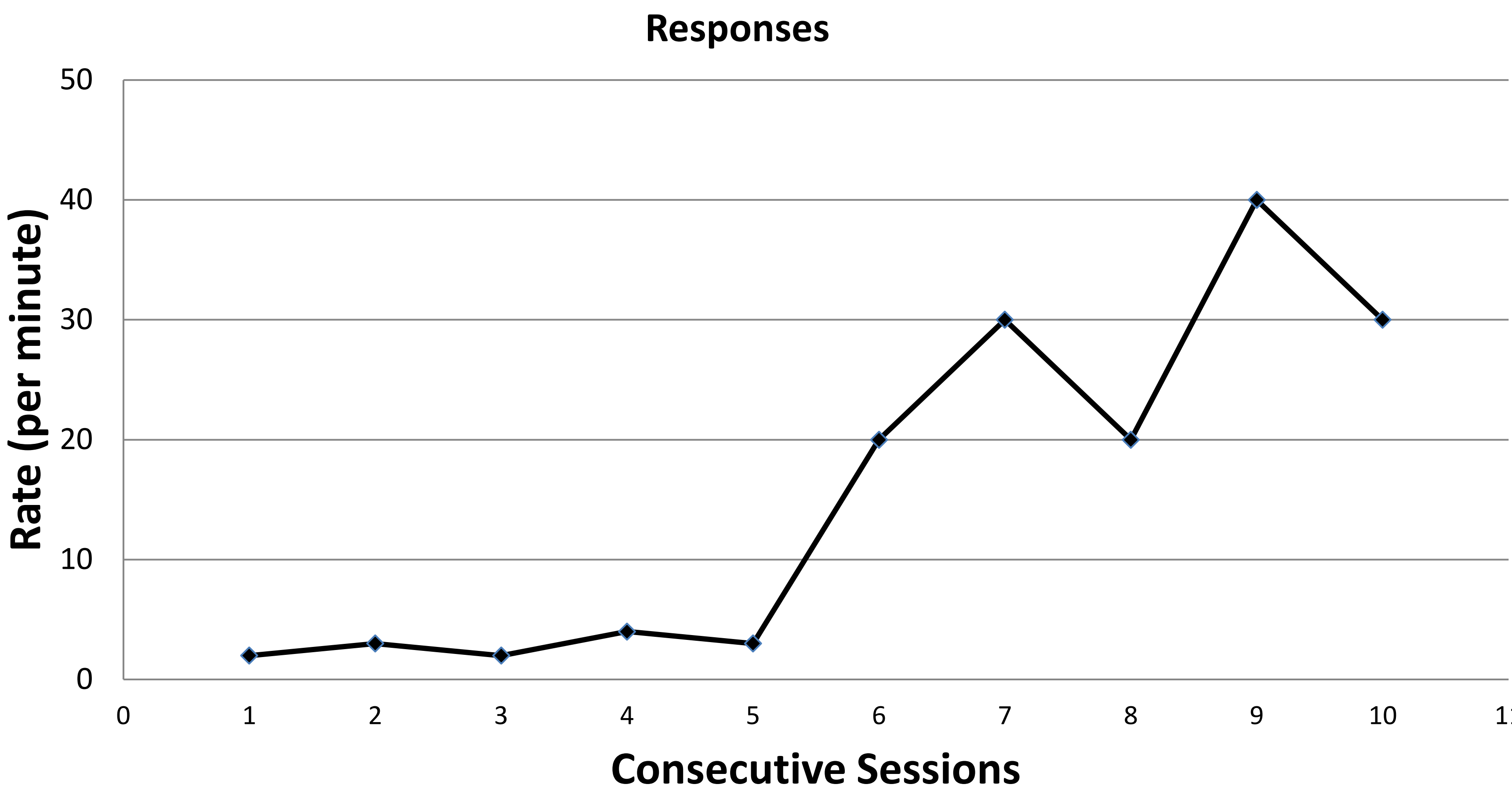
The graphs on the following pages (6 – 9) are all derived from the table shown on page 3. Though, some people may prefer to graph by hand, it's likely that many prefer to use an electronic program such as excel to graph their data. However, whether the custom-made graph is done by hand or by computer, custom-made graphs have the potential to significantly underemphasize variability (as shown with the first 5 sessions of the graph on page 7) and/or over-exaggerate variability (as shown with the last 5 sessions in the graph on page 8). The issues just noted with visually displaying variability have also been previously discussed in scientific literature regarding the use equal interval scales in general (e.g., Johnston & Pennypacker, 1980). Moreover, as can be seen in the following graphs, all of which are "equal interval" (because their scales are marked at equal distances and increase by equal values), if important information is not lost altogether, it is still very difficult to quickly make accurate and *precise* comparisons between the different displays. Keep in mind that the following graphs are all derived from the *same* set of data; thus, imagine the difficulty that would likely arise if different people attempted to make valid comparisons across *different* sets of data. Ultimately, without a standard, it could become quite difficult to make valid comparisons of such data quickly (Pennypacker, et al., 2003).


Rate (per minute)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10/7
10/8
10/9
10/10
10/11
10/12
10/13


Percent
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Consecutive sessions

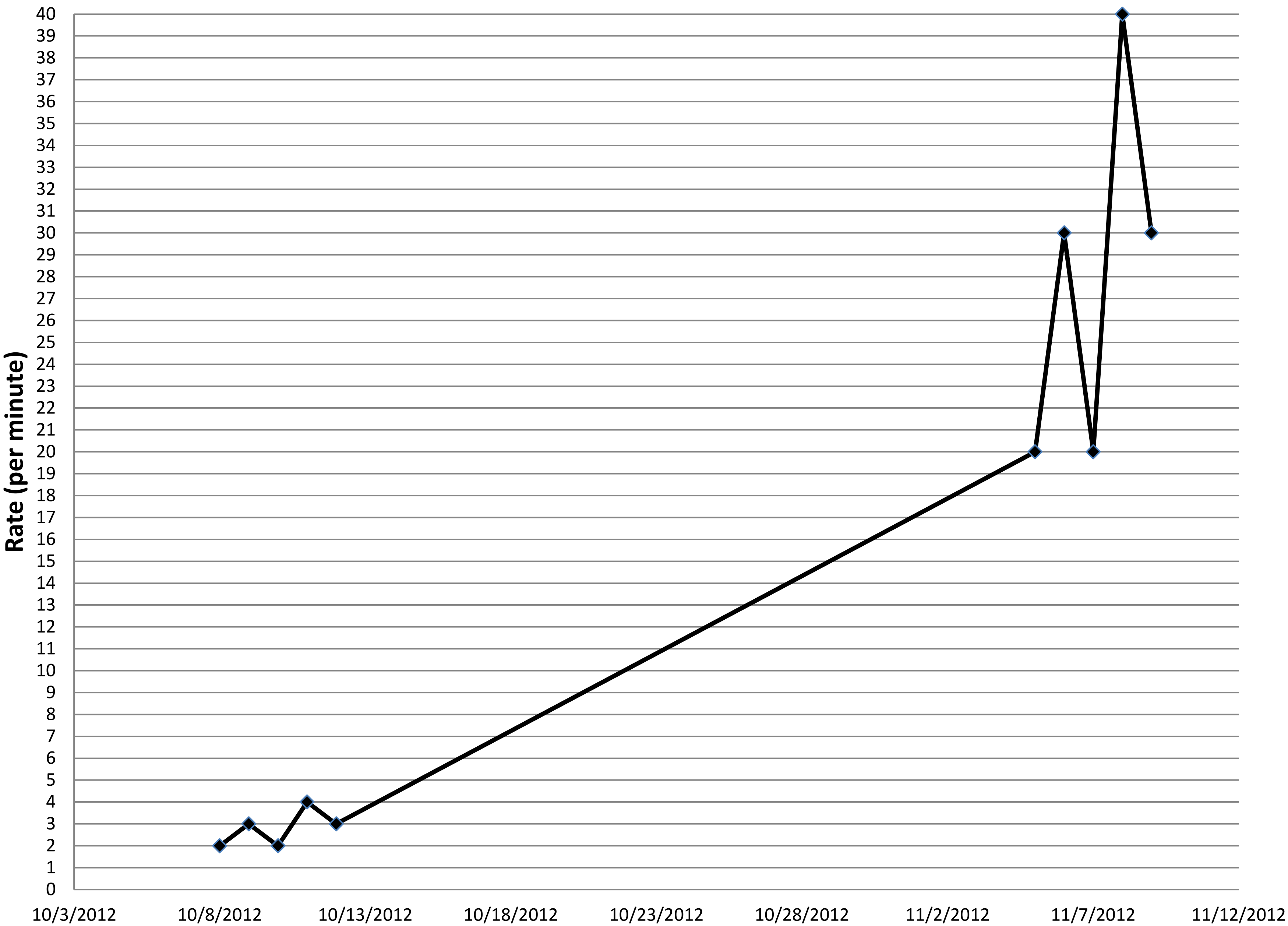

120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
total # of responses
recording time in min
response opportunities


Total # of responses
100
90
80
70
60
50
40
30
20
10
0
8-Oct
10-Oct
12-Oct
14-Oct
16-Oct
18-Oct
20-Oct
22-Oct
24-Oct
26-Oct
28-Oct
30-Oct
1-Nov
3-Nov
5-Nov
7-Nov
9-Nov



The four smaller graphs above (on pg. 6), depict excel versions of some of the different ways one could realistically and practically graph the data from the data set shown on page 3.

The large graph above on this page (7) may be a common way to graph the data set shown on page 3.


Rate (per minute)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
10/3/2012
10/8/2012
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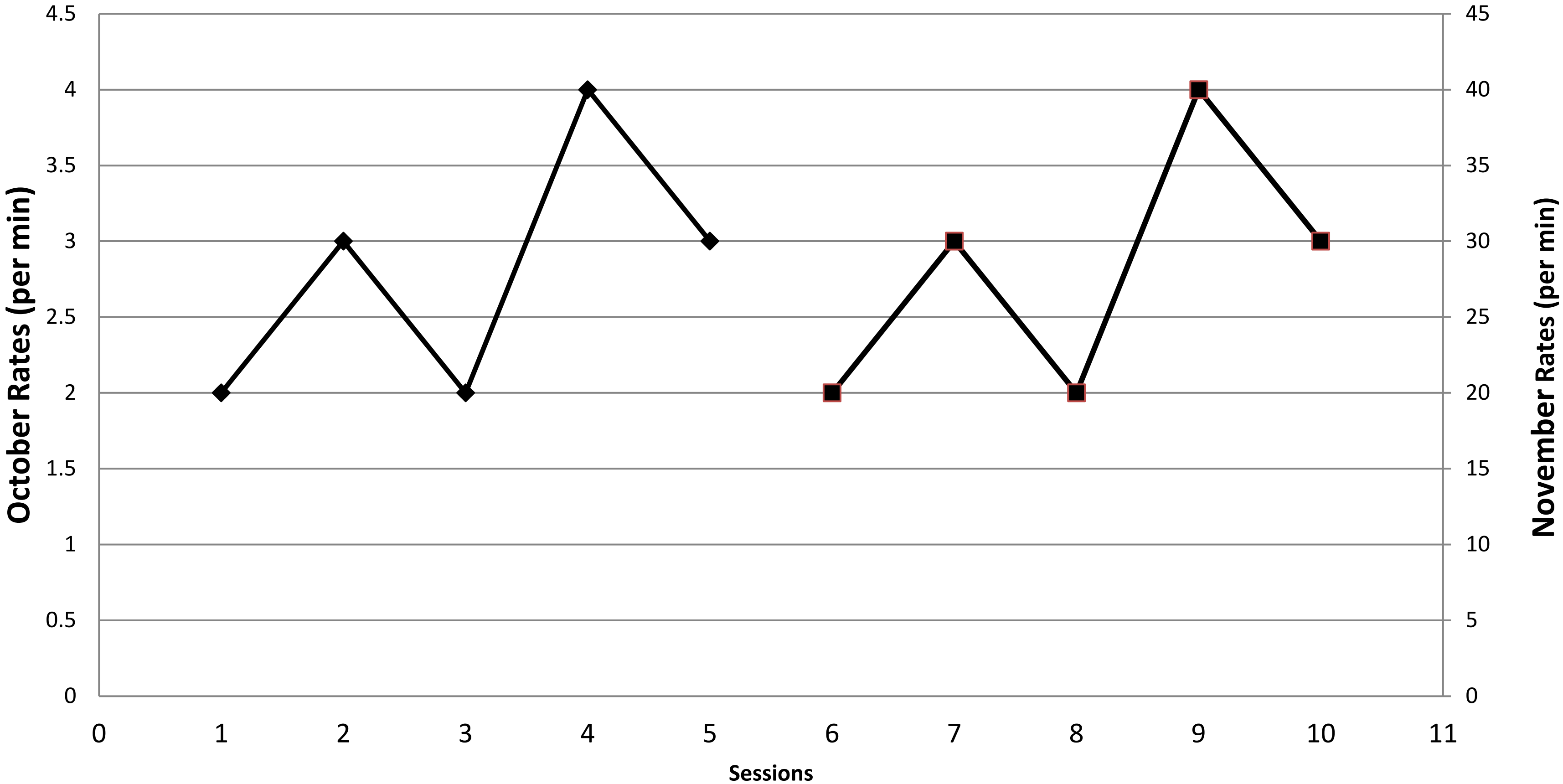
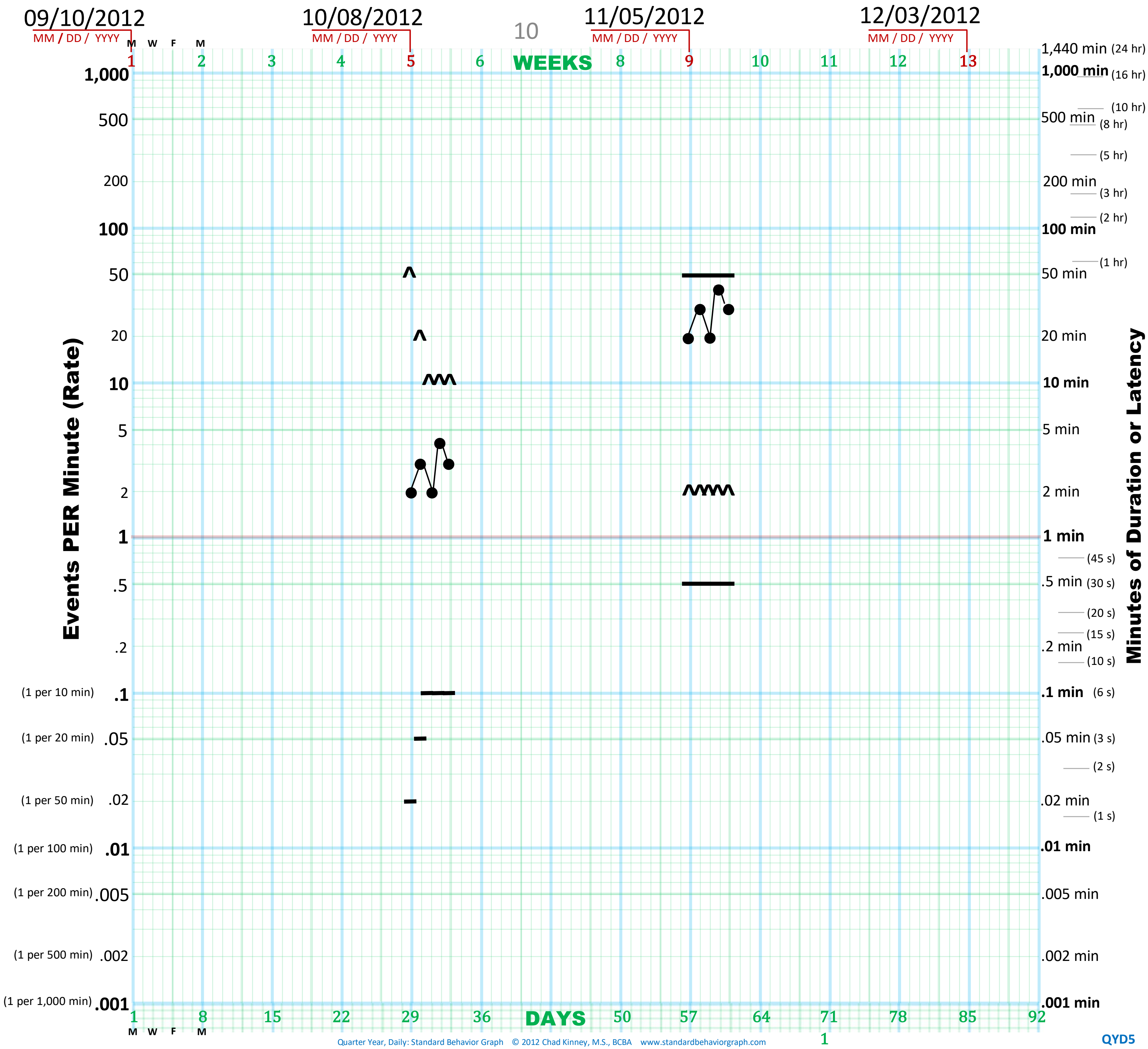
10/28/2012
11/2/2012
11/7/2012
11/12/2012



On the graph on page 8, notice that the y-axis is labeled by 1's, and how it exaggerates variability in the last 5 data points. Again, this graph was derived from the data table on page 3.

The graph above on this page (9), with it's double Y-axis, allows for a decent comparison of variability and trend between the first five data points and the last five data points on the same graph, but the real calendar time between the 5^{th} and 6^{th} session is lost. Additionally, if more points were added with far greater or lesser quantities, those data points would probably not fit on the same graph (and thus be harder to compare).



Jane Doe

Learner / Behaver / Performer

Responses/Rate

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Hotel Room at 8:40AM!

Setting(s) / Circumstances

Chad

Grapher | Counter | Timer

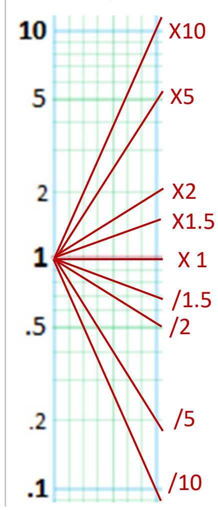
?

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

Demo Data!
Blah Blah
Blah So
Very Tired
Need Coffee
Help! Me!

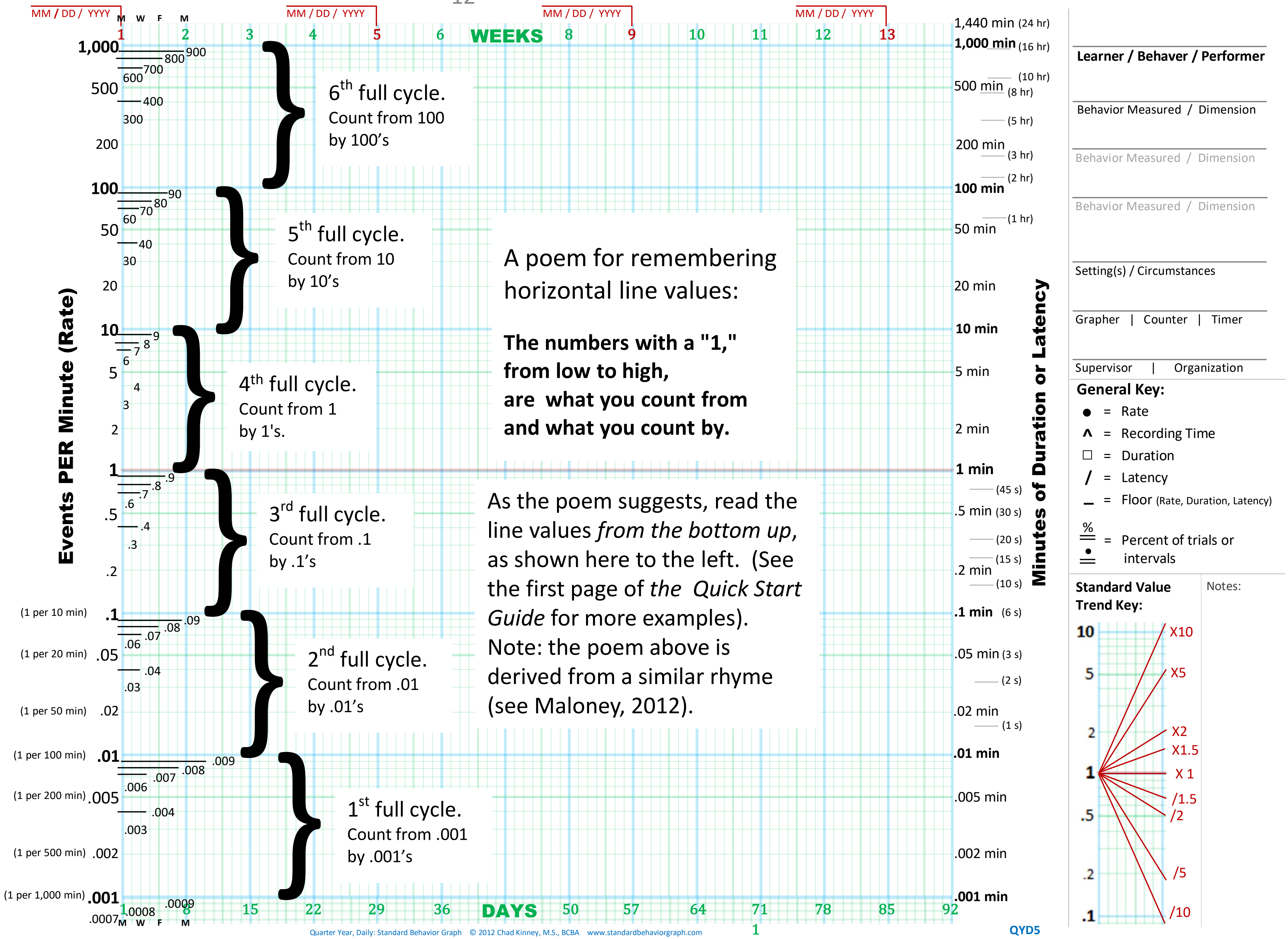
A Standardized Display of the Data (on the SBG):

One way to accurately plot a vast range of data on the same graph, without losing sensitivity and precision, is to make the Y-axis logarithmic (Johnston & Pennypacker, 1980). The advantages of using a logarithmic scale for a *standardized* display, provide good reasons for using a log scale on the SBG [1]. In the next chapter, those reasons will be more fully discussed (see page 17), and in the chapters ahead specific instructions will be given on how to read and plot data on a graph with a logarithmic Y-axis scale—i.e., the Standard Behavior Graph (SBG). Before moving ahead, please observe how the data patterns compare between graphs from the previous pages and the SBG above.

In the graph above, the reader might first notice that the time between sessions is anchored to real calendar time on the continuous X-axis, allowing anyone to quickly determine and communicate how much time (in weeks or days) has passed *between* sessions. Moreover, the reader may see the downward trend across all of the recording times in which observations took place—notice how recording times decrease in relation to increasing response rates! Additionally, the reader should observe that all of the raw data (from page 3) easily fit on the same standard graph, making a more complete display that is rich in important information. Logarithmic axes are useful for compressing large ranges of data to fit on a single page, while sensitively preserving the proportional patterns of the variability within the data (Johnston & Pennypacker, 1980). That is, an appropriate amount of sensitivity is preserved as the variability within both sets of data (1-5 and 6-10) has not been unduly flattened or over-exaggerated—allowing one data set to be readily comparable with the other.

The reason sensitivity is preserved on the SBG is partly because the Y-axis scale is logarithmic, but it's also partly because the scales on both the X and Y axes represent a *standard* that is very resistant to improper changes of the numbers that run along the axes. Even small manipulations in scale quantities on a graph's axis can hinder accurate data interpretation by distorting variability and trend in any plotted data set (Johnston & Pennypacker; McGreevy, 2007)--as can be observed from the graphs on the previous pages.

[1] Dr. Ogden Lindsley (2000) and colleagues first selected a 6-cycle log-scale (for the SCC) for many of the same reasons (for the SBG) listed on this page.


MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
1,440 min (24 hr)
1,000 min (16 hr)
500 min
200 min
100 min
50 min
20 min
10 min
5 min
2 min
1 min
.5 min (30 s)
.2 min
.1 min (6 s)
.05 min (3 s)
.02 min
.01 min
.005 min
.002 min
.001 min
(1 per 10 min)
(1 per 20 min)
(1 per 50 min)
(1 per 100 min)
(1 per 200 min)
(1 per 500 min)
(1 per 1,000 min)
6th full cycle.
Count from 100
by 100's
5th full cycle.
Count from 10
by 10's
4th full cycle.
Count from 1
by 1's.
3rd full cycle.
Count from .1
by .1's
2nd full cycle.
Count from .01
by .01's
1st full cycle.
Count from .001
by .001's
A poem for remembering horizontal line values:
The numbers with a "1," from low to high, are what you count from and what you count by.
As the poem suggests, read the line values from the bottom up, as shown here to the left. (See the first page of the Quick Start Guide for more examples). Note: the poem above is derived from a similar rhyme (see Maloney, 2012).
Learner / Behaver / Performer
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:
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QYD5

Chapter 1: Basic Features of the Quarter Year, Daily--Standard Behavior Graph

The Quarter Year, Daily's purpose is to capture the entire range of any human behavior whose dimensions can practically be observed in a single day. The SBG is for all who would like to assess precise measures of learning/performance and monitor the effectiveness of interventions that are designed to increase wanted behaviors and reduce unwanted behaviors. Ultimately, the SBG has been designed for precision teachers, behavior analysts, scientist-practitioners, and/or self-managers.

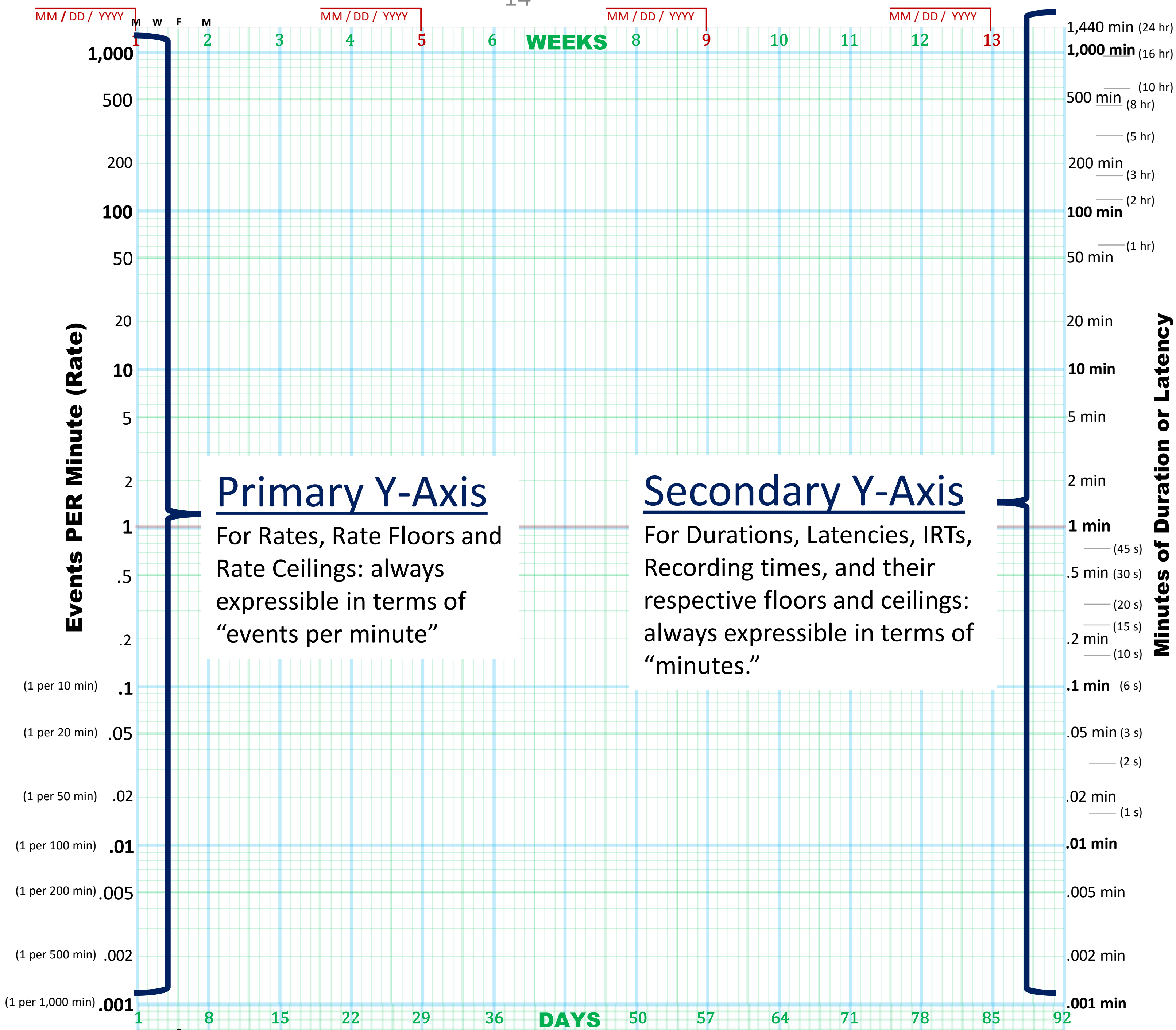
The Quarter Year, Daily--SBG grid dimensions (<u>NOTE</u>: the graphs in this guide book are only 95% of the size of an actual SBG):

The blue and green grid has a logarithmic double Y-axis with 6 full cycles. To capture a nearly complete range of any human behavior, both Y-axes have a range from .000694 (bottom) to 1440 (top)—approximately 192 mm in length. The grid's X-axis is "equal-interval," thus equally spaced. The X-axis displays calendar time continuously with a range from 1 day to 92 days (i.e., approximately 13 weeks, or ¼ of a year), and is approximately 176 mm in width. The grid itself takes up about 56% of the area on a standard sheet of 8 ½ inch x 11 inch printer paper. Again, It is important to note that most of the illustrative graphs within this guide book are slightly smaller than actual SBG graphs.

The Y-axes:

Except for the light red horizontal 1 line through the center of the grid, each logarithmic cycle is separated by a thick blue horizontal line (see the .001, .01,.1, 10,100, and 1000 lines in the graph above). The horizontal line in the center (the "1 line") is a partially transparent red ("light red") so that a user can more quickly determine the mid-point of the grid (this is also to prevent mistaking the .1 line for the 1 line). The values of all lines on the Y-axes increase as they move from the bottom up. The figure above (on page 12) indicates the values of all the horizontal lines and where the cycles are, and the poem can be used for remembering the values of the horizontal lines.

The lowest point on the grid, just below the .0007 line, is $.00069\overline{4}$ because .000694 per minute is the smallest possible rate of *any* response that one can observe occurring within a 24 hour day. Moreover, with regard to duration and latency, most practitioners have no practical use for amounts of time more precise than a $1/10^{th}$ of a second (or .00167 minutes); thus, the .000694 limit also accommodates most practical measures of duration and latency.



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QYD5

Learner / Behaver / Performer

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Setting(s) / Circumstances

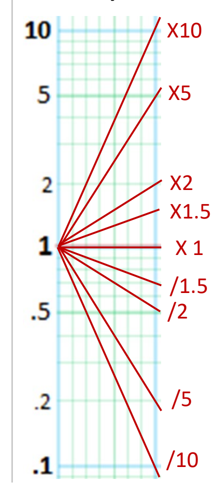
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- – = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

The highest point on the grid is 1,440 because there are no more than 1,440 minutes in a single day; thus the natural limit for any duration or latency is 1,440 minutes. Moreover, with regard to rate, the vast majority of measurable human behaviors are well under 1,440 per minute (an extremely fast rate that cannot be reliably or accurately measured without special equipment).

Within each cycle, between the horizontal blue lines, lie the horizontal green lines. Notice that every 5th line up from a horizontal blue line, is a horizontal green line that is a little bit thicker than the other green horizontal lines. The fifth lines are thicker only to allow users to more quickly find the midway line within any given cycle.

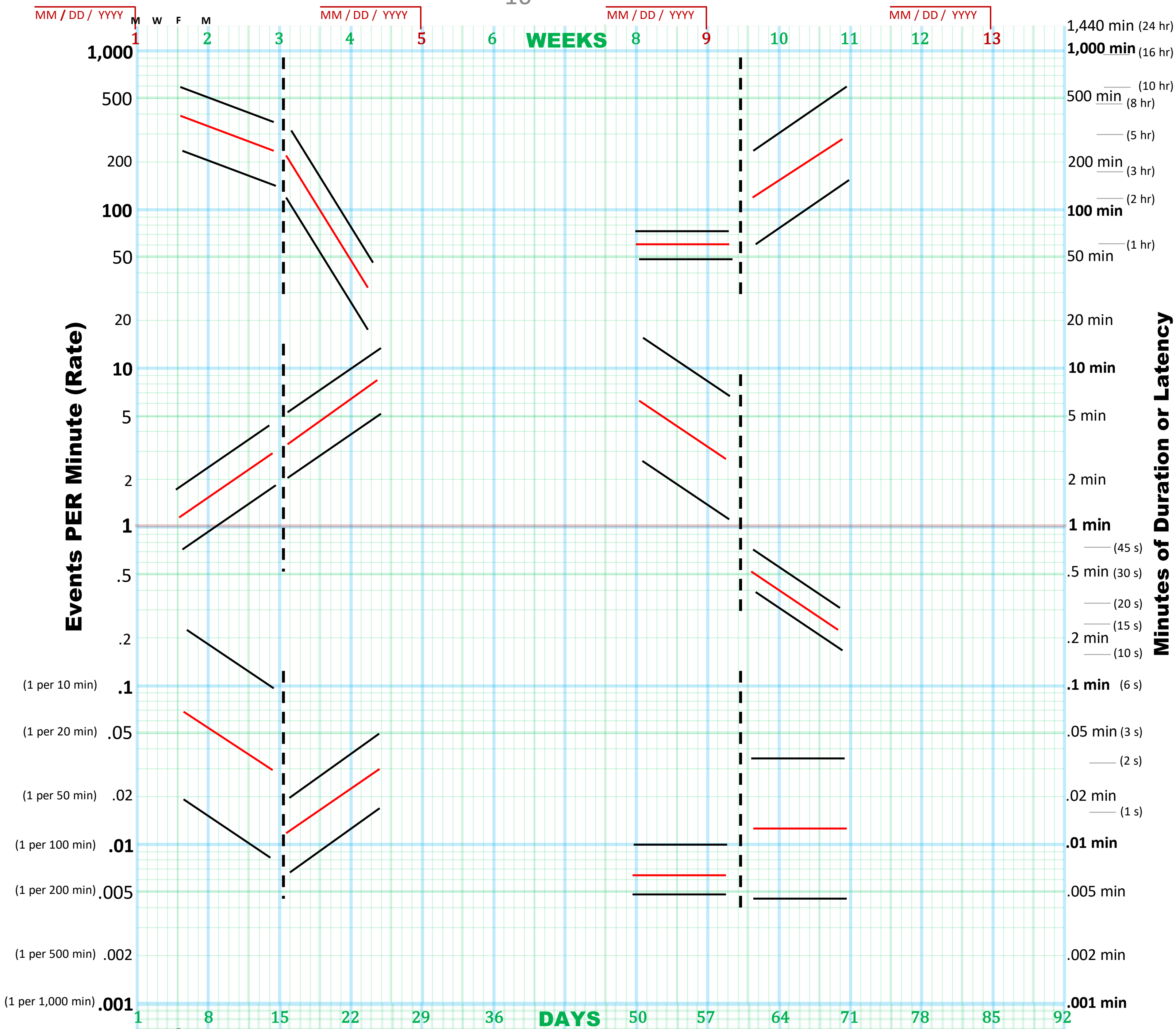
The horizontal grid lines along the Y-axes are spaced apart from each other in a way that corresponds with logarithmic values. The reader may notice that going from 10 to 20 on the SBG is doubling the amount (increasing by 100%), but going from 20 to 30, is only increasing the amount by 50%. Moreover, going from 90 to 100, is only increasing the amount by 11%! This may help one to understand why the physical distance between the 10 and the 20 line is the greatest, whereas the distance between the 90 and the 100 line is the smallest. These ratios apply to all the horizontal lines within every cycle of any logarithmic scale.

The Primary Y-axis:

The scale of the primary Y-axis is located by the left side of the grid. The primary Y-axis is used for the display of rate, rate floor, and rate ceilings. Rate is a dimension of behavior that is typically a ratio of the number of events observed divided by the number of *minutes* spent observing. Rate floor is a ratio of 1 event observed divided by the number of *minutes* spent observing. Also, one may notice that some of the numbers with decimals (below the 1 line) have a sentence in parentheses to the left of them. This is to aid a user's way of thinking about slower rates of behavior. E.g., instead of saying an event happened .1 times per minute, it may help to think of the event as happening about once every 10 minutes--as suggested by McGreevy (2007).

The Secondary Y-axis:

The scale of the secondary Y-axis is located along the right side of the grid. Though the scales on both the secondary and primary Y-axes have the same basic numbers on them, the secondary Y-axis is not used for the display of rate, rather it only displays dimensions of behavior that directly correspond to units of time. That is, in terms of *minutes*, the secondary Y-axis is used to display duration, duration floors, duration ceilings, latency, latency floors, latency ceilings, and IRTs, IRT floors and IRT ceilings. It should be noted that "recording time," or the time spent observing, is usually a special case of duration. Also, one may notice that various numbers of seconds and hours are in parentheses to the right of their equivalent minute values. This is to aid a user's quick estimation if it helps to think in terms of seconds or hours.



Learner / Behaver / Performer

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Setting(s) / Circumstances

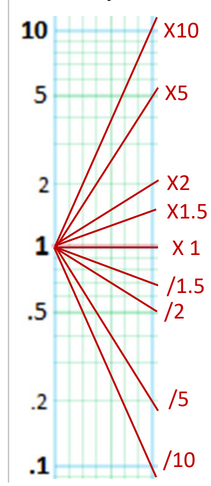
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % / ● = Percent of trials or intervals

Standard Value Trend Key:



Notes:

Recording time can be a special case of duration, because it is not the duration of the behavior of the performer, rather it may be the duration of the *observing behavior* of the *observer*! The observer's private behavior is "observing the presence or absence of event X." Additionally, the secondary Y-axis is not just labeled in terms of minutes, but also roughly marks the places where the minutes can be converted into hours and/or seconds. Note: To convert hours into minutes, multiply the hours by 60. To convert seconds into minutes, divide the seconds by 60.

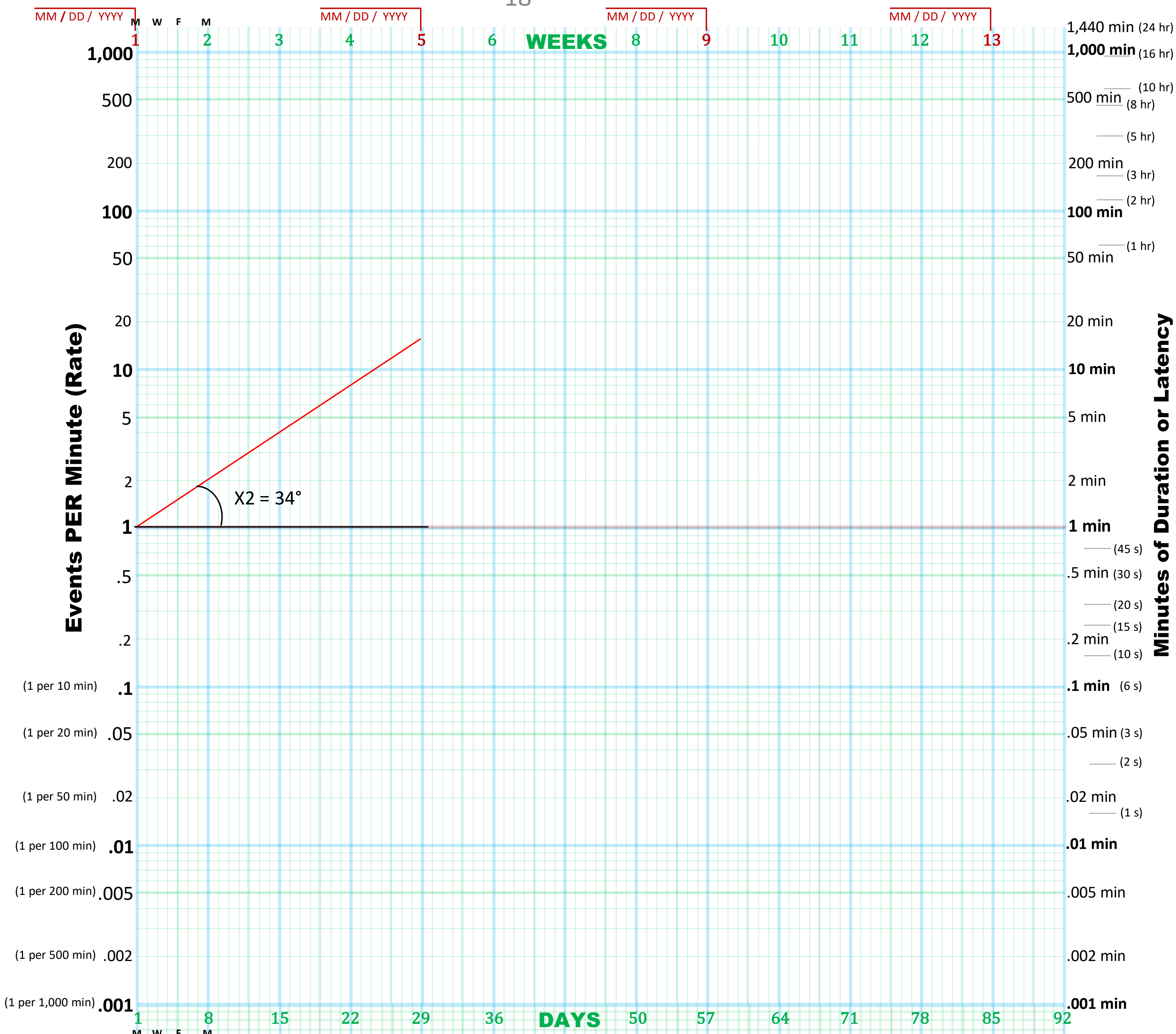
Four reasons for using a logarithmic scale (on the Y-axes):

(1) As already demonstrated in the Introduction of this guidebook, a logarithmic scale can be ideal for handling very large differences in quantity without distorting the picture of variability or forcing the presenter to display data on several separate graphs. Since the log scale on the SBG is able to show quantities proportionally, it remains a sensitive and easy way to display and compare data--with very large differences in quantity--on the same graph (Johnston & Pennypacker, 1980).

(2) In terms of communication, a standard display's importance can not be understated. The log scale allows for quick and precise communication about any behavior in terms of a *standard* that is well-suited for the analysis and comparison of data (Datchuk & Kubina, 2011).

(3) Behavior often multiplies or changes exponentially over time (Koenig, 1972; White & Haring, 1980), and when the growth of something can best be described with multiplication, instead of just addition, logarithms are useful (Vickers, 2010). On a regular equal-interval graph, exponential changes in a quantity may result in lines to best fit that are curved and thus difficult for the human eye to interpret. However, the log scale on the SBG's Y-axes has the effect of producing best-fit lines for behavioral data that are *straight* (see graph above). There are many examples in science in which data is transformed to create a straight line on a graph, thus allowing for easier comparison and interpretation of that data (Manikandan, 2010; Zuhmdahl & Zuhmdahl, 2009).

(4) Finally, there are many different scientific displays (e.g., within biology, chemistry, physics, engineering, economics, etc.) that use logarithmic scales in order to facilitate valid scientific comparisons. E.g., the pH scale for acidity and the Richter scale for earthquake magnitudes. Additionally, logarithmic axes are often used to analyze the exponential growth or change in things like monies, prices, organism populations, velocities, magnitudes, masses, chemical reactions, and temperatures, etc. Thus, it seems only natural that a science of behavior should also utilize logarithmic scales for data display. For a greater understanding on how a regularly scaled axis can be transformed into a logarithmically scaled axis, please see appendix C.



Learner/Behaver/Performer

Behavior Measured | Dimension

Behavior Measured | Dimension

Behavior Measured | Dimension

Setting(s) / Circumstance(s)

Grapher | Counter | Timer

Supervisor | Organization

General Key:

● = Rate

^ = Recording Time

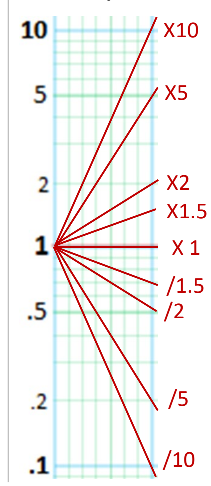
☐ = Duration

/ = Latency

_ = Floor (Rate, Duration, Latency)

% / • = Percent of trials or intervals

Standard Value Trend Key:



Notes:

The X-axis:

Along the X-axis of the SBG, each thick blue vertical lines represents the first day of the week, Monday [1]. The 6 green lines between each of the Monday lines are the other days of the week. Notice that the Friday lines are a little thicker than the rest of the green day lines; this may help the user more quickly find a midway line–and help distinguish "week days" from "week ends."

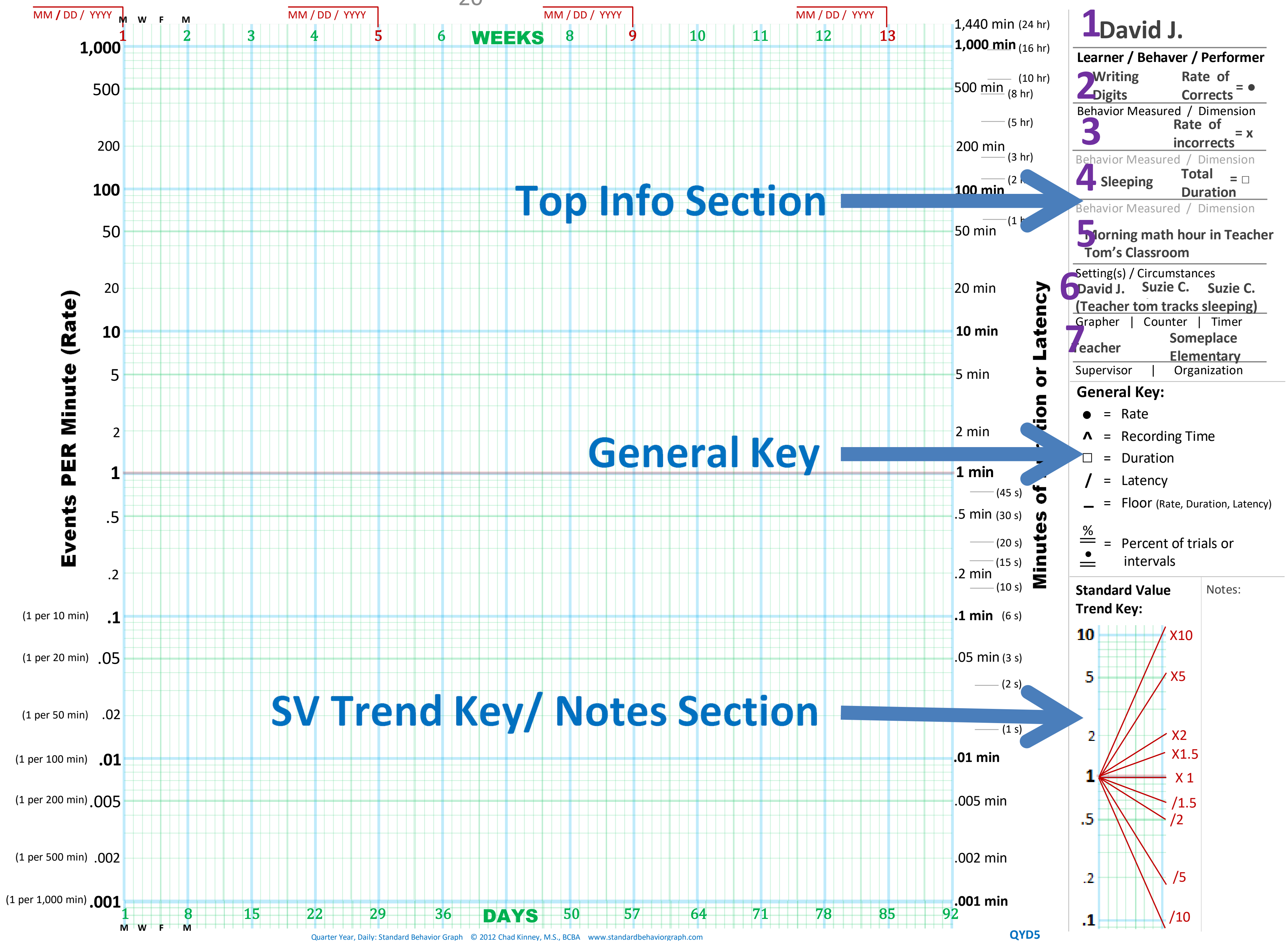
The very first vertical line on the grid is labeled "1" because people generally speak about beginning a task on the *first* day--as opposed to the "zeroth" day. Additionally, since the first line is 1, there is easier communication about which day or week a user is referring to when discussing data graphed on the SBG. For example, if one refers to "the data in week 3," the reference is quite clear and easy to find. That is, from left to right, week 3 lasts for seven days; it begins on Monday (day 15) and ends on Sunday (day 21). The next day (day 22) is a Monday that begins week 4.

The last vertical line on the grid is day 92 because this covers approximately 13 weeks or ¼ of year, and it seems very reasonable to divide a year up into quarters for data analysis. Additionally, 13 weeks allows for more than enough room for displaying data gathered from the 9 week grading periods found in schools.

At the bottom of the grid, the X-axis scale is labeled by calendar days. However at the top of the grid, the X-axis scale is labeled by the weeks that correspond with the calendar days. The week numbers 1, 5, 9 and 13 are red, while all the other week numbers are green. The red week numbers are red to make it easier for the user to find the calendar date that corresponds with that red week number. Above the grid, in red ink, there are four self-explanatory prompted blanks for the calendar dates (i.e., "MM/DD/ YYYY"). These allow the user to sync up the continuous days on the chart with continuous calendar time.

The numbers on the X-axis scale are embedded within the grid itself to maximize the grid's total surface area while remaining consistent with the SCC: Both the SBG and SCC have a x2 trend line with an angle approximately 34 degrees (Lindsley, 2000). Numerous field trials conducted by the author of this book have shown that the embedded numbers are very unlikely to hinder interpretation of any data point placed anywhere on the grid.

[1] According to the International Organization of Standardization, *Monday* is considered the first day of the week (ISO, 2004). Moreover, in common practice, it is the first day of the work week and school week in the United States.



MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
Top Info Section
General Key
SV Trend Key/ Notes Section
1 David J.
Learner / Behaver / Performer
2 Writing Digits
Rate of Corrects = ●
Behavior Measured / Dimension
3 Rate of incorrects = x
Behavior Measured / Dimension
4 Sleeping
Total Duration = □
Behavior Measured / Dimension
5 Morning math hour in Teacher Tom's Classroom
Setting(s) / Circumstances
6 David J. Suzie C. Suzie C.
(Teacher tom tracks sleeping)
Grapher | Counter | Timer
7 Teacher
Someplace Elementary
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
— = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
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QYD5

The Top Information Section[2]:

The **1st** blank to be filled in is the *Learner/Behaver/Performer*. For example, let's say that "David J." is our learner, a.k.a. behaver, or the one who should be learning to demonstrate an improvement in his performance by emitting some measurable behavior.

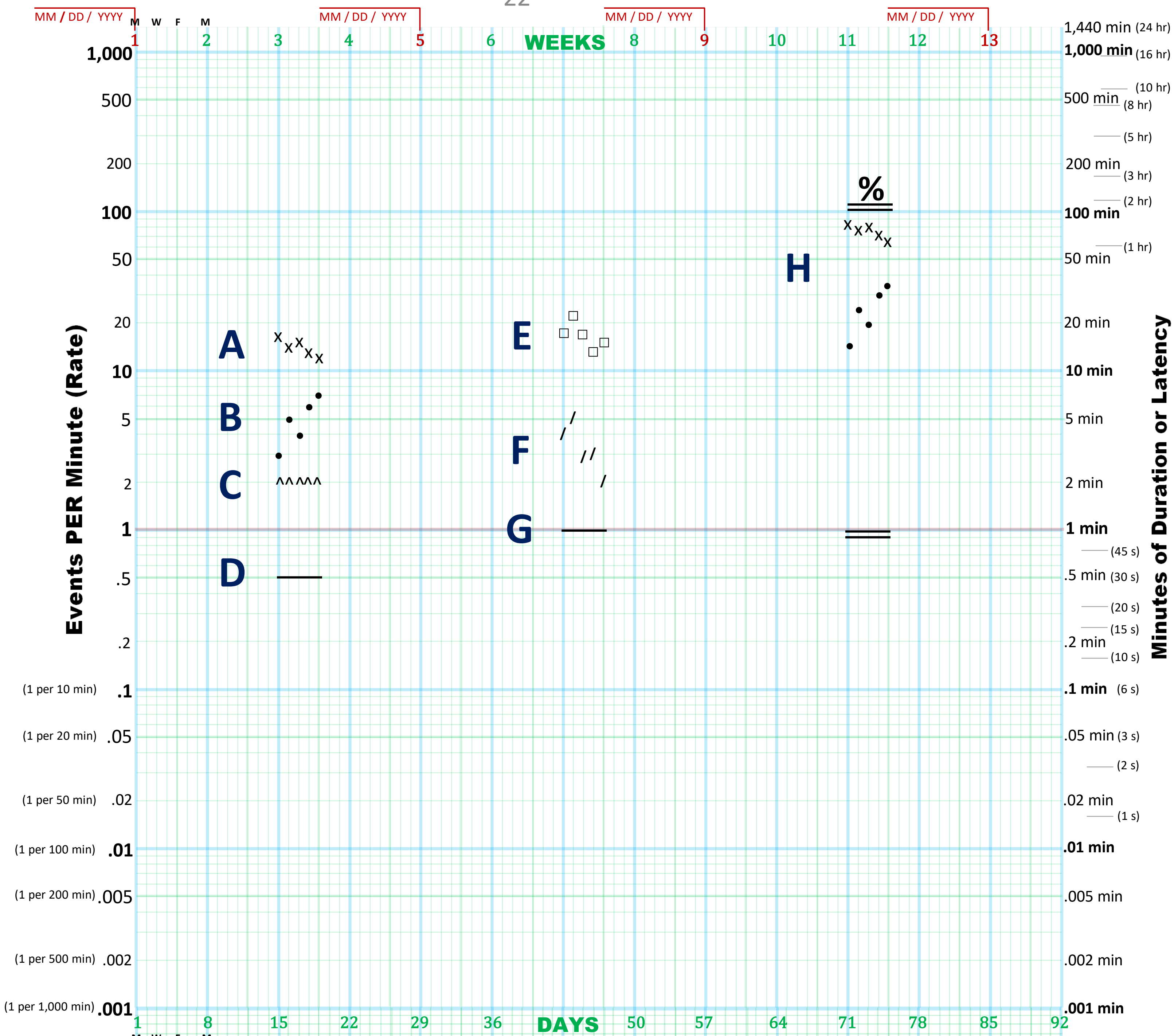
The **2nd** , **3rd**, and **4th** blanks from the top are for documenting the measurable behavior that the observer(s) pinpointed for measurement and possible intervention. These blanks generally have enough room for describing the behavior(s) targeted for measurement, the dimension of that behavior that will be measured and displayed, and what symbol will represent some measured dimension of behavior. For example, let's say that the target behaviors are rate of correct responses, rate of incorrect responses (notice "x" is not in the general key), and total duration of episodes of practicing the math skills to be learned. If one needs more room to describe the targeted behaviors, then one may also use the grid itself, the margins, the area for notes in the bottom section, or even the back of the SBG.

The **5th** blank, for Setting(s)/Circumstance(s), can used for describing the environmental conditions in which the behavior is measured. For example, we might measure David J.'s behavior during the morning math hour in Teacher Tom's classroom.

The **6th** blank is for the Grapher, Counter, and Timer: these can all be the same person or separate persons. The Grapher actually plots the data on to the graph. For example, David himself may graph his own behavior. The Counter directly counts the number of events that are being targeted for measurement (e.g., responses, or response products). For example, let's say David's peer, Suzie. C is counting corrects and incorrects. The Timer directly keeps track of the time that passes while measuring the targeted behavior. Let's say Suzie C. also uses a stopwatch to time David's performances.

The **7th** blank from the top is for the supervisor and organization. For example, let's say the supervisor is Teacher Tom, who works for the organization known as Someplace Elementary School. If there is no person or entity to fill a role indicated by a blank, then a dash may be placed in such blanks.

[2] Note: As with most of the features on the SBG, many of the information blanks in this section have been inspired by the information blanks on the SCC. However, there are very clear and obvious differences.



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QYD5

David J.

Learner / Behaver / Performer

Writing Digits Rate of On Math WS Corrects = ●

Behavior Measured / Dimension

Rate of inCorrects = x

Behavior Measured / Dimension

Sleeping — Total Duration = □ And Latency = /

Behavior Measured / Dimension

Morning math hour in Teacher Tom's Classroom

Setting(s) / Circumstances

David J. | Suzie C. | Suzie C. (Teacher tom tracks sleeping)

Grapher | Counter | Timer

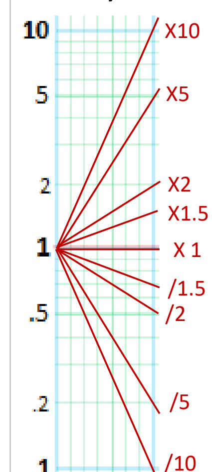
Teacher | Someplace Elementary

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

The General Key:

The General Key is for promoting consistency and standardization across data sets within and across graphs. Observe the graph above to see how the symbols may be applied. Note: If needed, these symbols can be modified.

The group of data points next to **A** in the graph above are not in the General Key, rather the special symbols that represent the rate of David's math errors (**x**) are defined in the top info section.

The group of data points next to **B** in the graph above correspond to the first item at the top in the General Key: the filled-in dots that represent the *rate* (●) of David's correct responses per minute on a math worksheet.

The group of data points next to **C** in the graph above correspond to the second item from the top in the General Key: the carrots that represent *recording time* (**^**). **Note: It's not always necessary to plot recording times--especially when the recording times are the same every day (or if it clutters the picture too much).**

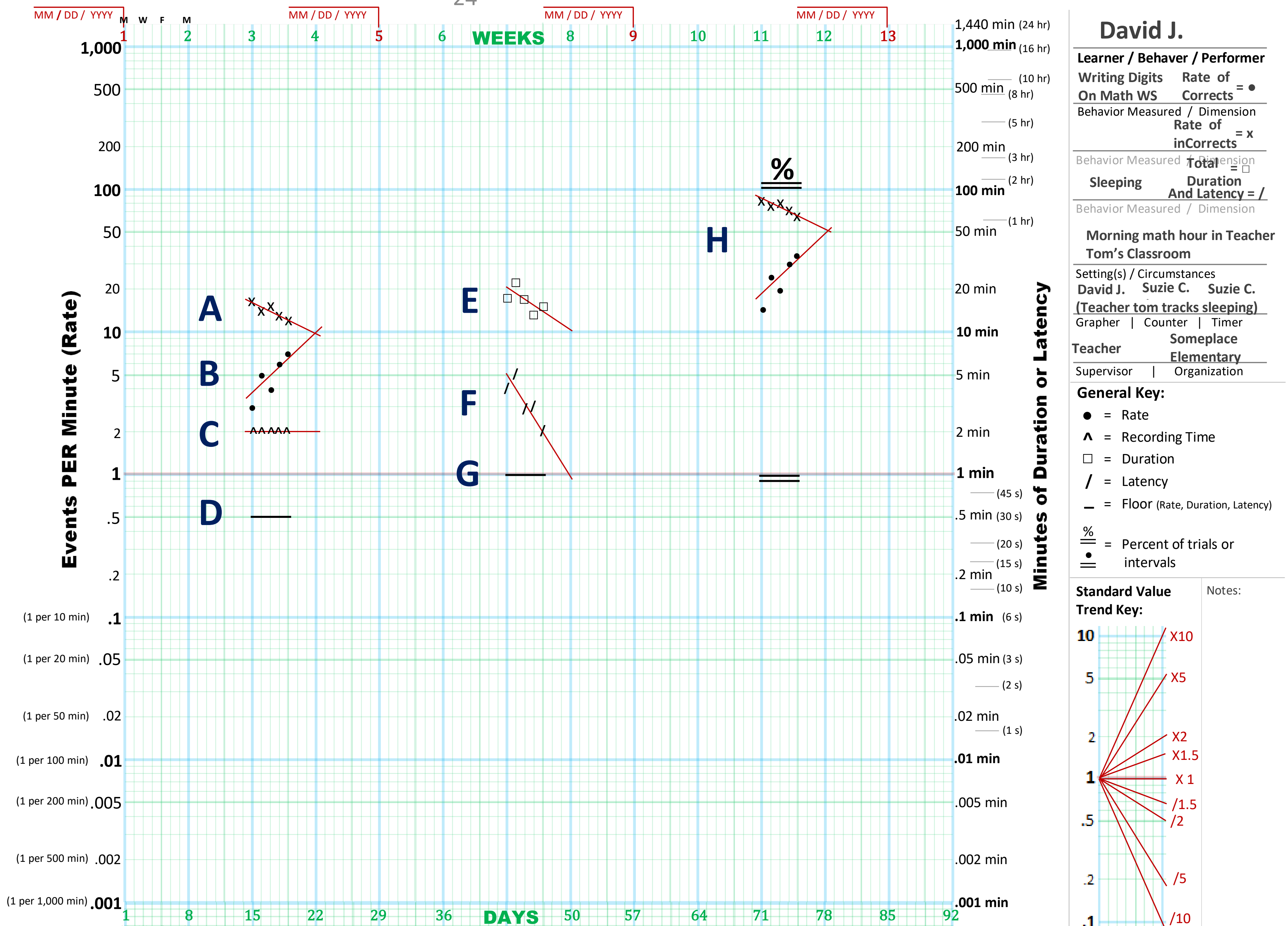
The group of data points next to **D** in the graph above correspond to the fifth item from the top in the General Key: the dashes that represent *rate floor* (**-**). Note: Rate floors only correspond to the *primary* Y-axis along the left.

The group of data points next to **E** in the graph above correspond to the third item from the top in the General Key: the data points that represent duration (□). In this case, they represent the duration of David's "sleeping" (or "head down") in class.

The group of data points next to **F** in the graph above correspond to the fourth item from the top in the General Key: the slashes that represent latency (/). In this case, they represent David's latency to begin working on class objectives after the bell rings.

The group of data points next to **G** in the graph above correspond to the fifth item from the top in the General Key: the dashes that represent duration floor and/or latency floor (**-**). Note: Duration or Latency floors only correspond to the *secondary* Y-axis.

The group of data points next to **H** in the graph above correspond to the last item in the General Key: the double lines (above the 100 level and below the 1 level) that represent the display of a derived measure; the large percent symbol (**%**) is placed on top to make it very clear that percentage data is displayed.


MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
A
B
C
D
E
F
G
H
%
(1 per 10 min)
(1 per 20 min)
(1 per 50 min)
(1 per 100 min)
(1 per 200 min)
(1 per 500 min)
(1 per 1,000 min)
1,440 min (24 hr)
1,000 min (16 hr)
500 min
200 min
100 min
50 min
20 min
10 min
5 min
2 min
1 min
.5 min (30 s)
.2 min
.1 min (6 s)
.05 min (3 s)
.02 min
.01 min
.005 min
.002 min
.001 min
David J.
Learner / Behaver / Performer
Writing Digits On Math WS
Rate of Corrects = •
Behavior Measured / Dimension
Rate of inCorrects = x
Behavior Measured / Dimension
Sleeping
Total Duration = □
And Latency = /
Behavior Measured / Dimension
Morning math hour in Teacher Tom's Classroom
Setting(s) / Circumstances
David J.
Suzie C.
Suzie C.
(Teacher tom tracks sleeping)
Grapher | Counter | Timer
Teacher
Someplace Elementary
Supervisor | Organization
General Key:
• = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:
QYD5

The Standard Value Trend Key[3]:

Within the bottom section, lies the Standard Value (SV) Trend Key. The term *Standard Value* is important, and will be described later in chapter 3. The SV Trend Key is exactly 8 day lines long (i.e., the "standard value trend period"), and can help one to quickly estimate the quantity of any trend line placed on an SBG. To the right of the SV Trend Key is an area for notes about things like raw data, ABC data, extra definitions, or extra explanations that may facilitate data interpretation.

In the graph above, both of the trend lines drawn in the data sets next to **A** and **H** (incorrects), have the same slope. By looking at the SV Trend Key, the quantity of both trend lines can be estimated at somewhere between /1.5 and /2.

The trend lines next to data sets **B** and **H** (corrects), both have the same slope. Again, by looking at the SV Trend Key, the quantity of both trend lines can be estimated at somewhere between X2 and X5.

The trend line for the data set next to **C** is flat and unchanging, but a quick glance at the SV Trend Key, indicates that its quantity is x1 (recall, that any time a number is multiplied by 1, the number remains unchanged).

The trend line for the data set next to **E** appears to have a quantity of approximately /2.

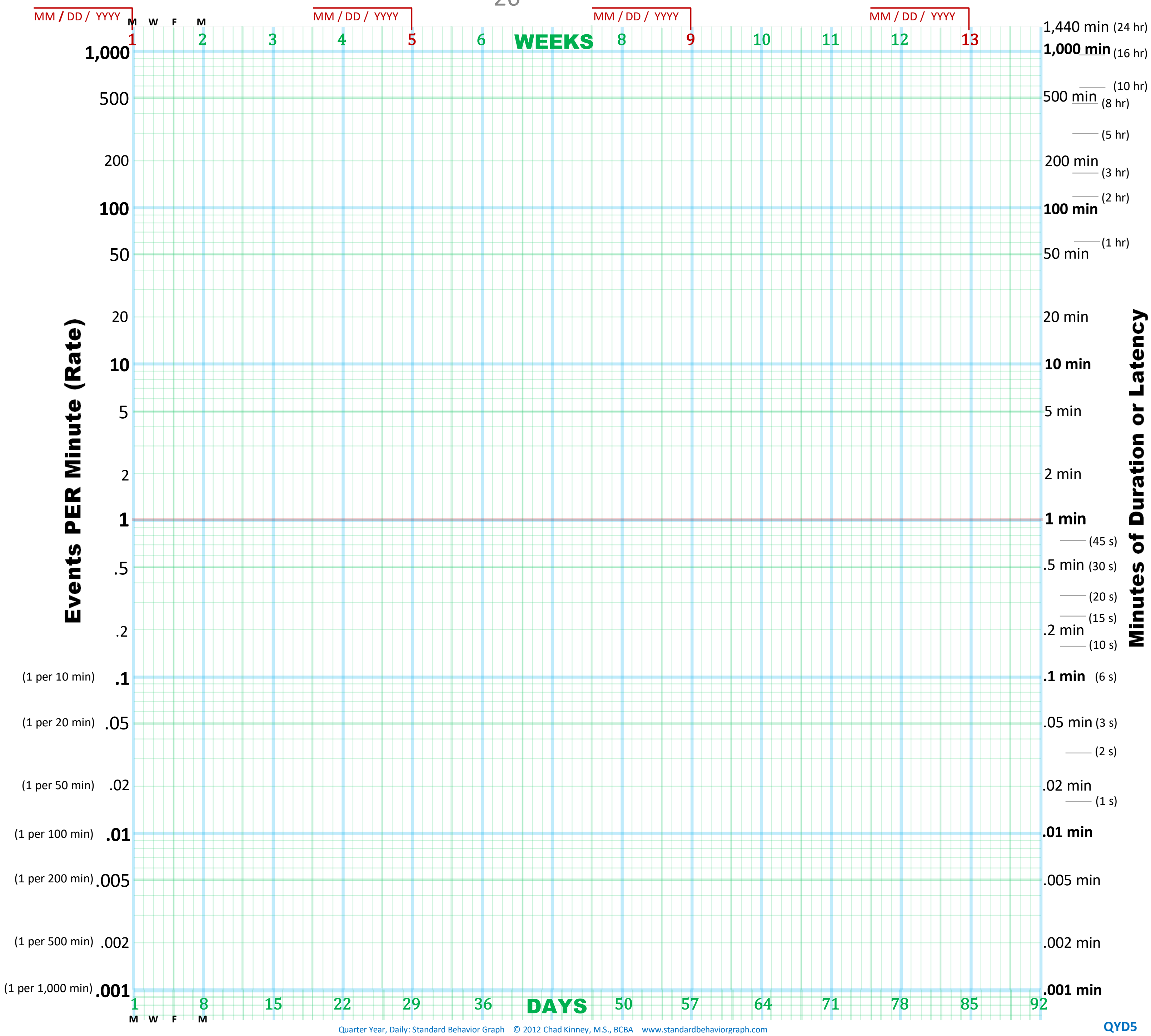
Finally, the trend line for the data set next to **F** appears to have a quantity of approximately /5.

When the quantities for trend lines are standard, people can effectively describe trends beyond imprecise phrases such as "it's going up" or "it's going down." That is, a standard way of quantifying trend lines can tell us precisely *how much* the trend is going up or going down (e.g., "it's going up by x3," or "…down by /10") (Pennypacker, et al., 2003). Moreover, a trend standard allows a user to immediately understand how to interpret trend values across any data set that is plotted over time on an SBG.

To determine the quantity of a trend line more accurately than with a quick "eye-ball estimation," please see chapter 10.

The *Notes* section, To the right of the SV Trend Key, is for any extra information that may useful toward data interpretation.

[3]The Idea for the SV Trend Key was inspired by the SCC's "standard celeration fan," and Skinner's (1938/1991) key on cumulative records. Though all of these designs have similarities, they have clear differences, see item 6 in appendix A.



Tanya K.

Learner / Behaver / Performer

Screaming Episodes | Total = ◯ Duration

Behavior Measured / Dimension

Avg. rate

Behavior Measured / Dimension

(3 seconds of no-screaming Must Pass before New episode counted)

Behavior Measured / Dimension

Morning math hour in Teacher Tom's Classroom

Setting(s) / Circumstances

Teacher Assistant Sam

Grapher | Counter | Timer

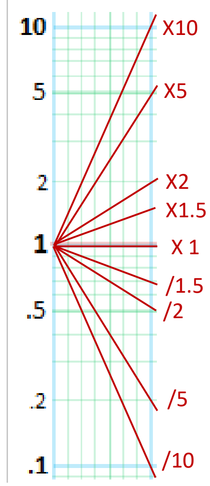
Teacher | Someplace Elementary

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % / ● = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Screaming Episodes" Include any vocal sound That could be heard Approx.. 50 ft. way with normal levels of bckgrnd noise.

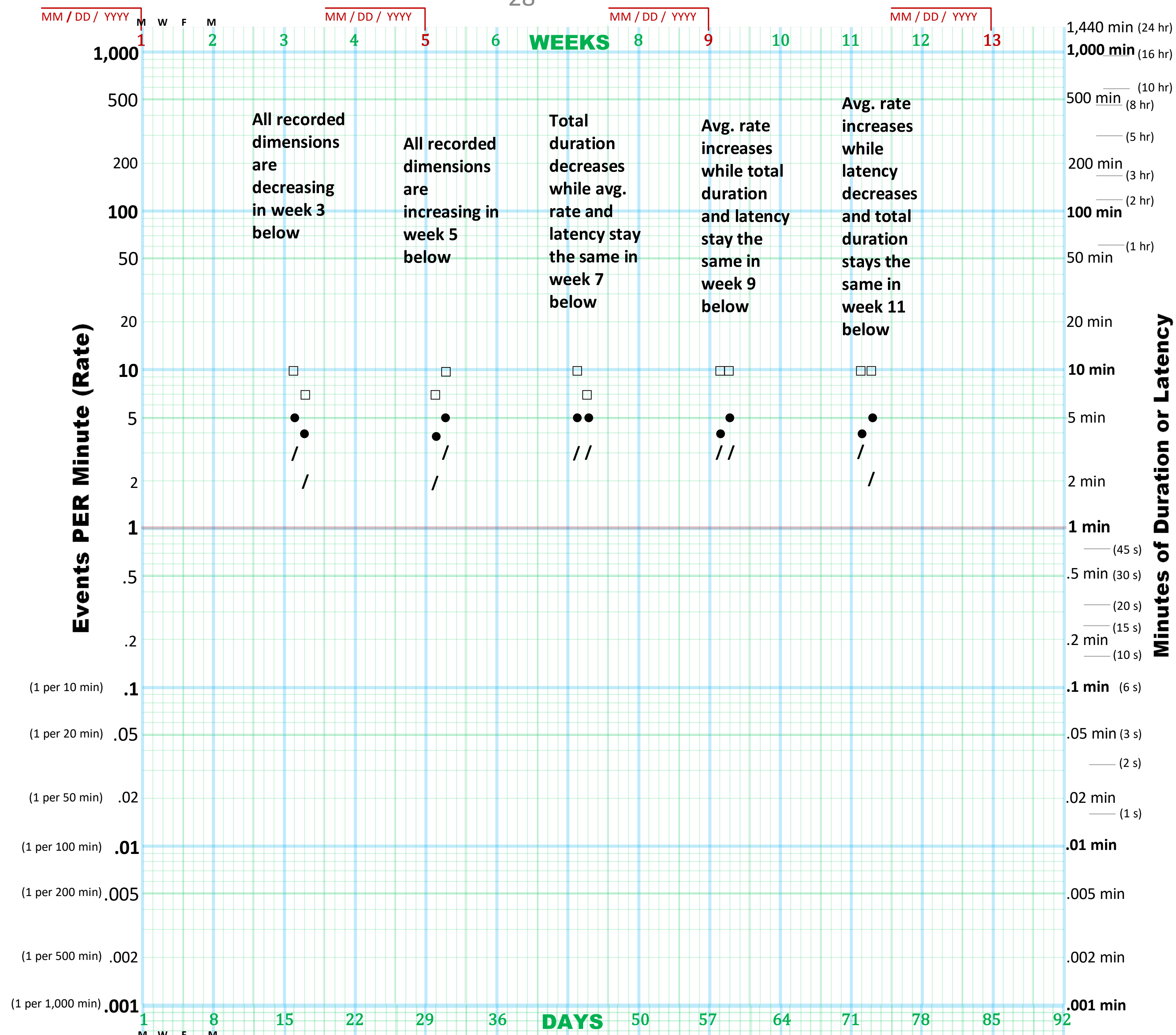
Chapter 2: Defining and Recording Fundamental and Derived dimensions of Behavior.

Before discussing how to record behavior, a definition of *behavior* itself must be stated. *Behavior* is a type of event that is the measurable movement of a living organism (Skinner, 1938/1991; Johnston & Pennypacker, 1993). Friman (2004) has argued that the term "behavior" may be used to refer to a single type of behavior (e.g., "the target behavior is reading") or many types of behavior**s** (e.g., "the target behavior**s** are reading and writing"). However, a single instance of any type of behavior is a *response* (e.g., "we measured hand-flapping behavior and counted 42 individual hand-flapping responses").

When defining a behavior for measurement and assessment, it is very important to clearly define the response *cycle* (a.k.a., the "movement cycle" or "event cycle"). A response cycle precisely describes when an individual response (or episode of responding) begins and ends (Johnston & Pennypacker, 1980). After choosing which behavior (or behavior product) to target, it is strongly suggested that the response cycle be clearly defined as it relates to the relevant dimension(s) of the behavior to be measured (Cooper et al., 2007).

For example, if we target episodes of Tanya's screaming, we may arbitrarily define the movement cycle by stating that it begins when Tanya makes a vocal sound that can be heard from at least 50 feet away, and ends when at least 3 seconds of no-screaming have passed. That is, if an initial vocalization occurs and stops, then 3 seconds of no-screaming pass, and next a 2^{nd} vocalization occurs, then the 2^{nd} vocalization will be counted as a new episode of screaming. On the other hand, if the 2^{nd} vocalization occurred *before* 3 seconds of no-screaming had passed, then the 2^{nd} vocalization would still be considered part of the same episode as the initial vocalization. In this case, the dimension of primary interest may be duration; however, one may need to record the dimensions of latency or rate of episodes, to ensure the measurement of the entire event is complete.

All responses have at least 3 measurable dimensions: Count, Duration, and Latency (Johnston & Pennypacker, 1980). Some authors appear to use the terms *property* and *dimension* interchangeably when referring to aspects of behavior such as count, duration, latency, etc. (Catania, 1998; Cooper, Heron, & Heward, 2007; Grant & Evans, 1994; Vargas, 2009). Others have made a distinction between the terms *dimension* and *property* when referring to behavior (Johnston & Pennypacker, 1993). However, this guidebook will attempt to emphasize the importance of simply defining and assessing the relevant and <u>measurable</u> aspects or features of behavior. Therefore, consistent with Cooper et al. (2007), this guidebook will only focus on the 'fundamental dimensions and derived dimensions by which behavior can be measured.'



Tanya K.

Learner / Behaver / Performer

Screaming Episodes	Total = □ Duration

Behavior Measured / Dimension

Avg. rate
Latency upon entry in Room

Behavior Measured / Dimension

(3 seconds of no-screaming
Must Pass before New episode counted)

Behavior Measured / Dimension

Morning math hour in Teacher Tom's Classroom

Setting(s) / Circumstances

Teacher Assistant Sam

Grapher | Counter | Timer

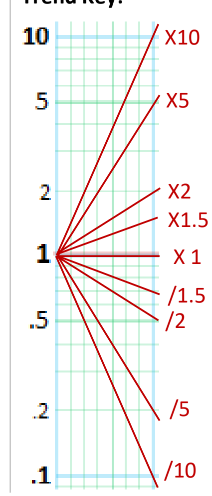
Teacher | Someplace Elementary

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % / ● = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Screaming Episodes" are any vocal sound That could be heard Approx.. 50 ft. way with normal levels of bckgrnd noise.

Fundamental dimensions of behavior

Fundamental dimensions of behavior are directly measurable aspects of behavior that are tied to standard units of measurement (e.g., minutes, hours, response cycles, etc.). Five fundamental dimensions of behavior listed here are: Count, Rate, IRT, Duration, and Latency (Cooper et al., 2007).

Although rate, duration, and latency often co-vary together in predictable ways, it is not necessary that a change in one must correlate, in a particular way, with a change in another. In one example, duration of a behavior can increase, while latency and rate remain the same. In another example, latency can decrease, while rate decreases and duration remains the same. In fact, any dimension of a behavior can be described in at least 3 ways: increased, decreased, or stayed the same. Thus, there are 27 basic combinations of change that are theoretically possible between rate, duration, and latency. Only a few of these possible combinations are illustrated above.

Ultimately, unless the most relevant and useful dimension of a target behavior is selected for measurement, it may not be possible to judge the effectiveness of an intervention. Therefore, if one is unsure of the most relevant dimension(s) of behavior to measure, then one should measure more than just one dimension of a target behavior (Miltenberger, 2004).

Count

Count is the number of times that a response occurs; it can be described in terms of the number of response cycles. Without regard to time, it answers the question "How many instances?" Count is not limited to only representing how often an entire response cycle repeats itself; it can also represent a mere aspect of a response that is only *part of* the whole response. For example, one can count the number of durations observed (which should be the same as the number of response cycles observed). However, simply enumerating the frequency of durations will tell us very little about the aspect of the response that *duration* is supposed to represent (Johnston & Pennypacker, 1980). That is, the number of durations observed tells us nothing about the extent through time that each response has lasted.

Count is typically used to calculate rate of response cycles, percentages, trends, and ranges in performance. By itself, count can be misleading when attempting to make comparisons to other measures, because it might not be reported in relation to time (Cooper et al., 2007).

Rate[1]

Rate is the number of times a response has occurred within a certain extent of time, and is the most sensitive measure of change in count. Rate is often expressed as an average--generally as the quotient of the ratio "count/time." Rate answers the questions "How many times did it occur within some amount of time?" or "How much was it occurring over some time period?"

Measuring rate can be useful when recording "free operants" (i.e. responses not restricted by a limited number of opportunities) or when observation times vary across measurements. For example, '100 response cycles recorded in a 10 minute observation period,' may become comparable to '50 response cycles recorded in a 5 minute observation period,' if each measure is converted into a count per minute measure, i.e., "10 response cycles per min."

As with count, *rate* can represent *any* measurable aspect of behavior that occurs within some amount of time. That is, an observer can enumerate the number of latencies, or durations, or counts of a behavior that have occurred within a specific amount of time, and the measurement can be expressed as the ratio "count/time" (Pennypacker et al., 2003). However, a simple enumeration of the number of latencies or durations over time, may tell us very little about the aspect of the response that *latency or duration* are supposed to represent (Johnston & Pennypacker, 1980). E.g., the 'rate of durations' may tell us very little about the extent through time that the responses lasted.

IRT (Interresponse time)

IRT is a special kind of latency that is the amount of time that has elapsed between the end of one response and the beginning of the next response. The IRT answers the question "How much time passes between two (or more) responses?" IRT may be expressed as an average by finding the quotient of the ratio "total interresponse time/total count" (Johnston & Hodge, 1989).

Measuring IRT can be important when the pace of responding is a relevant consideration. For example, an IRT's measure could inform an intervention that aimed to reduce excessive response rates to more socially acceptable levels (e.g., question-asking, joking, helping, escaping, assembling items, etc.). IRTs can also be useful for interventions that aim to *increase* rates of a behavior, and need to consider the time that elapses between responses.

[1]Consistent with the 4th edition BACB Task List (Behavior Analyst Certification Board, 2012) and the recommendation of Johnston and Hodge (1989), this guidebook uses the term *rate*--instead of *frequency,* to denote "count/time."

Duration

Duration is the extent that an event or response lasts through time; it can be expressed in terms of standard units of time such as seconds, minutes, hours, days, weeks, or years, etc. The duration answers the question "How long did it occur for?"

Measuring the duration of responses can be useful if one wishes to assess or change the length of time that a response lasts (e.g., the duration of a free diver's breath-holding). One might choose to measure *duration of* *episodes* instead of individual response durations (or individual response rates), if individual responses are too variable in length, too variable in topography, or occur too quickly, and thus are impractical to accurately and/or reliably measure (Johnston & Pennypacker, 1980). For example, duration might be a good measure for episodes of looking at or typing on the face of a smart phone, screaming, tantrumming, self-injury, property destruction, playing video games, kissing, exercising, reading, or working on a long-term project, etc.

Additionally, a *"results* oriented approach" may occasionally find duration to be the most relevant outcome to strive for and assess; e.g., with treading water, one may be primarily interested in how long a person can stay afloat (with only a secondary interest in the number of flutter kicks per minute he or she uses to stay afloat). Though recording the duration of a response or episode may yield a reliable and practical assessment of a behavior, it may often be useful to simultaneously measure other dimensions of the pinpointed behavior to gain a more complete assessment (e.g., rate of episodes or individual responses) (Johnston & Pennypacker, 1980; Miltenberger, 2004).

Latency

Latency is the point in time when a response occurs *after* the occurrence of some stimulus or event; it can be expressed in terms of a standard unit of time such as seconds, minutes, hours, days, weeks, or years, etc. The latency answers the question "How much time elapsed between the event and the response?"

Measuring latency of responding can be useful if one wishes to asses or change how long it takes for a response to occur. For example, the latency of a child's compliance with a parent's direction might be targeted for decrease (i.e. comply faster!). On the other hand, the latency between a teacher's question presentation and a student's problem behavior (e.g., whining and crying) might be targeted for increase.

Estimating Fundamental Dimensions of Behavior:

A continuous measure of behavior involves the direct observation and complete recording of the *entire* amount of a fundamental dimension of behavior (Cooper et al., 2007; Miltenberger, 2004). Ideally, direct and continuous measurements of behavior should always be what an observer strives to obtain; however, it is not always practical to obtain direct and/or continuous measures of dimensions like rate and duration, etc. Therefore, when the cost or effort is too great to get accurate and reliable continuous measures, one may need to resort to methods that allow for estimation of behavior—via discontinuous and/or indirect measures (Cooper et al., 2007).

Discontinuous measures:

Common methods for estimating duration or rate is to use discontinuous measures like partial interval recording, whole interval recording, momentary time sampling, or PLA-check (Cooper et al., 2007). Detailed descriptions of these methods are beyond the scope of this text; however, the results of these methods may be graphed on an SBG as an estimated duration or estimated rate, count of intervals scored, or just a percentage of intervals scored. The completeness and accuracy of discontinuous measures of behavior are generally not as good as the completeness and accuracy of continuous measures of behavior (Johnston & Pennypacker, 1980).

Indirect measures:

One indirect measure of a behavior that might be useful to graph is *response products* (or permanent products) of behavior (Cooper et al., 2007). That is, though nobody may have directly observed the behavior that produced the product, one may still be able to reasonably estimate the number of times a behavior occurred by simply counting the response products. For example, one may attempt to estimate the rate at which a person smokes cigarettes by counting the number of butts in an ashtray, rather than directly observing that person smoke the cigarettes. Naturally, indirect measures may suffer from questionable validity.

Derived Dimensions of behavior [2]

Derived Dimensions of behavior are formed from two or more measures of fundamental dimensions (Cooper et al., 2007). The three derived dimensions discussed in this chapter will be *percentage*, *Standard Value Trend*, and *Standard Value Range*.

Percentage

A percentage is just some portion of a whole that has been mathematically divided into 100 equal portions. Easily calculated and easily communicated, percentage is a ratio that can be used to determine accuracy of responding (as in percentage of correct responses) or the amount of responses given the number of opportunities for the response to occur. Generally, when trials, intervals, or time samples are used to record data, the results are converted into a percentage (Cooper et al., 2007). E.g., percentage of intervals in which the target behavior occurred, or percentage of trials in which the target response occurred without prompting.

The greatest *disadvantage of percentage* is a serious loss information. In particular, the relationship between time spent recording and raw count of responses is hidden, because usually only the count is used to calculate percentage (Johnston & Pennypacker, 1980). When rate or recording time are lost, the observer of the data is less able to determine if improvements in percentage is actually due to improvements in performance, or if the percentage shown is due to other factors such as the number of opportunities to respond, the amount of time spent recording, or the interval length used for a discontinuous measure, etc. On the other hand, if the factors listed in the previous sentence are kept reasonably constant, and clearly reported, the loss of information can be somewhat mitigated for sophisticated observers; however, a significant difference in interpretation might still result between simply reporting such factors in text, and actually graphing such factors on a visual display. Ultimately, percentage data should only be used if there is no practical alternative, or if it's used only to supplement more sensitive and informative data displays.

[2] A derived dimension that has lost its units of measurement (due to mathematical cancelation) may be referred to as a "dimensionless quantity" (Johnston & Pennypacker, 1980). Due to the loss of information that results from the cancellation of units, dimensionless quantities (e.g., percentage) can hide or distort important information about behavior. However, other dimensionless quantities (e.g., Standard Value Trend) can greatly enhance the description and communication of data--see page 34 and 35 for more detail.

Standard Value (SV) Trend [3]:

Trend is the tendency for a performance to systematically and consistently decrease or increase over time (Kazdin, 1982). When data is plotted on a graph, systematic increases or decreases take on a particular direction, i.e., up or down. A trend *line* may visually summarize a set of data points and the overall direction that data has been heading (Kazdin, 1982; McClave & Sincich, 2000). *Standard Value Trend* is a derived measure of systematic change in *any quantity* associated with behavior through a particular period of time on an SBG.

Once a trend line is drawn on an SBG, the moment it extends or projects across 8 day lines, it acquires a *Standard Value* (see chapter 3). "8 day lines" define the standard value *trend period* for a Standard Value Trend on the Quarter Year, Daily SBG. Standard Value Trends can be used to describe the mean or median amount of change in any dimension of behavior within a specific amount of time. The Standard Value Trend answers the questions "In what direction is some dimension of behavior changing?" and "How much or how quickly is it changing within a certain amount of time?"

[3] For readers who are used to the Standard Celeration Chart, *SV Trend* has been derived from the concept of *standard celeration*, as it can be mathematically calculated in the same way as *Standard Celeration*. Standard Celeration lines are little more than trend lines (Cooper et al., 2007). Please see Chapters 9 and 10 for more information regarding how to draw SV Trend lines and calculate their values. Notice that a Standard Celeration value is also dimensionless (e.g., X 1.4). However, regarding celeration, though Johnston and Pennypacker (1980, pg. 138) note that "Implicit in the behavior properties of temporal locus and repeatability is the complex dimensional quantity of celeration that references the characteristic of changeability over time," celeration does not appear to state that it includes changes in duration or temporal extent. I.e., the formula given has been defined as the 'change in count/time/time,' i.e., the "change in *rate* over time," or the "change in frequency over time" (Johnston & Pennypacker, 1980; Pennypacker et al., 2003). Therefore, other than the change in name, the main difference between Standard Celeration and SV Trend is that *SV Trend* is more explicitly and broadly defined to include how quickly *any dimension* of behavior changes over time. Please see appendix B for more regarding a comparison between SV Trend and Standard Celeration. Additionally, it should be noted here that duration has been discussed in terms of *celeration* before, e.g., "decelerating" (Kubina & Yurich, 2012, pg. 181-182), but the description of the decelerating duration was further explained in terms of a rate that was simultaneously *increasing* or accelerating as it 'moved up on the *frequency* lines.'

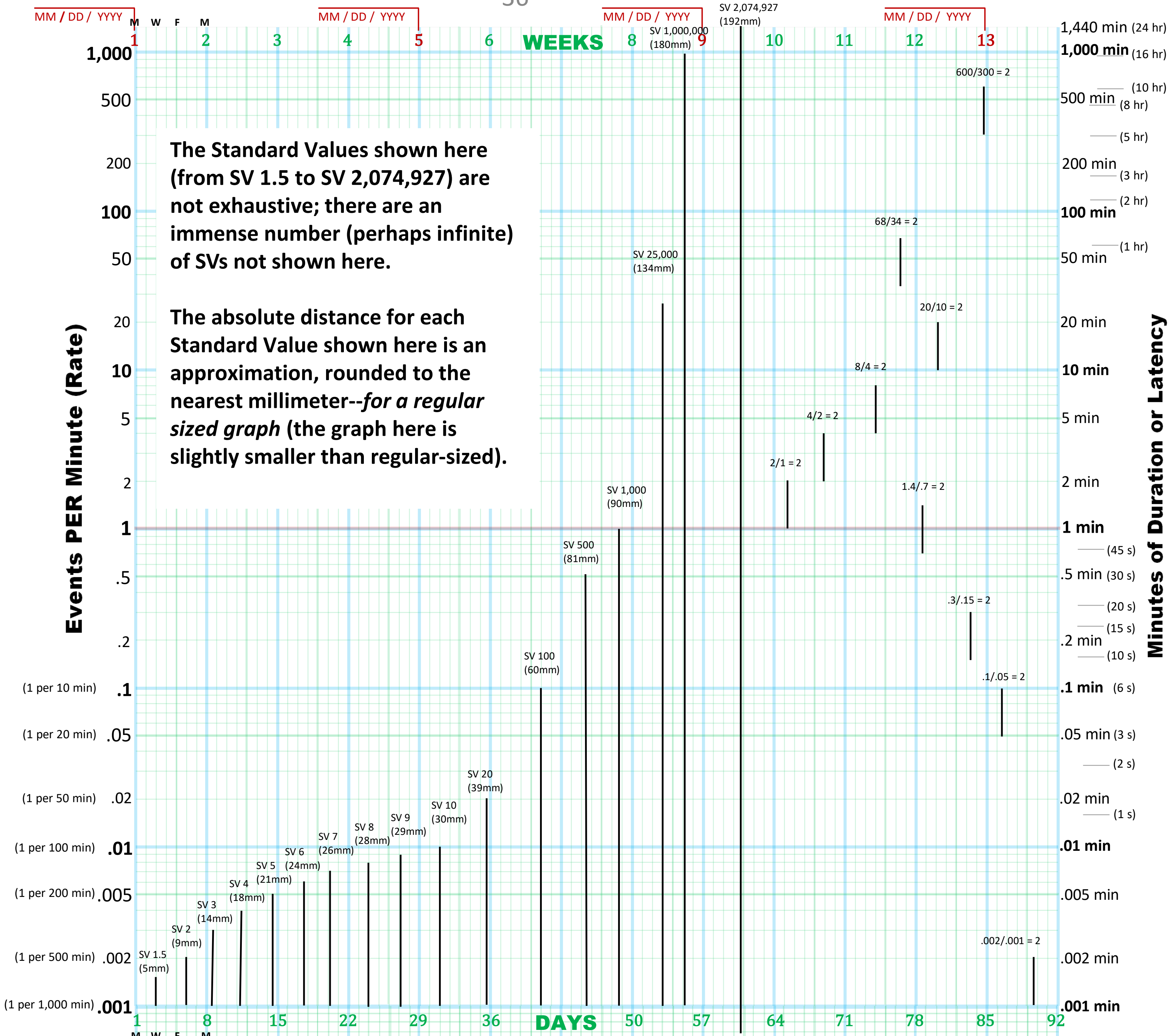
Standard Value (SV) Range [4]:

Standard Value Range is a derived measure of variability in *any* quantity associated with behavior. Variability is the fluctuation in a subject's performance over time (Kazdin, 1982), and a *range* is an extent or distance from some arbitrary point that can be used to measure variability. Range can be calculated when a minimum value is subtracted from a maximum value within a specified set of fluctuating values. However, *Standard Value Range* is not calculated through subtraction; rather, since a *Standard Value* is a distance on the SBG's ratio scale, SV Range must be found by either division or simply measuring the physical distance between some minimum and maximum value (as that physical distance aligns to the SBG's ratio scale on the Y-axis).

Once a set of data points are graphed on an SBG, the ranges within that data set acquire a *Standard Value*, and thus become *Standard Value Ranges*. Standard Value Range can be used to describe ranges of quantities in *any* of the dimensions of behavior within a specific amount of time. The Standard Value Range can answer the questions "Is the variability increasing or decreasing?" and "How much is that dimension of behavior fluctuating during a certain amount of time?"

A major difference between SV Trend and SV Range is that *SV Range* can describe amounts of fluctuation in performance *independen*t from the overall direction the performance has been going. However, the SV Range is very often used to describe ranges in fluctuation of data across (and parallel with) an SV Trend line. For more detail, see chapters 11 and 12.

[4] SV Range is derived from the SCC's term "bounce," and the term bounce is derived from the term "range" (Pennypacker et al., 2003). In this author's opinion, the traditional everyday use of the word "range" is in harmony with its use here (in reference to a distance between data points on a ratio scale).



Learner / Behaver / Performer

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Setting(s) / Circumstances

Grapher | Counter | Timer

Supervisor | Organization

General Key:

● = Rate

^ = Recording Time

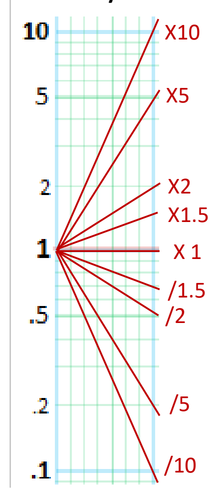
□ = Duration

/ = Latency

_ = Floor (Rate, Duration, Latency)

% over ● = Percent of trials or intervals

Standard Value Trend Key:



Notes:

Chapter 3: Standard Value (SV)[1]

Standard Values allow for fast, easy, and precise communication about behavior, because Standard Values consistently describe *proportional* differences in quantities that are anchored to standard units of physical distance. Since quantities described and compared with Standard Values can be from *any* measurable dimension of behavior, one might say Standard Values are a valuable standard!

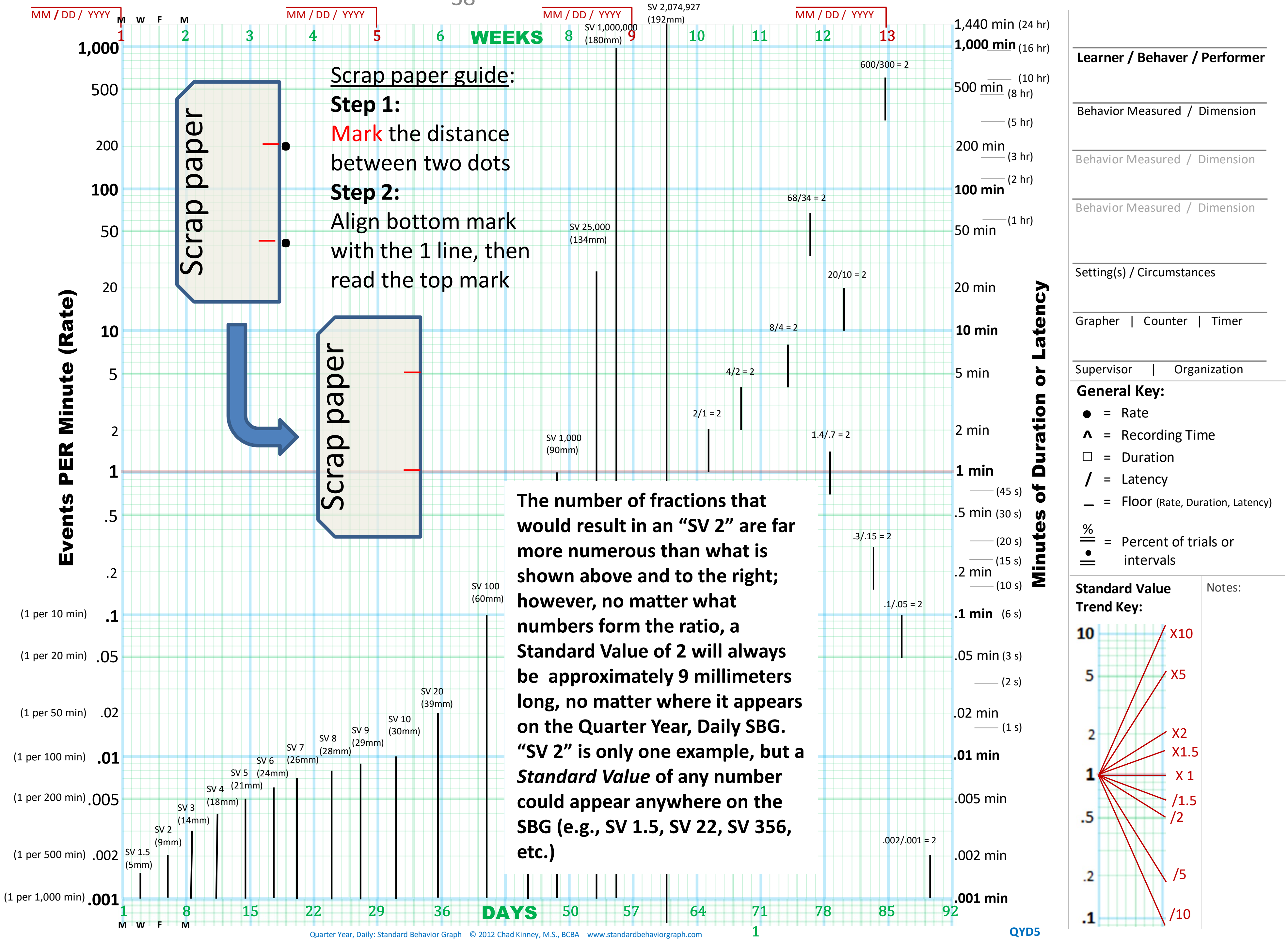
To fully grasp the advantages that any standardized display brings to the description of data, one should understand the concept of *Standard Value*. Fortunately, the definition and application of Standard Value is fairly straightforward.

A *Standard Value* is the quotient of a fraction form ratio that is composed of two numeric values along a Y-axis of the SBG. In the ratio composing every Standard Value, the larger number is always the numerator, and the smaller number is always the denominator. For example, if one performance was at 10 per min and another was at 5 per minute, then the Standard Value between them would be 2, because 10 divided by 5 equals 2—the units (e.g., minutes) cancel.

When two quantities of the same dimension of a behavior are put into a ratio form, the units cancel, and all one is left with is a number without a dimensional unit (Johnston & Pennypacker, 1980). However, just because the units cancel does not necessarily imply that information must be lost. For example, the ratio of two speeds lose their units, e.g. kilometers per hour, but still retain their meaning when we put the word "Mach" before the number; thus a speed of "Mach 2," or twice the speed of sound, is the ratio of the speed of a traveling object (e.g. a jet) over the speed of sound (Johnston & Pennypacker, 1980).

Every Standard Value corresponds to its own precise physical distance that can be measured in standard units (e.g., millimeters). As shown above, a Standard Value of 2 corresponds to a distance of approximately 9 mm. On the Quarter Year, Daily SBG, the standard values can range from SV 1 (0 mm) to SV 2,074,927.95 (approximately 192 mm).

[1] "Frequency Multipliers" on the SCC are very similar to SVs, and inspired thought about Standard Values, but there are clear differences: An SV does not require a sign to indicate its direction of change, because it is a *static*, unchanging distance on an SBG , and is not described in terms of going either up or down. Additionally, an SV is not a measure for just *frequencies*. Finally, each SV has it's own specific physical length that does not correspond with the physical lengths on the SCC that a frequency multiplier might be. However, the SBG does have a term that is (in this author's opinion) more similar to *frequency multiplier*, but is known as the *LCM*, and is covered in chapter 14.


MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
1,440 min (24 hr)
1,000 min (16 hr)
(10 hr)
500 min (8 hr)
(5 hr)
200 min
(3 hr)
(2 hr)
100 min
(1 hr)
50 min
20 min
10 min
5 min
2 min
1 min
(45 s)
.5 min (30 s)
(20 s)
(15 s)
.2 min
(10 s)
.1 min (6 s)
.05 min (3 s)
(2 s)
.02 min
(1 s)
.01 min
.005 min
.002 min
.001 min
Scrap paper guide:
Step 1:
Mark the distance between two dots
Step 2:
Align bottom mark with the 1 line, then read the top mark
Scrap paper
Scrap paper
SV 1.5 (5mm)
SV 2 (9mm)
SV 3 (14mm)
SV 4 (18mm)
SV 5 (21mm)
SV 6 (24mm)
SV 7 (26mm)
SV 8 (28mm)
SV 9 (29mm)
SV 10 (30mm)
SV 20 (39mm)
SV 100 (60mm)
SV 1,000 (90mm)
SV 25,000 (134mm)
SV 1,000,000 (180mm)
SV 2,074,927 (192mm)
600/300 = 2
68/34 = 2
20/10 = 2
8/4 = 2
4/2 = 2
2/1 = 2
1.4/.7 = 2
.3/.15 = 2
.1/.05 = 2
.002/.001 = 2
The number of fractions that would result in an "SV 2" are far more numerous than what is shown above and to the right; however, no matter what numbers form the ratio, a Standard Value of 2 will always be approximately 9 millimeters long, no matter where it appears on the Quarter Year, Daily SBG. "SV 2" is only one example, but a Standard Value of any number could appear anywhere on the SBG (e.g., SV 1.5, SV 22, SV 356, etc.)
Learner / Behaver / Performer
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
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^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com
QYD5

In the graph above, on the right side of the grid, multiple examples are shown of where SV 2 could appear on the SBG. Moreover, the fractions above each different SV 2 distance are revealed so that the reader can see how standard values may be calculated through simple division: Simply divide the larger number by the smaller number within the range selected.

Though the Standard Value can be found through division, it can also be quickly estimated by simply measuring the distance between two points on and SBG. On the left side of the grid in the graph above, there is an example of how to use a single piece of scrap paper to estimate the Standard Value between two points (one point is on the 200 level, the other is on the 40 level).

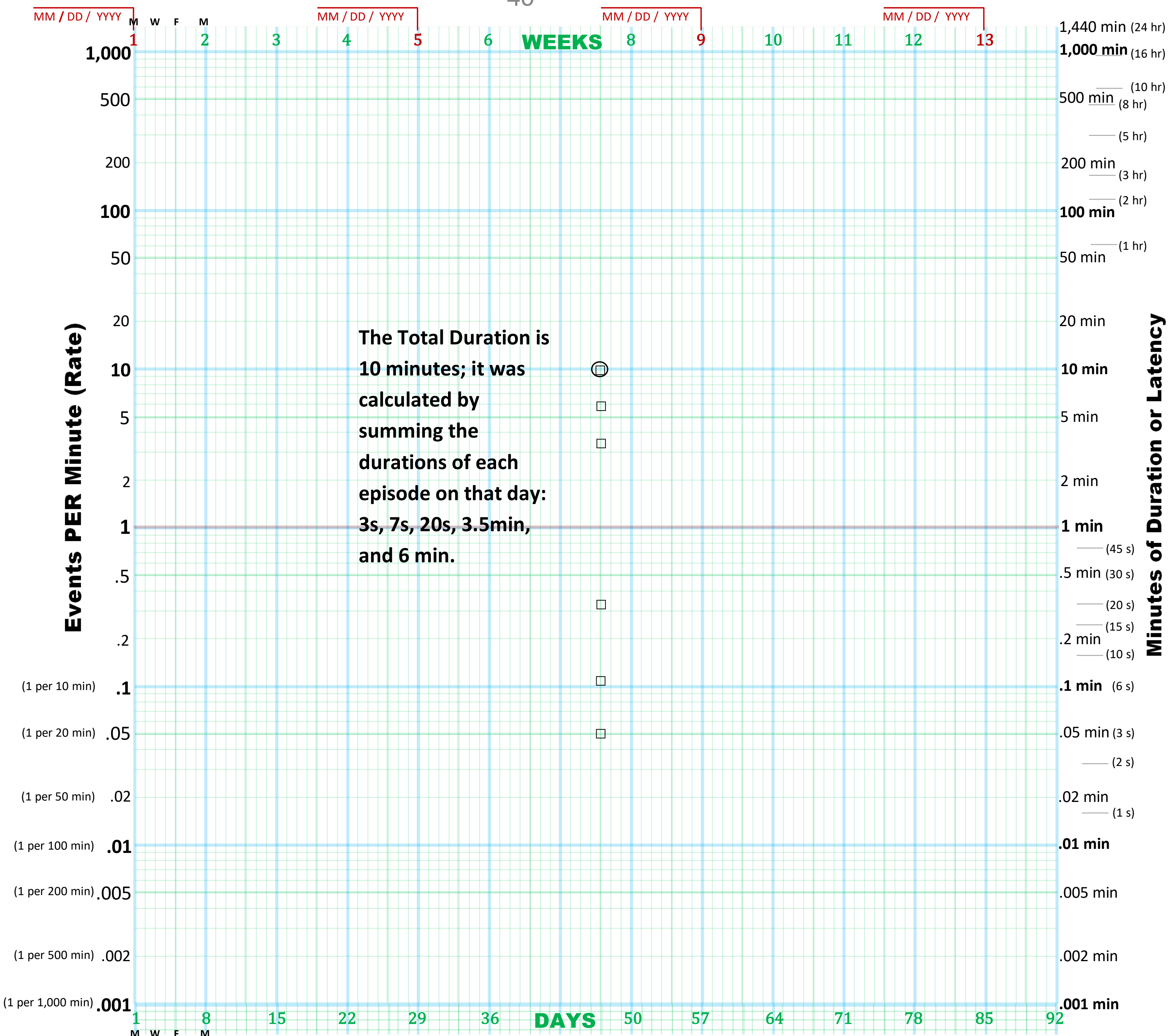
To use the scrap paper method of finding *Standard Value* simply follow two steps:

(1) Place the scrap next to the points you will be measuring the distance between, and place your marks on the scrap to indicate that distance (see the two red marks placed on the scrap paper above).

(2) Align that marked off distance on the scrap of paper to the scale on the Y-axis of the SBG by sliding the scrap so that the bottom mark aligns with the horizontal 1 line. Next, read the level at which top mark falls on the SBG (the top mark is at the 5 level, so the S*tandard Value* is 5 between the two points (at 200 and 40)—also notice that 200/40 = 5.

Finally, an even faster way to find a Standard Value is to simply use a *range finder* (see page 50 for more detail).

Ultimately, the concept of *Standard Value* is essential to understanding nearly all of the more sophisticated ways of describing and analyzing data on an SBG. Moreover, when communicating precise differences and changes in trends, variability, and levels within (or between) any data set, *Standard Value* is necessary for consistent description, comparison, and prediction of data.



Tanya K.

Learner / Behaver / Performer

Screaming Episodes | Total = ▢ Duration

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Morning math hour in Teacher Tom's Classroom

Setting(s) / Circumstances

Teacher Assistant Sam (all)

Grapher | Counter | Timer

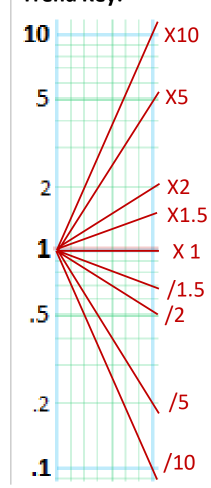
Teacher | Someplace Elementary

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Screaming Episodes" Include any vocal sound That could be heard Approx.. 50 ft. way with normal levels of bckgrnd noise.

Chapter 4: Graphing Guidelines and Tools for Measurement:

Graphing Recorded days, ignored days, and no chance days

Every day line will be either a recorded day, an ignored day, or a no-chance day (Pennypacker et al., 2003). If we've observed and plotted some product or dimension of behavior, then that's a recorded day. If the behavior had the opportunity to occur, but wasn't recorded, then it's an ignored day. Lastly, if behavior didn't have any opportunity to occur, then it's a no-chance day.

Though there are different guidelines for connecting dots to show a data path (see Cooper et al., 2007; Pennypacker et al. 2003), this guidebook will adhere to the following principal: Graphics should *reveal* the data (Tufte, 2001). Thus, if information is distorted, hidden, or easily misinterpreted due to how the dots are (or are not) connected, then the display should be adjusted.

Graphing Symbols

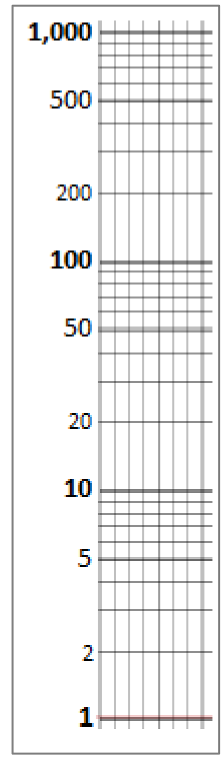
Filled dots indicate rate (•) is being plotted. Open squares (□) indicate duration. Forward slashes (/) indicate latency. The same symbols can be used for plotting totals, averages, medians, etc., but totals should be circled if several durations or latencies are also plotted on the same day line of the graph (e.g., ⦸, or ⧇)—see the example above. Note: the idea of circling totals is borrowed from Pennypacker et al. (2003). Carrots (^) indicate the recording time. Recording time is a special case of duration; except where automated, it's the duration of the observer's *observing* response.

Single dashes (-) and double dashes (=) indicate both floors and ceilings. There is always a floor that marks the spot where measured values equal to 1 or more cannot go below. A floor (-) can be for rates, durations, or latencies . Double floors and ceilings (=) are used for indicating trial data, interval data, or limited opportunities that can be converted into a percentage. If data has been converted to a percentage, then a large percent sign (%) should go over the double dash ceiling (as shown on page 22 and found in Koenig's (1972) dissertation).

Ultimately, the symbols described on this page are to be used as guidelines in order to preserve an appropriate amount of standardization between graphs. However, as needs may vary, the user of the graph should be encouraged to use whatever symbols they find most useful and practical toward revealing their data.

Scrap of paper torn from a larger piece

Range Finder



Tools for Measurement:

The Pocket calculator

The calculator method does not rely upon measurement of physical distance on the SBG to determine Standard Values; rather it merely relies upon simple mathematic calculations to find the quantities of rates, floors, celeration lines, etc. Using a pocket calculator to determine the values of rates and floors is probably an excellent way to gain a sturdy understanding of how data is graphed upon the SBG. Most values are simple enough to calculate by hand, but a calculator may be fast and accurate.

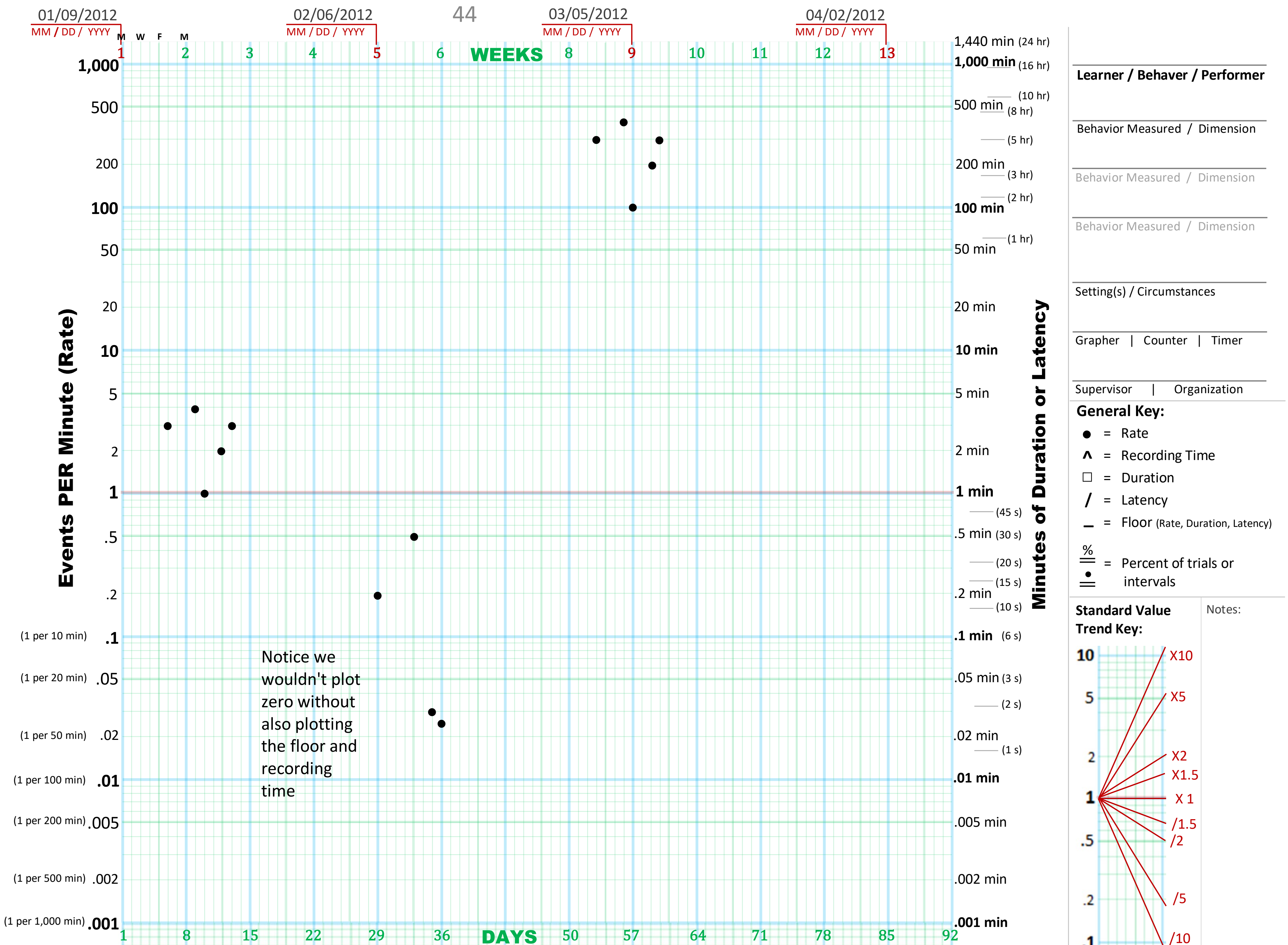
The scrap of paper

The primary emphasis of the scrap of paper method is determining physical distance between various marks on an SBG. It's as easy as measuring the length of an object with a piece of string (instead of a tape measure). With a piece of string, it's a simple task to pinch it where its length matches the extent of some object you want to measure (e.g. a piece of furniture in your living room). If you want to convert the string's length into standard units, just align the string against a ruler or a tape measure. Similarly, with the scrap paper method, you simply align the marks on the scrap of paper with the scale on the Y-axis of the SBG.

The Range Finder[1] (aka fancy scrap of paper)

As with the scrap of paper method, the range finder method also measures the physical distance between various marks on an SBG. However, when one is first learning how to plot data and find Standard Values, it may be more beneficial to just use the scrap paper a few times. Later, once a sufficient understanding of the scrap paper method is achieved, one should graduate to the Range Finder. When cut out from the Y-axis scale of any Quarter Year, Daily SBG, the grid on the *range finder* is exactly the width of a standard value *trend period* (8 day lines), and has a vertical scale of 1 to 1000.

[1]For readers familiar with the SCC, the Range finder is very similar to the "chart finder" (aka "frequency finder"), yet with slight, but functionally important, differences in the way it is cut out (Pennypacker et al., 2003).


01/09/2012
02/06/2012
03/05/2012
04/02/2012
MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
1,440 min (24 hr)
1,000 min (16 hr)
500 min (10 hr) (8 hr)
(5 hr)
200 min (3 hr)
(2 hr)
100 min
50 min (1 hr)
20 min
10 min
5 min
2 min
1 min
(45 s)
.5 min (30 s)
(20 s)
(15 s)
.2 min
(10 s)
.1 min (6 s)
.05 min (3 s)
(2 s)
.02 min
(1 s)
.01 min
.005 min
.002 min
.001 min
Notice we wouldn't plot zero without also plotting the floor and recording time
Learner / Behaver / Performer
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
QYD5

Chapter 5: Graphing Rate

Rate is commonly measured and displayed as an average. To determine the average rate of a behavior, one may divide the total number of response cycles they've observed by the number of minutes spent observing; i.e., average rate = number of cycles observed/recording time (or rate = c/t). For example, if one counted 36 instances of behavior, while recording for 3 minutes, then the rate would be 12 per minute because 36 instances/3 minutes = 12 instances per min.

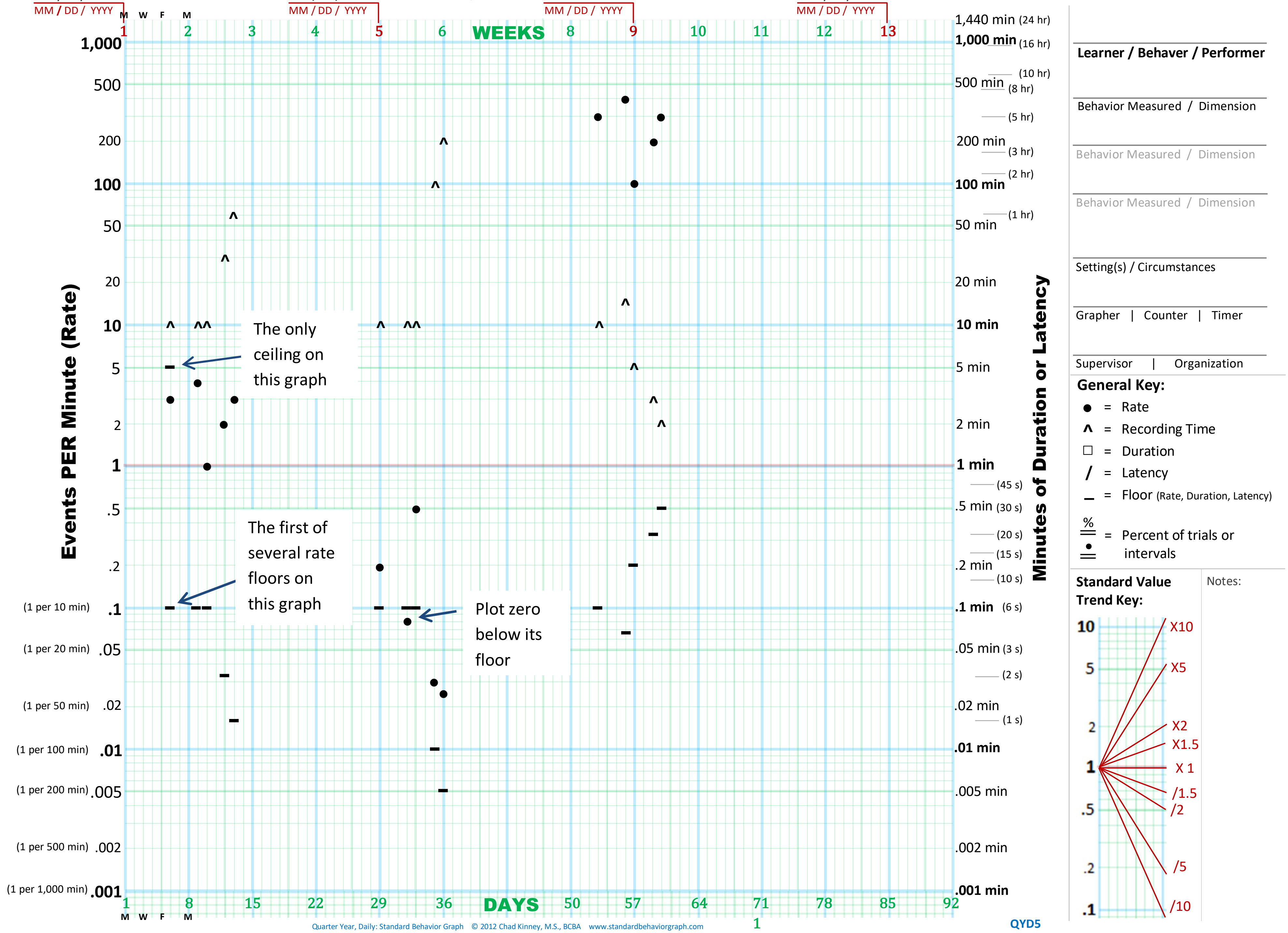
For a quick exercise that will demonstrate how to plot rate, try covering up the graph above, and PLOT ONLY THE RATE DOTS from data below on a separate sheet of SBG paper. It is recommended that you initially use a calculator to determine the rates, then see if your data matches the plotted data on the graph above. Notice the 4 blanks that prompt the calendar dates above are already filled in; we'll graph the floor and recording times in separate exercise on the next page.

Session 1: 30 responses in 10 minutes on Saturday, January 14th
Session 2: 40 responses in 10 minutes on Tuesday, January 17th
Session 3: 10 responses in 10 minutes on Wednesday, January 18th
Session 4: two responses per minute, on January 20th from 10 am to 10:30am
Session 5: three responses per minute, on January 21st from 12:35 pm to 1:35 pm

Session 6: 2 responses in 10 minutes on Mon., Feb. 6th
Session 7: 0 responses in 10 minutes on Thurs., Feb. 9th
Session 8: 5 responses in 10 minutes on Fri., Feb. 10th
Session 9: 3 responses in 100 minutes on Sun., Feb. 12th
Session 10: 5 responses in 200 minutes on Mon., Feb. 13nd

Session 11: 300 responses per minute on Thursday, March 1st, recording time 10 minutes
Session 12: 400 responses per minute on Sunday, March 4th, recording time 15 minutes
Session 13: 100 responses per minute on Monday, March 5th, recording time 5 minutes
Session 14: 200 responses per minute on Wednesday, March 7th, recording time 3 minutes
Session 15: 300 responses per minute on Thursday, March 8th, recording time 2 minutes

Remember: if the data are already converted to per minute, then you can just plot it as is; but if not already in per minute form, then you'll need to convert to per min *before* you plot your points!



01/09/2012
02/06/2012
03/05/2012
04/02/2012
MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
1,440 min (24 hr)
1,000 min (16 hr)
The only ceiling on this graph
The first of several rate floors on this graph
Plot zero below its floor
(1 per 10 min)
(1 per 20 min)
(1 per 50 min)
(1 per 100 min)
(1 per 200 min)
(1 per 500 min)
(1 per 1,000 min)
Learner / Behaver / Performer
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
= Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com
QYD5

Graphing Rate Floors and Ceilings:

A *rate floor* is the smallest number of events (greater than zero) that can be observed in the time spent recording; i.e., the rate floor is *ONE event per total recording time,* and it represents the lowest limit of our rate measure. Therefore, when rate floor is plotted, it's showing the lowest rate (per minute) possible in relation to the recording time. Also, any instance(s) of behavior that we plot must be at least equal to that lower limit or greater than it. That is, if we observe one or more instances of behavior, our data point (a dot) will be placed either right on the floor or somewhere above the floor.

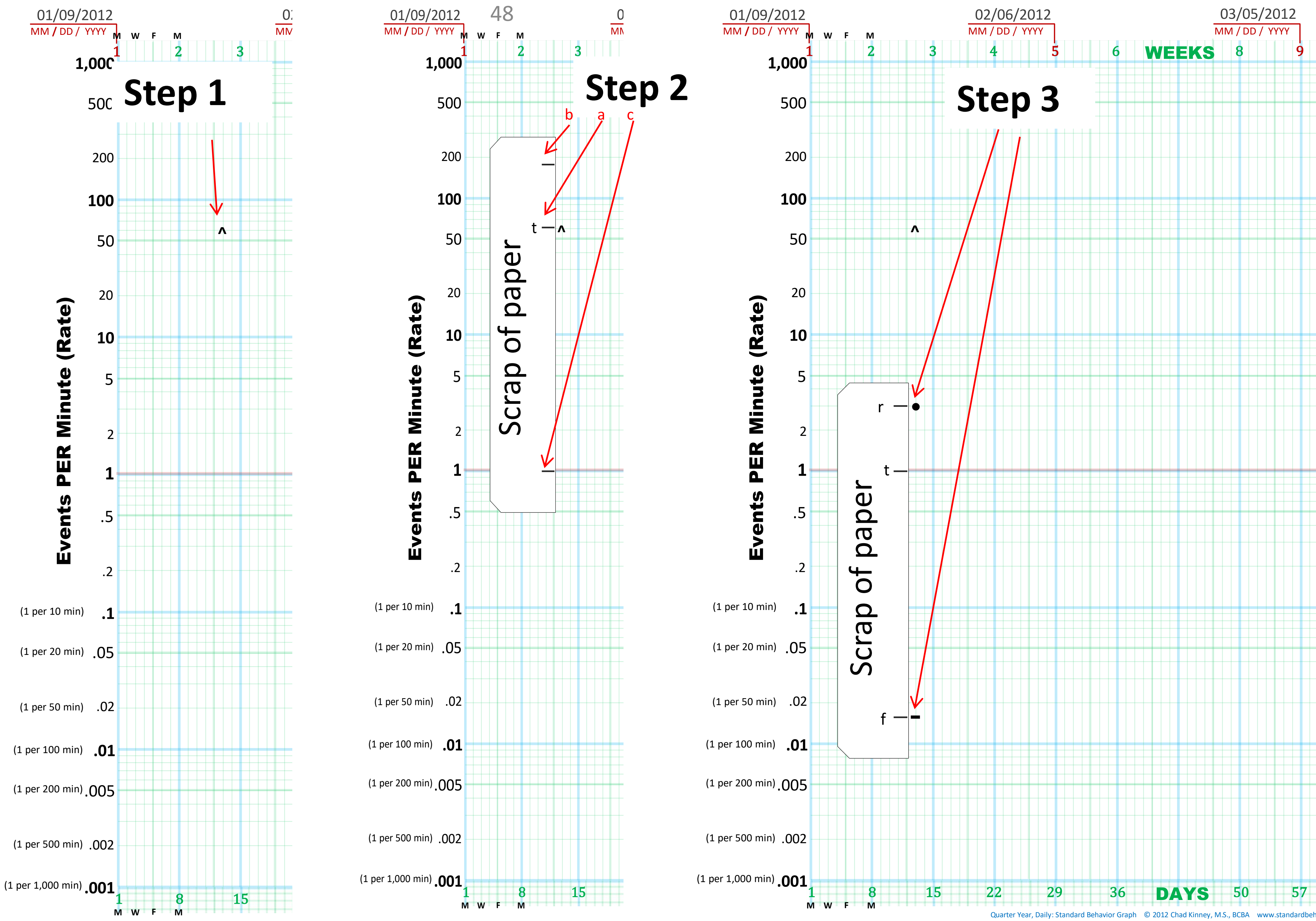
As shown on the graph above, if we recorded for 10 minutes on Sat., Jan 14^{th}, and the smallest number of observable instances is 1, then dividing 1 by the time spent recording will give us a rate floor of .1 per minute. That is, 1 instance/10 minutes = .1 per min. To mark our rate floor on the SBG, we simply put our dash on the day line that represents the day we were recording on.

A *rate ceiling* is the largest number of events that can be observed in the time spent observing. The ceiling is the *number of opportunities for an event to occur per recording time interval* and represents the highest limit of our rate measure. Many performances do not have a known ceiling and thus do not require a ceiling to be plotted on a graph; however, ceilings may be imposed for several reasons (e.g., a discrete trial training session with a limited number of opportunities to respond).

For example, if we are measuring behavior from a 10 minute discrete trial session, and there are only 50 opportunities to respond (let's say the teacher only presents the opportunity to respond 50 times during a 10 minute session), then dividing the number of opportunities by the time spent recording will give us a *rate ceiling* of 5 possible responses per minute. That is, 50/10 minutes = 5 per min. Though not all data needs a ceiling, all data should have a floor. Try covering up the graph above, then use a calculator to determine the rate floors for the data set on page 45. Plot on a separate graph, and see if your work matches the floors above. ***Notice that, like a mirror image, the rate floors ("-") are the same distance from the light red 1 line as their respective recording times ("^").*** Note: floors and ceilings are calculated like they are on the SCC (Pennypacker et al., 2003).

Plotting zero

The only time a data point falls below its rate floor (our lowest limit) is when <u>no</u> responses are observed during the recording time (see the plotted point for session 7, Thursday, Feb. 9th in the graph above). Since there is no "zero" on the log axis scale, the convention used here is to plot a zero at the level of ".8 x the floor value." E.g., .8 x .1 = a dot for "zero" at .08 per min. Note: the .8/record floor placement for zero has also been noted as 'visually pleasing' by Dr. Ogden Lindsley (2004).



Step 1
Step 2
Step 3
Events PER Minute (Rate)
Scrap of paper
b
a
c
t
r
f
^
01/09/2012
02/06/2012
03/05/2012
MM / DD / YYYY
WEEKS
DAYS
M W F M
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA

Using a scrap piece of paper to plot data:

To find any of the values above (rate, rate floors, ceilings, etc.) without using long division or a calculator, one can quickly cut or rip a piece of scrap paper that has a straight edge. One should keep in mind that the scrap paper is used to measure physical distances on the SBG.   After doing the guided exercise with the example shown above, readers should attempt to find the values of the rest of the data set from this chapter (and also from the Introduction section) with a piece of scrap of paper--instead of a calculator, as was previously suggested.

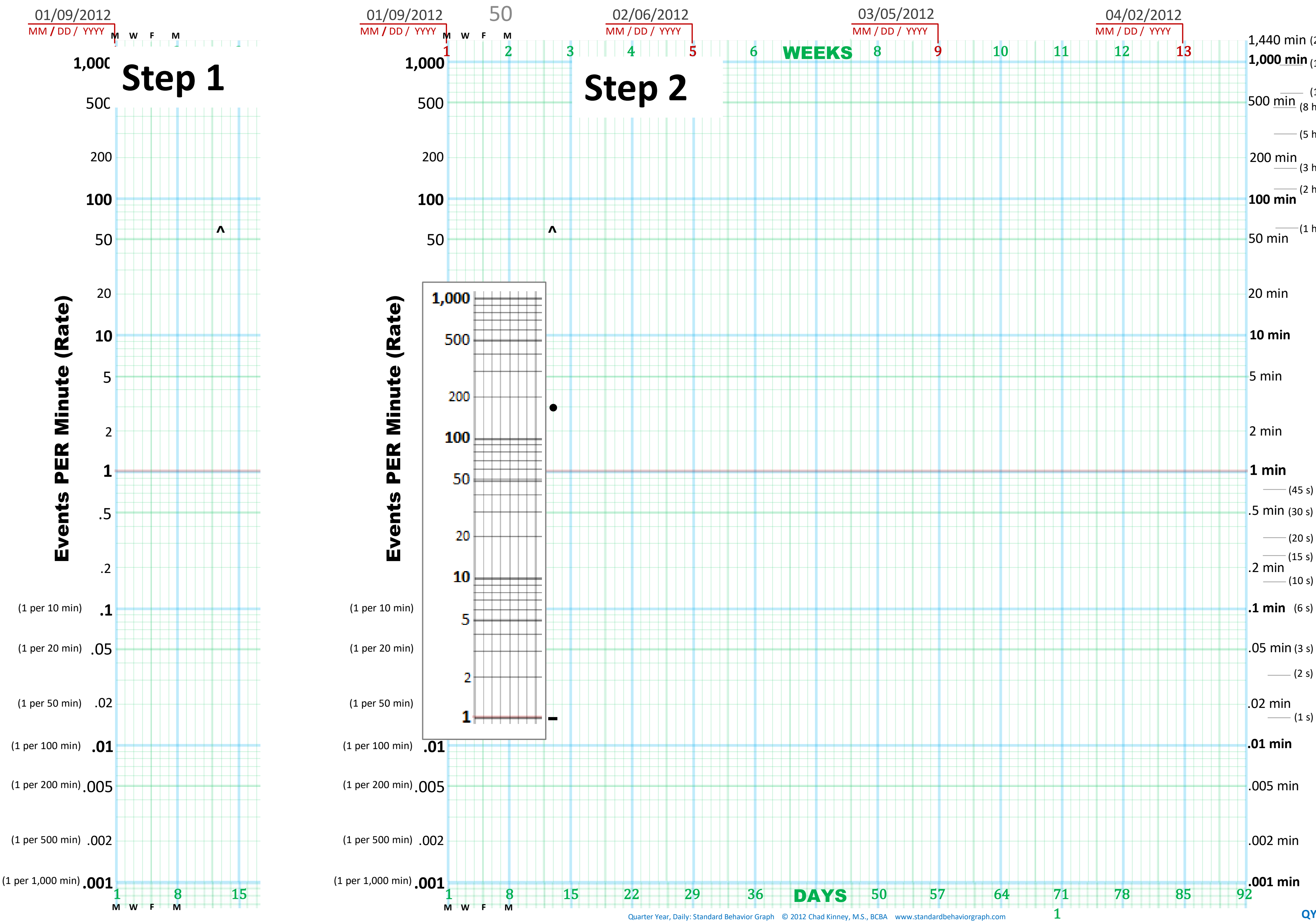
<u>Session 1</u>: 180 responses in 60 minutes on Saturday, January 21st

Step 1: Mark the time spent recording on the actual SBG before you put down the scrap of paper.

Step 2: Lay your scrap flat across the SBG and keep it still when you (a) put a mark on your scrap next to the recording time, (b) put a mark on your scrap next to the raw count level, and (c) put a mark on your scrap next to the horizontal light red “1” line. Keep in mind, all you’re really doing is just marking off the distances between these values. It’s like using a regular piece of string to measure the length of a piece of furniture in your house when you don’t have a tape measure handy.

Step 3: Slide the scrap so that the time mark on the scrap aligns with the light red 1 line on the SBG, then place a dot on the SBG next to the raw count mark on your scrap, and a dash on the SBG next to the bottom mark on your scrap.   Congratulations, you’ve just plotted your rate and rate floor without doing any math! (note: the “r,” “t,” and “f” on the scrap of paper are only in the illustration above to help indicate to the reader which mark on the scrap of paper is for “rate,” “time,” and “floor.”)

The advantage to the scrap paper method is that it doesn’t require any special equipment like calculators or special tools to figure out values on the SBG; with a small bit of practice, it’s fairly quick and easy to do. However, there is a method for finding values and plotting data on the SBG that is slightly faster than using a scrap piece of paper or even a calculator: the *range finder* method.



Step 1
01/09/2012
MM / DD / YYYY
M W F M
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
Events PER Minute (Rate)
1 8 15
Step 2
01/09/2012
50
02/06/2012
03/05/2012
04/02/2012
1 2 3 4 5 6 WEEKS 8 9 10 11 12 13
1,440 min
1,000 min
500 min
200 min
100 min
50 min
20 min
10 min
5 min
2 min
1 min
(45 s)
.5 min (30 s)
(20 s)
(15 s)
.2 min
(10 s)
.1 min (6 s)
.05 min (3 s)
(2 s)
.02 min
(1 s)
.01 min
.005 min
.002 min
.001 min
1 8 15 22 29 36 DAYS 50 57 64 71 78 85 92
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com
QY

Using a range finder to plot data:

Perhaps the fastest way to plot data (and to find other values) is to simply use a range finder. The range finder is mostly little more than a fancy piece of scrap paper. The finder works best if it was printed and cut from a transparency of the SBG, but its still basically just marking the distances between various points on the SBG. It saves the user time because distances on it are already marked and labeled. The example above uses the same session data from the example on the previous page (p. 49):

<u>Session 1</u>: 180 responses in 60 minutes on Saturday, January 21st

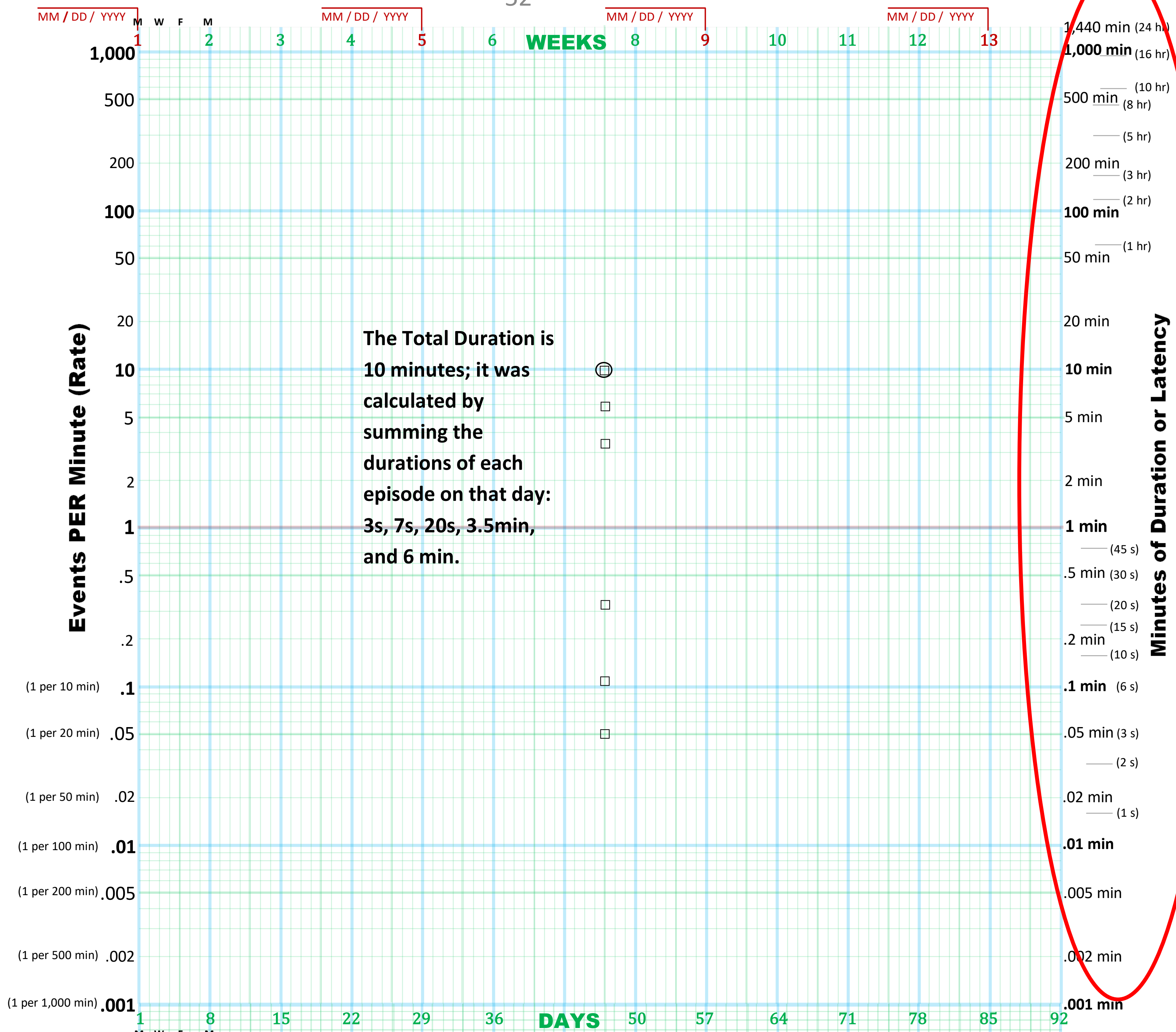
Step 1: Plot the time spent recording.

Step 2: Place the range finder on the SBG and align the time (60) on the range finder with the horizontal light red 1 line on the SBG, then place a dot on the SBG where the range finder level is at the raw count (180) on the finder. Additionally, place a dash on the SBG where the 1 line on the range finder falls.

The disadvantages to this method are that it might not give as precise of a number as a calculator would, and there may be some worry about having to carry this extra piece of equipment around just to plot and describe data (as it may be easy to misplace). However, there's no reason to believe that the difference resulting from the use of a calculator and the use of a range finder is clinically significant; additionally, if one knows the scrap paper method, then there's no need to worry about a misplaced range finder or calculator.

Graphing multiple rates on the same day:

If there are several rates that were measured on the same day for the same behavior, then one has the option of displaying them as a combined average, a median value, the fastest rate, the slowest rate, the first rate measured, the 2^{nd} rate measured, or individual points stacked on the same line, or some combination of these—whichever way best reveals the data and is the most practical and useful. One might initially try several ways to visually display such data to determine what is best.



Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com

QYD5

Tanya K.

Learner / Behaver / Performer

Screaming Episodes | Total = ⊡ Duration

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Morning math hour in Teacher Tom's Classroom

Setting(s) / Circumstances

Teacher Assistant Sam (all)

Grapher | Counter | Timer

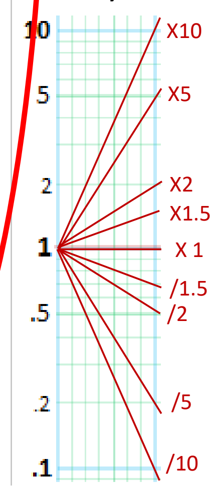
Teacher | Someplace Elementary

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Screaming Episodes" Include any vocal sound That could be heard Approx.. 50 ft. way with normal levels of bckgrnd noise.

Chapter 6: Graphing Duration

Duration is the amount time it takes for an event or behavior to occur, from start to finish. Once a duration is determined, that time can be directly plotted on the SBG. Sometimes it is helpful to record and graph the duration of *episodes* of responding (Pennypacker et al., 2003), e.g., the graph above is a record of the duration of Tanya K's screaming episodes on a Friday.

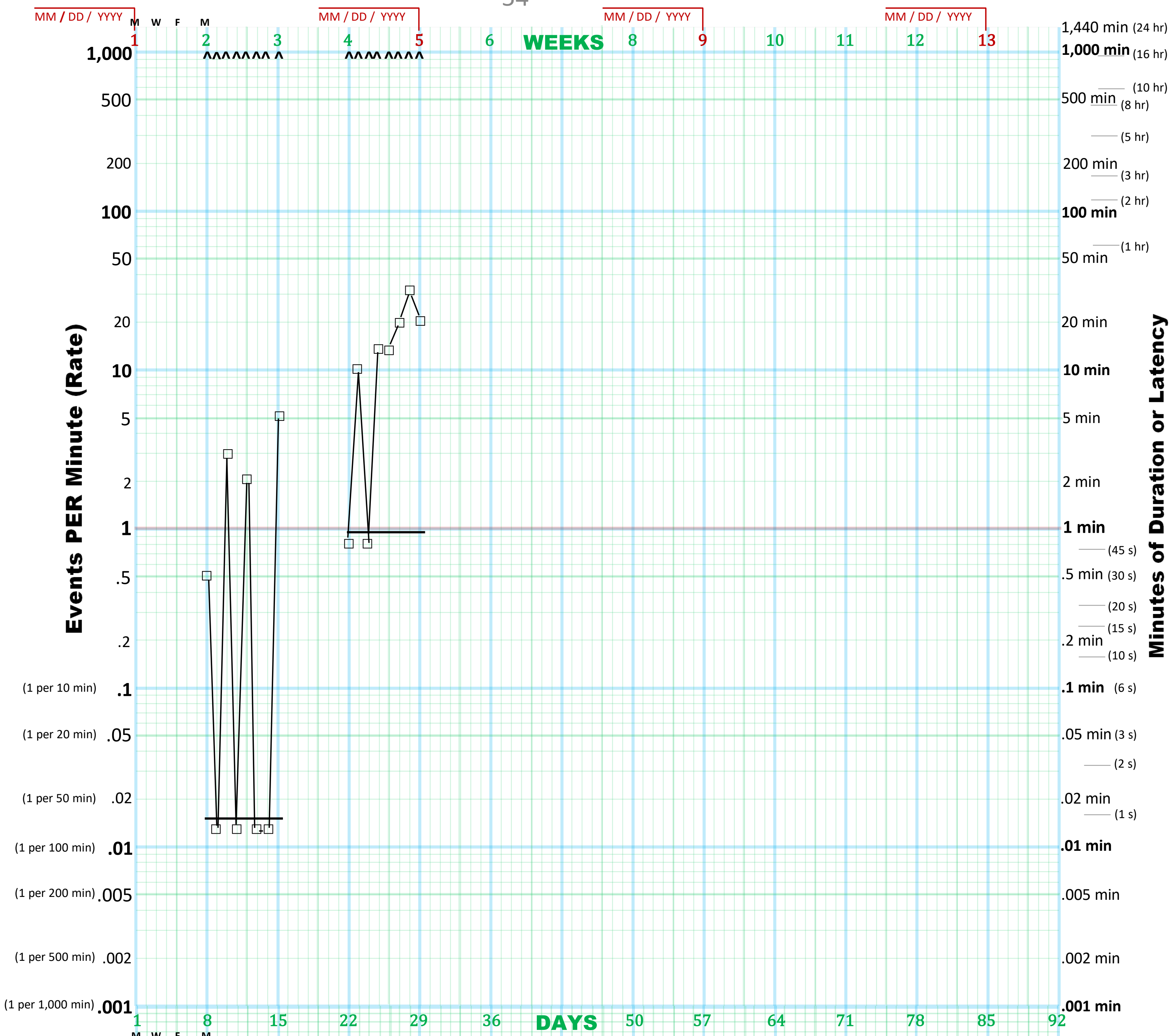
The secondary Y-axis (circled above) denotes what time values are on the SBG in minutes. Since duration is directly plotted on the SBG, there is usually no need for a range finder or a calculator to find its value. However, if one is plotting extremely short durations, then it may help to convert seconds into minutes by simply dividing the number of seconds by 60. E.g., a duration of 3 seconds is also a duration of .05 minutes, because 3/60 = .05. In another example, 20 seconds is also a duration of .33 minutes, because 20/60 = $.3\overline{3}$.

The following behaviors are just a few examples for which duration might be a useful dimension to record: Typing on or looking at the face of a smart phone, tantrumming, whining, sleeping, exercising, hugging, conversing appropriately, or even holding on to a bucking mechanical bull!

Graphing Total Duration, etc.

In some instances it may be helpful to graph the total duration of an event, if that event occurs several times throughout the time spent recording (Pennypacker et al., 2003). That is, one may wish to add up all durations of multiple events, and express the sum as one total duration. For example, if we were interested in the total duration of texting episodes per day, we might need to add up the durations of all episodes of texting. Like with graphing the duration of a single response, the sum of durations is plotted directly on the SBG. Notice in the example above that the total duration is circled because the durations that compose it are also on this same graph.

It should also be noted that if one needed to graph the *average duration, median duration, longest duration,* or any type of duration, then this could easily be shown by indicating, in the information section, what is actually being plotted.



QYD5

Myself

Learner / Behaver / Performer

Exercise over 120 Bpm | Total Duration

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

In gym, running, cycling, swimming, aerobics, etc.

Setting(s) / Circumstances

Me / XTS3 Heart Rate Monitor

Grapher | Counter | Timer

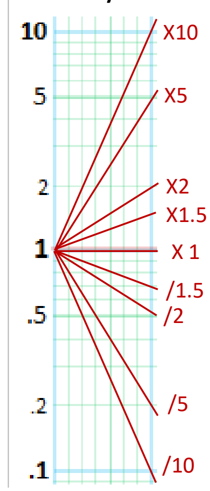
DR. Doctor ——

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % over ● = Percent of trials or intervals

Standard Value Trend Key:



Notes:

Graphing Duration Floors

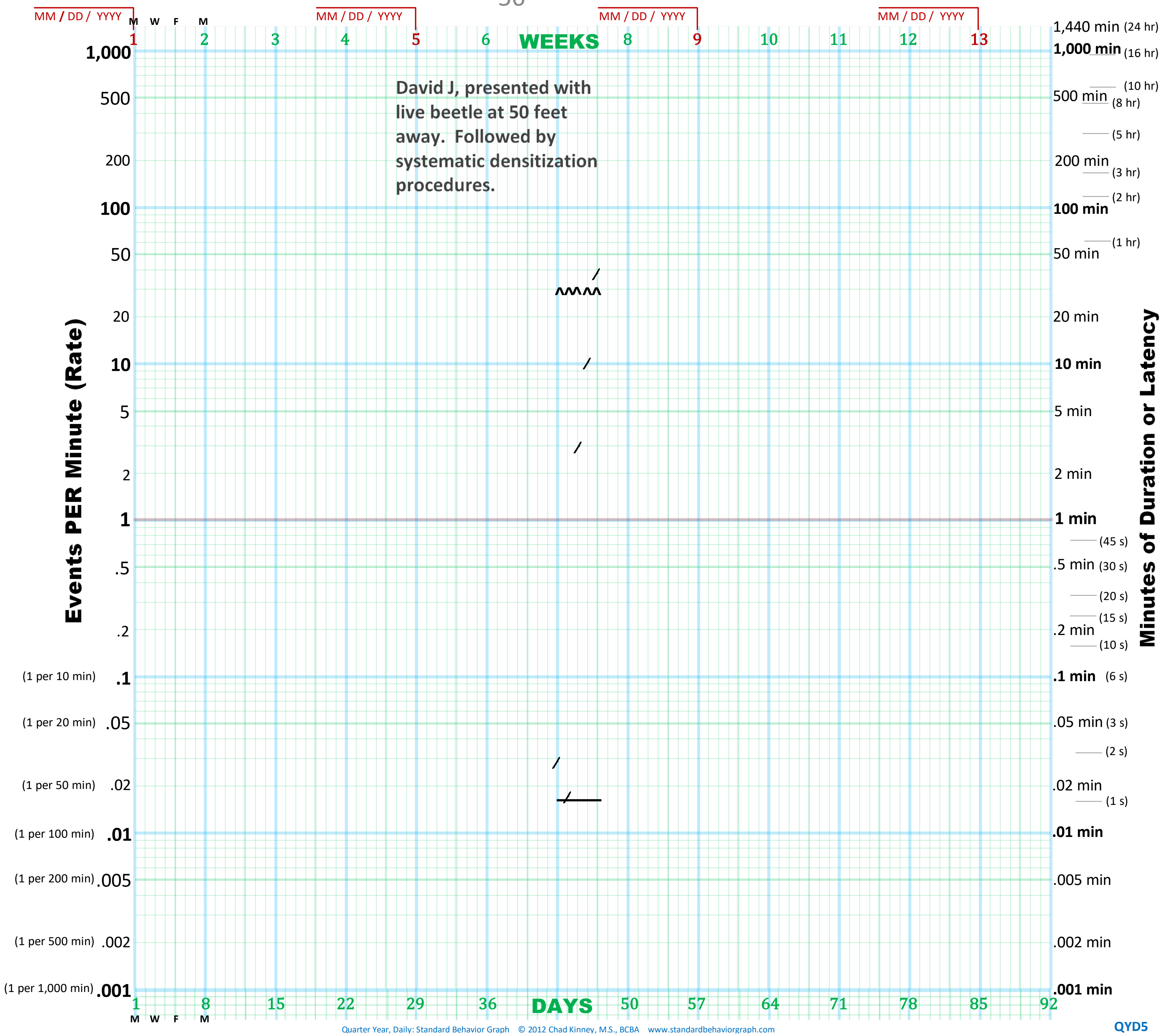
A duration floor is the smallest recorded amount of time a behavior could have occurred (besides zero) in the time an observer spent observing. The duration floor represents the lowest limit of a duration measure, and is an arbitrary boundary that the observer must determine based upon the level of precision required for measurement. For example, if one is recording the total duration of time spent studying for a test, the duration floor might be set at 1 minute, because studying for less than a minute might not even be significant enough to count. On the other hand, if an observer is recording the duration of an event that typically only lasts a few seconds in duration, and that observer needs to know how the duration of the event changes down to the precision of a single second, then the observer may need the duration floor to be at the .0167 minute level on the SBG (1 s/60 s = .0167 minutes); any duration of less than a second would be considered insignificant and marked as "not observed" by plotting below the duration floor. Duration floors can even be as low (and precise) as 1/10th of a second (i.e., .00167 min).

The graph above shows what could happen if one selected a duration floor at 1 second initially (during week 2), but then later decided that a 1 min floor would be more appropriate (during week 4). Notice how the floor selection alone affects variability!

Graphing Duration Ceilings

A duration ceiling is the largest amount of time a behavior could have occurred in the time an observer spent observing. The duration ceiling represents the highest limit of a duration measure, and will never be more than the recording time (marked as a "^"). For example, if an observer only records a behavior (e.g., screaming) for a time of 30 minutes, then the duration ceiling is also 30 minutes. That is, you can't correctly record a duration that is greater than for how long the behavior has been observed. The observer must determine the recording time (and duration ceiling) based upon how much time the observer reasons is necessary to have the most practical and representative measure. If the duration of a behavior typically reaches the duration ceiling, it may be advisable to increase the observer's recording time to ensure a believable and more representative measure.

In the self-monitoring example graphed above, the waking day (approximately 16 hours) was selected as the observational ceiling for duration. Natural limits might possibly prevent the performer from coming anywhere near the theoretical ceiling, which should be accounted for; however, the ceiling above may have the advantage of at least staying constant and reliable.



David J.

Learner / Behaver / Performer

screaming — Latency

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

After 1st insect presentation, during after-school therapy sessions in dr.'s office

Setting(s) / Circumstances

Dr. D. Sensitizer

Grapher | Counter | Timer

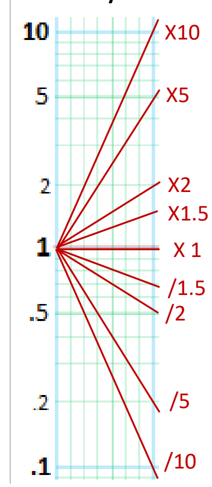
— —

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % / • = Percent of trials or intervals

Standard Value Trend Key:



Notes:

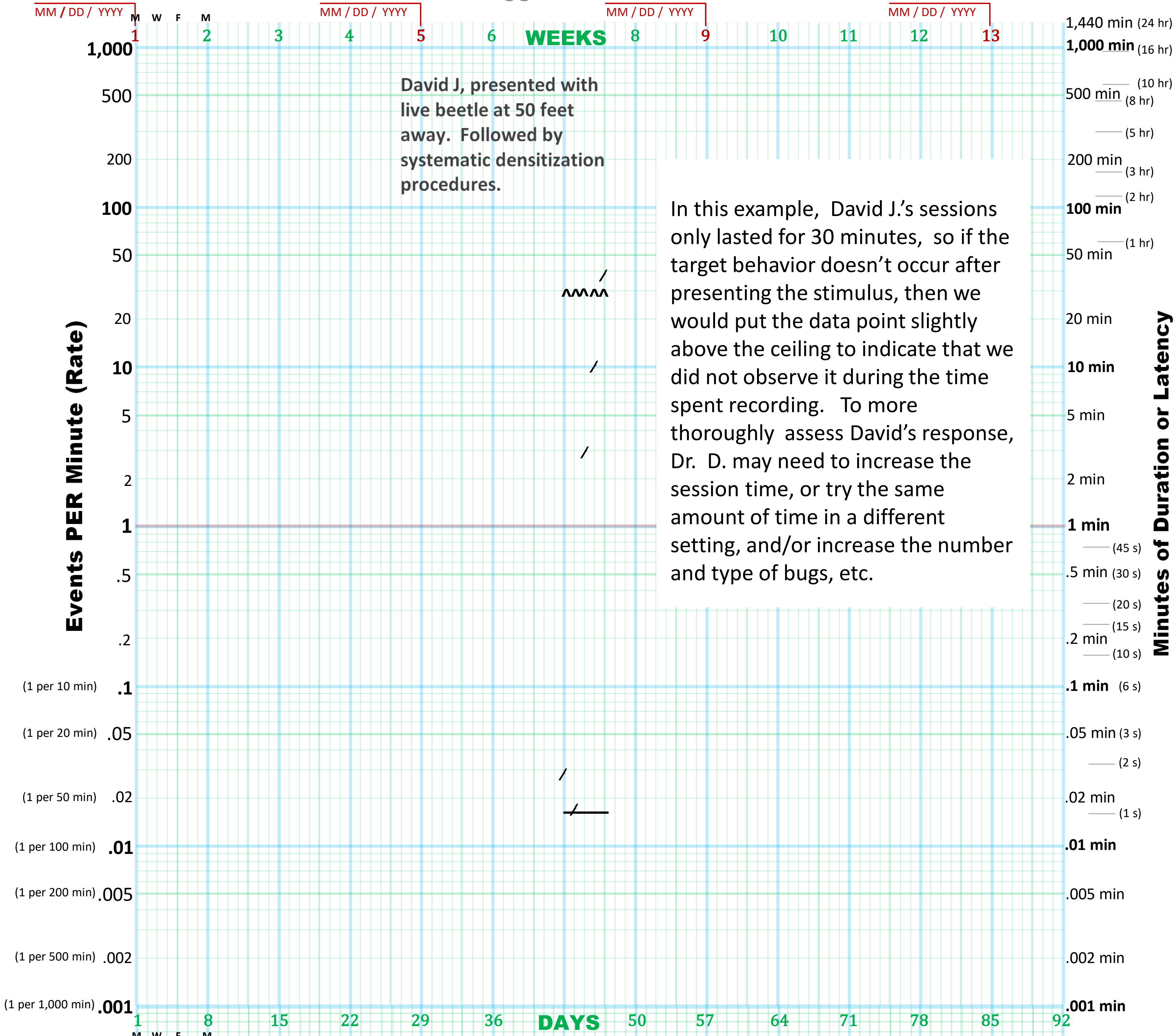
Chapter 7: Graphing Latency

Latency is the amount of time that passes between the onset of some event and beginning of some response after that event's onset (Skinner, 1938/1991). To determine the latency of a behavior, one must simply time how long it takes for a response to occur after some stimulus has been presented. For example, if an instruction is given to a child, then 10 seconds elapse before the child begins following the instruction, we would say that the latency for the response is 10 seconds. Similarly, if it takes an adult 3 seconds to begin cursing at you after you have blocked their access to an activity, the latency for cursing would be 3 seconds. In the example shown above, the latency of screaming is recorded each day after the 1st beetle is presented 50 feet away from David J. It can easily be seen, as desired in this case, that the latency is increasing very quickly: the SV Trend is well over X1,000. Perhaps Dr. D. Sensitizer will next see if David J. is ready for the beetle at only 25 feet away!

Graphing Different Latencies

Average latency, *median latency, shortest latency, first latency, total latency*, etc., could all be easily recorded, plotted, and then described in the top information section of the SBG. If more than one type of latency were plotted on the same graph, then it would be helpful to make it clear what the difference was by distinguishing its symbol from others (e.g., circle the median latency, and describe it's symbol in the top information section).

In the example above, the first latency of screaming ("after [the] 1st insect presentation") was selected for plotting each day. Of course, other measures might also have been selected, but the main purpose of the example above is to show how latency may be plotted.



In this example, David J.'s sessions only lasted for 30 minutes, so if the target behavior doesn't occur after presenting the stimulus, then we would put the data point slightly above the ceiling to indicate that we did not observe it during the time spent recording. To more thoroughly assess David's response, Dr. D. may need to increase the session time, or try the same amount of time in a different setting, and/or increase the number and type of bugs, etc.

QYD5

David J.

Learner / Behaver / Performer

screaming | Latency

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

After 1st insect presentation, during after-school therapy sessions in dr.'s office

Setting(s) / Circumstances

Dr. D. Sensitizer

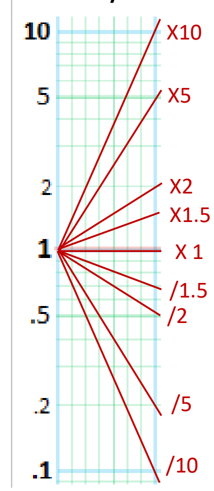
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

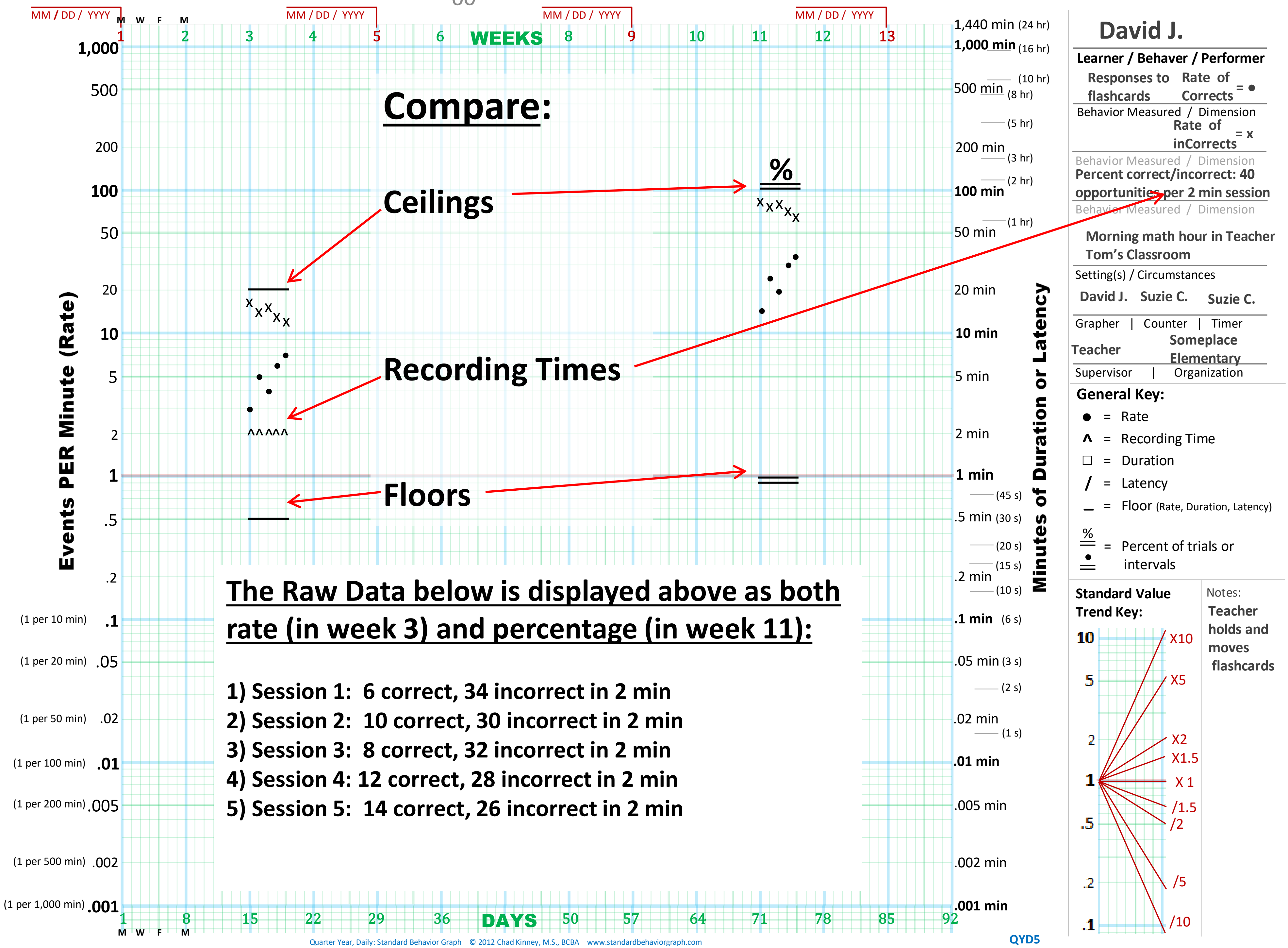
Graphing Latency Floors:

A latency floor is the smallest recorded amount of time it could have taken for a behavior to occur after an event was presented. The latency floor represents the lowest limit of our latency measure, and is an arbitrary boundary that the observer must determine based upon the level of precision required for measurement. For example, if one records the average latency of a dog's responding to a vocal command, then the latency floor might be set at 1 second, because responding within 1 second or sooner may meet or exceed a trainer's expectations. Thus, if responding were to occur more quickly than a second (e.g., 6 tenths of a second), that response may simply be rounded to "1 second" to achieve the desired level of precision. In the case of David J., graphed above, it was decided that changes in latency of only a few seconds would be clinically significant, thus the latency floor is set at the 1 second level. Of course if one is trying to increase the latency of a response, and the average latencies are always greater than *a minute*, then it may be more practical to set the latency floor at the 1 *minute* level. If necessary and practical, latency floors can also be as low as one tenth of a second (i.e., .00167 min).

Graphing Latency Ceilings

A latency ceiling is the largest amount of time it could have taken a behavior to occur within the time an observer spent observing. The latency ceiling represents the highest limit of our latency measure, and will never be more than the recording time (marked as a "^"). For example, if an observer only records a behavior (e.g., complying with a demand) for a time of 30 minutes, then theoretically, the latency ceiling is also 30 minutes. That is, one can't correctly record a latency that is greater than for how long one has observed for. The observer must determine the recording time (and latency ceiling) based upon how much time the observer reasons is necessary to have the most practical and representative measure. If the latency of a behavior typically reaches the latency ceiling, then it may be advisable increase the observer's recording time to make sure they are getting the most representative measure. If the response doesn't happen at all during the time spent observing, a latency mark may be place at 1.2 X the ceiling value (indicating the latency may have been greater than observed, if a response occurred.)

Note: Sometimes one may find it more practical to record the rate or count of compliance. Thus, if a latency exceeds the temporal requirement of a response definition, it may not be counted as having occurred (e.g., Wilder, 2006). For example, if *compliance* is defined as "following directions within 10 seconds of giving the direction," and then the latency of a response exceeds 10 seconds, that response may not be counted as and instance of "compliance." (Wilder).


Compare:
Ceilings
Recording Times
Floors
%
The Raw Data below is displayed above as both rate (in week 3) and percentage (in week 11):
1) Session 1: 6 correct, 34 incorrect in 2 min
2) Session 2: 10 correct, 30 incorrect in 2 min
3) Session 3: 8 correct, 32 incorrect in 2 min
4) Session 4: 12 correct, 28 incorrect in 2 min
5) Session 5: 14 correct, 26 incorrect in 2 min
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
MM / DD / YYYY
David J.
Learner / Behaver / Performer
Responses to flashcards
Rate of Corrects = ●
Behavior Measured / Dimension
Rate of inCorrects = x
Behavior Measured / Dimension
Percent correct/incorrect: 40 opportunities per 2 min session
Behavior Measured / Dimension
Morning math hour in Teacher Tom's Classroom
Setting(s) / Circumstances
David J.
Suzie C.
Suzie C.
Grapher | Counter | Timer
Teacher
Someplace Elementary
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:
Teacher holds and moves flashcards
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com
QYD5

Chapter 8: Graphing Percentage Data.

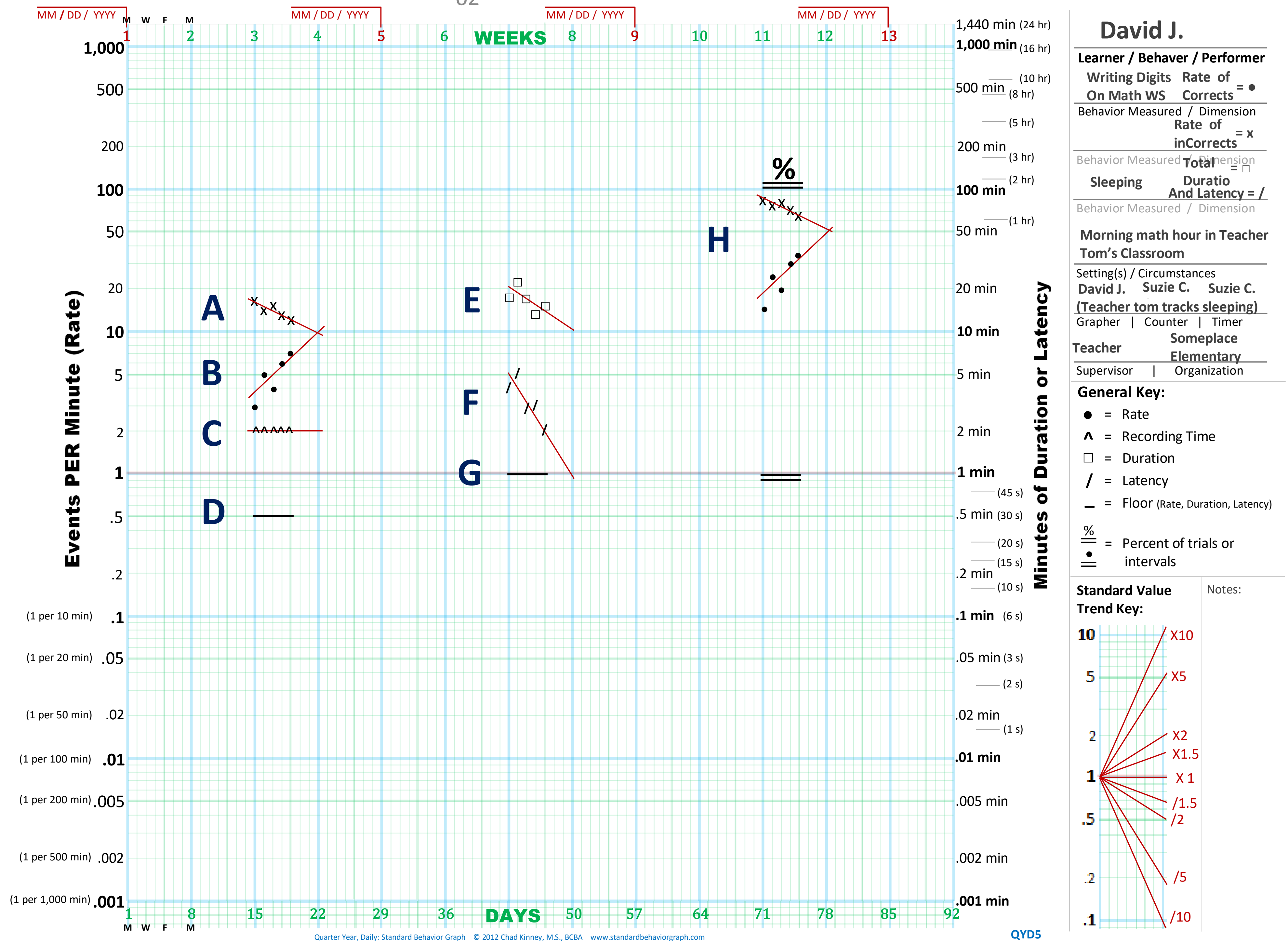
Direct measures of rate, duration, and/or latency are ideal; however, some circumstances can make percentage data seem more practical. Percentages can result from many different recording methods, e.g., partial interval recording, whole interval recording, momentary time sampling, trial data, etc. (Cooper at al., 2007). Additionally, Cooper et al. recommend using percentages and/or trials to criterion data in instances in which a behavior is restricted by a limited number of opportunities to respond.

Advantages and Disadvantages of Percentages

Any set of data can be converted into a percentage. Though percentage may seem advantageous because it's more widely understood and makes different data sets easier to compare, the advantages gained often may not outweigh the disadvantages. The *disadvantages* are that percentage data can easily hide very important information, e.g., time spent recording, number of opportunities, raw counts, and the units of measurement used to form the percentage (Graf & Lindsley, 2002; Kubina & Yurich, 2012; Pennypacker & Johnston, 1980). Additionally, a loss of such information has the potential to distort the picture of variability and trend in the data, leading to ineffective and/or inefficient treatment decisions (Cooper et al., 2007).

However, if one finds the benefits of displaying percentages outweigh the risks, then percentages can (and should) still be displayed on the SBG. In the above example, the same data set is graphed first as rates (to the left), and then as a percentage (to the right). Interestingly, in this special case, they both show the same data patterns, amount of variability, and trend lines. It is a "special case," because the percentage graphing method above is generously displayed in its best possible form, by accounting for (and keeping constant) the number of opportunities and the time spent recording (as read in the info section). Note: a method for depicting percentage that is similar to what is shown above can be found in a dissertation by Carl Koenig (1972).

Unfortunately, the percentage data above still has the disadvantage of not *visually* emphasizing (1) relationships between time spent recording and raw rates, (2) a floor that represents the lowest rate possible in relation to the observed rates, and (3) a ceiling that represents the highest rate possible in relation to the number of opportunities to respond and time spent recording. Moreover, if a teacher did not go to the trouble of keeping the number of opportunities constant per learning session, then the variability and trend of the percentage data could be drastically altered and more difficult to make valid comparisons with.


MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
A
B
C
D
E
F
G
H
%
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
1,440 min (24 hr)
1,000 min (16 hr)
500 min (10 hr) (8 hr)
(5 hr)
200 min (3 hr)
100 min (2 hr)
50 min (1 hr)
20 min
10 min
5 min
2 min
1 min
(45 s)
.5 min (30 s)
(20 s)
(15 s)
.2 min
(10 s)
.1 min (6 s)
.05 min (3 s)
(2 s)
.02 min
(1 s)
.01 min
.005 min
.002 min
.001 min
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QYD5
David J.
Learner / Behaver / Performer
Writing Digits On Math WS
Rate of Corrects = •
Behavior Measured / Dimension
Rate of inCorrects = x
Behavior Measured / Dimension
Sleeping
Total Duratio And Latency = □ /
Behavior Measured / Dimension
Morning math hour in Teacher Tom's Classroom
Setting(s) / Circumstances
David J. Suzie C. Suzie C. (Teacher tom tracks sleeping)
Grapher | Counter | Timer
Teacher
Someplace Elementary
Supervisor | Organization
General Key:
• = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:

Chapter 9: Graphing Standard Value Trend Lines (i.e., “SV Trend”)

There are several methods that can be used to produce a trend line (Cooper et al., 2007). The “correctness” of a method can’t be judged without taking into account how well it describes current data, and how well it predicts future data (Koenig, 1972; White, 2005). However, regardless of which method is used to draw a trend line, when it is drawn on an SBG and projected across the trend period, it will have a S*tandard Value*. A Standard Value Trend line is a line that seems to best summarize or fit a set of data plotted on an SBG. On the Quarter Year, Daily SBG, a *standard value trend period*[1] is 8 consecutive day lines, and the *Standard Value* of the trend is the line’s vertical range within one trend period. The specific quantity of the Standard Value Trend can be determined for *any* dimension of behavior throughout the specified trend period. For example, if within 8 days the trend line value for duration changed from 5 min to 10 min, then we could say “The SV Trend is X2.” Remember from chapter 3 that a *Standard Value* can be found by dividing the larger value by the smaller value, e.g., 10/5 = 2. For more information regarding *SV Trend* and how it relates to *Standard Celeration*, see page 34.

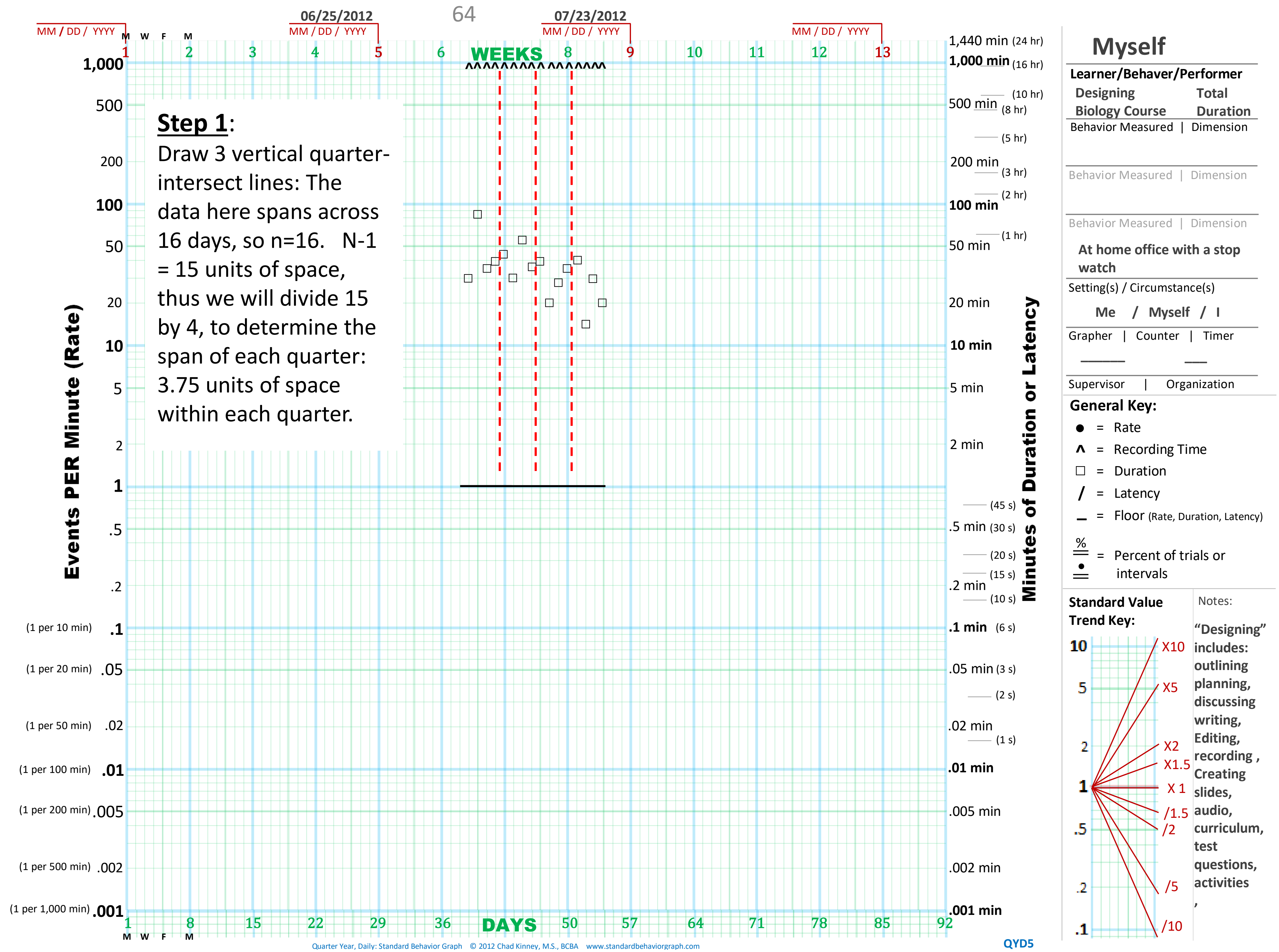
On the SBG[2], an increase over time in any dimension of behavior is shown by an SV Trend line that is going up (and given the sign for multiplication: “X”). A decrease in any dimension over time is shown by an SV Trend line that is going down (and given the sign for division: “/”). No change at all in a dimension over time is shown with a flat SV Trend line (and can be given either sign because a flat trend has a Standard Value of “1,” and X 1 and / 1 both represent no change in the behavior).

The free-hand and focus-line methods:

Without any statistical calculations, the free-hand method relies on eye-ball estimates to hand-draw a line that seems to best fit a plotted set of data points. The focus-line method is very similar to the free-hand method, but the focus-line itself is pre-drawn on a separate paper, then placed on top of the data so that it can be adjusted several times before one settles on how the actual line will be hand-drawn through the data (Kubina & Yurich, 2012). All that is required to correctly use these methods is a minimal amount of practice and corrective feedback. Once one has achieved proficiency with free-hand or focus-line methods, the lines may be drawn faster and more accurately than with other methods (White, 2005). Additionally an analyst may be able to better consider data outliers that formulaic mathematical models could overlook (Kubina & Yurich, 2012).

[1] The SV trend period is derived from the SCC’s *celeration period*.

[2] The SCC has already used the “X“ and “/” signs for the same purposes.



06/25/2012
07/23/2012
MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
Step 1:
Draw 3 vertical quarter-intersect lines: The data here spans across 16 days, so n=16. N-1 = 15 units of space, thus we will divide 15 by 4, to determine the span of each quarter: 3.75 units of space within each quarter.
Myself
Learner/Behaver/Performer
Designing Biology Course
Total Duration
Behavior Measured | Dimension
At home office with a stop watch
Setting(s) / Circumstance(s)
Me / Myself / I
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
"Designing" includes: outlining planning, discussing writing, Editing, recording , Creating slides, audio, curriculum, test questions, activities
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QYD5

The Quarter Intersect Method[3]:

The Quarter-Intersect method is a “nonparametric quantitative method” for determining trend, and is recommended as a ‘rapid means of trend estimation’ (Pennypacker et al., 2003). In order to perform the Quarter Intersect Method correctly, one should have a “minimum of 6 data points” as long as a stable pattern has emerged (McGreevy, 2007).

Step 1:

First, determine the time span that will be analyzed. In the example above, the considered time span is across 16 days. Though each day in the considered time span has a data point on it in the graph above, we would also have included days without data.

Second, subtract the number of days (n) by 1. That is, use the formula “n – 1”; where n = number of days in the considered span of time. In the example of above n = 16, thus n - 1 = 15. This formula is used because we’re not actually dividing the number of days by 4; instead we’re dividing *the units space between the days lines*, and there is always one less unit of space than the number of day lines within a span of time considered for analysis.

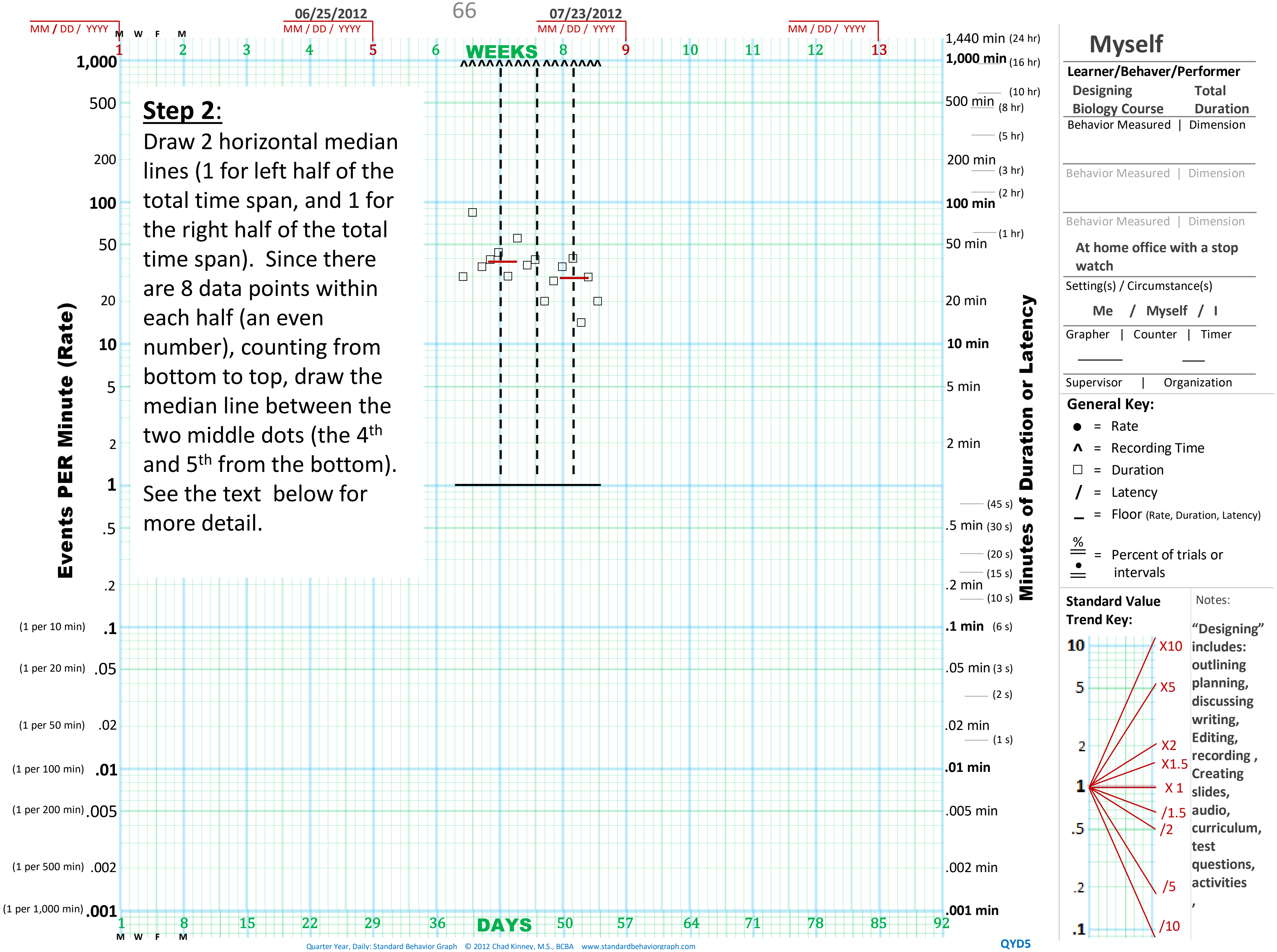
Third, quarter the total space between all the days lines within the considered time span. That is, divide the space into 4 equal parts, so that each part has an equal number of units of space between lines. In the above example, with a 16 day time span (starting on Thursday in the 6th week and ending on Friday in the 8th week), we’ll divide 15 by 4 to determine how much space each quarter of space has in it. Thus in the above example, 15/4 = 3.75 (or 3 and ¾) units of space within each quarter.

Finally, determine where to put your quarter intersect lines. Starting with the first day line of the span of time considered count the number of units of space needed, and place a quarter intersect line at that point. In the example above, count 3.75 units of space from the Thursday day line of week 6. The 1st quarter-intersect line will fall between the Sunday day line of week 6 and the Monday day line of week 7--slightly closer to the Monday line. From your first quarter-intersect line, count exactly 3.75 more units of space and draw your 2nd quarter-intersect line directly in the center of the space between the Thursday and Friday lines in week 7. Finally, draw your 3rd quarter intersect line after counting 3.75 units of space past your 2nd quarter-intersect line. The 3rd quarter-intersect line will fall between the Monday and Tuesday day lines in week 8--slightly closer to the Monday line.

[3] All the steps shown for this method can be found in Pennypacker et al. (2003)--with the exception of the “Second…” part of step 1 above. The author was unable to locate a source for this part of the step, though it seems inherent in the process as a whole.

Step 2:

Draw 2 horizontal median lines (1 for left half of the total time span, and 1 for the right half of the total time span). Since there are 8 data points within each half (an even number), counting from bottom to top, draw the median line between the two middle dots (the 4th and 5th from the bottom). See the text below for more detail.



The Quarter Intersect Method (continued):

Readers may note that if two quarters are combined, they form a half. Thus, in the example above 3.75 + 3.75 = 7.5 units of space in the left *half* (and 7.5 units of space in the right *half*). This might be useful if one wishes to draw the 2nd quarter-intersect line, or "middle intersect line," first. Note: as long as one can determine if a quarter intersect line should fall exactly on a day line or somewhere in the space between, that may be of sufficient precision when actually drawing the intersect lines.

Step 2:

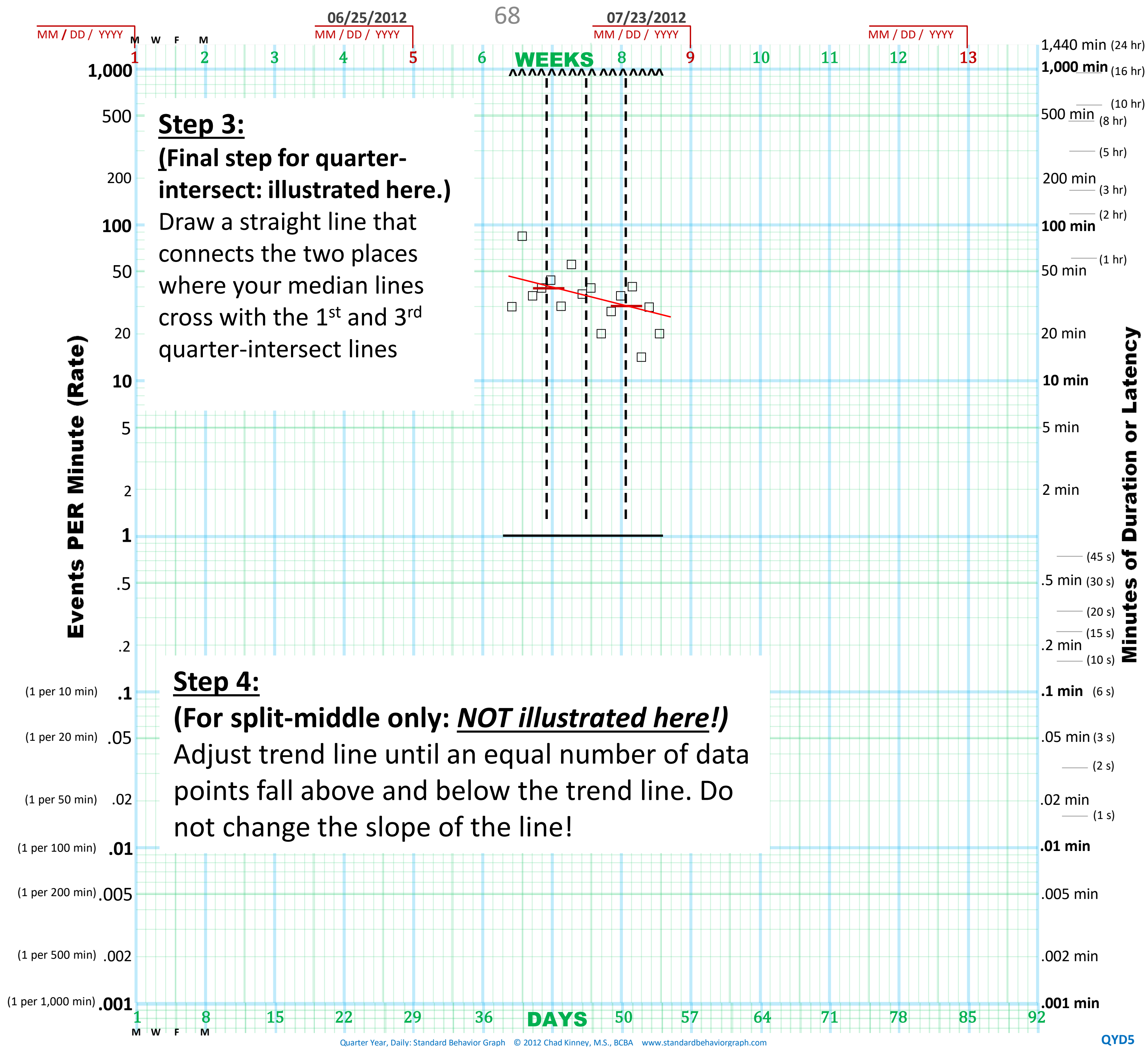
First, count the total number of data points in the left half of the time span considered for analysis. In the example of above, there are 8 data points in the left half (and 8 in the right half).

Second, find the median (or middle) data value for the left half of the time span, and draw a horizontal line to indicate where it crosses the <u>1st</u> quarter intersect line. In the example above, there are an even number of data points, thus the median value will be between the average of the two middle most points—*when counting from bottom to top* (NOT from left to right). The two middle most points are the 4th and 5th data points from bottom to top (i.e. the point on Sunday of week 6 and the point on Thursday of week 7). Had there been an odd number of data points on the left side of span of time, then the median data value would have fallen precisely on the level of the middle data point from the bottom.

Third, find the median data value for the right side of the time span considered for analysis in the same way as directed above, except draw the horizontal line to indicate where the median value crosses the <u>*3rd*</u> quarter-intersect line.

Step 3

Draw a straight line that connects the point at which the left-half median value crosses the 1st quarter intersect line and the point at which the right-half median value crosses the 3rd quarter-intersect line: this is your trend line! Since it is graphed on the SBG, see if you can estimate what its Standard Value is (answer shown in Chapter 10).



Myself

Learner/Behaver/Performer

Designing Biology Course | Total Duration

Behavior Measured | Dimension

Behavior Measured | Dimension

Behavior Measured | Dimension

At home office with a stop watch

Setting(s) / Circumstance(s)

Me / Myself / I

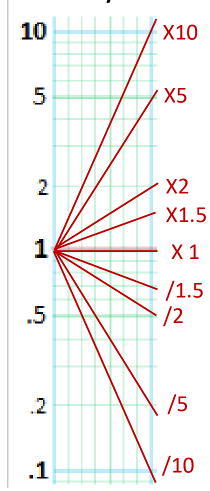
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Designing" includes: outlining planning, discussing writing, Editing, recording , Creating slides, audio, curriculum, test questions, activities
,

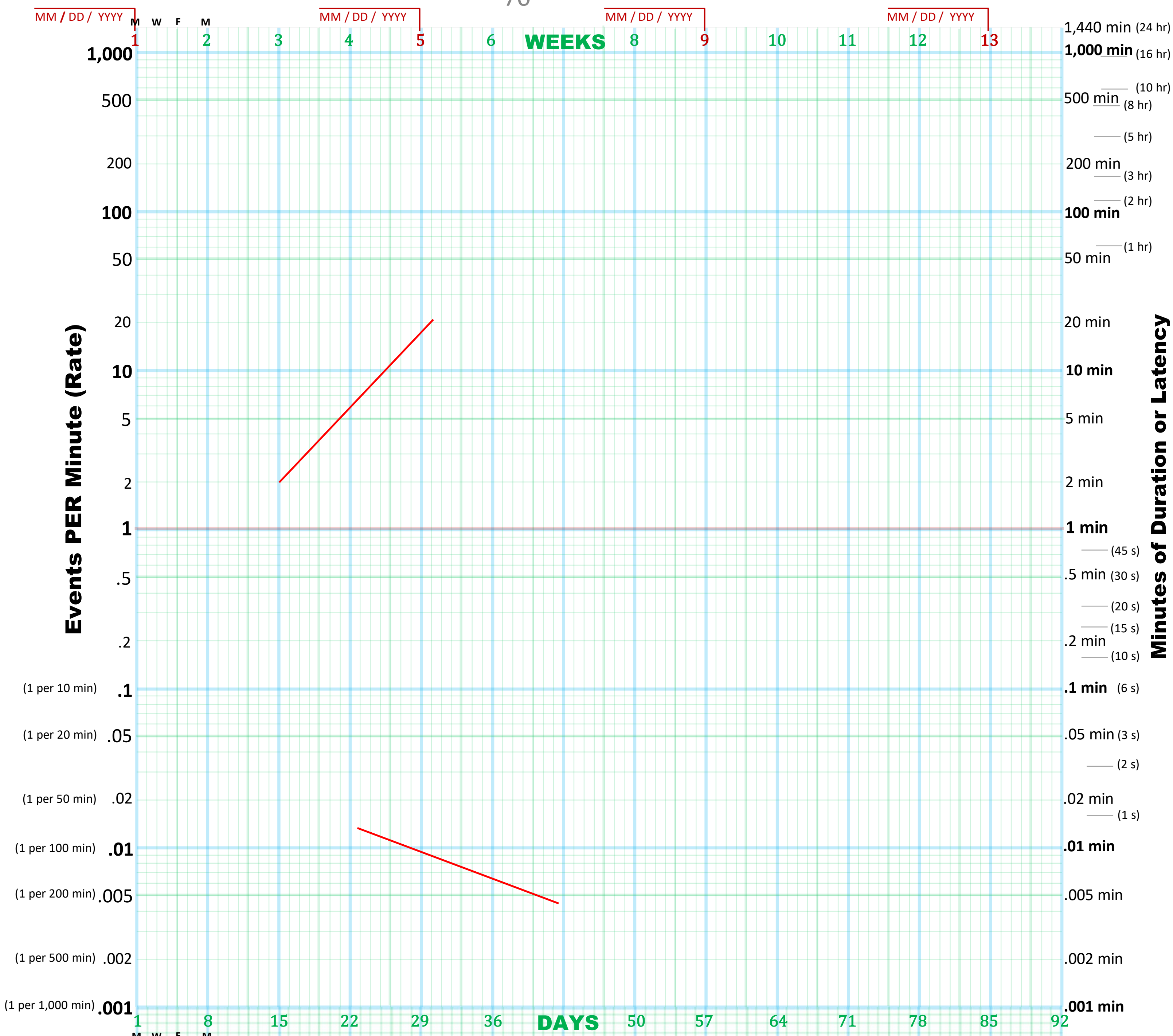
The Split-Middle Technique:

The Split-Middle Technique is very similar to the Quarter-Intersect Method, in that both methods involve drawing a straight line through the medians of each half of the data, but they have two major differences (White, 2005). First, the quarter-intersect method divides up an entire span of time whether a day line has data on it or not; however, the split-middle technique only considers day lines that have data points on them when dividing the data into equal parts (thus any gaps in the record are not considered) (White). Therefore, the split-middle technique will always result in 4 divisions that have an equal number of data points. Second, the quarter-intersect method is completed once the trend line is first drawn; however, the split-middle technique is not yet completed once the initial trend line has been drawn. With the split-middle technique, the final step is completed after the trend line has been adjusted (while keeping the *same* slope) so that exactly half of all the data points fall above the adjusted trend line, and half fall below it. White (2005) suggested that the split-middle technique may be preferable to the quarter-intersect method when the pace of performance change is likely not steady through gaps in the record.

The Least Squares Method of Linear Regression:

The Least Squares Method of Linear Regression is a very common approach to drawing a trend line (McClave & Sincich, 2000). There is a fairly simple statistical formula that produces extremely reliable (i.e., replicable) results (McClave & Sincich). However, despite the advantage of reliability, the problems associated with the accuracy and validity of this procedure can make it less than optimal in some circumstances: Unlike with methods that rely upon finding the median values of the data (e.g., the quarter-intersect and split-middle), the Least Squares Method relies upon mean (average) values of the data (Pennypacker et al., 2003); also, due to the Least Square's reliance on averages, trend lines drawn with a least squares method may poorly describe current and predicted data points when the data set contains "unusual data points," extreme data points, and/or outliers (Vickers, 2010; White, 2005).

To perform a Least Squares Method of Linear Regression without the aid of a computer, one must consider that the SBG has both log scale and a linear scale. Therefore, to make the statistical formula used to calculate a line-to-best-fit work, one may transform values on the log-axis into linear values, so that the y-axis values will match the x-axis values. After transformed values have been processed, the results must then be transformed back into a log format in order to plot trend line values correctly on the SBG (Pennypacker et al., 2003).



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QYD5

Learner / Behaver / Performer

Behavior Measured / Dimension

Behavior Measured / Dimension

Behavior Measured / Dimension

Setting(s) / Circumstances

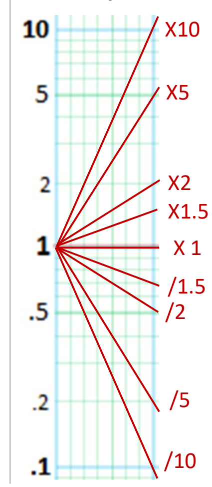
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- ☐ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

Chapter 10: Finding the Quantity of a Standard Value Trend Line:

Once a trend line has been drawn or projected across the trend period (e.g. 8 day lines) on an SBG, it has a Standard Value Trend quantity, and thus becomes a Standard Value Trend. When the slope of the SV Trend line is going up, the multiply sign (X) is used, and when the slope of the SV Trend line is going down, the divide sign is used (/). There are several ways to find the quantity of a Standard Value Trend.

The eyeball method[1]:

The eyeball method involves simply estimating the quantity of a Standard Value Trend line based upon the values assigned to the red trend lines in the Standard Value Trend *Key* (found in the bottom right-hand corner of every SBG). In the example above, one might quickly estimate the top trend line to be between X5 and X2, and the bottom trend line to be about /1.5 or /2.

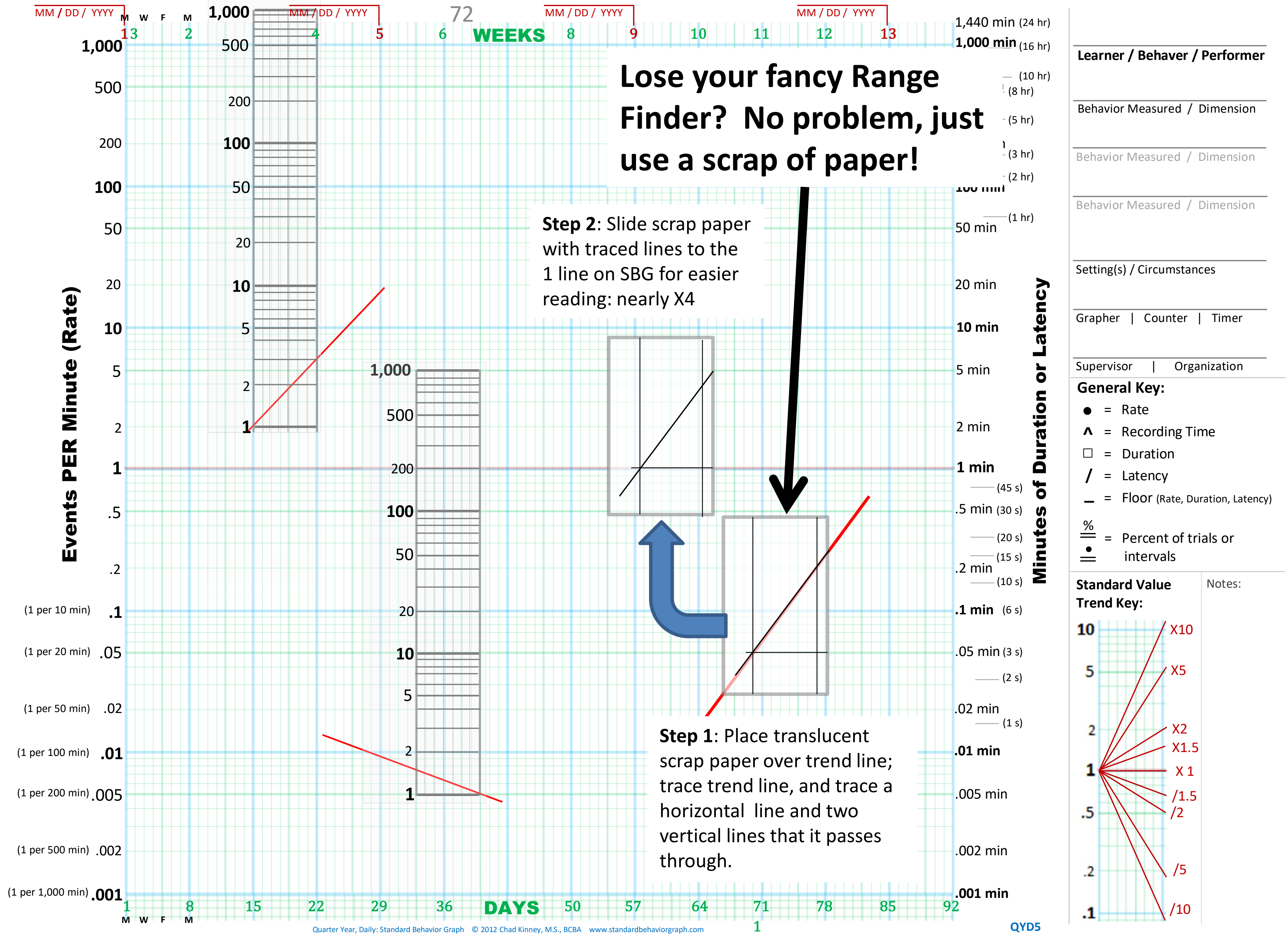
A formula method[2]:

One can quickly estimate the value of the trend line as it passes through "day n," then estimate the value of the trend line as it passes through "day n + 7." Next, divide the larger value by the smaller value; the quotient is the *Standard Value*. If the trend was upward, give the Standard Value Trend a times (X) sign. If it was downward, give the Standard Value Trend a divide (/) sign.

In the top trend line above, let's say that "day n" will be day 15, and "day n + 7" will be day 22. The value of the trend line on day 15 is approximately 2 per min, and the value of the trend line on day 22 is about 6 per min. To find the Standard Value, divide the larger number by the smaller: 6 per min / 2 per min = 3. Since the trend is upward, we can say "it's an *SV X3 Trend*."

With the trend line graphed above at the bottom of the grid, let's say that "day n" will be day 33 (the Friday line), and "day n + 7" will be day 40 (the next Friday line over). The value of the trend line on day 33 is approximately .0075 per min. The value of the trend line on day 40 is approximately .005 per min. To find the *Standard Value*, divide the larger number by the smaller: .0075 per min / .005 per min = 1.5. Since the trend is downward, we can say "it's an *SV /1.5 Trend*."

[1 & 2] Very similar methods that these are derived from can be found in Pennypacker et al.(2003).



Lose your fancy Range Finder? No problem, just use a scrap of paper!
Step 2: Slide scrap paper with traced lines to the 1 line on SBG for easier reading: nearly X4
Step 1: Place translucent scrap paper over trend line; trace trend line, and trace a horizontal line and two vertical lines that it passes through.
MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
1,000
500
200
100
50
20
10
5
2
1
.5
.2
(1 per 10 min) .1
(1 per 20 min) .05
(1 per 50 min) .02
(1 per 100 min) .01
(1 per 200 min) .005
(1 per 500 min) .002
(1 per 1,000 min) .001
1,440 min (24 hr)
1,000 min (16 hr)
50 min
20 min
10 min
5 min
2 min
1 min
.5 min (30 s)
.2 min
.1 min (6 s)
.05 min (3 s)
.02 min
.01 min
.005 min
.002 min
.001 min
Learner / Behaver / Performer
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
= Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:
Quarter Year, Daily: Standard Behavior Graph © 2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com
QYD5

The Range Finder method [3] (using a Range Finder printed and cut from a clear plastic transparency sheet):

Since the Range Finder is already the width of a trend period (8 day lines), in just one easy step, one can quickly discover the approximate vertical range that a trend line covers: simply place the range finder on top of the trend line so that the 1 line on the range finder is aligned with any horizontal line on the SBG that the trend line passes through, and observe the range of the trend line from the first to the last day line on the range finder. If the trend line has an upward slope, then align the range finder so that the trend line passes through bottom left corner of the range finder (where the 1 line on the range finder meets the first day line on the range finder). In the graph above, the vertical range of the trend line (in the top left of the grid) is 3, so the SV Trend is X3. If the trend line has a downward slope, then align the range finder so that the trend line passes through the bottom right corner of the range finder. In the graph above (in the bottom left of the grid) the SV Trend is about /1.5.

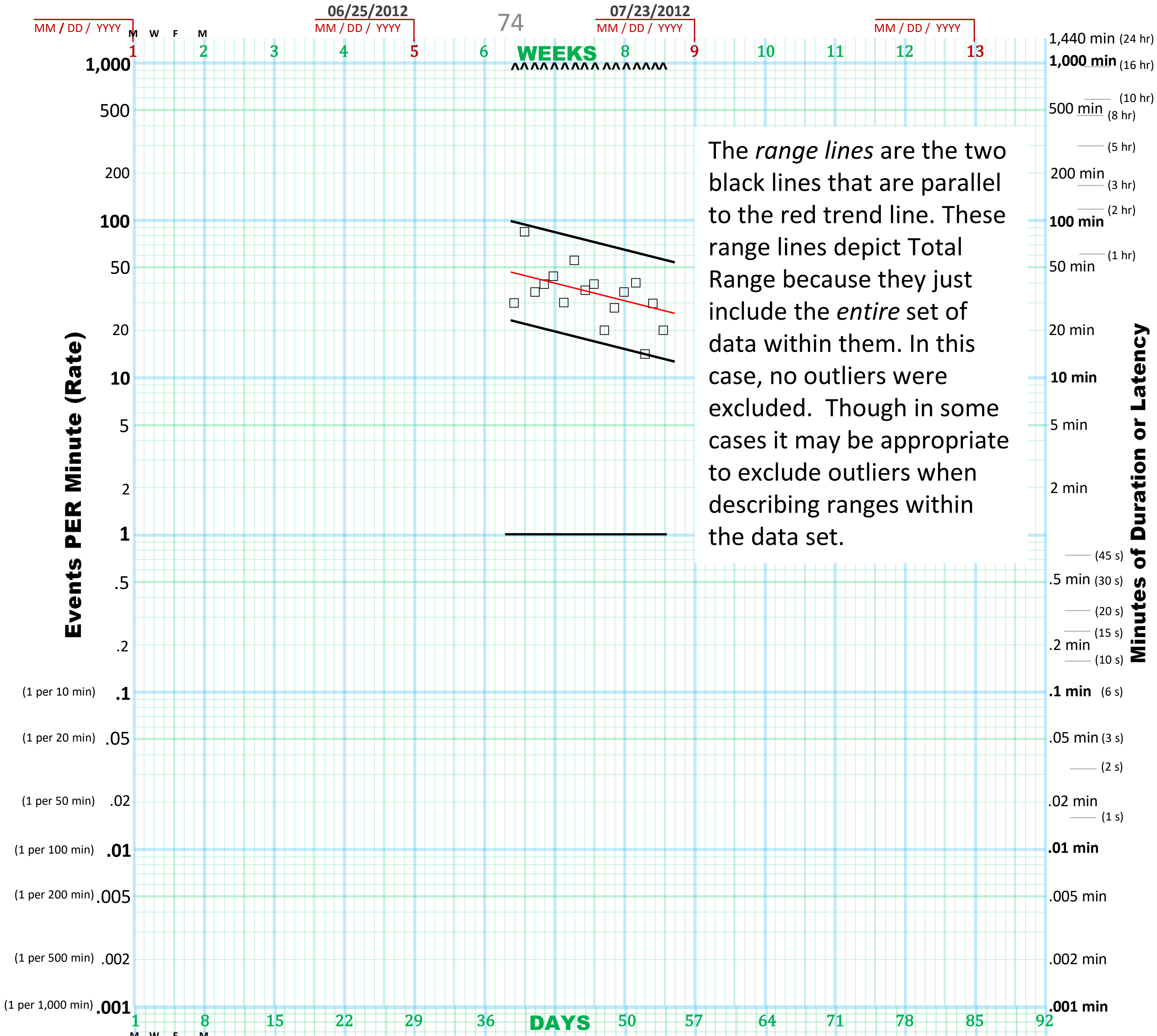
Scrap paper method 1 (trace):

Scrap paper methods are similar to the Range Finder method, only the lines aren't already marked on your scrap. Still, the main idea is to simply mark the vertical length of the trend line across a single trend period, then read the value of that distance. If you can see through your scrap paper then follow these two steps: (1) Place the scrap of paper on top of the trend line, trace the trend line, and also trace a horizontal and two vertical lines of the SBG that the trend line passes through, and (2) Slide your scrap tracing paper to align with the 1 line for easy measurement—as shown above (on the right side of the grid). If it is an upward trend, align the 1st day of the traced trend line with the 1 line on the SBG, then read where the traced trend crosses the 8th day line on your scrap: that's the *Standard Value* of the trend. If it is a downward trend, align the 8th day of the traced trend with the 1 line on the SBG, then read where the traced trend crosses on the 1st day line on your scrap.

The scrap paper method 2 (non-trace):

If you can't see through your scrap paper. First, make a mark on your scrap paper where the trend line passes through the first day in the time span (*day n*) on the SBG. Second, keeping the scrap paper at the exact same level on the y-axis, slide the scrap paper horizontally over 7 days lines on the SBG (that's the 8th day line in the time span, or *day n + 7*), and mark on the scrap paper where the trend line crosses on that day (*day n + 7*). Finally, estimate the distance between these two marks on your scrap, by aligning the bottom mark on the scrap with the 1 per min line on the SBG, then reading the level of the top mark.

[3] A similar method that this one has been derived from can be found in Pennypacker et al. (2003)



The *range lines* are the two black lines that are parallel to the red trend line. These range lines depict Total Range because they just include the *entire* set of data within them. In this case, no outliers were excluded. Though in some cases it may be appropriate to exclude outliers when describing ranges within the data set.

Myself

Learner/Behaver/Performer

Designing Biology Course | **Total Duration**

Behavior Measured | Dimension

Behavior Measured | Dimension

Behavior Measured | Dimension

At home office with a stop watch

Setting(s) / Circumstance(s)

Me / Myself / I

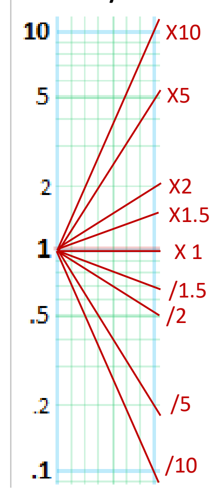
Grapher | Counter | Timer

Supervisor | Organization

General Key:

- ● = Rate
- ^ = Recording Time
- □ = Duration
- / = Latency
- _ = Floor (Rate, Duration, Latency)
- % = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Designing" includes: outlining planning, discussing writing, Editing, recording , Creating slides, audio, curriculum, test questions, activities

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Chapter 11: Variability and graphing Standard Value Range (i.e., "SV Range")

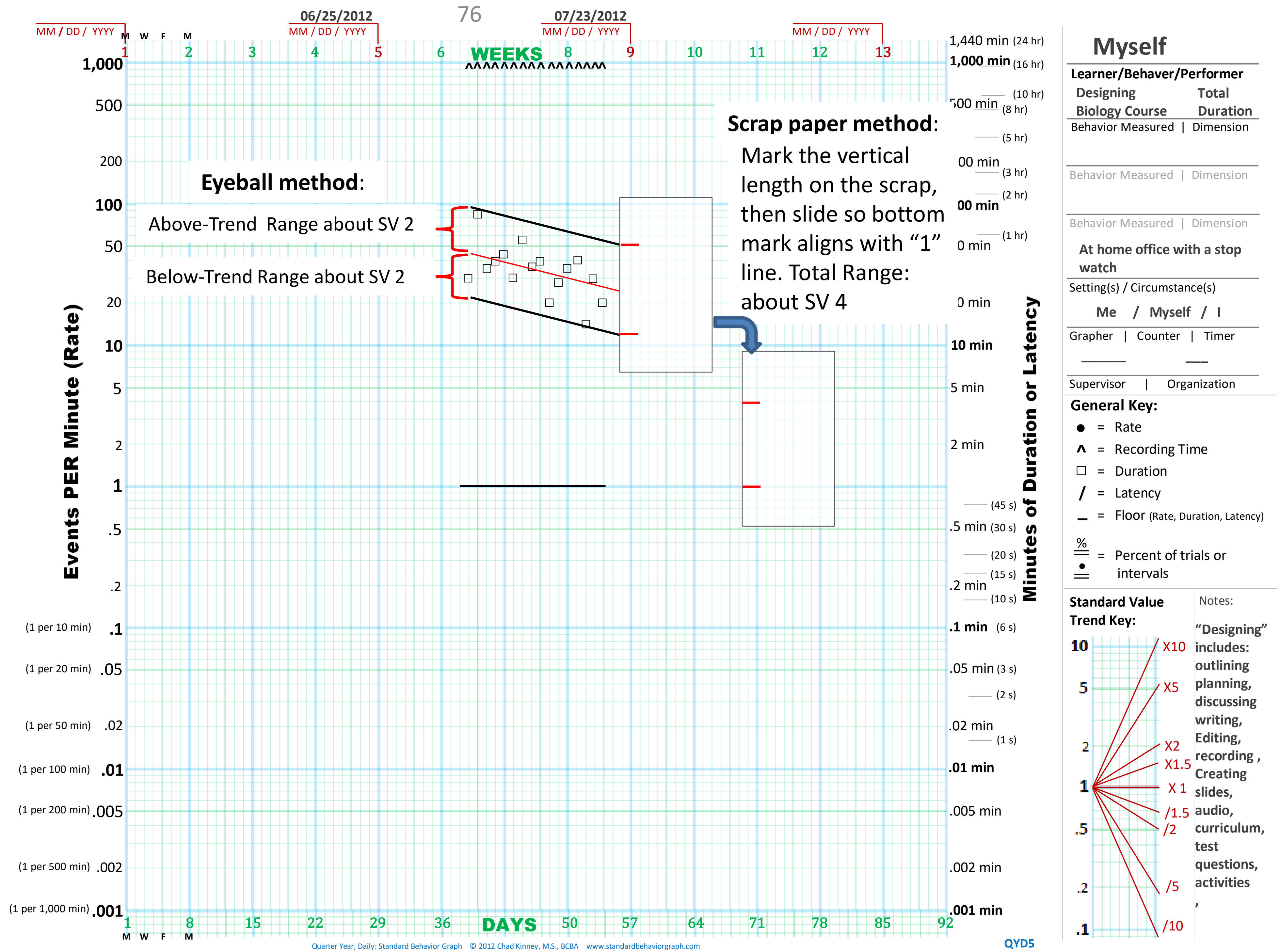
There often is no single measure of variability that will, by itself, be a truly complete representation of change within a set of data (Johnston & Pennypacker, 1980; Vickers, 2010). Therefore, it might be beneficial to consider using more than one method for describing the variability within data (Graf & Lindsley, 2002; Johnston & Pennypacker). Though this guidebook lists a few methods for quantifying variability, the list is not complete. The importance of a standard graph is that no matter which aspect of variability is measured, and which method was used to calculate that aspect, the display of the measure can be put in terms of a *Standard Value*. Moreover, Standard Values of variability can help emphasize the importance of protecting validity by reporting exactly which aspect of variability was measured, and what method was used to measure it.

Due to the great need for flexibility in the description of variability, it is not necessary for there to be a *standardized* amount of time that a Standard Value Range occurs over. However, it will be important to clearly define the specific, but arbitrarily selected, amount of time a Standard Value Range occurs within; that amount of specified time will be called the "range period."

SV Range can be calculated around the trend line in numerous ways: total range, interquartile range, average range, standard deviation ranges, etc. [1] One would merely specify what range period was used (e.g., days 15 through 22) and the type of SV Range measured. For example, one could say the following, "The SV Total Range is 25, within 8 days" or "The data has an SV 25 Total Range over days 15 through 22". Though *SV Range* is usually calculated in relation to the trend line, the *overall range* can be calculated without regard to the trend by simply dividing the largest number in the data set by the smallest.

Drawing *range lines*[2] may be necessary to estimate a particular range. For example, if the *total range* is to be determined, then the range lines need to enclose all the data points (with the possible exception of outliers), and yet remain pararallel to the trend line (see the example above). Additionally, if quartile ranges (e.g., lower, inter, and upper quartiles) are to be determined, then the data will be divided into 4 equal parts parallel with the trend line (Vickers, 2010). Moreover, if average ranges are to be determined, then the data will be divided according to its average range above the trend line, and it's average range below the trend line. One may even draw range lines that indicate a number of standard deviations away from a trend line (McClave & Sincich, 2000). Finally, if trend is not to be considered, and a trend-free range needs to be determined, then horizontal range lines may be drawn.

[1 & 2] Some of these terms were derived from terms used to analyze data on an SCC, please see the glossary for further explanation.


06/25/2012
07/23/2012
MM / DD / YYYY
WEEKS
DAYS
Events PER Minute (Rate)
Minutes of Duration or Latency
Eyeball method:
Above-Trend Range about SV 2
Below-Trend Range about SV 2
Scrap paper method:
Mark the vertical length on the scrap, then slide so bottom mark aligns with "1" line. Total Range: about SV 4
Myself
Learner/Behaver/Performer
Designing Biology Course
Total Duration
Behavior Measured | Dimension
At home office with a stop watch
Setting(s) / Circumstance(s)
Me / Myself / I
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
☐ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
Notes:
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QYD5

Chapter 12: Finding the Quantity of a Standard Value Range

As mentioned previously, there are several ways to measure variability; however, when a data set is placed on the SBG, a Standard Value for that variability measure emerges. For example, one could measure the total range around the trend line, or the range between the trend line and one of the parallel range lines. Several methods are described below for determining the values of various ranges that aim to describe variability.

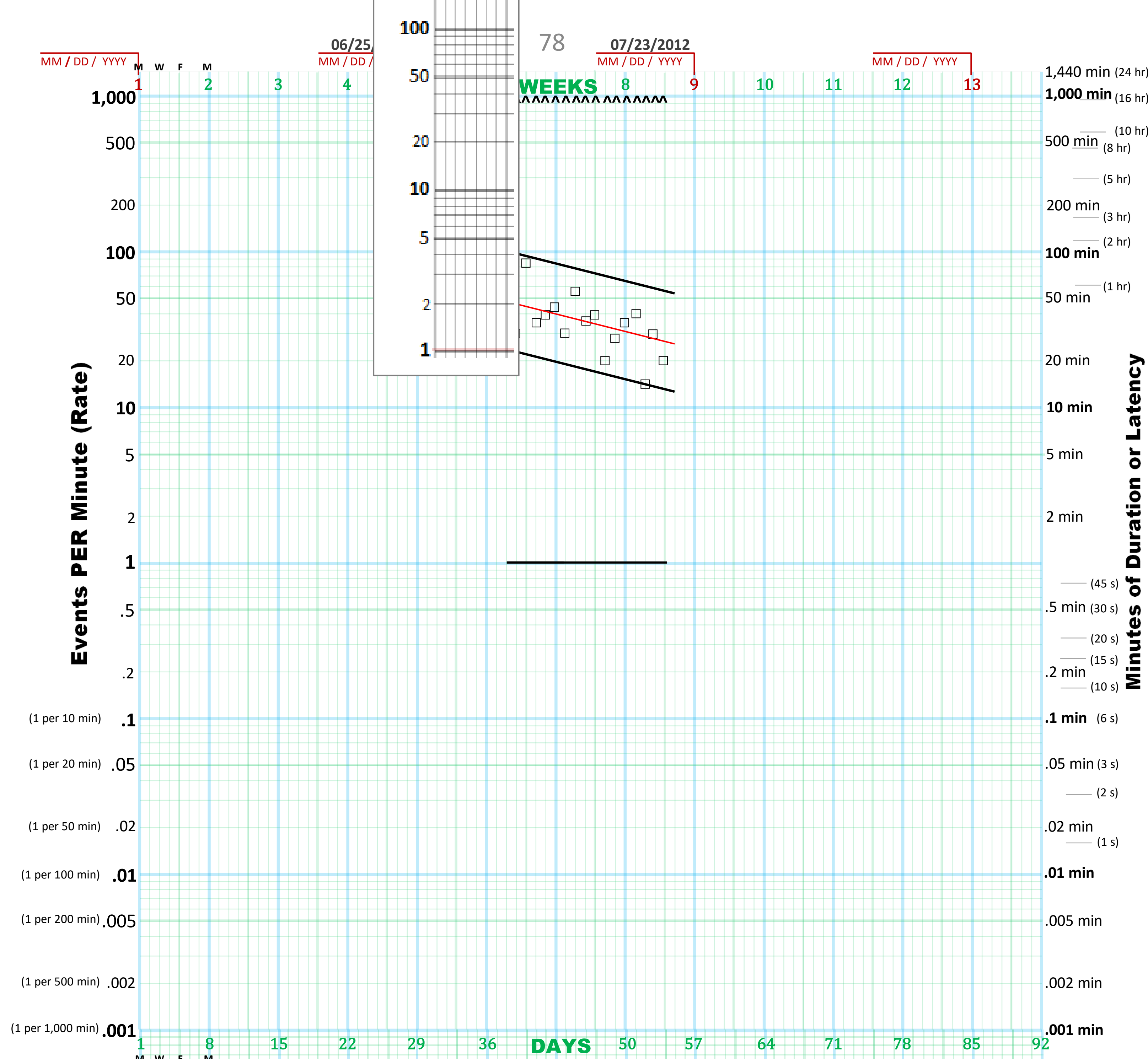
The eyeball method[1]:

Once range lines are drawn, a person may simply use their eyes to estimate the distance of those range lines from each other or from the trend line. In the example above, the Upper Range and the Lower Range (distance from trend line to upper range line and to lower range line), were both at about SV 2. Multiplying them together would yield an SV Total Range of 4, from day 39 to day 54.

Scrap paper method:

To measure the distance between range lines, place a scrap of paper next to any of the day lines that cross through the range lines. Then, mark the vertical distance between the range lines (or between the trend line and range lines). Next, slide the scrap piece of paper to where the distance can easily be measured by aligning the bottom mark on the scrap with the 1 per min line on the SBG. Finally, read the level that the top mark on the scrap aligns with on the SBG. In the example above, the top mark lines up with the 4 per min line, thus the *total range* of the data set shown above is approximately SV 4 within 16 days.

[1] A very similar method of calculation is described in Pennypacker et al. (2003).



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QYD5

Myself

Learner/Behaver/Performer

Designing Biology Course | Total Duration

Behavior Measured | Dimension

Behavior Measured | Dimension

Behavior Measured | Dimension

At home office with a stop watch

Setting(s) / Circumstance(s)

Me / Myself / I

Grapher | Counter | Timer

Supervisor | Organization

General Key:

● = Rate

^ = Recording Time

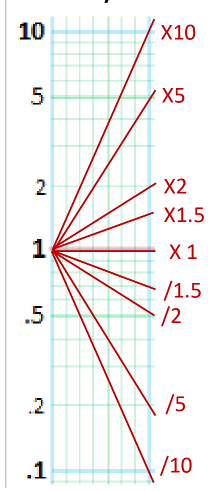
□ = Duration

/ = Latency

_ = Floor (Rate, Duration, Latency)

% = Percent of trials or intervals

Standard Value Trend Key:



Notes:

"Designing" includes: outlining planning, discussing writing, Editing, recording , Creating slides, audio, curriculum, test questions, activities
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The Range Finder Method[2]*:*

The Range Finder method may be the simplest way to determine the SV Range. In one easy step, a user can quickly see the *Standard Value* between any two range lines that cross on a particular day line. This method is very similar the first scrap paper method shown previously (page 77); the only difference is that the marks on the range finder are already made, therefore there's no need to slide the range finder to the SBG's 1 line for measurement, because the 1 line on the range finder can be brought to the range lines for any day line that the range lines cross—as with the example above. Notice that the range finder above is not made from transparent plastic, but was merely cut from a black and white copy of the SBG.

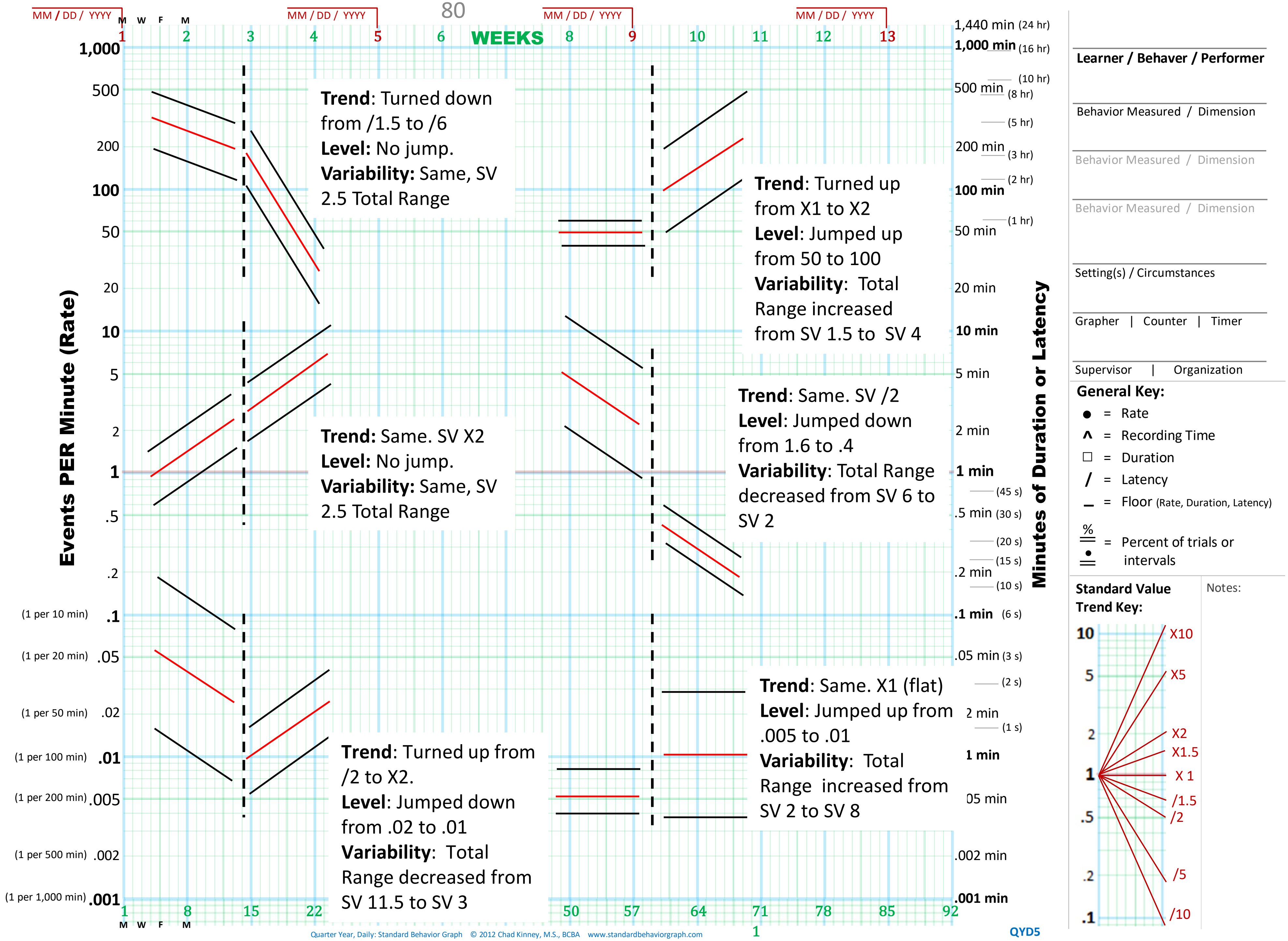
The Standard Error Method:

This method involves using a statistical formula (beyond the scope of this book) to determine the average distribution of data around the predicted data line (or line-to-best-fit). Roughly anywhere from 75% to 95% of the data should fall within 2 standard deviations from the mean (McClave & Sincich, 2000).

The Geometric means and "Kappa" Methods:

Though these methods are beyond the scope of this guidebook, should a reader be interested in analyzing data with more advanced statistical methods, the geometric mean method and kappa method can be found in the appendix of Johnston and Pennypacker's (1980) book "Strategies and Tactics of Human Behavioral Research."

[2] A very similar method is described in Pennypacker et al. (2003).


MM / DD / YYYY
MM / DD / YYYY
MM / DD / YYYY
MM / DD / YYYY
WEEKS
Events PER Minute (Rate)
Minutes of Duration or Latency
Trend: Turned down from /1.5 to /6
Level: No jump.
Variability: Same, SV 2.5 Total Range
Trend: Turned up from X1 to X2
Level: Jumped up from 50 to 100
Variability: Total Range increased from SV 1.5 to SV 4
Trend: Same. SV X2
Level: No jump.
Variability: Same, SV 2.5 Total Range
Trend: Same. SV /2
Level: Jumped down from 1.6 to .4
Variability: Total Range decreased from SV 6 to SV 2
Trend: Turned up from /2 to X2.
Level: Jumped down from .02 to .01
Variability: Total Range decreased from SV 11.5 to SV 3
Trend: Same. X1 (flat)
Level: Jumped up from .005 to .01
Variability: Total Range increased from SV 2 to SV 8
Learner / Behaver / Performer
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
☐ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
QYD5
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Chapter 13: Common Ways to Describe Data Within and Across Phases.

The illustrations above show possible changes in measures of data across dashed vertical intervention lines: the SV Trend lines are red, and the parallel SV Range lines are black. Interpreting whether an intervention had an effect or not largely relies upon the research design used during data collection; however, *interpretation also relies upon accurate description of data*.

Trend:

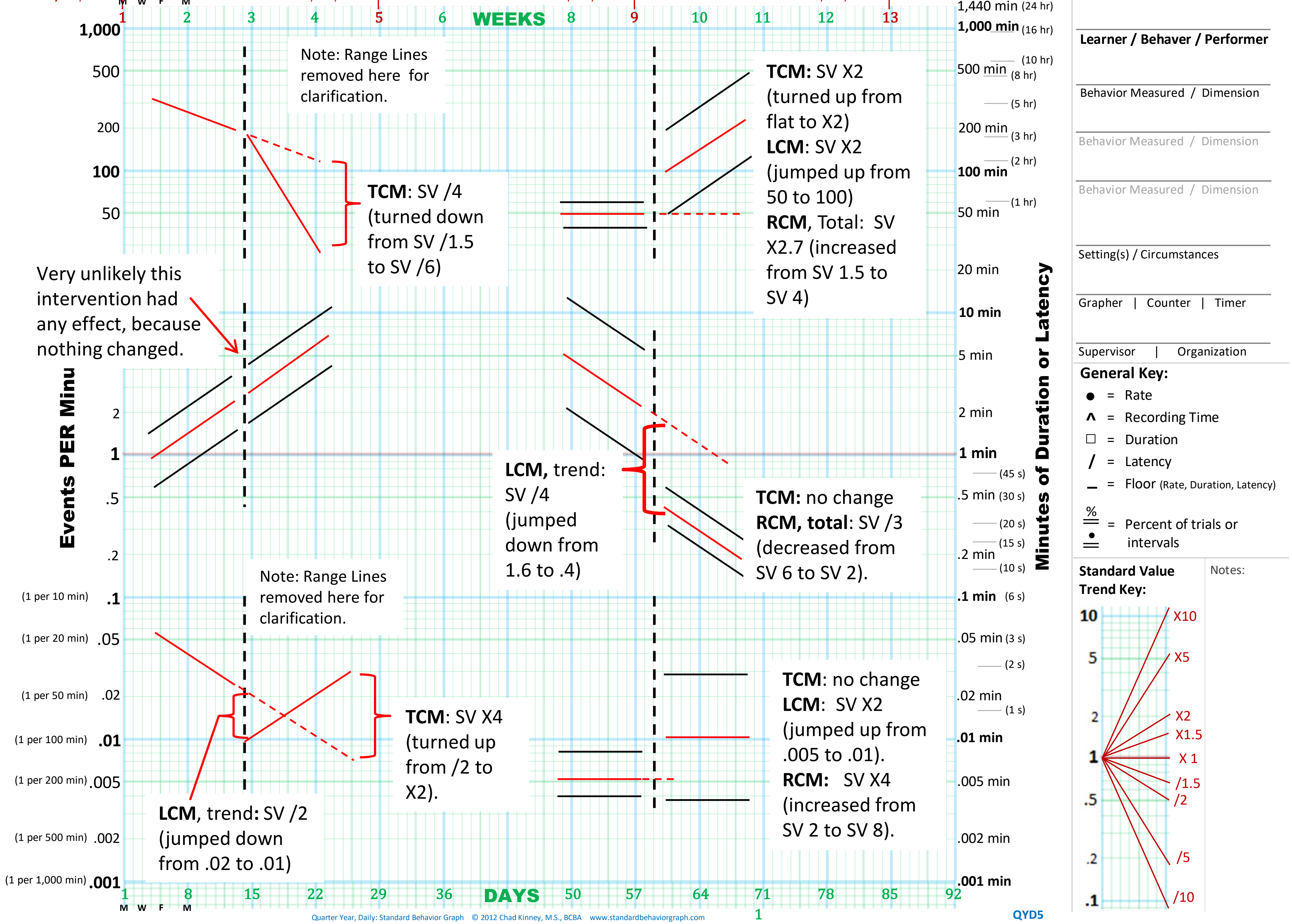
The following words are often used to describe trend: up, down, flat, increased, decreased, turned up, turned down, or stayed the same (Graf & Lindsley, 2002; Kazdin, 1982; Pennypacker et al., 2003). The great advantage of *SV Trend* is that it quickly and consistently communicates more precision when describing *how much* the trend is going up or down, e.g., "During week 3, the SV Trend is X2."

Level:

The following words are often used to describe differences in level: up, down, jumped up, jumped down, increased, decreased, or stayed the same (Graf & Lindsley, 2002; Kazdin, 1982; Pennypacker et al., 2003). In relation to the scale on the Y-axes, the level may describe the location of a single value or data point, the location of the mean of all the data points in a particular set, or the location of the projected end of one trend line to the beginning of the next trend line (Cooper et al., 2007; Graf & Lindsley, 2002). In all the illustrations on the left side of the grid in the graph above, the trend lines in the first phase would need to be extended to the Monday line (day 15) to properly determine the difference in level across the intervention line. All the illustrations to the right would need to have the trend line in the first phase extended to the Friday line in week 9 to determine the differences in level across the intervention line.

Variability:

The following words are often used to describe variability (Graf & Lindsley, 2002; Kazdin, 1982; Pennypacker et al., 2003): unstable, variable, stable, high, moderate, low, increased, decreased, etc. The great advantage of *SV Range* is that it quickly and consistently communicates more precision when describing *how much* variability exists within a data set, e.g., "The *total range* deceased from SV 6 to SV 2 after the intervention." There are several types of ranges that may describe variability (see chapter 11), but the example above refers only to *total range.*


MM / DD / YYYY
WEEKS
DAYS
Events PER Minute
Minutes of Duration or Latency
Note: Range Lines removed here for clarification.
TCM: SV /4 (turned down from SV /1.5 to SV /6)
Very unlikely this intervention had any effect, because nothing changed.
TCM: SV X2 (turned up from flat to X2)
LCM: SV X2 (jumped up from 50 to 100)
RCM, Total: SV X2.7 (increased from SV 1.5 to SV 4)
LCM, trend: SV /4 (jumped down from 1.6 to .4)
TCM: no change
RCM, total: SV /3 (decreased from SV 6 to SV 2).
Note: Range Lines removed here for clarification.
TCM: SV X4 (turned up from /2 to X2).
LCM, trend: SV /2 (jumped down from .02 to .01)
TCM: no change
LCM: SV X2 (jumped up from .005 to .01).
RCM: SV X4 (increased from SV 2 to SV 8).
Learner / Behaver / Performer
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
□ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
% = Percent of trials or intervals
Standard Value Trend Key:
Notes:
X10
X5
X2
X1.5
X 1
/1.5
/2
/5
/10
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QYD5

Chapter 14: Advanced Descriptors: Trend, Level and Range Comparison Measures.

Trend Comparison Measure (TCM)[1]

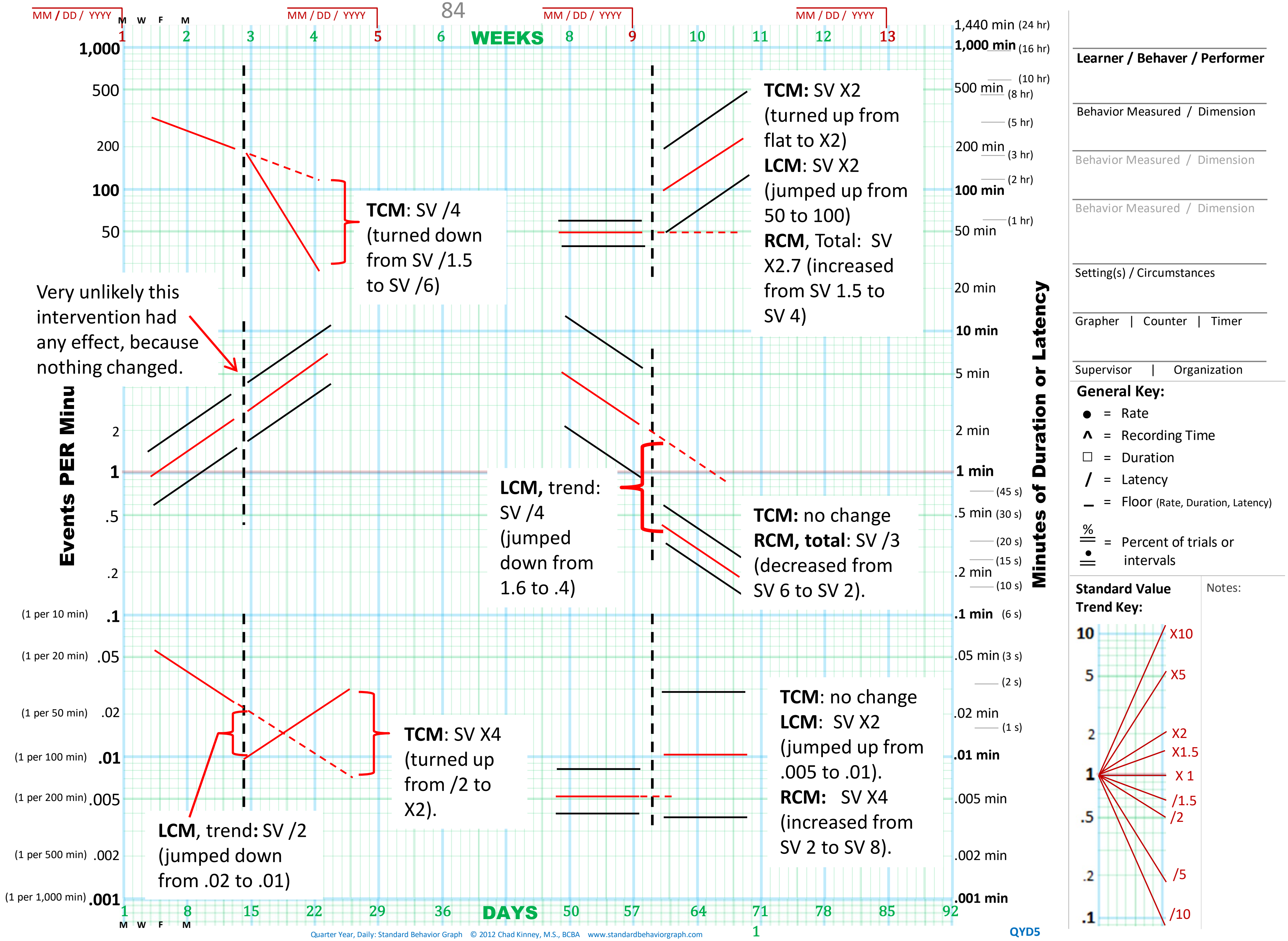
The TCM can compare any two trends, and it can show *how much* a trend turns up or turns down after a given point in time (e.g., after an intervention). In the examples above, *TCM* is merely a ratio of two SV Trend values on *day n + 7* when those two trend lines converged at the same level on the same day line on *day n*. If two trend lines do not naturally converge, then data analysts may visually determine the TCM by either extending trend lines (shown by the dashed red lines above), or completely moving them without altering their slope. When both trend lines converge on *day n*, then a scrap of paper or range finder can be used to determine the distance between the two trend values on *day n + 7*. Notice that “day n” for the illustration above at the top left side of the grid is day 15 (a Monday line), and “day n+7” is day 22 (also Monday). However, for the illustration that is at the bottom left side of the grid, “day n” is on the Friday line in week 3, and “day n +7” is on the Friday line in week 4.

Another method for determining *TCM*, without moving or extending any trend lines, is to follow some basic mathematic rules. That is, if two trend lines go in the <u>same direction</u> (e.g., both are downward, or both are going upward), then one would *divide* the larger SV Trend value by the smaller SV Trend value. Moreover, if the second trend line was increasing relative to the first, then the quotient would receive a multiply sign (X), but if it were decreasing relative to the first, then the quotient would receive a divide sign (/). On the other hand, if two trend lines go in <u>opposite directions</u>, then one would *multiply* the two SV Trend Values, and the product would receive either a multiply sign (if the 2^{nd} trend is increasing) or divide sign (if the 2^{nd} trend is decreasing).

Accuracy Improvement Measure (AIM):

A special case of the TCM is the *Accuracy Improvement Measure*. The AIM indicates the accuracy of overall performance through time (Kubina & Yurich, 2012; Pennypacker et al., 2003). Of course to determine AIM, one of the trend lines must describe correct responses and the other trend must describe incorrect responses. In terms of *Standard Value*, the AIM is merely the ratio of two SV Trend values on *day n +7* when those two trend lines converge at the same level on the same day line on *day n*. One can also determine the AIM by following the basic rules described in the second paragraph above on this page (Kubina & Yurich).

[1] Note: the TCM and its calculation has been derived from the SCC’s *celeration multiplier* (see Pennypacker et al., 2003, pg. 68).


MM / DD / YYYY
WEEKS
DAYS
Events PER Minu
Minutes of Duration or Latency
TCM: SV /4 (turned down from SV /1.5 to SV /6)
Very unlikely this intervention had any effect, because nothing changed.
TCM: SV X2 (turned up from flat to X2)
LCM: SV X2 (jumped up from 50 to 100)
RCM, Total: SV X2.7 (increased from SV 1.5 to SV 4)
LCM, trend: SV /4 (jumped down from 1.6 to .4)
TCM: no change
RCM, total: SV /3 (decreased from SV 6 to SV 2).
TCM: SV X4 (turned up from /2 to X2).
LCM, trend: SV /2 (jumped down from .02 to .01)
TCM: no change
LCM: SV X2 (jumped up from .005 to .01).
RCM: SV X4 (increased from SV 2 to SV 8).
Learner / Behaver / Performer
Behavior Measured / Dimension
Setting(s) / Circumstances
Grapher | Counter | Timer
Supervisor | Organization
General Key:
● = Rate
^ = Recording Time
☐ = Duration
/ = Latency
_ = Floor (Rate, Duration, Latency)
= Percent of trials or intervals
Standard Value Trend Key:
Notes:
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QYD5

Level Comparison Measure (LCM)[1]

The LCM can compare the levels of any two data values, and show *how much* a level jumps up or down after a given point in time (e.g., after an intervention). The data values can be from individual data points, averages of points, or entire trend lines. In the example above, the LCM ("LCM, trend") refers to the amount of jump in *SV Trend* across the intervention line. That is, the end of the first trend line has been extended to at least the first day of where the second trend line begins (Cooper, 2007), and this *LCM* is determined by dividing the larger trend line value by the smaller trend line value on that first day of the second trend line. If the level has jumped down, then the *Standard Value* representing the *LCM* receives a divide sign (/). However, if the level has jumped up, then the Standard Value representing the LCM receives a multiply sign (X).

Accuracy Ratio (AR):

A special case of the LCM is the *Accuracy Ratio.* The Standard Value distance between the rate of corrects and the rate of incorrects on a single day line describes the Accuracy Ratio--a concept that has been previously described in depth (see Pennypacker et al., 2007; Kubina & Yurich, 2012). One can find this distance with a scrap of paper, a range finder, or by simply dividing the larger value by the smaller. If the corrects are greater than the incorrects then the accuracy ratio will have a multiply sign, but if the incorrects are greater than the corrects then the (in)accuracy ratio will have a divide sign. <u>If the number of corrects or incorrects is **zero**</u>, then one may follow the convention of multiplying the rate floor value by .8 to determine the level of that zero (Lindsley, 2004). For example, if one recorded for two minutes, and observed 100 corrects per min and zero incorrects, then the Accuracy Ratio would be SV X250. That is, since rate floor would be .5 per min, and .8 x .5 = .4, after dividing the larger value by the smaller value (100 per min/.4 per min), SV X250 is calculated.

Range Comparison Measure (RCM)

It is important to specify which type of range is being described. In the examples above, RCM ("RCM, total") refers to the change in *total range* after the intervention. However, once the type of range has been specified, determining the amount of difference in range is only a matter of dividing the larger SV Range by the smaller SV Range of the two data sets being compared. If the range has increased in the second set of data then the Standard Value representing *RCM* receives a multiply sign (X). However if the range has decreased in the second set of data, then the Standard Value representing RCM receives a divide sign (/). Note, if the two ranges being compared are of different lengths, this might effect the usefulness of the RCM—this concept and calculation of it has also been derived from the bounce measures used for the SCC (see Pennypacker et al., 2003).

[1] the LCM has been derived from the SCC's "frequency multiplier" (see Pennypacker et al., 2003).

Chapter 15: Limitations and Considerations Regarding the SBG

Standardization, Log Scales and Cumulative Data

As cited previously, log scales often have the effect of preventing both over-exaggeration and under-emphasis of variability in data; however, there may be cases in which steady change in a quantity is too small to see on a log scale because the change happens very slowly. If the change cannot be detected, but it is still important, it may fail to evoke the appropriate response of an observer without additional adjustment of the scales (Johnston & Pennypacker, 1980). For example, a student may be motivated by changes in their rates of reading, but see little to no change on their SBG when their rates of reading are between 105 and 120 words per minute, and thus lose motivation to strive for improvement. In this case, it might be a good idea to use a custom graph in *addition* to a standard graph. Also small changes in quantities like weight, calories, and even average global temperature may not be noticeable on a log scale—but still very significant none-the-less!

Additionally, log scales may not be ideal for displaying cumulative data because a constant rate of responding will change drastically in slope merely because it enters a new log cycle on a graph's log scale. The main feature of cumulative graphs (estimating rate of change by glancing at the slope) is somewhat defeated on a log scale when the data crosses several log cycles. Thus, If one needs equal interval cumulative graphs, then one might consider them *in addition to* standardized graphs.

Finally, as Johnston & Pennypacker (pg. 353) have said, 'though standardization is extremely important because it makes the results of all investigations immediately comparable, investigators of behavior should "…also feel free to depart from a standard format for supplementary displays, always making clear both the nature and reason for the departure."'

Dangerous Assessments and Interventions:

Though the SBG (and the SCC) is a wonderful tool that may be useful for exploring behavior in a scientific way, one should keep in mind that dangerous behaviors (e.g., Self-injury, aggression, etc.) require the assistance of a competent professional (e.g. a BCBA). Additionally, precious time may be lost if interventions are based only on descriptive data collection and do not consider the current "function(s) of behavior" (Catania, 1998; Cooper et al., 2007; Miltenberger , 2004). While descriptive data collection procedures can reveal possible functional relationships, only an *experimental* analysis of behavior (as opposed to descriptive analyses) can confirm functional relationships between behavior and the environment (Cooper et al.).

Though data from nearly any single-subject research design can effectively be displayed on an SBG, again, assessments such as a "functional analysis" *should only be done with the guidance of a competent professional* in order to manage all possible risks to the health and well-being of the individuals we serve.

A Call To Action:

Despite some of the limitations just mentioned, there are more than enough reason to take full advantage of the numerous and important benefits that a standardized visual display--such as the SBG--offers.

Just as the introduction to this book makes the case for standardization, and shows how the many non-standard ways to display just one set of data can slow down and/or mislead interpretation and communication, Datchuk & Kubina (2011) note that by using a standardized visual display, chart readers can 'instead focus on interesting characteristics of the *data* rather than spending time decoding and analyzing the *construction* of non-standard charts or graphs.'

Ultimately, the best way to truly realize the advantages of standardized displays is to actually *use them*. That includes both the SBG, and the SCC, and even any future data displays that help to uphold standards. Thus, the author of this book strongly encourages readers to go to the website www.standardbehaviorgraph.com and download as many free copies of the Quarter Year Daily, SBG (and also the 100 Minute, SBG) as they like. One could re-graph data they've already seen plotted elsewhere, or (better yet) one should plot some newly gathered data of behaviors that may be considered for intervention.

Above all else, the author hopes readers always encouraged to engage in life-long learning, contribute to their community, and help other people in the world around them as best they can (perhaps even through graphing!). Even if we only help *one* person (other than our self) in our entire life, sharing our time and effort with another makes the world a far happier and more meaningful place to live in.

Notes:

"To the extent that behavioral data consist exclusively of measures of the basic dimensional quantities of behavior, it is not unreasonable to foresee further development of standard, universal formats for displaying these measures that will enjoy widespread utility and acceptance and that will enhance, rather than limit, communication" (Johnston & Pennypacker, 1980, p. 354).

Appendix A: Comparisons to the Daily Per Min, Standard Celeration Chart (SCC)

To view an image of the SCC, the "Daily per Minute," please visit www.behaviorresearchcompany.com

Features	SCC	SBG
1) Space between grid lines.	Within any cycle (e.g., 1 – 10), across one week (e.g. Sunday to Sunday), the total area on the SCC is approximately 220 mm^2.	Within any cycle, across one week, the total area on the SBG is approximately 420 mm^2. Nearly doubling the space between grid lines may help reduce possible eye-strain. When grid lines are too close together it's possible for a "moiré effect" to occur (Tufte, 2001).
2) The 2ndary Y-axis : on the right side of the grid.	The SCCs secondary Y-axis is a *reciprocal* logarithmic axis that is designated for describing latency and duration. As one moves up the scale the values *decrease* (whereas the primary Y-axis on the left is normal, because its values *increase* as one move up the scale). This has the effect of displaying decreases in latency or duration as *increases* in trend. Likewise, increases in latency or duration are displayed as *decreases* in trend. (whereas, decreases in rate are shown as *decreases* in trend, and increases in rate are shown as increases in trend on the SCC).	The SBG's secondary Y-axis is a *normal* logarithmic axis with values that simply increase as one moves up its scale—it is also designated for describing latency and duration. The SBG's secondary Y-axis is consistent with its normal primary Y-axis. Therefore increases in duration , latency , and/or rate are all consistently and clearly shown as increases in trend. Likewise, decreases in any of these dimensions of behavior are clearly shown as decreases in trend.
3) Display of duration and latency.	Duration and latency values are not directly displayed, rather the reciprocal of their values must be calculated and displayed(Pennypacker et al., 2003). For example, a duration of 10 minutes would be displayed as it's reciprocal 1/10 or .1. Historically, latency has occasionally been displayed as its reciprocal values because a decrease in latency is correlated with an increase in response strength (Solomon & Wynne, 1953). Additionally, duration and latency are intended to be displayed as a kind of rate on the SCC (Pennypacker et al., 2003).	Duration and latency data are directly displayed upon the SBG—without mathematical transformation into reciprocal values. For example, a duration of 10 minutes is plotted on the 10 min line, not the .1 per min line. Regarding response strength, not all increases in latency indicate decreases in response strength, and increases in duration often do not correlate with decreases in response strength or even 'slower behavior,' thus the SBG does not transform raw data into reciprocal values to reflect response strength or speed; rather the SBG allows the intelligent user to interpret the response strength on their own from the display of the untransformed data. Additionally, simply enumerating the number of durations or latencies to form a rate measure, provides very little information about a behavior's length or location in time.

Features	SCC	SBG
4) Percentage display of data	Percentage data can be displayed on the SCC but it is discouraged; however there is precedent for it's display on the SCC (Koenig, 1972).	Percentage data is welcomed on the SBG--despite flaws associated with percentage data. The convention for plotting percentage is visible on the SBG, in hopes of expanding the usability and awareness of a *standard* display, and improving the quality of percentage data displays.
5) Rate floors and Recording Time.	The display of a single "record floor" (-) on the SCC represents a combination of two separate values: *rate floor* and *recording time.* This is possible because the recording time is a duration that is represented by the *reciprocal* secondary y-axis., and the rate floor is itself a rate that is represented on the primary y-axis (Pennypacker et al., 2003). Thus, if one records for 10 minutes, it just so happens that the rate floor of 1 in 10 minutes (i.e., .1 per min) is also the reciprocal of 10 (i.e., 1/10).	The *rate floor* and *recording time* values are separate and symmetrically located across the 1 line because the secondary Y-axis that represents duration is normal and consistent with the primary Y-axis. This has the effect of emphasizing the recording time independent from the rate floor, making *recording time* more readily comparable to the behavior pinpointed for recording. That is, it can emphasize the relationship between response being observed and the "observing response"! The display of rate floor (-) is a rate value itself; it's the lowest possible number (greater than zero) during that recording time. Since the lowest possible is "1 per recording time interval" it is calculated with the formula 1/number of minutes spent recording. Thus, a 10 minute recording time would yield a rate floor of 1/10 or .1 per min. The display of recording time (^)is a duration plotted with a different mark than the floor (-). Its location is symmetrical with the location of the rate floor across the light red horizontal 1 line. A 10 min recording time is plotted on the 10 min line.
6) Trend Value reference Key	The SCC has "standard celeration fans" on each chart that help a user estimate common standard celeration values (i.e., values of trend lines that summarize changes in rate "per week"). The lines in the celeration fan are not the length of a *celeration period*, and by themselves, not instructive on how to derive trend values with different angles not shown by the fan.	The SBG has a Standard Value Trend Key on each graph that helps a user estimate common trend values . The SV Trend Key is the length of a trend period (8 day lines) and contains a portion of the SBG grid; thus it is more instructive on how to estimate the *Standard Values* of trends that aren't explicitly shown on the key. Additionally, the SV trend values are explicitly defined to be used for describing change in rate, duration, latency, etc.—rather than just changes in rate. Thus, the SV Trend Key serves an essential function on the SBG, without which, correct interpretation and description of trends on the graph could be lost. Note: similar "fans" that predate the SCC's fan have also been useful to data interpretation on other types of graphs (Skinner, 1938/1991).

Features	SCC	SBG
7) Thick vertical blue grid lines.	All Sunday lines are the thick vertical blue lines on the SCC. The first vertical line in the SCC's grid is a Sunday line. Many calendars in the U.S. begin the week on Sunday.	All Monday lines are the thick vertical blue lines on the SBG. The first vertical line on the SBG's grid is a Monday line. Despite U.S. calendars, U.S. schools and businesses do not often speak about Sunday as being the first day of the week, rather Sunday is the last day of the week*end,* and Monday is spoken of as the first day of the work week or school week. Additionally , the International Organization for Standardization has determined that Monday is the international standard for the first day of the week (ISO, 2004).
8) The first day line's label.	The first day line is labeled day zero and week zero. It's also known as the sync date, because one can sync a chart to real calendar time and other charts, by filling in the date above week zero (Kubina & Yurich, 2012). If one argues the first day of the week is Sunday, then if a data point is placed on the Sunday line with the number *4* above it, then that data point is actually on the first day of *week 5*-- since the first Sunday is on day zero. However, if one argues the first day of the week is Monday on the SCC (Kubina and Yurich note the convention of not plotting on day zero), then since the label for the week falls on the last day of the week, one must look backward to determine which week the data is plotted in. E.g., the 6 days lines *before* the day line labeled "4" are all in week 4.	The SBG clearly begins on day one and week one. Calendar time and other graphs can also be synced to day 1 on the SBG. Since there's no zero day or zero week that corresponds with how people talk about when an event begins, it is not present. Additionally, there's nothing inherently wrong with plotting a point on the 1st line of a grid. Moreover, a zero day and week can cause confusion when talking about where data specifically is on a graph. Thus, the beneficial result of beginning the SBG on day 1 is that the process of determining which week(s) a set of data falls within is more readily understandable. For example, the data point on the Monday Line with the number *4* above it, is clearly the *first* data point in week 4. Thus, the 6 day lines *after* the day line labeled "4"--from left to right--are also all clearly in week 4.
9) Days and Weeks that are labeled on the X-axis	At the top of the X-axis, starting with zero, every 4th week is labeled with a number on the SCC. At the bottom of the X-axis, every 14th day is labeled with a number. The labels of the days and weeks are outside of the grid.	At the top of the X-axis, starting with one, every single week (except week 7) is labeled with a number on the SBG. At the bottom of the X-axis, starting with one, every 7 days (except day 42) is labeled with a number. The extra labels on the X-axis are intended to enhance the speed and accuracy of locating and discussing particular data points graphed on the SBG. Though the X-axis labels are embedded within the grid (to conserve space), if needed , one can easily plot data on top of them without distorting any information.

Features	SCC	SBG
10) Number of days, weeks, months, and years.	The SCC has 140 days, 20 weeks, 4.62 months, and .3846 years. It can fit more data on one page than the SBG.	The SBG has 92 days, 13 full weeks, 3 months, and ¼ of a year. A quarter (1/4) of a year is a commonly used division of a year, as it is often a sufficient amount of time span for data to be displayed in most settings.
11) Color and grid line thickness.	One very carefully selected color (Lindsley, 2000), and 3 noticeably different thicknesses in grid lines.	5 different colors are used for clear contrast. Most folks with color blindness should still be able to see the contrast in hue, if not the contrast in the thickness and labels of lines. There are 5 different thickness in grid lines, e.g., the Friday lines have far more contrast than the other green days, allowing one to quickly see the weekend.
12) Calendar date prompts	The SCC date prompts are "DAY/MO/YR"	The SBG date prompts are "MM/DD/YYYY". The International Organization for Standardization uses YYYY-MM-DD (ISO, 2004); however, common practice in the U.S. is to write and say the month first, then the day, then the year.
13) Blanks that prompt for Information	At the bottom of the SCC, if one moves their eyes (and/or head) all the way from left corner of the chart to right, information in the information blanks can be read.	Condensed to the right of the grid on the SBG, from top to bottom, are many of the same information blanks that the SCC has. However, there is greater emphasis on stating which dimensions of behavior are pinpointed, and the setting/circumstances in which that behavior occurred. It also has extra space for notes in the bottom right.
14) General Key	The SCC does not have a general Key on it. Conventions for plotting duration, latency, etc., are not readily accessible by looking at any SCC.	The SBG has a general key for more readily accessible standard graphing conventions. This may enhance the fidelity and speed at which one can interpret and communicate different types of data. However, the key may be eschewed if necessary. Additionally, note that several of the symbols used for the SBG are the same as those used for the SCC (Kubina & Yurich, 2012, pg. 163).
15) Numbers with decimals on the y-axes, below the horizontal 1 line.	The SCC has many numbers with decimals below the horizontal 1 line.	The SBG also has many numbers with decimals below the horizontal 1 line, however, they are put into context with the numbers in parentheses beside them. E.g., on the primary y-axis, instead of just saying . 01 responses per min, one can quickly say 1 response per 100 minutes. This feature may help the numbers with decimals seem less conceptually intimidating, a need and remedy already noted by McGreevy (2007), when he presented his own innovative revised SCC, that was derived from the original SCC.

Features	SCC	SBG
16) Horizontal 1 line	The SCCs horizontal 1 line is the virtual center of the grid, but there is no special contrast to indicate its location amongst other horizontal lines (e.g., the .1 line).	The SBGs horizontal 1 line is exactly in the center of the grid, and it is contrasted with the other thick blue horizontal grid lines with a slightly thicker light red line. As a result of this contrast, it is more difficult to confuse the 1 line with the .1 line—avoiding loss of time, effort, and messy erasures.
17) Quick estimates for seconds and hours on the 2ndary Y-axis	The SCC has numbers for hours and seconds next to their corresponding *reciprocal* values (expressible as per minute). Since they are reciprocal, they increase as they move DOWN the scale, starting at the 10 second (i.e., 6 per min) level.	The SBG, inspired by the SCC's notation of hours and seconds, also marks its hours and seconds next to the corresponding minute values (except they start at 1 second, and increase as they move UP the scale, since they are direct values rather than reciprocal values).
18) semi-logarithmic	On the SCC, both Y-axes are logarithmic; the X-axis is linear.	On the SBG, both Y-axes are logarithmic; the X-axis is also linear.
19) Number of log cycles	The SCC has 6 full log cycles.	The SBG also has 6 full log cycles. With an additional partial cycle at the top (between 1000 and 1440).
20) Standard	The SCC is the original chart Standard for human behavior, conceived in the late 60's, and proven effective to this day!	The SBG is a new putative standard (2012) in graphing behavior. It is has updated features, but has been heavily influenced by the predecessor it was derived from, the SCC. The evidence of its effectiveness is still growing.
21) Standard angles of trend lines.	On the SCC a 34 degree angle across 8 day lines (i.e., "1 week" or "7 days"), has a standard celeration value of X2.	On the SBG a 34 degree angle across 8 day lines , has a SV Trend value of X2. Additionally, *all* the angles on the SBG are the same value as the angles on the SCC.

"To the extent that behavioral data consist exclusively of measures of the basic dimensional quantities of behavior, it is not unreasonable to foresee further development of standard, universal formats for displaying these measures that will enjoy widespread utility and acceptance and that will enhance, rather than limit, communication" (Johnston & Pennypacker, 1980, p. 354).

Formulas from the science of Physics

$$\text{Speed}^{1} = \frac{\text{Distance}}{\text{time}} \qquad \text{E.g.: Speed} = \frac{40\ \text{Km}}{1\ \text{min}}$$

$$\text{Acceleration} = \frac{\Delta\ \text{speed}}{\text{time interval}}$$

$$= \frac{(d/t)_f - (d/t)_i}{t} \ *$$

$$= \frac{d/t}{t}$$ ← The units that will remain

$$\text{E.g.: Acceleration} = \frac{\dfrac{40\ \text{Km}}{1\ \text{min}} - \dfrac{1\ \text{Km}}{1\ \text{min}}}{1\ \text{min}}$$

$$= \frac{39\ \text{Km/min}}{1\ \text{min}} = \left[\text{Or } 39\ \text{Km/min}^2\right]$$

* Note: the subscript "f" refers to the final measurement taken at the end of the span of time, and the subscript "i" refers to the initial measurement taken at the beginning of that same span of time. Thus, "Δ speed" means "*change in* speed" The *E.g.* shows its application.

Formulas from Behavioral Science, Analogous to Formulas from the Science of Physics.

$$\text{Rate} = \frac{\#\ \text{of cycles}}{\text{time}} \qquad \text{E.g.: Rate} = \frac{40\ \text{cycles}}{1\ \text{min}}$$

$$\text{Celeration} = \frac{\Delta\ \text{rate}}{\text{time interval}}$$

$$= \frac{(c/t)_f - (c/t)_i}{t}$$

$$= \frac{c/t}{t}$$ ← The units that will remain**

$$\text{E.g.: Celeration} = \frac{\dfrac{40\ \text{cycles}}{1\ \text{min}} - \dfrac{1\ \text{cycles}}{1\ \text{min}}}{7\ \text{days}}$$

$$= \frac{39\ \text{Cycles/min}}{7\ \text{days}} = \left[\text{Or } .004\ \text{cycles/min}^2\right]$$

**Note: recall that units in physical science can be *feet*, *inches*, *seconds*, *minutes*, etc.. If the number 39 were presented without such dimensions, you might say, "39 what?" Conversely, in behavioral science, the units are *response cycles*, rather than units of distance like *feet*, etc.

Appendix B: About the Terms *Celeration* and *Standard Value Trend.*

The analogy between formulas from physical science and formulas from behavioral science

The graphic above shows the side-by-side comparison of formulas from physical science to formulas found in behavioral science. That is, the speed[1] of a moving object is considered to be analogous to the speed of responding; but rather than measuring the distance that an object travels over time, *behavioral speed* measures the number of times an event repeats itself over time--i.e., behavioral speed is synonymous with a behavior's rate of occurrence (Pennypacker et al., 2003).

In physics, an increase in the speed of a physical object over time is called *acceleration*; similarly, in behavioral science, a change in the speed of behavior over time has been referred to as *celeration* (Pennypacker et al., 2003). "Celeration" is derived from the root of the word "acceleration." Thus, behavioral speeds that increase over time are "accelerating," and behavioral speeds that decrease over time are "decelerating" (Pennypacker et al, 2003).

On the surface, the analogy above appears to be fairly solid, as shown in the side-by-side comparison above. Even if one argued that the analogy above is not *direct*, there's enough correspondence between the two ideas to be confused for a direct analogy. However, though 'analogies or metaphors can facilitate (or highlight) comprehension of certain aspects of the phenomena under consideration, at the same time they could inhibit (or hide) comprehension of other aspects' (Vuchinich, 2000).

The material in this appendix (B) will make the argument that comparing behavioral celeration to physical acceleration may 'hide aspects of interest.' Moreover, a replacement term for *celeration* will be suggested. The complex argument will partially rely upon a distinction made between plain "celeration" and "*standard* celeration"—as shown on the next page.

[1] In physics, when the direction of a moving body is not changing, acceleration may be expressed as the rate at which *speed* changes (Hewitt, 2002). Though velocity and speed cannot always be used interchangeably in physics, the formula above is an expression of when they *can* be used interchangeably (i.e., when direction remains constant). This version of the physical science formula for speed and acceleration must be used in order to *strengthen* the argument for using the analogous terms *speed* and *celeration* in behavioral science--because in behavioral science the physical direction of an actual behavior is generally not considered (e.g., hitting self in a north-eastward direction, and then hitting self in an southern direction, won't change behavioral speed or velocity of "hitting self").

Standard Celeration

$$\text{Rate} = \frac{\text{\# of cycles}}{\text{time}} \qquad \text{E.g.: Rate} = \frac{\text{40 cycles}}{\text{1 min}}$$

$$\text{Standard Celeration} = \frac{\Delta \text{ rate}}{\text{within pre-defined time interval}} = \frac{\text{trend line value on } \textit{day n+7}}{\text{trend line value on } \textit{day n}}$$

$$= \frac{c/t}{c/t}$$

= The units cancel *.

$$\text{E.g.: Standard Celeration} = \frac{\frac{\text{40 cycles}}{\text{1 min}}}{\frac{\text{1 cycles}}{\text{1 min}}}$$

$$= 40 = \left[\text{Or } \times 40 \right]$$

*notice in the example that units have cancelled so all one is left with is the number "40" --all by itself.

Celeration

$$\text{Rate} = \frac{\text{\# of cycles}}{\text{time}} \qquad \text{E.g.: Rate} = \frac{\text{40 cycles}}{\text{1 min}}$$

$$\text{Celeration} = \frac{\Delta \text{ rate}}{\text{time interval}}$$

$$= \frac{(c/t)_f - (c/t)_i}{t}$$

$$= \frac{c/t}{t}$$ ← The units that will remain

$$\text{E.g.: Celeration} = \frac{\frac{\text{40 cycles}}{\text{1 min}} - \frac{\text{1 cycles}}{\text{1 min}}}{\text{7 days}}$$

$$= \frac{\text{39 Cycles/min}}{\text{7 days}} = \left[\text{Or } .004 \text{ cycles/min}^2 \right]$$

Comparing "Standard Celeration" to "Celeration"

Regarding the Standard Celeration Chart, 'the word "Standard" modifies the word *celeration*, not the word *chart*; thus, one may have many charts with celerations that are not standard' (Eschleman, 2010). Keep in mind that a "celeration line," or a "standard celeration line" on a chart is little more than a *trend line* (Cooper et al., 2007). The figure above will be referred to for side-by-side comparison.

Celeration may be defined as the change in rate over time; as shown above, it keeps its units of measurement: count/time/time (Johnston & Pennypacker, 1980). That is, a plain celeration value would still be bound to its units, and not rely upon standardized displays. For example, like in the figure above, a plain celeration value may appear as something like ".004 cycles per min[2(squared)]." However, plain celeration values are rarely (if ever) reported; instead what is actually typically reported are *Standard* Celeration values [2(foot note)] (e.g., see Datchuck & Kubina, 2011; Koenig, 1972; Selfridge & Kostewicz, 2011; Twarek, Chihon, & Eschleman, 2010, etc.).

Standard Celeration values have lost their units due to cancelation, thus a *Standard Celeration value is a dimensionless value*: it is unbound to the units *count/time/time*. For example, a *standard* celeration value of *"X 2"* has no units. Standard Celeration is primarily *standard* due to the slope of its line; e.g., a rate that's doubling over a given celeration period will always have the same X 2 slope—approximately 34 degrees (Eschleman, 2010; Lindsley, 2000). However, to achieve these standard slope values, it's necessary to abandon the conceptual formula for plain celeration, and instead adopt a method that works for determining *Standard* Celeration values as they appear on a ratio scale (i.e., the logarithmic axis on the SCC). Notice in the side-by-side comparison above that the formula used for finding *standard* Celeration values is simply a ratio of two other ratios: (c/t) / (c/t). Please examine the figure above to see how the answers differ when the method for finding plain celeration values is used versus when the method for finding for *standard* celeration values is used.

To find the *standard celeration* value with a celeration period of 1 week (or 8 day lines), one may put the rate value of *day n* and the rate value of *day n+7* into a ratio (Pennypacker et al., 2003); where the larger of those two rate values is the numerator. Thus, if the rate value on *day n+7* is larger than the rate value on *day n*, then the rate value on *day n+7* is in the numerator (as shown in the formula above), and the quotient is given a multiplication sign (X). However if the value on *day n* is the larger of the two, then the value on *day n* is the numerator (not shown above), and the quotient is given a division sign (/).

[2] In this author's experience, the term "Celeration" is often used to mean what is stated here as "Standard Celeration." Thus, when "celerations" are reported in journal articles, such reports may be seen as an abbreviated way to actually report *standard celerations*--as per Eschleman's (2010) distinction. Moreover, any number with units that can cancel, but has a "X" or "/" in front of it, is not a plain celeration value, but actually a *standard* celeration value if it's representing the change in rate over time on a standard celeration chart.

Standard Value Trend

Analogies to physical science are not required with SV Trend.

Q = quantity of *any* dimension of behavior (rate, duration, latency, etc.)

$$\text{SV Trend} = \Delta \text{ any Quantity within a pre-defined time interval} = \frac{\text{trend line value on } day\ n+7}{\text{trend line value on } day\ n}$$

$$= \frac{Q}{Q}$$

= The units cancel

E.g.1: SV Trend = for **rate**

$$\frac{\frac{40 \text{ cycles}}{1 \text{ min}}}{\frac{1 \text{ cycles}}{1 \text{ min}}} = 40 = \left[\begin{matrix}\text{Or} \\ \text{X } 40\end{matrix}\right]$$

E.g.2: SV Trend = for **duration**

$$\frac{\frac{40 \text{ minutes}}{1 \text{ cycle}}}{\frac{1 \text{ min}}{1 \text{ cycle}}} = 40 \quad \left[\begin{matrix}\text{Or} \\ \text{X } 40\end{matrix}\right]$$

Standard Celeration

"Speed" ≈ Rate (i.e., frequency of cycles over time)

"Ac***celeration***" ≈ Change in rate (i.e., frequency of cycles over time) over time

$$\text{Standard Celeration} = \Delta \text{ rate within pre-defined time interval} = \frac{\text{trend line value on day } n+7}{\text{trend line value on } day\ n}$$

$$= \frac{c/t}{c/t}$$

= The units cancel

E.g.: Standard Celeration =

$$\frac{\frac{40 \text{ cycles}}{1 \text{ min}}}{\frac{1 \text{ cycles}}{1 \text{ min}}}$$

$$= 40 = \left[\begin{matrix}\text{Or} \\ \text{X } 40\end{matrix}\right]$$

Comparing "Standard Value Trend" to "Standard Celeration"

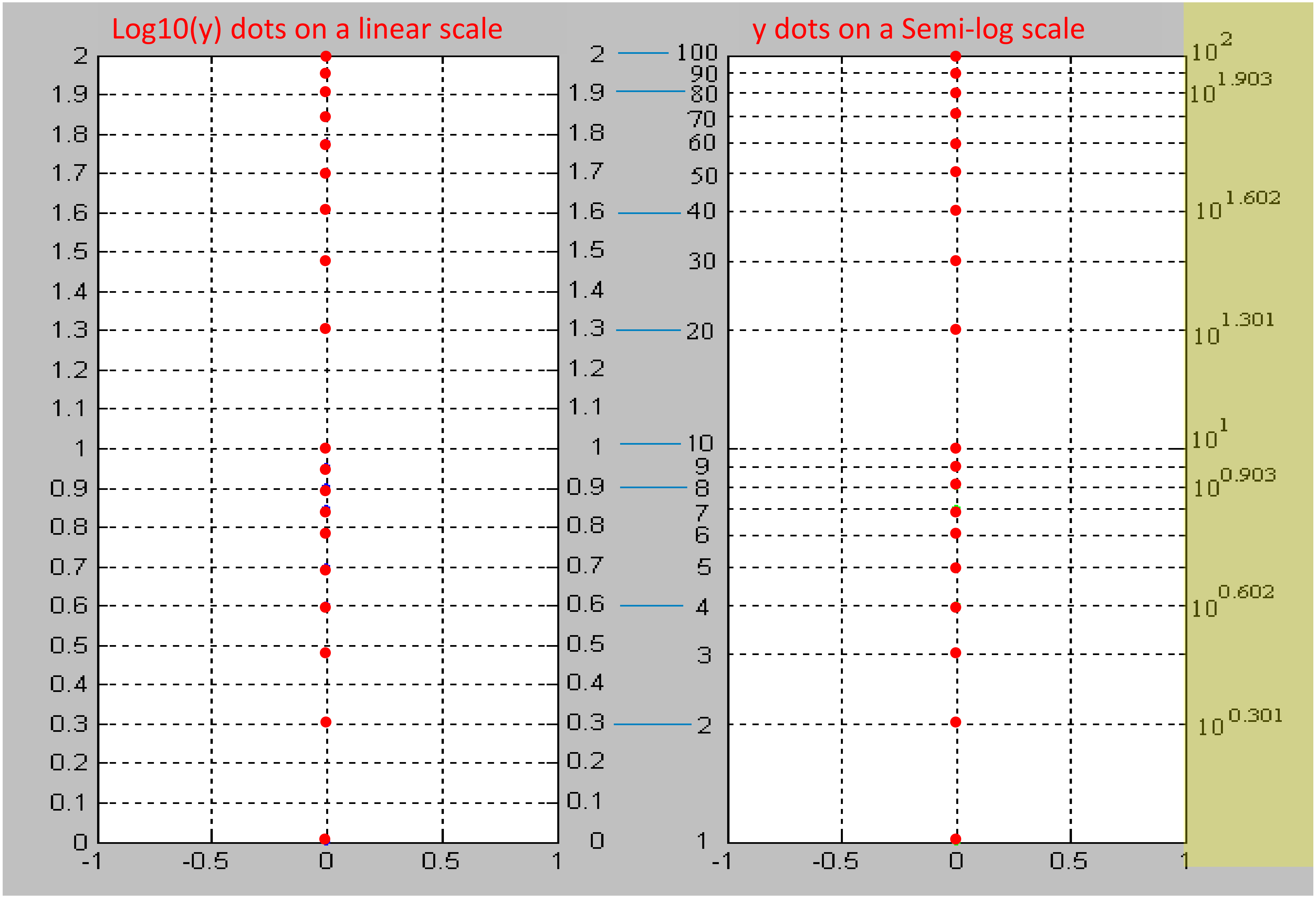
Now that we've compared celeration to **ac**celeration, and made clear the distinction between celeration and Standard Celeration, we can proceed to the reasons why this author has chosen to replace the term "celeration" on the SBG:

Jokes about the word *celeration* like "'*w*hat's that, the process of putting celery into your lunch?" or "It looks like you misspelled *cele**b**ration*," are not valid reasons for finding a replacement term. However, though many of *celeration's* features are analogous to *acceleration*, and this similarity to physical science seems to lend prestige to behavioral science, the analogy's limitations seem to have the potential to hold back a *standard* description of *behavior*—particularly if anyone is opposed to expressing/interpreting concepts like *duration* in terms of *rate. Standard celeration* is defined as the change in *rate* over time, which may possibly obscure the analysis of changes in other dimensions (e.g., duration, latency, etc.) over time. Moreover, the emphasis on rate seems to lead people to express all behavioral dimensions in terms of rate (Pennypacker et al., 2003, pg. 32; White, 2012). E.g., a single duration of "breath holding" could be expressed as count/time, where the count is 1. Unfortunately though, calculating the rate of the occurrence of a duration itself does little to describe how long the event actually lasts in time. E.g., if one held their breath for 5 minutes, the rate might be expressible as .2 per minute (c/t = 1/5 = .2), but what we really care about is duration--not rate! We wouldn't say that a smoker who is holding their breath for shorter and shorter periods is "getting faster" at breath-holding over time. Moreover, given that *any* quantity (not just rate) of a behavior can increase or decrease within a certain amount of time, there does not appear to be a convincing reason for restricting the idea of *"celeration"* to *only* changes in rate . Additionally, it doesn't seem practical to express every behavioral dimension in terms of rate, and/or describe a *duration* as "decelerating" (if it's going in an *upward* direction on an SCC) while simultaneously *accelerating* in terms of rate (as shown in Kubina & Yurich, 2012, pg. 181-182)--due to the SCC's 2ndary y-axis being flipped upside-down so that it matches up with *rate*.

Furthermore, In this author's opinion, the useful *concept* that standard celeration does embody might be better preserved if ratios from various dimensions of behavior (not just rate) could be measured by it *without* reference to a formula from physical science (or flipping the 2ndary y-axis). Instead, the term *Standard Value Trend (*or *SV Trend)* can be used to describe everything that the concept of standard celeration brings to bear on the science of behavior, without having to borrow from a loose analogy to physics--which is okay since we're *not studying physics*.

As shown in the side-by-side comparison above, an *SV Trend* value can be found in the same way as a Standard Celeration value (with a trend period of 8 days lines): by placing the quantity of *day n* and the quantity of *day n+7* into a ratio--where the larger of those two quantities is the numerator. Thus, if the quantity on *day n+7* is larger than the quantity on *day n,* then the quantity on *day n+7* is in the numerator (as shown in the formulas above), and the quotient is given a multiplication sign (X); however if the quantity on *day n* is the larger of the two, then the quantity on *day n* is the numerator (not shown above), and the quotient is given a division sign (/). The number above without units (X 40) can represent either standard celeration or *Standard Value Trend*.

Therefore, rather than saying "the rate is accelerating" or "rate is decelerating," in this author's opinion, it's probably more practical and useful to simply say "the rate is trending up" or "the *duration* is trending down," etc. The word *trend* has long been used in science, and is a readily understandable term when describing changes in behavior. Thus, in this author's opinion, the term *trend* can be used to quickly and accurately communicate changes in behavior over time, without getting weighed down by meanings that have been traditionally reserved for physical science.



This is image is an adaptation of the of the image titled: semi-log plot description by Darren O'connor 'E in 2007, found on http://en.wikipedia.org/wiki/File:SemiLogPlotDescription.GIF#file .

Appendix C: How Log Scales are Made

"The greatest shortcoming of the human race is our inability to understand the exponential function."__Dr. Albert Bartlett

The word 'logarithm' (or log) might sound intimidating, but it's just referring to an 'exponent', or 'power'. Probably the strangest thing about it is that it asks folks to think about exponents in reverse. Never-the-less , *exponential growth* can be well described and understood if logs are used (particularly on the scale of a graph!).

For example, most people that have passed a basic algebra class understand how to solve for X when $10^X = 100$. But how many know that $\log_{10}100 = X$ is really asking to solve for the same thing? My guess: relatively few. But that can change!

$\log_{10}100$ just means: 'To what power of 10 is 100?'

The answer is X = 2. That is, 10 raised to the 2^{nd} power equals 100. I.e., you multiply together two 10's.

$\text{Log}_{10}80$, or 'to what power of 10 is 80?' may need a calculator to solve, but if you type 80 into it and hit the log button, the answer will be approximately 1.9. Thus 10 raised to $1.903...^{th}$ power will result in 80.

When values that span large ranges need to be plotted, a logarithmic scale can provide a way to view the data that allows for the values to be determined from the graph itself. *The logarithmic scale is marked off in distances proportional to the logarithms of the values being represented* (Logarithmic scale, 2013). For example, in the figure above, for both graphs, y has the values of: 1, 2, 3, 4, 5, 6, 7, 8, 9 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100. For the graph on the left, the $\log_{10}$ of the values of *y* are plotted on a linear scale (Logarithmic scale, 2013). Thus the first value is $\log_{10}(1) = 0$; the second value is $\log_{10}(2) = 0.301$; the 3rd value is $\log_{10}(3) = 0.4771$; the 4th value is $\log_{10}(4) = 0.602$, and so on (try this with your calculator! Type in the number 2 and hit the log button). The plot on the right uses logarithmic scaling on the vertical axis (Logarithmic scale, 2013). One should pay special attention to how the exponents on the highlighted scale on the graph to the right, align with the linear (equal interval) scale numbers on the graph to the left.

Without going into too much detail regarding logs, one should type any of the numbers above (for y) into a calculator, hit the log button, and see how each number is transformed.

Learner/Behaver/Performer

Behavior Measured |Dimension

Behavior Measured |Dimension

Behavior Measured |Dimension

Setting(s)/Circumstance(s)

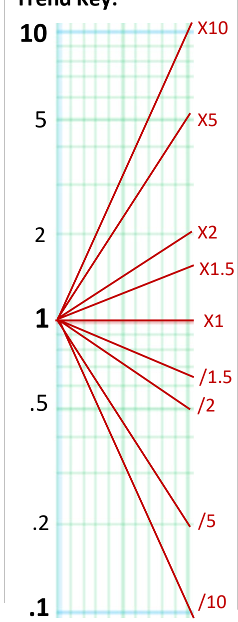
Grapher | Counter | Timer

Supervisor | Organization

General Key:

● = Rate
^ = Recording Time
□ = Duration
/ = Latency
– = Floor

Standard Value Trend Key:



Notes:

Appendix D: The 100 Minute, Minutely, SBG (i.e., the 100 Minute Graph)[1].

The 100 minute graph's purpose is to capture a practical amount of human behavior that can be observed within a 100 minute period. Sometimes, it may be important to see how behavior is occurring by the minute, thus the 100 minute graph has consecutive minutes across the X-axis. Additionally, since many recording sessions are 20 minutes in length or less, there is a break between lines every 20 minutes--in case new session data needs to be recorded. However, on this graph, a single session that last up to 100 minutes long could be recorded in continuous time.

At the top of the grid, there are blanks for session information, including real times by the hour and minute. This feature can be used if it might be important to know how much time passes between responses, or between trials.

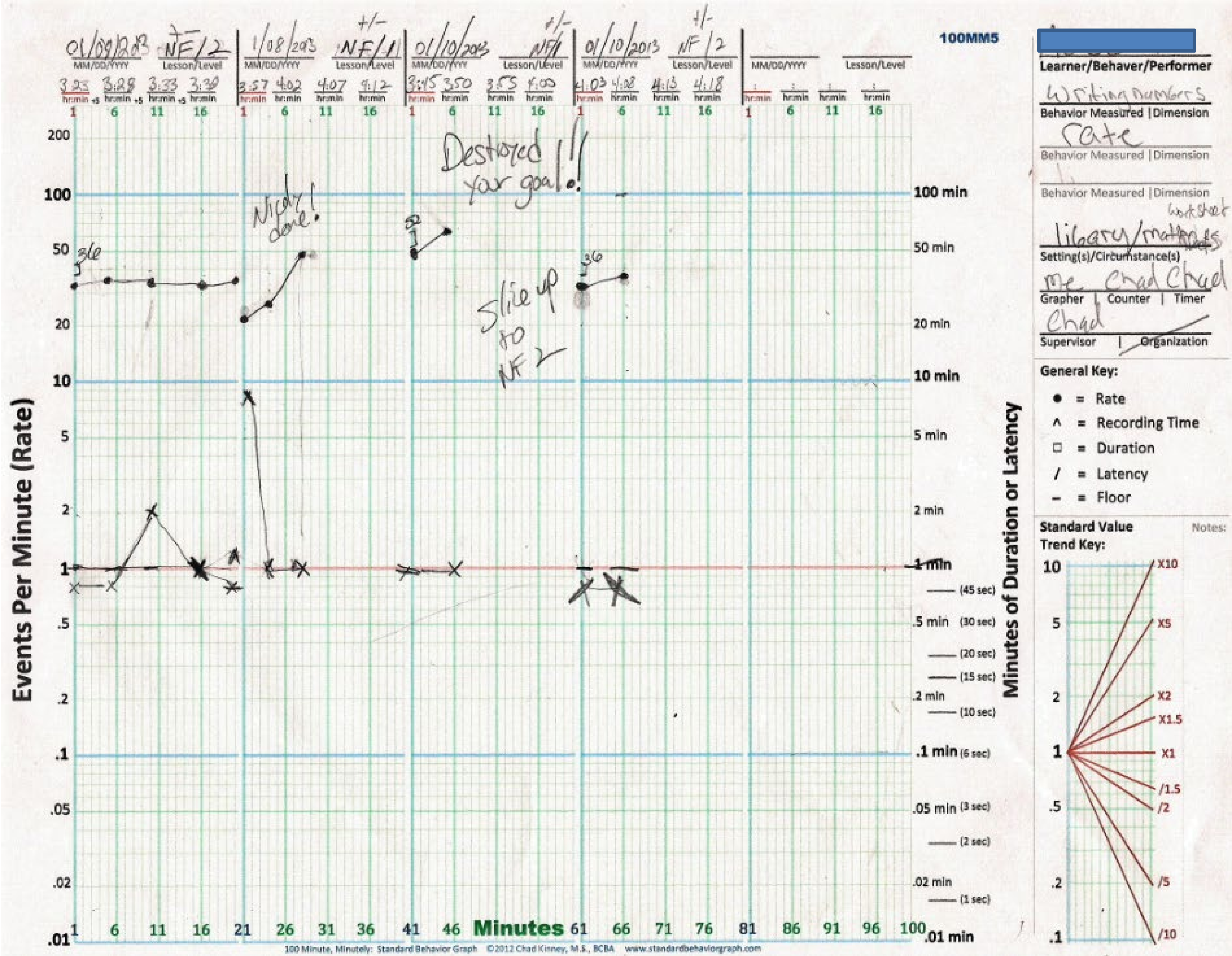
The Y-axis there are only 4 full log cycles on the 100 minute graph, thus the range on the y-axis in only from .01 per minute (or .01 minutes) to 300 per min.

A X 2 *SV Trend* line is approximately 34 degrees with a trend period of 11 consecutive minute lines—as shown in the 100 minute graph's SV Trend Key in the bottom right corner. However, the absolute units associated with each *Standard Value* on the Quarter Year, Daily, are different than those on the 100 minute graph. E.g., An SV 2 on the Quarter Year, Daily is about 9 mm in length, but an SV 2 on the 100 minute graph is about 12 mm in length.

Because a user of the 100 minute graph would be more likely to stick to direct and continuous measures of behavior (as the X-axis scale is continuous minutes), it is doubtful that percentage data would be used on this graph; thus to save space, the percentage icon has been removed from the General Key.

Recording times, durations, and latencies can be shown as small as 1 second, and as large as 100 minutes. If a recording time is exactly 1 minute, then it is recommend to only show the rate floor and not use the recording time symbol (^). However, If a recording time is shorter or longer than a minute (for example, say 3 minutes) then the above convention is recommended, where the average rate *per minute* within 3 consecutive minutes of performance was 40 per minute.

[1] The 100 min graph has been derived from a chart in the SCC family known as the "Timings Chart" (created by Dr. Lindsley).   Look for the "Tpmin-5EC TIMINGS CHART" at www.behaviorresearchcompany.com, for more information and images regarding timings charts.


01/09/2013 NF/2
MM/DD/YYYY Lesson/Level
1/08/2013 NF/1 +/-
01/10/2013 NF/1 +/-
01/10/2013 NF/2 +/-
100MM5
[redacted]
Learner/Behaver/Performer
Writing numbers
Behavior Measured | Dimension
rate
Behavior Measured | Dimension
Behavior Measured | Dimension
library/math class worksheet
Setting(s)/Circumstance(s)
me Chad Chad
Grapher | Counter | Timer
Chad
Supervisor | Organization
General Key:
● = Rate
∧ = Recording Time
☐ = Duration
/ = Latency
– = Floor
Standard Value Trend Key:
Notes:
Nicely done!
Destroyed your goal!!
Slice up to NF 2
Events Per Minute (Rate)
Minutes of Duration or Latency
Minutes
100 min
50 min
20 min
10 min
5 min
2 min
1 min
.5 min
.2 min
.1 min
.05 min
.02 min
.01 min
100 Minute, Minutely: Standard Behavior Graph ©2012 Chad Kinney, M.S., BCBA www.standardbehaviorgraph.com

The natural limit for durations and latencies on the 100 minute graph is at the 1 line, but if *totals* are to be graphed, they can be circled and rise above the 1 line. *Count-within-interval*s could also be graphed when using 1 minute intervals.

Application of the 100 minute graph

The graph above shows the academic performance of a 5th grade math student during after-school tutoring sessions. With a little bit of training and guidance, this student was able to graph their own performance on a math facts worksheets (purchased from Morningside Academy) during the their very 1st session with the tutor.

Finding the correct vertical minute line was not a big issue for this student. Before each session began, the clock time (every 5 minutes in the blanks above the grid) was filled out on the graph by the tutor, and then the tutor would signal when the minute would begin for the performer to start writing digits on the math worksheet. However, by later sessions (not shown above), this same student filled in the time at the start of every practice session on their own, both when the tutor was present (to verify a performance) and not present.

Readers familiar with the Timings Chart (in the SCC family), may observe the similarities (and differences) between the Timings Chart and the 100 minute graph by going to the www.behaviorresearchcompany.com website and looking at or purchasing a timings chart, and by going to the standardbehaviorgraph.com website and printing out a free copy of the 100 minute graph. Note: the contents of this book are not associated with or endorsed by any company or website that sells or promotes Timing's Charts or Standard Celeration Charts.

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Recommended websites for related information:

www.standardbehaviorgraph.com (Go here for FREE stuff: SBGs, range finders, and Excel versions of the SBG).
Also, Please email comments or feedback of how this book, the website, or the SBG itself could be improved!

http://www.albartlett.org/presentations/arithmetic_population_energy_video1.html

www.celeration.org www.behaviorresearchcompany.com www.morningsideacademy.org (disclaimer: this book and its contents is not affiliated with, associated with, or endorsed by any company, organization, entity, or website that sells or promotes the Standard Celeration Chart).

Glossary:

Note: Though many of the terms in this glossary have been derived from terms used to describe the SCC, as previously stated in the preface/acknowledgement section, the terms in green ink are still only experimental.

100 Minute Graph: The 100 Minute Graph (a.k.a. the 100 Minute, Minutely) is a standard behavior graph (SBG) that is in the same family as the Quarter Year, Daily, SBG. The scale on its X-axis represents consecutive *minutes*. It is intended to easily capture very precise minute-to-minute data within 20 minute timing sessions. It is well suited for displaying data from count-within-interval timing methods (where each interval is 1 min long), or count within trial methods. It is also well suited for self-graphing fluency data on a particular skill (e.g., math facts) for the purpose of precision teaching. Note the 100 Minute Graph is highly correlated with the "Timings Chart" in the SCC family. See Appendix D for an image.

Above-Trend Range: The range from the SV Trend line to the *upper range line*. On the SBG it is a type of Standard Value Range, with a Standard Value that can be calculated by dividing the value of the upper range line by the value of the SV trend line, where both lines cross somewhere along the same day line. This term has been derived from the term "up bounce" on the SCC.

Accuracy Improvement Measure (AIM): A Standard Value measure derived from the distance (on a standard graph) between the trend of correct responses rates and the trend of incorrect response rates (at *day n+7*), when the trend lines converge at *day n*. The measure shows a change in accuracy through time, and may be calculated the same way as the *Trend Change Measure (TCM)*. Note: this measure has traditionally been developed and used for the SCC.

Accuracy Ratio (or inaccuracy ratio): The Standard Value distance between corrects and incorrects on a single day line will yield this ratio amount. The Standard Value can be calculated by taking the larger number divided by the smaller number. The accuracy ratio is the number of correct responses to incorrect responses when the correct responses are larger (thus, it should logically follow that the number of incorrects to corrects would be the "inaccuracy ratio" when the incorrects are greater). The sign of the accuracy (or inaccuracy) ratio is determined by which number was larger. If the corrects were larger, then it will be an accuracy ratio with a multiply sign. However, if the incorrects were larger, then it will be an inaccuracy ratio with a division sign. This term was traditionally developed and used for the SCC.

Average Rate: The *average* rate is the average number of events that occur within a certain amount of time. This fundamental dimension of behavior, is typically calculated by dividing the total number of events counted by the total amount of time spent recording those events.

Behavior: Any measurable movement cycle of a living organism. A single instance of a behavior is a response, and every response has several measureable fundamental dimensions. Responses are fundamentally measureable in terms of how often they occur, how often they occur *over time,* the point in time they begin to occur, and the length of time in which they last.

Behaver: The organism who is learning or performing the behavior to be targeted or pinpointed.

Below-Trend Range: The range from the SV Trend line to the *lower range line*. On the SBG it is a type of Standard Value Range, with a Standard Value that can be calculated by dividing the value of the SV Trend line by the value of the lower range line, where both lines cross at some level along the same day line. It's derived from the term "down bounce" on the SCC.

Celeration Line (i.e., standard celeration line): A straight line to best fit or trend line on a standard celeration chart. "Celeration" has been conceptually defined as (count/time)/time, and considered a basic unit of behavior change. The standard celeration period, used to define the standard value of a celeration line in ratio form, covers a one week period, or 8 day lines (e.g., from Sunday to Sunday) on the Dpmin SCC.

Ceilings: The uppermost limit that some dimension of behavior can occur within the limited recording time of the observer.

Circumstance: A description of potentially significant contingencies in place within some environment or setting in which the target behavior is occurring.

Counter: The individual who enumerates and records the amount that some dimension of behavior has occurred within some particular amount of time.

Data Path: A line that connects sequentially placed data points on a graph, much like a "connect-the-dots" picture. A data path is usually not a straight line because the data points that the path connects do not change level in the same amount from day to day. The data path should not be confused with a trend line.

Day line: Any vertical line (blue or green, thick or thin) on the grid of the SBG. Each day line covers a 24hr. period of time.

Data Set: An arbitrary number of data points that are grouped together and analyzed, and compared to other sets of data.

Dimensions of Behavior: Fundamental or derived aspects or properties of behavior. Fundamental dimensions of behavior are universal to all behaviors and are expressed in absolute units of measurement.

Direct Measurement: The measurement of event or objects via the direct use of one's senses (e.g., sight, sound, touch etc.). Instances in which machines are used to measure a phenomenon of interest may still be considered instances of direct measurement, assuming it can be verified that the machine is indeed measuring the phenomenon of interest.

Equal interval axis: Any axis with a scale that is divided into equal amounts with equal distances between those amounts. To move equal distances along this axis, one may add or subtract by some particular amount. On the SBG, the x-axis is an equal interval axis. However, the Y-axis on the SBG is an equal *ratio axis* because its scale is logarithmic: to move equal distances along its axis, one may multiply or divide by some particular amount (rather than add or subtract).

Floor: A floor is the lower limit of an observable dimension of behavior. A dash is used to mark the spot where measured values (greater than zero) cannot go below. A floor can be for any dimension of behavior, and any data point that goes below its floor is considered "zero".

Grapher: The person who actually plots the data points on the graph.

Ignored Day: A day that behavior may have occurred, but was not graphed. It is not uncommon to leave a day line blank when an observer is unable to take reliable, accurate, or valid data that day.

Interquartile Range: A commonly used statistic that shows the range of 50% of data points closest to the median trend line. The Interquartile range may be expressed as a *Standard Value* on the SBG.

Interval Recording: The practice of segmenting one's total observation time into equal parts or intervals, and then counting the number of intervals in which the event was observed occurring (or not occurring)—based upon some criterion for marking the interval (e.g., must occur just once in the interval to marked, or must occur for the entire interval to be marked). The marked intervals are then divided by the total number of intervals. Interval recording is a discontinuous measure of behavior that can estimate rate and duration when one has insufficient resources to obtain reliable continuous measures. There are several methods of interval recording that can be found in other texts.

IRT: Also known as *Interresponse Time*, IRT is a fundamental dimension of behavior that describes the time between two responses. It may be expressed as an average by dividing the total amount of IRTs by the total count.

Jump: A descriptive term used to describe a sudden change in level. The level of a single data point, the mean level of a data set, or the level of a trend line, can jump up or down on a graph. On a Standard graph, a standard value can be used to describe *how much* jump occurred. Note: this term was originally developed and used to describe a change in level on the SCC.

Kappa: A measure of variability based on ratios rather than differences. It can also be expressed as a Standard Value.

Latency: The time between the occurrence of an event and the beginning of a response. For example, let's say that after the light turns green, it takes a driver 15 seconds before he or she starts to press the gas pedal. The latency of pressing the pedal is 15 seconds.

Learner: The organism whose behavior or performance changes as a result of experiencing environmental contingencies.

Level: Any possible value along the continuous vertical (y) axis. For example if a data point falls upon the 300 per min line, then it is at the 300 level. If a data point falls about half way between the 10 min and the 20 min lines, then it is at about the 15 level.

Level Comparison Measure (LCM): The Standard Value vertical distance between the level of one data point and the level of another data point will yield the LCM. Data points can be individual data points, averages of points, or points on SV Trend lines. LCM can be calculated by dividing the larger measure by the smaller measure. When a second data point jumps up in level (relative to the first), the LCM gets a multiply sign. When a second data point jumps down in level (relative to the first), the LCM gets a division sign. The calculation of LCM is nearly identical to the one made for determining an accuracy (or inaccuracy) ratio. Note: the experimental term *LCM* is correlated with a term known a "frequency multiplier," however the author of this guidebook needed a descriptive label that appears broadly applicable to all data, not restricted to the concepts of *frequency* or *multiplicative operations*.

Linear Regression: A statistical method for finding a straight line-to-best-fit by using the least squares method.

Line-to-best fit: A straight line that best summarizes the central tendency and trend direction of a graphed set of data points.

Logarithms (logs): A logarithm is an alternative type of exponential expression. For example if you raise 10 to the 3rd power (3 is the exponent), you get 1000. This exponential expression can be shown as: $10^3 = 1000$. Alternatively, that same exponential expression written as a logarithm will appear as: $\text{Log}_{10}(1000) = 3$. Logs can make understanding certain relationships between numbers more manageable. Logarithmic scales on a graph are well-suited for describing and predicting exponential increases or decreases in amounts, and comparing extremely large amounts with extremely small amounts via ratios.

Mean Level: The average level of a data set.

Minute Line: Any vertical line on the grid of a 100 Minute, Minutely, SBG.

Observation time: The amount of time an observer spent recording some behavior. Observation time is often expressed as a total duration. It can represent the observing response, if a person is observing the entire time; however, it can also represent the amount of time that a machine automatically recorded some event(s) without the direct observation of a person.

Outliers: Any data point that falls far outside the rest of the data set. The distance an outlier is from the *total range lines* can be quickly estimated when one wishes to scrutinize (rather than dismiss) outliers.

Overall Range: It was unclear to the author if this term should be green or not, but it describes the distance between the largest and smallest point in a data set, without regard to any trend in the data. It describes the same thing as the term "total bounce" from the SCC (Pennypacker et al., 2003).

Percentage recording: If the entire amount of something were divided into 100 equal parts, then the percentage would be some portion of those 100 parts. For example, if a person had 5 opportunities to respond, but only responded in 4 out of the 5 opportunities, then we'd divide the smaller number by the larger number, then multiply the quotient by 100 to get the percentage (80% in this case). Data that is typically converted into percentages are from interval recording methods, trials with limited opportunities to respond, and academic quizzes or tests.

Performer: The performer is the organism that is engaging in the behavior that we would record on the SBG. The performer can be the same person as the learner/behaver. It is typically the goal to change the performer's performance in some way.

Pinpoint: A directly observable and measurable behavior that has a clearly defined movement cycle and has been targeted for monitoring and possibly for change.

Precision Teaching: "A system for precisely defining, measuring, and facilitating the subsequent analysis, interpretation and decision making of behavior" (Kubina & Yurich, 2012). Precision teaching goes hand-in-hand with the Standard Celeration Chart; however, this book argues that precision teaching can easily be done with the SBG too!

Quarter Year, Daily SBG: A semi-logarithmic, time-series graph designed to provide a consistent and standardized display of all dimensions of behavior (rate, duration, latency, etc.). It is considered by the author of this book to be the archetype graph in the SBG family because it can accurately display nearly any range of human behavior, in any of its dimensions, in a continuous fashion over a practical amount of time (1/4 of a year). Moreover, its condensed organization of contextual information, emphasizes that information's relationship to the behavior(s) being graphed. Though the Quarter Year, Daily, SBG is significantly correlated with the Daily Per Min, SCC (e.g., they both have semi-logarithmic, time-series grids held as a "standard" with the same angle for x2 trend lines), there are important differences (e.g., the dark vertical lines on the SBG are Monday lines, rather than Sunday lines, and the secondary axis on the SBG is for plotting direct measures of duration and latency, rather than *reciprocal* measures of duration and latency, etc.).

Quartile Range Lines: There can be 3 Quartile Range lines drawn in any data set, the *lower quartile range line*, the *middle quartile range line* (aka the *median trend line*), and the *upper quartile range line*. The lower and upper quartile range lines are parallel to the median trend line. These 3 lines split the data into 4 areas that have an equal number of dots, and they may be used to describe the variability in a data set beyond what the total range around a trend line might.

Range Finder: A tool that can be used to speed up plotting and describing data on the SBG. Note: It is not at all necessary to have a *range finder* in order to quickly find any quantity on the SBG, but having one can make finding values go a little more quickly. The range finder is very similar to the SCC's "frequency finder," except that the range finder displays an exact trend period, which can be useful quick and inexpensive SV trend value estimation.

Range Lines: Lines that are parallel to a trend line and show the range of some values in the data set. There may be several types of range lines to be drawn, but a very common type, total range lines, just enclose all of the data set within them while remaining parallel to the trend line. By measuring the distance between the upper and lower range lines, where they cross on the same day line, one can determine the *Standard Value* of the *total range*. Note: The term *range lines* has a strong correlate to "bounce lines" on an SCC known as an "envelope" (Pennypacker et al., 2003; Kubina & Yurich, 2012); thus, the term *range lines* is only experimental in that it is an attempt to find a descriptive label that directly refers to what such lines on a graph actually are: lines that reveal some range.

Range Comparison Measure (RCM): The Standard Value distance between one *SV Range* and another *SV Range*, will yield the *RCM.* The *Standard Value* can be calculated by dividing the larger range by the smaller range. If one range is greater than another range, then we give the RCM a multiply sign where the RCM describes the greater range relative to the other. If one range is lesser than another range, then we give the RCM a divide sign where the RCM describes the lesser range a relative to the other. On a time-series graph, the RCM is most likely used to show how much a range has changed after an intervention. Thus, if the range was small and then became larger after the intervention, the RCM will get a multiply sign; however, if it was large and then became smaller after the intervention, the RCM will get a divide sign. It can be calculated in the same way that changes in bounce can on the SCC.

Rate: A ratio that describes a quantity in relation to another quantity. When dealing with events such as behavior, *rate* is the speed of the occurrence of that behavior in relation to time only. Generally, rate is expressed as an *average* measure, and in the behavioral sciences the ratio for average rate is the total number of events counted divided by the total amount of time spent recording (i.e., total count/total time = avg. rate). For example, if one counted 50 events within 10 minutes of recording time, then the average rate of events would be 5 events per minute (or 50 events/10 minutes). Note, in the physical sciences the term *rate* is synonymous with the term *frequency*.

Ratio: A mathematical statement of how two numbers compare. For example, if we had 2 events in 10 minutes, we could express this ratio as the fraction 2/10. The fraction can be reduced to 1/5 or computed into its quotient: .2. That is, we could say that on average, the event occurs twice every 10 minutes, once every 5 minutes, or .2 times every minute. It might be strange to think of something occurring .2 times every minute, and though the math carries out for easy comparison to other ratio quotients in per minute form, in some cases it might be more practical to speak about the event occurring on average of once every 5 minutes or twice every 10 minutes.

Rate Floor: The lowest number (greater than zero) that an event can occur within an observation time; i.e., 1 per recording interval. For example, if the observation time is only 10 minutes, then the lowest rate observable is 1 per 10 minutes (or .1 per min). The rate floor is marked with a dash. Any rate dot that is below it is considered "zero." Note: *rate floor* is correlated with the term *record floor* or *time bar* on the SCC; however, a new descriptive label is necessary given that the rate floor on the SBG only marks the lowest number (greater than zero) that an event can occur during some observation time. That is, the *rate floor* does NOT mark the amount of time spent recording, rather the amount of time spent recording is separately marked with a carrot symbol (^) and plotted as a duration. For example, an observation time of 10 minutes would have a carrot (^) on the 10 line on the SBG, and the rate floor (-) would be at the .1 line.

Raw Count: The number of events recorded without any relation to time. For example, if one counted 50 events in 25 minutes, the raw count is still just 50 events. Note, raw counts are not plotted on the SBG, the raw count must first be converted to a rate (in this case 2 per minute would be plotted).

Reciprocal: A fraction that is the inverse of another fraction, and when a fraction and its inverse are multiplied, the product must equal 1. On some graphs, the reciprocal of a value (rather than the original value) is used to invert the direction of the data, as would a mirror image. For example, if decreasing latencies in a response class is correlated with increasing "response strength," and observers are looking for "response strength," then the reciprocal values of latency might be plotted rather than directly plotting the original values of latency (Solomon & Wynne, 1953). Note: Users of the SBG do not graph reciprocal values; they directly graph original values. Moreover, though *rate floors* on the SBG may coincide with the reciprocal values of their respective recording times, there is a subtle conceptual difference between graphing the minimal number possible within a recording time and merely graphing the reciprocal value of a recording time or duration.

Recording Time: This is a special duration of time that *recording* was occurring. The recording time measure is directly plotted on the SBG according to the values on 2ndary y-axis on the right side of the grid. Its special symbol is a carrot (^). The reason this duration is special is because it explicitly puts an additional emphasis on the relationship between the behavior of the one being recorded, and act itself of recording that behavior! Note: The concept of *recording time* is not new, but the experimental term is correlated with a term known as the "record floor" or "time bar" our "counting time floor" on the SCC. However the measure of *recording time* is plotted as its original value, not as a reciprocal of the original value; thus it is liberated from any floor (or lower limit) and able to express that special relationship between observing and the observed with greater ease and clarity.

SBG (i.e., Standard Behavior Graph): A Standard Behavior Graph is a semi-logarithmic, time-series graph designed to provide a standardized display of all dimensions of behavior (rate, duration, latency, etc.). It was chosen as a standard primarily because it can accurately display common ranges of human behavior, in any of its dimensions, over a practical and continuous amount of time. Moreover, its condensed organization of contextual information emphasizes that information's relationship to the behavior(s) being graphed. Though the SBG is derived from and significantly correlated with the SCC, (e.g., they are both semi-logarithmic, time-series graphs held as a "standard" with the same angle for x2 trend lines), there are important differences (e.g., the dark vertical lines are Monday lines on the SBG, rather than Sunday lines, and the secondary axis on the SBG is for plotting direct measures of duration and latency, rather than reciprocal measures of duration and latency, etc.).

Standard Behavior Graph Paper (SBG paper): Standard Behavior Graph Paper is the official physical display of the Standard Behavior Graph. The author of this book and creator of the SBG, intends for the SBG Paper to forever remain free of charge to all users, and has provided a free electronic template that can be downloaded and printed out--provided the users have a color printer and regular 8½ x 11 inch printer paper. Warning: distorting the original dimensions of SBG paper (especially lengths and widths of any lines on the grid), will render the graph no longer "standard" and will likely make comparison to data plotted on a true SBG very complicated. The official template can always be found at the following website: www.standardbehaviorgraph.com

SCC (Standard Celeration Chart): A family of charts of which the Dpmin (daily per minute) is the archetype chart. It is a standard, semi-log, time-series graph that is used for displaying performance over a 20 week period--primarily in terms of frequency (i.e., rate) and celeration, but may also be used for displaying latency and duration (as reciprocal values). To view an image, see the websites listed at the end of the reference pages.

Semi-logarithmic graph (i.e., Semi-log graph, or log-lin graph): A semi-logarithmic graph is a graph that has one logarithmic axis, and the other axis is usually linear, equal-interval . On the SBG, the y-axes are logarithmic and the x-axis is linear. In contrast, a graph with both logarithmic x *and* y axes, is a logarithmic graph; and a graph with both linear x *and* y axes is a linear graph.

Setting: A setting is the place (or places) in which a behavior or event is occurring. The SBG has a place designated on it for setting ("setting(s)/circumstance(s)") to emphasize the importance of stating potentially pertinent environmental conditions in which the behavior being recorded is occurring.

Single-Subject Designs: Scientific research designs that are used to empirically study and graphically display changes in the behavior of each individual subject in relation to specific changes in the environment. Single subject designs are not the same as "case studies," as only S-S designs have rigorous experimental controls and systematic manipulations. Single subject designs are also different from group designs, as S-S designs show individual data points for the visual analysis of *clinically* significant differences, whereas group designs average and process large quantities of data for the analysis of *statistically* significant differences. The SBG is well suited (sometimes with a bit of modification) to display data from *any* kind of Single-Subject design, e.g., a multiple baseline, changing criterion, multi-element, reversal, and/or any combination of the aforementioned.

Standard Value (SV): A Standard Value is a quotient that represents the fraction form ratio of two quantities that both correspond to values on the scale on the SBG's Y-axis. When the ratio is expressed as a quotient, it represents a standardized physical distance between two values on the scale of the SBG's Y-axis. Moreover, multiplying the Standard Value by the lesser quantity in the ratio will yield the greater quantity in the ratio. Finding a Standard Value is done by placing the larger quantity over the smaller quantity, and then carrying out the division (notice that the units will cancel out). Standard Values are "standard" because the SBG's Y-axis provides a standardized reference regarding physical distance between any two quantities along the Y-axis scale, no matter where they are placed. The standardization found in Standard Values allows for quick and easy comparison. For example, the Standard Value of "2" on the Quarter Year, Daily, SBG is always approximately 9 millimeters long, and will be the same vertical distance on the SBG whether it's between the 2 min level and 1 min level, the 1000 per min level and 500 per min level, or the .06 per min level and .12 per minute level, etc. Standard Values may be used to help describe any dimension of behavior (e.g., rate, duration, latency, etc.) plotted on an SBG, or the amount of any change in any dimension of behavior that is plotted on an SBG (e.g., jumps in level, turns in trend, or differences in variability, etc.). Note: SVs are similar to concept of "frequency multipliers" used on the SCC, but different enough to merit their own term.

Standard Value (SV) Range: A range is typically used to describe variability, and is the difference between the larger and smaller values within a set of data points. On the SBG, range is typically measured around the trend line (rather than around the average level) in a set of data points. Any range that is determined from data graphed upon an SBG immediately has a *Standard Value*. The Standard Value for any range is calculated by dividing a larger range quantity by a smaller range quantity in any set of data points. For example, if the *total range* around an SV Trend line in a data set is between 10 per minute and 2 per minute, over 22 days, then the *SV Total Range* would be 5 within 22 days. There may be multiple types of ranges within any single set of data, depending upon the focus of the observer: total range, interquartile range, outlier range, above trend range, below trend range, etc. Note: the concept of "bounce" on the SCC closely matches SV Range.

Standard Value (SV) Trend: The Standard Value Trend is the value of any trend line on the Quarter Year, Daily, SBG that crosses at least 8 consecutive day lines (e.g. from Monday to Monday). Its value is defined as the ratio between the level of the trend line on *day n* and the level of that same trend line on *day n +7*, where the larger of the two quantities is the numerator in the ratio. The sign of the SV Trend indicates its direction *on the SBG*. That is, if the level of the trend line on *day n + 7* is larger than the level on *day n*, then the slope's direction is up, and it will have the multiply sign (X). However, if the level of the trend line on *day n* is larger than the level on *day n + 7*, then the slope's direction is down, and it will have the divide sign (/). Note: *Standard Value Trend* is highly correlated with *Celeration* on the SCC; they both have the same number of day lines in the trend period, and they both make approximately 34 degree angles when they double across a trend period. To place greater emphasis on trend values in *any* dimension of behavior, a new descriptive label was required, as the term *celeration*, by definition, only emphasizes changes in rate.

Standard Value (SV) Trend Key: The Standard Value Trend Key is located in the lower right-hand corner of every SBG. This key may help the user make a quick eye-ball estimate of the Standard Value of any trend(s) in data graphed on the SBG. Additionally, the SV Trend Key may help to remind or inform the user how the quantity of any Standard Value trend can be found, given the width of the key is the same width of a trend period. It has been derived from similar keys (or fans) found on B.F. Skinner's cumulative graph, and O.R. Lindsley' s SCC.

Standard Value (SV) Trend Period: The period of time that helps define the ratio used to determine the *Standard Value* of a trend line. The SV Trend Period on *the Quarter Year, Daily* SBG is exactly 8 day lines. On the *100 Min Graph*, the SV Trend Period is exactly 11 minute lines. The SV Trend Period is derived from the SCC's "celeration period."

Timer: The one who is measuring the duration of some event or behavior that has been targeted. Typically, a dimension of behavior is measured in the context of the entire observational period of time. From start to finish, measurement of time is often accomplished with a stopwatch or a kitchen timer.

Time-series graph: A time-series graph is a line graph where sequentially occurring events and behaviors are measured against a backdrop of time that runs continuously along the horizontal axis (i.e., the X-axis). Time-series graphs are commonly used for visual analysis of behavioral analytic data that use single-subject research designs.

Total Duration: The sum of durations measured within a given period of time. If one is measuring and displaying *both* individual durations of responses *and* total duration, then the convention to distinguish between them is to circle the symbol that represents duration (▢) to indicate that it is a total.

Total Latency: The sum of latencies measured within a given period of time. If one is measuring and displaying *both* individual latencies of responses *and* total latency, then the convention to distinguish between them is to circle the symbol that represent latency (⁄) to indicate that it is a total.

Total Range Lines: Lines that are parallel around a trend line, and just enclose ALL of the data within a given set of data. On the SBG, *total range lines* have a Standard Value that is calculated by dividing the *upper range line* by the *lower range line*, where they both cross at some level on the same day line. The *upper range line* is a total range line that is above the trend line and parallel with it, and the *lower range Line* is the other total range line that is *below* the trend line and parallel with it. This concept is derived from the different bounce lines on the SCC.

Trend: A systematic or consistent increase or decrease in performance through time. In a sense, it is also a description of variability and direction of change in data that may be summarized with a single line-to-best-fit. One may observe trends in rate, duration, latency, etc.

Trend Comparison Measure (TCM): The Standard Value distance between two trend line values on the last day of a trend period. When a trend changes, the amount of change can be calculated by dividing the larger trend line value on *day n + 7* by the smaller trend line value on *day n+7* (when one of the SV Trend lines is moved so that both trend lines converge at the same level on *day n*). If the second trend line has decreased or turned in a downward direction relative to the first trend line, then the *TCM* will have a divide sign (/). However, if the second trend line has increased or turned upward in relation to the first trend line, then the *TCM* will have a multiply sign (X). Note: This term is correlated with a term known as "celeration multiplier" on the SCC, but a new descriptive label was required to emphasize its applicability to changes in *any* dimension of behavior over time.

Trend Period: See *Standard Value Trend Period*.

Turn: A description of a change in the direction of a trend line. By some specific amount, a trend line can turn up, down, or not at all.

Variability: Fluctuation in performance (or measured aspects of some event) within a certain amount of time. Variability can be described in relation to trend or independent from trend.

Zero: An important number or place holder that is represented by a data point placed below a floor marking the smallest recordable amount (i.e., *zero* is a mark *below* the level of "1 per recording interval"). Interestingly, there is no absolute line or level designated for zero on the SBG's logarithmic Y-axes (i.e., zero does not appear on a log scale, as $10^0 = 1$). Additionally, dividing any number by zero results in an undefined quotient, making zero difficult to incorporate in calculations of trend lines, level change measures, accuracy ratios, etc. Therefore, it may be helpful to use an arbitrary convention to determine the Standard Value when finding a distance on the chart between some number and "zero." Though several conventions exist (Lindsley, 2004), the convention preferred by this author is to place the mark for zero at ".8 X the value of the floor" (Kinney, 2013)—as Lindsley (2004) also found the .8 convention 'pleasing to the eye'. For example, if corrects are at 100 per minute, incorrects are at 0, and we observed for 2 minutes, then we would have a rate floor value of .5 per min (i.e., 1 per 2 minutes), and a "zero" mark at .4 per minute (since .8 x .5 = .4). Moreover, to determine the Standard Value for the *accuracy ratio*, we'd divide 100 by .4 and get an *accuracy ratio* of "X 250."

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