

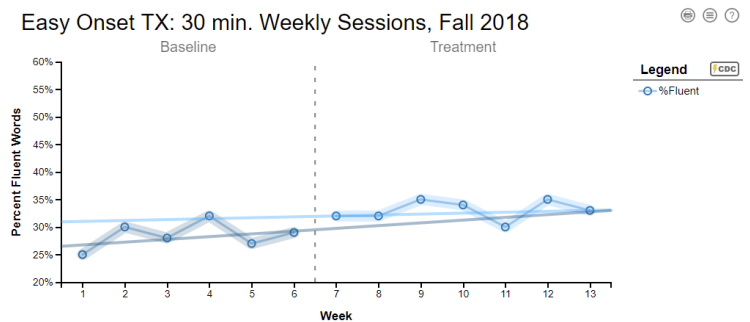


## Overview

By now you should be getting comfortable with the basic skills of entering data, customizing the look of your iGraph™, and performing some basic analysis to examine and compare level and trend of your baseline and treatment data paths.

At the conclusion of the last module we had identified a concern that JB was not progressing at a rate that we had expected. It looked like progress was still positive, but it was also quite possible that she had plateaued and the next course of action was to take a look at the variability of the data prior to making any plans for future treatment.

In this module we are going to explore some of the detailed statistical analysis elements that are available in your iGraph™ (specifically, variability) and see how we can combine those statistical measures with our knowledge about the client to help make clinical decisions. We'll start by looking at the variability of the baseline measurements for JB.



## Variability – A Quick Refresher

Before looking at JB's results, just take a moment to do a quick review on some variability concepts and measures.

We'll start with the quartile values q0 through q4 and what they represent. As a reminder, when we order the data points from lowest to highest in value, they can be divided into quartiles (not by value, but by the number of data points in the ordered list).

- q0 = the lowest data point
- q1 = the lowest 25% of the data points marker
- q2 = the median or middle 50% of the data points marker
- q3 = the lowest 75% of the data points marker
- q4 = the highest data point (or 100% of the lowest data points marker)

If you do not have a firm grasp of the concepts described by box and whisker plots, it is probably best if you take some time to review them now by searching for boxplot in the Therapy-Science resources (or through some other means). You will gain more from the

following discussion if you are comfortable with those concepts. With that in mind, we can examine the variability data that is provided in the details panel.

- **Level:** The median of the data.
- **IQR:** The interquartile range (or  $q_3 - q_1$ ). This is half of the data that falls nearest to the median. (It is like Standard Deviation, if that helps.)
- **Whiskers Range:** The total range between the upper and lower whisker (as well as their actual values). This is the range for most data points. Points that fall outside this range are considered outliers.
- **Tukey Fences Range:** The total range between the upper and lower Tukey Fences (as well as their actual values). The upper and lower Tukey fences are defined as  $q_3 + (1.5 \times \text{IQR})$  and  $q_1 - (1.5 \times \text{IQR})$  respectively.
- **Data Range:** the total range of the data path (as well as the min,  $q_0$ , value and the max,  $q_4$  value)

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*NOTE: The Whiskers are a product of the data Range and Tukey Fence values. The iGraph™ visualization draws the upper (and lower) Whiskers as either the upper (or lower) data Range value or the calculated upper (or lower) Tukey Fence value – choosing the one that is the least distance from the Median.*

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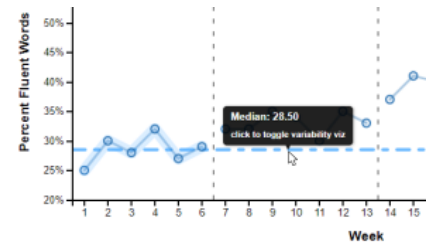
## Variability – Qualitative Analysis

We will visualize variability on JB's iGraph™ by first analyzing the baseline data path and then examining the level. We have done this before, but this time we will explore some additional visualization features that will give us a qualitative look at the variability of the baseline data.

*iGraph™ Practice 1.3.a*

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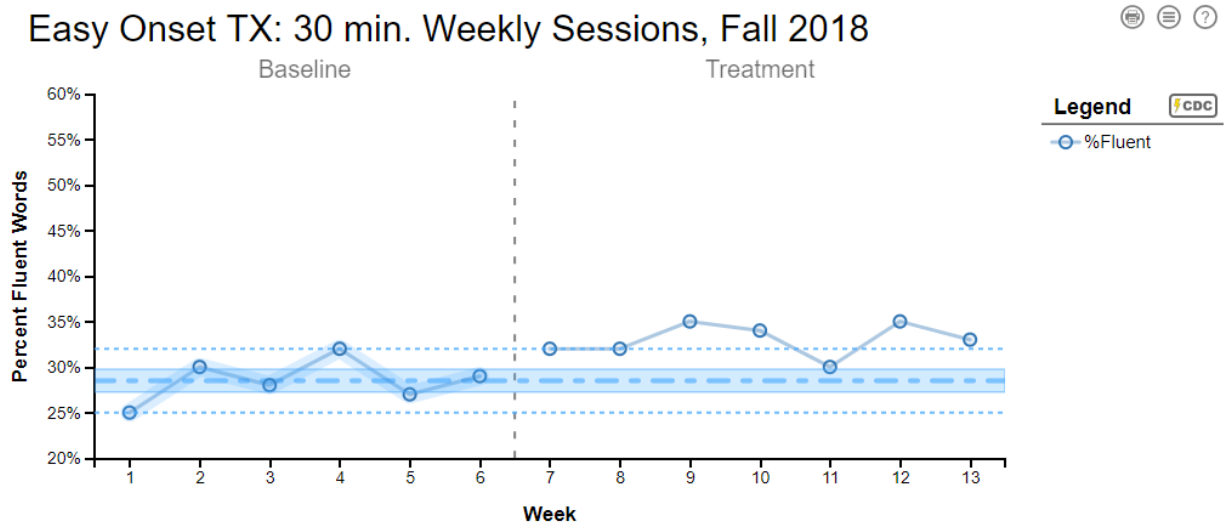
1. Click on the baseline data path to bring up the Analysis Results panel. Next click on the level icon in the left column. This will show the level estimate in on the iGraph™.
2. If you hover and pause the mouse over the level line that is projected across the graph, a tooltip will appear (see the example on the right). The tooltip not only provides information about the media for the baseline data, but also states that you can “click to toggle variability viz”. Click on the line and see the visualization.



The visualization shows a projected boxplot across the entire graph. The interquartile range (IQR or range within which 50% of the data points fall) is shaded and the minimum and maximum whiskers are also shown as dotted lines.

The projection allows us to visually compare the boxplot representation of variability against other data paths shown on the iGraph™. This can be useful to allow us to see if other data paths are outside the bounds of the whiskers (considered outliers) or to visually compare the variability of two data paths (more on this later).

The visualization for JB’s baseline is shown below.

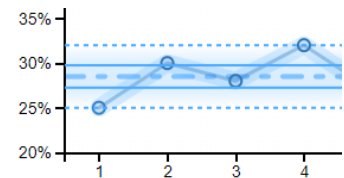


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**NOTE:** If you are unfamiliar with a boxplot – or just need a refresher – the definition of a boxplot can be found in the Therapy-Science glossary (or just search boxplot on the resources page). There is a link in the definition to an excellent overview of a boxplot and its components.

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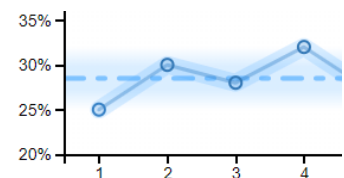
3. In all, there are three (3) different visualizations that you can use to help understand the variability of the data. Click on the median level line to toggle to the next one. Like the first, it is a representation of a boxplot, only in this visualization, the shading fades from the IQR to the whisker boundaries – with the shading representing the growing distance from the IQR. However, the IQR and whisker boundaries are still explicitly marked. See the example on the right.



4. Click on the median level line again to reveal the third visualization option. This time we are left with just the IQR and gradual shading. This is a more subtle representation but helps illustrate the data level as more of an uncertain band, where the darker the shading – the more likely that the actual level is in that band.

This is an important concept to get comfortable with. The crisply drawn level line is – after all – just an estimate, and the gradual shading helps to remind the viewer that when working with such a few number of data points, we need to be aware that the estimates are just that: estimates. They can be drawn with a crisp, certain, line (and it is often helpful to do so). However, that visual clarity of a line is not a true representation of our certainty about the data – or ultimately – about our client.

Becoming comfortable with the “fuzzier” uncertainties will be helpful when you begin asking the data more complex questions. By using gradients, we can remind the viewer of this ever-present uncertainty in the data and statistical tests that rely on that data. You can see an example of this type of visualization on the right.




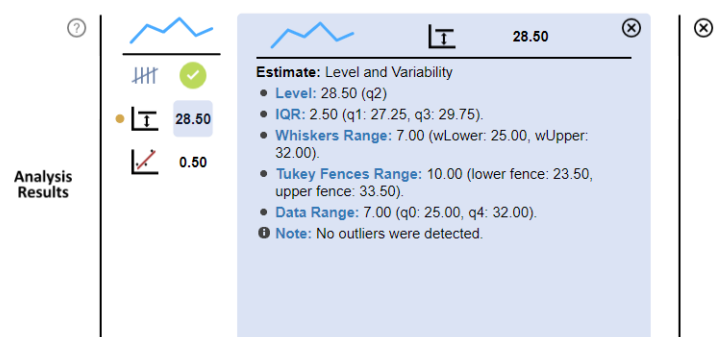
5. Click on the median line a third time and the visualization will be removed. You can toggle through these visualizations to get the visual you need prior to printing the iGraph™ or downloading it as an image.

## Variability – Quantitative Analysis

As shown in the previous section, there are several ways that you can visually represent the variability details of a data path on your iGraph™. However, what if you need the actual statistical measures of the data range, IQR, and whisker values? That is readily available as well.


### *iGraph™ Practice 1.3.b*

- To get the details for our baseline data path, click on the number to the right of the level icon  in the **Analysis Results** panel. This will bring up the results details panel as shown to the right. Here you can see all the details for the analysis associated with the level of the data.



You can go through each metric and review the values for JB's baseline data. There is also a "note" included at the end of the analysis details that may be of interest when considering the level and variability. In this case it is noted that there aren't any outliers detected – which means that no data point falls outside the Tukey Fence range.

- Examining the details panel for JB's baseline data, can you tell whether the Whiskers drawn in the visualization are drawn at the minimum and maximum data Range values or at the minimum and maximum calculated Tukey Fence values?
- Can you come up with a value for a data point that would be considered as an outlier?
- Let's temporarily add that data point to the baseline data. I picked 40 as an outlier data point (it is greater than the upper Tukey Fence value of 33.5). Add it as the very first data point in the data series, just after the ":" used to terminate the data series label (don't forget to add a comma afterwards) and then update the iGraph™.

Analyze the baseline data path again and look at the details panel for the level  analysis. Compare the details to those shown previously for the original data (see the image back in step 1). Notice any differences? Is your new data point considered an






outlier?

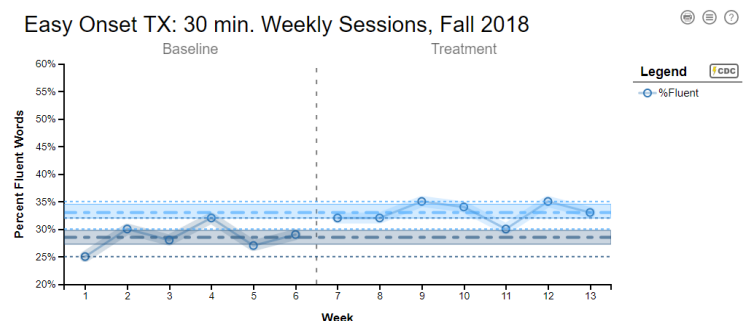
- Remove the data point (and don't forget the comma following it) and then update your iGraph™ to get back to our original baseline data for JB.

## Comparing Variability

We saw in a previous module that we can compare levels between data paths. We will do the same here with variability by examining the variability visuals and the Analysis Results details for the baseline and treatment data paths.

### *iGraph™ Practice 1.3.c*

- Drag and drop the treatment phase data path onto the baseline data path. Select the level icon  to show the level estimate for the baseline data path. Click on the median line show in the iGraph™ to see the variability visualization.
- Next bring up the level details panel as we did in the previous exercise (click on the number to the right of the level icon ). Your values should match those shown in the image in step 1 of the previous practice exercise (1.3.b). Write those details in the table shown below and then close the details panel by clicking on the close button  in the upper right of the details panel.
- Click on the level icon  for the treatment data and then click the median line to show the variability visualization for the treatment data. Your iGraph™ should look like the one on the right.
- Next, pull up the details panel for the treatment data (click on the number to the right of the level icon ) and write down the details in the table below. We'll be examining both the qualitative (visual) and quantitative differences between the baseline and treatment data.



5. What are your initial impressions of the visual differences in the iGraph™? Things look similar, the only significant difference (visually at least) is that it looks like the IQR of the treatment data is not in the center of the range – oh, and it also looks to have a smaller overall range.

When the IQR is not centered (or close to the center... *centered-ish*) in the overall range, that is an indication that a small number of data points (in this case the one from week 11) has strayed from the general grouping of the rest. Variability is natural, so this is not necessarily an indication of something that has significance. The week 11 data point is not an outlier, so in this case it looks like it is just the result of the natural variability in JB's performance. We'll look at analyzing for an outlier in later modules and how we can account for outliers in the data analysis process as well as in our understanding of the client's progress.

For now, let's compare your visual analysis to the numerical analysis. The numbers in the table below back those observations up as the IQRs are the same, but the treatment data does have a smaller range (5 as compared to 7 for the baseline).

#### Level details for the baseline and treatment phases

Metric	Baseline (step 2)	Treatment Phase 1 (step 4)
Level		
IQR		
Whiskers		
Tukey Fences		
Data Range		

A decrease in IQR or Range can be an indication that the client is reducing the variability of their performance. This is usually a good thing, and so along with the jump in level, we have some hard data to support our conclusion that the treatment seems to be having a positive impact. However, as we saw in the last module, we did uncover a discouraging trend: the rate of improvement seemed to be slowing down.

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*NOTE: A decrease in IQR (or to a lesser extent, data range) can be an indication that a client is becoming more consistent with their performance. This is usually a good thing and should be checked so that the results can be integrated into your clinical decision process.*

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## Next Steps

Collecting and monitoring client data allows you to obtain insight into client progress that otherwise would not be available to help you in your clinical decision making. While working with JB, we have strong indications that Easy Onset treatment can be effective for her:

- There is strong support for its efficacy in the literature
- She responded to treatment with an initial jump in performance after treatment started

However, by measuring and monitoring her performance, we have become aware that her progressed is stagnating. This is strong evidence that we need to modify her treatment plan if we are to help facilitate a clear and steady rate of improvement.

Rather than abandon our treatment plan entirely, we will make an adjustment. JB is a 17 year old and while your 1/2-hour weekly sessions seem to be going well, you also realize that at 17, JB may not be entirely focused or motivated to put forth the effort required to develop the improved fluency that she desires.

At the end of the the last module we hypothesized some changes that we might make to the treatment plan. Should you increase treatment time to 1 hour each week instead of 30 minutes? Should you assign more homework or a different type of homework?

In speaking with JB, you discover that she is hoping to get her driver's license soon and a summer job. You also find out that she is has to work hard on her school homework, so it is quite possible that she does not have the time (or energy) to do the homework you have assigned her for fluency development.

However, perhaps with some additional focused time with you, she may be able to get the practice (and confidence) she needs to reach her fluency goals. With that in mind, you have a conversation with her about moving from 1/2-hour sessions to full 1-hour weekly sessions. You explain that you'd like her to get more focused time working on improving her fluency, but you do not think that introducing more homework would help. If she is able to fit an additional half



hour into with you into her schedule, then you two can work together to make the most of the additional time you have together and hopefully reach her fluency goals by summer.

With this change, you will need to closely monitor progress to ensure that the additional time is effective and that a more significant modification to her treatment plan is not required. In addition, now that JB is beginning to express that she has some goals for the summer timeframe, you can use that to help define some goals for your fluency work with her. In the next module, we'll prepare for this new phase of treatment by defining a goal and setting up JB's iGraph™ to show the goal and progress towards it as we work through the adjusted treatment plan.

## Congratulations!

You have now begun to utilize the variability analysis tools that are included iGraph™. This – along with the ability to visually and quantitatively analyze level and trend can help you in assessing the ongoing progress of your clients.

Below are listed a series of How-To resources that you can use to obtain more information on analyzing data series using Therapy-Science and the included iGraph™ analysis methods.

## Relevant How-To Resources

Additional information on some of the technical steps covered in this tutorial are covered in the following How-To articles. You can find these by searching in the **Resources** section of Therapy-Science.

- How-To Analyze Data I: Single Data Series
- How-To Analyze Data II: Level, Trend, and Variability