

**MWSUG 2017 – Paper BI02-SAS**  
**If You Build It, Will They Understand?**  
**Designing Reports for the General Public in SAS® Visual Analytics**

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## ABSTRACT

Your organization already uses SAS® Visual Analytics and you have designed reports for internal use. Now you want to publish a report on your external website. How do you design a report for the general public considering the wide range of education and abilities? This paper defines best practices for designing reports that are universally accessible to the broadest audience. You learn tips and techniques for designing reports that the general public can easily understand and use to gain insight. You also learn how to leverage features that help you comply with your legal obligations regarding people with disabilities. The paper includes recommendations and examples that you can apply to your own reports.

## INTRODUCTION

Designing a report for the general public differs from designing a report for people within your organization. When designing for your organization, you usually know a lot about your audience. You probably know the levels of education, technical knowledge, literacy, numeracy, and any impairments of your audience members. Also, there might be little variation in your audience's abilities. However, the general public has a wide range of education, knowledge, and abilities. When designing reports for the general public, it is important to make it as easy as possible for this diverse audience to understand the story that your data tells.

Basically, two factors affect whether your audience can understand and use your reports:

1. Your audience's abilities. This includes innate abilities like cognitive function and sight. It also includes learned abilities like reading and mathematical ability.
2. The nature of the report information. This includes:
  - The information that your audience is trying to understand.
  - How the information is presented. This includes the design of the report itself, the software used to present the report (SAS Visual Analytics), and the device on which the software is running (a personal computer, a tablet, and so on).
  - The environment in which the audience is trying to use the information, such as a quiet room with good light and low glare or a crowded classroom with noise and distractions.

If your audience does not understand your report, it is important not to blame your audience. Instead, accept that there is a mismatch between these two factors. The only thing that you (the report author) can control is the report design. That is the aim of this paper—to teach you how to eliminate barriers that stand between your audience and their full understanding of your reports. These guidelines are intended for anyone creating reports for the general public or other wide audiences. Some of the guidelines in this paper might not apply when designing reports for a narrower audience, such as statisticians or economists. Before describing what you can do, it's helpful to examine the wide range of abilities present among the general public.

## UNDERSTANDING YOUR AUDIENCE

The general public has a wide range of skill and ability levels that contribute to their ability to understand your reports. These include literacy, numeracy, familiarity with computers and technology, situational disabilities, cognitive function, mobility impairments, and vision impairments. Each of these factors, along with what device they are using, comes into play when someone tries to use your reports. As a report designer, it is worthwhile to understand each of these factors.

Eliminating barriers to access and understanding is not only good for your audience—it is good for your organization as well. Many countries around the world have enacted laws intended to provide equal

access to information for all of their residents, regardless of ability. These include the Rehabilitation Act and Americans with Disabilities Act in the United States; the Canadian Human Rights Act and Ontarians with Disabilities Act in Canada; various country-specific laws throughout the European Union; and the Disability Discrimination Act in the United Kingdom (WebAIM a, b). Organizations have been sued under these laws for not providing access to their online content to people with disabilities (W3C WAI).

## **LITERACY**

Literacy is “the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one’s goals, and to develop one’s knowledge and potential.” (OECD 59). A person’s literacy level has a large effect on whether he or she can understand your report. In 2013 the Organization for Economic Co-operation and Development released a report that includes data on the literacy of residents in 22 countries, including the United States, the United Kingdom, France, and Japan (OECD 20). Literacy rates varied from country to country, but within each country there was a wide range of literacy levels among the population. Each country had people at the extreme ends of the scale, with either very low or very high literacy levels. In all but one country, Japan, at least 10% of the population had only the most basic literacy skills (OECD 28).

In the OECD study, literacy levels were scored from level 1 (basic) to level 5 (advanced). A person with skill level 1 would likely have trouble navigating to a typical “Contact Us” page on a website and finding a phone number (OECD 64-65). Across all participating countries, around 15% of the population had only the most basic literacy skills and scored at level 1 or below. Around 12% of the population scored in the highest groups, levels 4 and 5. (If you are reading this paper, you would likely score in literacy level 5). Overall, around 48% of the population of these countries scored at level 2 or lower (OECD 64).

## **NUMERACY**

The OECD study also covered numeracy. Numeracy is “the ability to access, use, interpret, and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life.” (OECD 59). Study participants were ranked on a similar scale, from level 1 (basic) to level 5 (advanced). For example, a person with numeracy skill level 1 would likely have trouble calculating a mileage reimbursement amount given a mileage log book and a reimbursement rate. A person with skill level 5 would generally be able to complete this example task:

[The test-taker is shown] two stacked-column bar graphs presenting the distribution of the Mexican population by years of schooling for men and women separately. The y axis of each of the graphs is labeled “percentage” with 6 grid lines labeled “0%”, “20%”, “40%”, “60%”, “80%” and “100%”. The x axis is labeled “year” and data are presented for 1960, 1970, 1990, 2000 and 2005. A legend identifies three categories of schooling: “more than 6 years of schooling”, “up to 6 years of schooling” and “no schooling”. The test-taker is asked to approximate what percentage of men in Mexico had more than 6 years of schooling in 1970, choosing from a menu that has 10 response categories: “0-10%”, “10-20%”, and so on. (OECD 78).

Across all participating countries, over half the population had only basic numeracy skills and scored in level 2 or below. Those with the highest levels of numeracy, who scored in levels 4 and 5, made up only around 12% of the population (OECD 76).

## **TECHNICAL PROBLEM-SOLVING ABILITIES**

The OECD study also covered problem-solving abilities in technology-rich environments. These abilities are defined as “using digital technology, communication tools, and networks to acquire and evaluate information, communicate with others, and perform practical tasks.” (OECD 86) Survey participants were ranked in levels from 1 to 3. A person who scored level 1 might not be able to sort email responses to a party invitation into folders that categorize them as accepted or declined. A person who scored at the top of the scale would generally be able to manage requests to book a meeting room using email and a reservation system, including checking the schedule of the meeting room and declining requests when the meeting room is already booked.

Across all participating countries, around 66% of people fell into one of the following groups:

- Had only basic skills and scored level 1 or below
- Opted out of taking this portion of the test
- Had no computer experience and were not offered this portion of the test
- Failed a basic screening involving tasks like using a mouse and were not offered this portion of the test.

Only around 6% of participants had scores in the highest level, level 3 (OECD 88).

## **COGNITIVE ABILITIES**

Cognitive abilities vary from person to person and can affect literacy, numeracy, and technical problem solving. People with cognitive disabilities form a large and diverse group. These disabilities can affect the following:

- memory
- problem-solving
- attention
- reading, linguistic, and verbal comprehension
- math comprehension
- visual comprehension

(WebAIM c)

These aspects of cognitive disabilities suggest certain design considerations. For example, it's helpful to consider what pieces of information your audience will need to keep in their short-term memory while using a report, and minimize this memory load on your audience wherever possible (NIA).

## **LIMITED VISION AND NO VISION**

Many in your audience will have limited vision. According to the World Health Organization, there are 285 million people worldwide with some form of vision loss: Of those 39 million are blind and 246 million have low vision (WHO 2014). This statistic includes people with common but uncorrected vision problems such as astigmatism or myopia, people with color blindness, as well as people with more serious vision problems like cataracts, glaucoma, and macular degeneration.

People who have no functional vision use software called screen readers. A screen reader narrates information presented on screen and provides additional ways of interacting with a device. There are many different screen readers: JAWS and NVDA are popular screen readers for Windows; VoiceOver is the screen reader built in to Mac OS X and iOS devices; TalkBack is the screen reader built into Android devices. While the details of screen readers vary, their basic purpose is the same—to describe information on screen via audio. They all announce the content on screen using text-to-speech functionality. All screen readers have some type of cursor that the user moves from object to object on the screen in order to hear the object's name and description and to interact with the objects. They provide special ways of interacting with the content, such as jumping between links, navigating from heading to heading, or moving from one button to another.

People with low vision can have a wide range of functional vision and might use assistive technology like screen magnifiers or screen readers. They might have trouble distinguishing between colors, seeing text or images that have low contrast, reading small print, or distinguishing details in images (WebAIM e).

## **MOTOR IMPAIRMENTS**

Like those with vision loss, people with motor impairments are a diverse group. The causes of motor impairments can be, among others, spinal cord injuries, or diseases like multiple sclerosis, Parkinson's, cerebral palsy, and arthritis (WebAIM d). People with motor impairments are likely to have trouble using a mouse (WebAIM d). They might use a keyboard or one of a number of alternative input devices. These

alternative input devices include switch access devices, where a single switch is used for input and paired with specialized software; voice recognition software; eye tracking software that allows users to provide input using only eye movements; and sip-and-puff systems that allow control of a computer using the breath. Most alternative input sources work with or emulate keyboards (WebAIM d).

## **AGING**

According to the U.S. National Institute on Aging, older adults are the fastest-growing group of Internet users (2009). As people age, their abilities might change in a number of the areas mentioned above. They might have reduced cognitive abilities such as memory and attention. They might have difficulty reading small text or distinguishing colors. They might also develop motor impairments. Older adults are also less likely to be technology-savvy, and are less likely to be familiar with conventions used on the web (OECD 30, NIA). In a study of seniors as web users, Nielsen found that half of seniors who participated kept a list of steps and instructions about how to use websites that they visited frequently (2013).

## **SITUATIONAL LIMITATIONS**

Your audience is also affected by situational limitations—situations that “limit their ability to hear, see, use their hands, concentrate, understand instructions, etc.” (W3C EOWG). Have you ever tried to read information on your phone when in bright sunlight? It’s often hard to do. This is a situational limitation. Similarly, loud or distracting environments can make it difficult to pay attention to and understand information presented in a report. People in challenging environments will benefit from the report design considerations discussed later in this paper.

## **DEVICE LIMITATIONS**

Finally, your audience is affected by the devices that they use to view reports—whether desktop or laptop computers, tablets, phones, or hybrid devices. Each has its own capabilities and limitations. For more information about designing Visual Analytics reports so that they work well across a wide range of devices, see “Designing SAS Visual Analytics Reports: Write Once, View Anywhere” (Mobley, Hogan, and Phadke).

## **DESIGNING REPORTS THAT ARE EASY TO UNDERSTAND**

Now that you have a better understanding of the general public and the wide range of abilities that they have, how do you create reports that can be easily understood by the widest possible audience?

There are a number of techniques that you can apply to make your reports easier for everyone to use, regardless of ability. There are additional guidelines that you can follow to make your reports easier to use for people with particular impairments.

The rest of this paper refers to an example report called US Disabilities 2014. The report and screen captures of the report use data from the US Census Bureau<sup>1</sup>. This example report illustrates many of the guidelines recommended in this paper.

## **IDENTIFY THE STORY YOUR REPORT NEEDS TO TELL**

Your report tells a story. If you are not clear about what this story is, your report is more likely to be confusing. Think about its purpose. Is it to inform? To explain? To persuade? What will it inform your audience about? What will it explain? Of what will it persuade them?

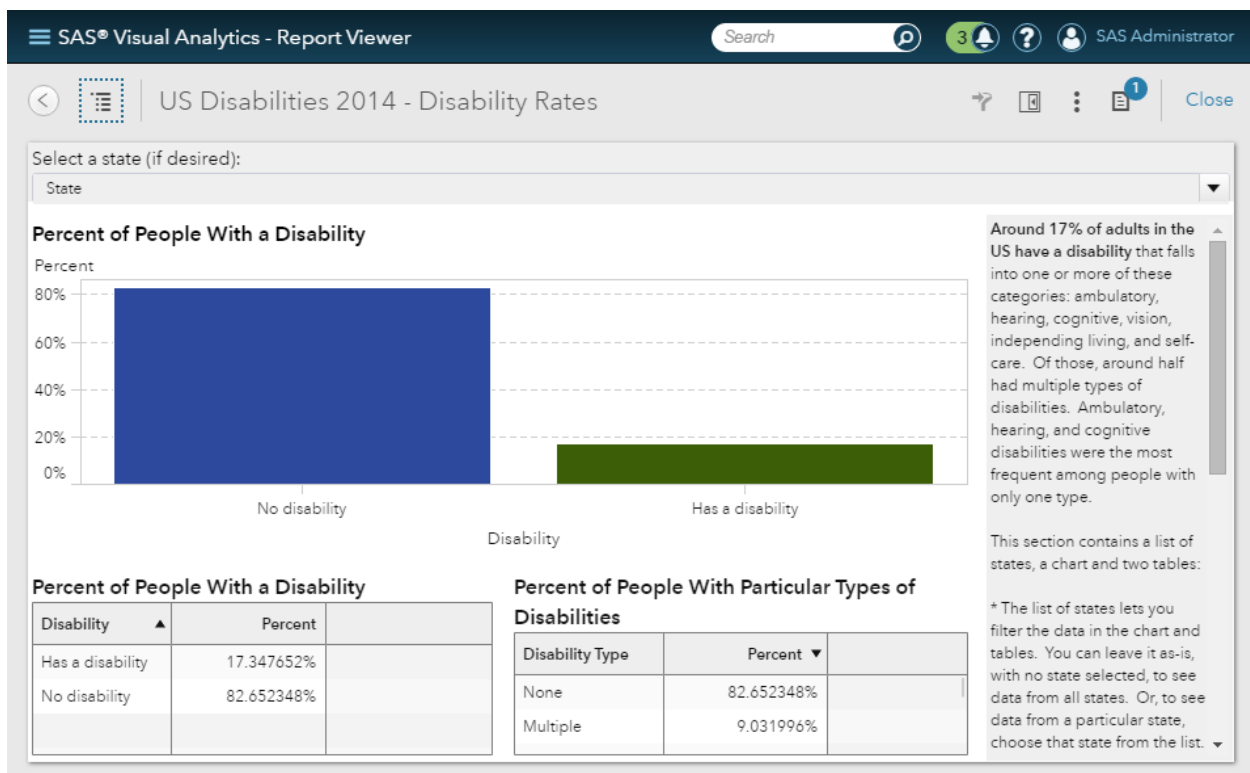
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<sup>1</sup> United States Census Bureau. American Community Survey 2014 Estimate Data One Year Estimate. September 17, 2015. Raw data. [https://www.census.gov/programs-surveys/acs/news/data-releases/2014/release.html#par\\_textimage\\_11](https://www.census.gov/programs-surveys/acs/news/data-releases/2014/release.html#par_textimage_11), Washington, DC.

## Tell One (and Only One) Story in Each Report

The example report US Disabilities 2014 tells a story about people with disabilities in the United States. It is intended to inform.

Display 1 shows the first section of this report. The section contains a bar chart, two tables, a drop-down list, and a text object. The title of the bar chart is “Percent of People with a Disability.” It has two bars, “No disability” (83%) and “Has a disability” (17%). The title of the first table is also “Percent of People with a Disability.” It has two rows, showing the same data as in the bar chart. The title of the second table is “Percent of People With Particular Types of Disabilities.” It has multiple rows, but only two are visible. The rows list the percent of people with no disability (83%) and the percent of people who reported having multiple disabilities (9%). The drop-down list contains names of US states. It filters the chart and tables. The text object contains an explanation of the section and instructions on how to use it.



**Display 1. The Disability Rates Section of the US Disabilities 2014 Report**

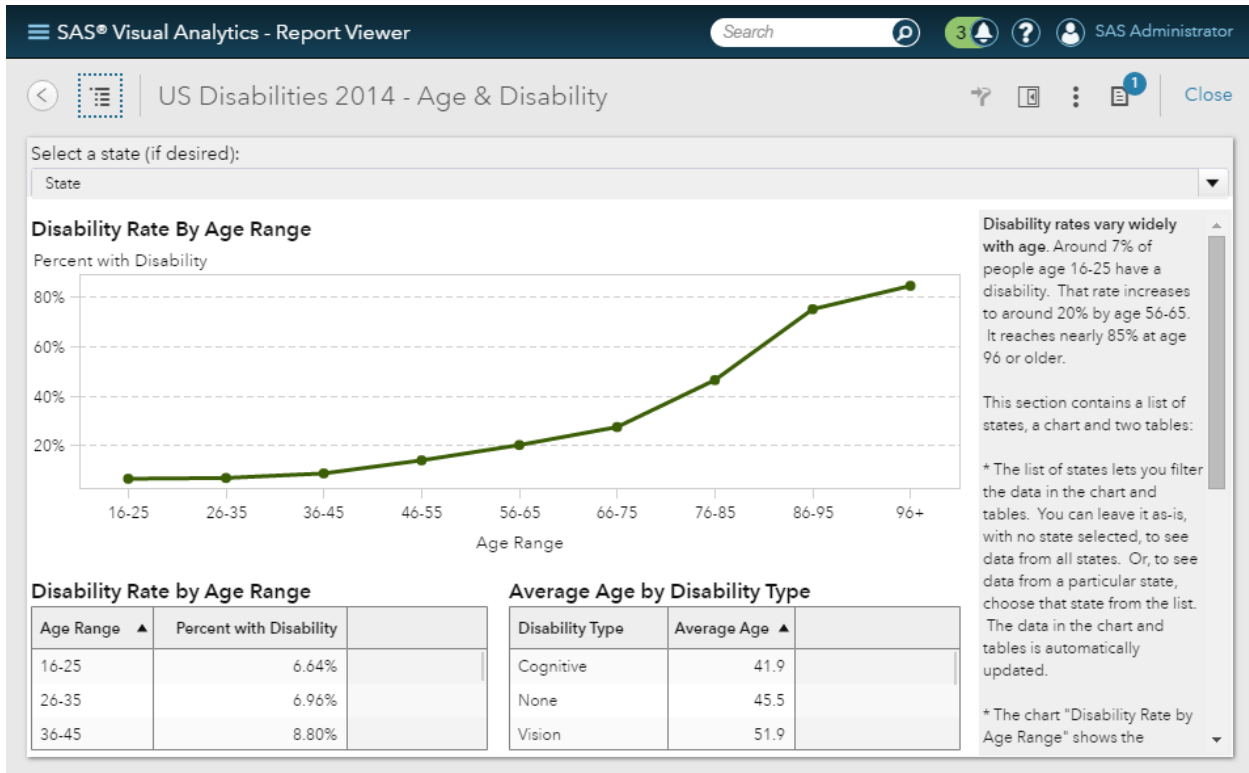
Each part of the story is told in its own section:

1. Disability Rates: disabilities are widespread; though some are more common than others.
2. Age & Disability: older people are more likely to have a disability.
3. Employment & Disability: people with disabilities work fewer hours than people without disabilities.
4. Income & Disability: people with disabilities make less money than those without; people with certain types of disabilities make more than those with other types of disabilities.
5. Location & Disability: most of the US states with the highest disability rates are in the south. States with low disability rates are spread out throughout the country.

(There is also a “Welcome” section that introduces the report and its contents, and links to the other sections).

Think of the major points in the story of your report and then create a section for each one. Display 2 shows the second section of the example report US Disabilities 2014. The section contains a line chart,

two tables, a drop-down list, and a text object. The title of the line chart is “Disability Rate by Age Range.” It has one line, showing the percent of people with a disability at various age ranges, starting with 16-25 and ending with 96+. The disability rate increases with age, from around 6% in the 15-26 age range to over 80% in the 96+ age range. The title of the first table is also “Disability Rate by Age Range.” It shows the same data as in the line chart. The title of the second table is “Average Age by Disability Type.” It shows the average age of people with various types of disabilities—cognitive, none, and vision are visible. There are more rows not shown in the image. The drop-down list contains names of US states. It filters the chart and tables. The text object contains an explanation of the section and instructions on how to use it.



## Display 2. The Age and Disability Section of the US Disabilities 2014 Report

If you are unsure about what part of the story a given section tells, it can be helpful to ask yourself, what are the questions that this section answers? For example, the primary question that the Age & Disability section of the example report answers is, “do older people have higher rates of disabilities than younger people?” It also answers the secondary question, “are people likely to have certain types of disabilities at a younger age than other types?” The section is precisely focused on those questions and does not include extraneous information.

As a guideline, telling one story might not apply to dashboards, which attempt to convey many pieces of information in a single report, and often in a single section. The guidelines in this paper apply mainly to reports, and not all of them apply to dashboards. Dashboards are a topic of future research.

This guideline benefits everyone.

## KEEP SECTIONS SIMPLE

### Keep Each Section Simple

Keep each section of your report simple and focused on answering one primary question or conveying one primary point. Include a primary report object that conveys the main point of the section. Include secondary report objects, if needed, to help convey the main point or address closely related points. To

cover a separate point, use a separate section. The example report uses separate sections to show employment and income information. While they are related, they are not the same point.

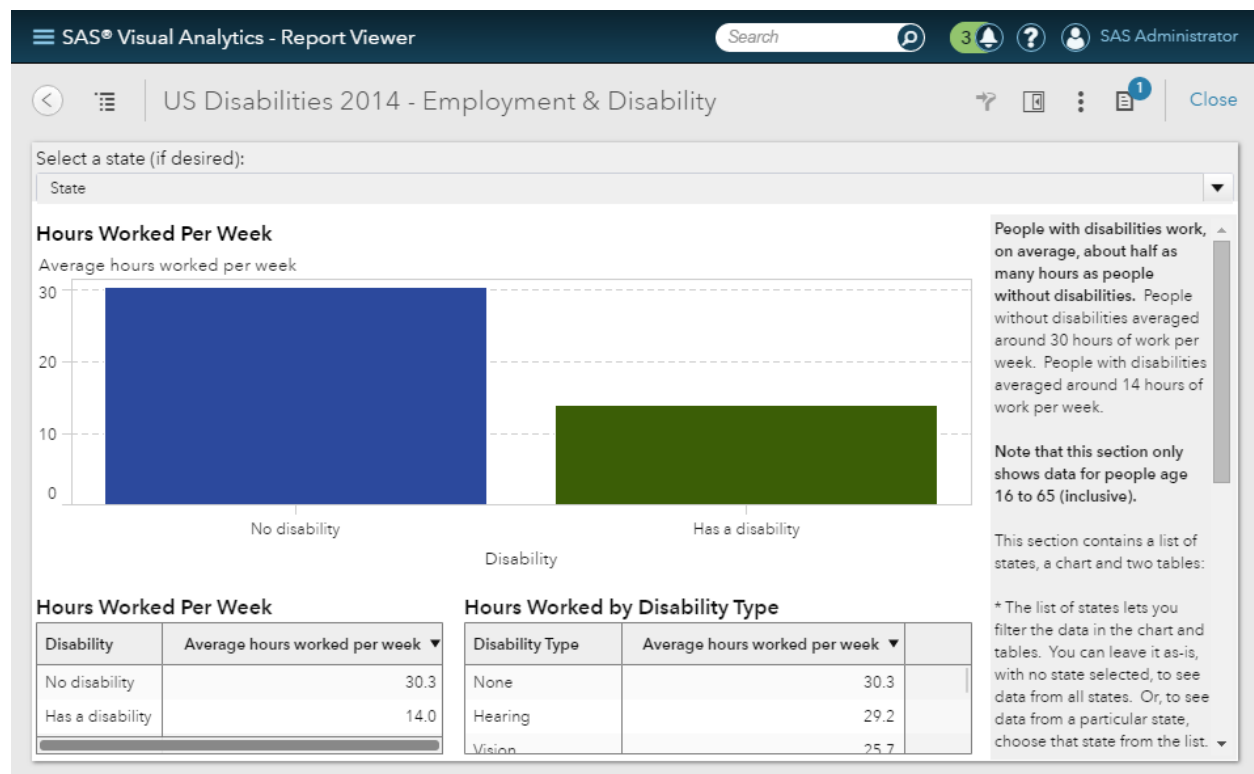
This guideline benefits everyone.

### Do Not Rely on Your Audience’s Memory

Do not make your audience remember content from one section to another. Each section should stand on its own. If there are values that your audience would want to compare to one another, put these values in the same section—preferably in the same report object. Avoid making your audience switch back and forth between sections to compare values.

Display 3 shows the Employment & Disability section of the example report. The section contains a bar chart, two tables, a drop-down list, and a text object. The title of the bar chart is “Hours Worked Per Week.” It has two bars, “No disability” (30.3 hours per week) and “Has a disability” (14 hours per week). The title of the first table is also “Hours Worked Per Week.” It has two rows, showing the same data as in the bar chart. The title of the second table is “Hours Worked by Disability Type.” It has multiple rows, but only two are fully visible. The rows list the average number of hours worked per week by people with no disability (30.3), people with a hearing disability (29.2) and people with a vision disability (25.7). The drop-down list contains names of US states. It filters the chart and tables. The text object contains an explanation of the section and instructions on how to use it.

This section includes information about hours worked per week by people with and without disabilities. It also includes data about hours worked per week by people with particular types of disabilities. The audience doesn’t have to open another section to see this closely related information.



**Display 3. The Employment and Disability Section of the US Disabilities 2014 Report**

This guideline benefits everyone, especially those with memory impairments, older adults (NIA), those who use alternative input devices who might not be able to move through the UI as quickly as others, and screen reader users.

## Be Consistent

Structure each section of your report in a similar way, if the content lends itself to doing so (NIA 6). For example, if each section of your report includes a primary chart object, a secondary chart object, a table, and a text object, place those objects in the same location and make them the same size in each section. (Most of the sections in the example report are structured in this way.) Once your audience is familiar with one section, they can easily switch to another section and use it, without learning a new layout.

Format your data consistently throughout your report. For instance, in the example report, each chart uses green to represent people with a disability and blue to represent people without a disability. This is consistent throughout the sections of the report.

This guideline benefits everyone, especially those with cognitive impairments and older adults.

## CHOOSE THE RIGHT TOOL FOR THE JOB

Presenting your data using the right report object will make it easier to understand. The type of data and its intended use dictate the type of report object to use to present it. While SAS Visual Analytics offers a wealth of different chart types, your data will be understood by the widest audience if you **stick to simple, common report objects**: list tables, bar charts, line charts, time series plots, pie charts, and geo maps.

Table 1 shows the definitions of tables and charts, as outlined by Stephen Few (2005):

Table	Chart
Data is expressed in the form of text (that is, words and numbers, rather than graphically)	Data is expressed graphically (that is, as a picture)
Data is arranged in columns and rows	Data is displayed in relation to one or more axes along which run scales that assign meaning to the values

**Table 1. Definitions of Tables and Charts**

Discussing the many considerations involved in choosing to use a table or one of these types of charts is beyond the scope of this paper. However, it is useful to look at some of the basic considerations.

The following guidelines for using report objects benefit everyone.

### List Tables

List tables are a simple grid of rows (horizontal) and columns (vertical). They can be used to show a mix of categories and/or measures. List tables work well when an audience looks up individual values, or when the values need to be expressed precisely (Few 2005). If either of these is true, use a table instead of, or in addition to, a chart. In the example report US Disabilities 2014, the section Income & Disability answers the question, “does income vary for people with disabilities based on their type of disability?” Because an audience is likely to look up precise incomes based on disability type, this information is presented in a table (in addition to a chart).

Display 4 shows a typical list table. It includes two columns, Disability Type and Average Income, and several rows. The data in this table shows that people with cognitive disabilities have the lowest average annual income (\$15,379). People with hearing disabilities have the highest average annual income (\$43,360)—higher than people without a disability (\$40,002).



Income by Disability Type	
Disability Type	Average Income ▲
Cognitive	\$15,379
Multiple	\$15,717
Independent Liv...	\$16,645
Ambulatory	\$24,194
Self-care	\$28,171
Vision	\$28,985
None	\$40,002
Hearing	\$43,360

#### Display 4. A List Table

Use crosstabs with caution. If you cannot present your data using a list table, you can use crosstabs, which are both more advanced and potentially more confusing. Simple crosstabs, with few levels of hierarchy, are more likely to be understood than complex crosstabs with many levels of hierarchy.

#### Bar Charts

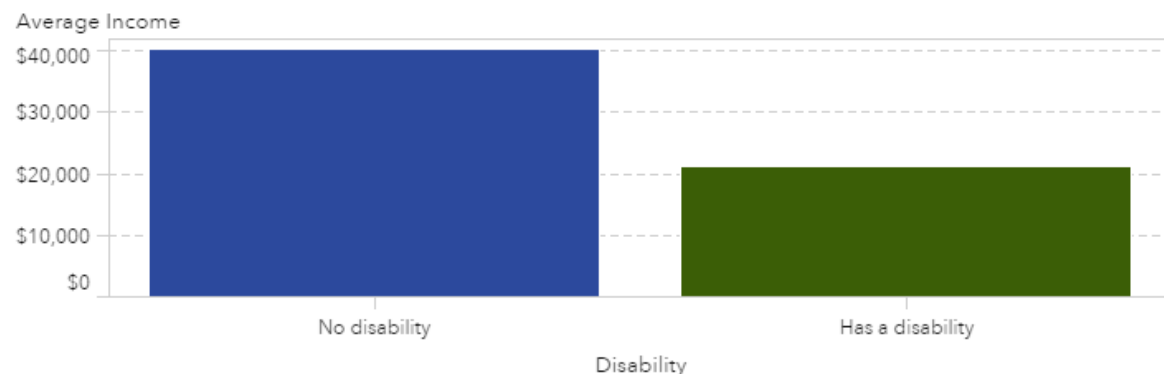
Bar charts are the most versatile of the basic chart types and are suitable for a wide range of uses. They show category values along one axis, and one or more measures along the other axis. Bar charts can be used to show many types of relationships, including the following:

- nominal comparisons, where the categorical data has no particular order
- time series, where the categorical axis shows a scale representing time (days, months, quarters, and so on)
- rankings, where the data is ordered based on the value of the measure being shown (for example, disabilities ranked by prevalence)
- parts of a whole (for example, percentage of people with various types of disabilities)

(Few 2004)

Display 5 shows a simple bar chart. The title is “Average Income for People With and Without Disabilities.” It has two bars, “No disability” (around \$40,000) and “Has a disability” (around \$20,000).

#### Average Income for People With and Without Disabilities



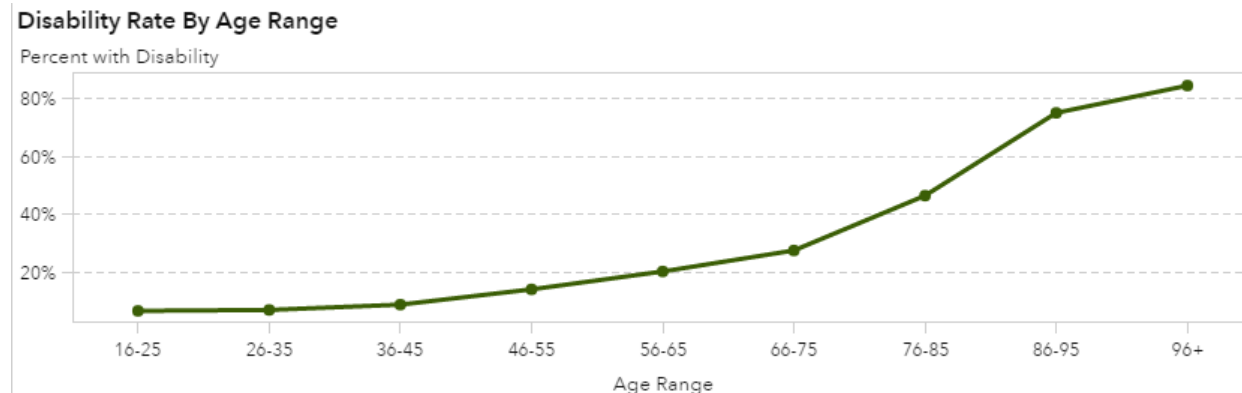
#### Display 5. A Bar Chart

Use grouped bar charts cautiously. If your chart includes too many groups, it can become difficult to read. Also, as of the publication of this paper, in SAS Visual Analytics you can distinguish between groups

based only on color. Some people with low or no vision might not be able to distinguish one group from another. (SAS is considering alternate ways to distinguish between groups, such as distinct fill patterns).

### Line Charts and Time Series Plots

Line charts and time series plots are excellent at showing the overall “shape” of the data. They place the emphasis on the trend of the data, rather than individual points (Few 2004). These charts show either category (line charts) or datetime (time series plots) values along the horizontal axis, and one or more measures along the vertical axis. Display 6 shows an example of a line chart. The title of the line chart is “Disability Rate by Age Range.” It has one line, showing the percent of people with a disability at various age ranges, starting with 16–25 and ending with 96+. The disability rate increases with age, from around 6% in the 15–26 age range to over 80% in the 96+ age range.



Display 6. A Line Chart

Be careful not to include too many measures in line charts or time series plots, as more than a few lines can become confusing. To help people who have trouble distinguishing colors tell the difference between measures, consider using the **Show markers** property. When this property is enabled, SAS Visual Analytics uses different shapes for the markers of each measure (for example, squares, circles, triangles).

### Pie Charts

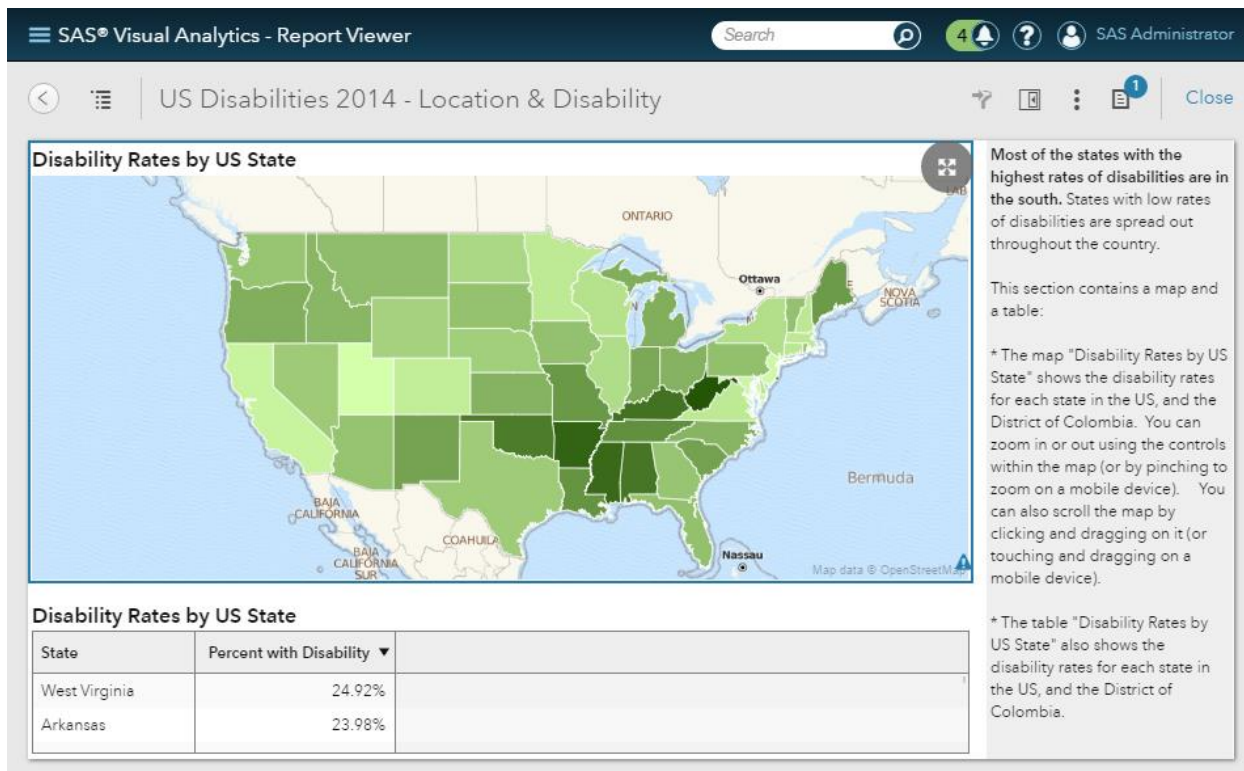
Pie charts, while not conveying as much information as other chart types, are familiar and simple, and might be useful in certain limited cases. In most cases where you might use a pie chart, a bar chart would be a better choice. However, if you are displaying only two or three values, and you want to emphasize comparison of these parts to the whole, a pie chart can be a sound choice (Gabrielle 2013).

As of SAS Visual Analytics 7.3, the primary distinguishing characteristic of slices in a pie chart is color, though you can also include text labels. People who have trouble distinguishing colors might find pie charts difficult to use. Including labels will help. To include labels on each slice within your pie chart, enable the **Show category labels** property. (SAS is considering alternate ways to distinguish slices, such as distinct fill patterns.)

### Geo Maps

Geo maps are a powerful way to present data that includes geographic relationships. When considering using a geo map, think about how your audience will use the data that it contains. If your audience will look for trends in the data, a geo map is an excellent choice. If they will simply look up values based on a geographic area, a list table can be a better choice. For instance, the example report shows that most states with the highest rates of disability are in the south. This type of pattern in the data can be easier to spot in a geo map than in a table. If you do decide to use a geo map, consider also presenting your data in an alternate format such as a list table. In the example report, the section includes a list table that is sorted by disability rate. This helps people who are not able to use the map, as well as people who prefer information in a table.

Display 7 shows the Location & Disability section of the example report, which uses a geo map as its primary object. The section contains a Geo Region Map, a list table, and a text object. The title of the Geo Region Map is “Disability Rates by US State.” It shows a map of the United States, with disability rates indicated using visual shading of each state. Darker shaded states have higher disability rates. The title of the list table is also “Disability Rates by US State.” It has multiple rows, but only two are visible. The rows list the percentage of people with a disability in West Virginia (24.92%) and Arkansas (23.98%). Data on other states is included but not visible in the image. The text object contains an explanation of the section and instructions on how to use it.



**Display 7. The Location and Disability Section of the US Disabilities 2014 Report**

### Scatter Plots

Use scatter plots with caution. People with low numeracy skills might be unfamiliar with them. In most schools in the United States, scatter plots are introduced in the 8<sup>th</sup> grade—several grade levels higher than most of the other chart types mentioned in this paper (Common Core State Standards Organization). In addition, screen reader users are less likely to be able to understand scatter plots. As SAS adds full screen reader support to SAS Visual Analytics, other chart types will likely be supported before scatter plots.

### USE MORE THAN ONE FORMAT

Present your data in multiple formats (WebAIM c). Different people will understand your data best when presented in different ways. Consider presenting the main point of each section as a chart, a table, and a text object. Include similar data in the table and chart; summarize the data and key takeaways in the text object. For example, in the screenshot shown above, the data is presented in a geo map, a table, and summarized in a text object.

This guideline benefits everyone, especially people with cognitive impairments and people with low or no vision.

## USE CLEAR LANGUAGE TO NAME AND ANNOTATE THE ELEMENTS OF YOUR REPORT

### Label Clearly

Use clear, descriptive names for each section and titles for each report object. Your audience should understand which part of your story each section of your report tells based on the section name. Include descriptive titles for your report objects so that your audience does not have to infer the purpose of the object based on its contents. Include labels on each axis in your charts—to do this, enable the Show label options for each axis, in the chart's properties. For instance, in the example report, the section name Disability Rates clearly tells you what information you will get in that section. The report objects include titles that make it clear what data each object presents. The axes all include labels.

This guideline is especially important for screen reader users, who rely on what their screen readers announce to understand a report. When a user moves their screen reader cursor to a report object, screen readers will generally announce the object's title, or, if no title is set, the object's name. This, along with the type of the object (such as a chart or drop-down list) is the only information a screen reader user will get to decide whether this object is the one they are looking for and whether they want to interact with it. This is another reason to set clear, descriptive titles on your report objects. If you do not want a visible title on a particular report object, set a clear, descriptive name instead. This will enable screen reader users to understand what the object is and what data it presents. You can set a title on most report objects in the object's properties.

For instance, in the example report, in the Income & Disability section, the primary chart object in the section is a bar chart with the title "Average Income for People With and Without Disabilities." See Display 8, which shows this section in SAS Visual Analytics Designer. The section contains a bar chart, two list tables, a text object, and a drop-down list. The title of the bar chart is "Average Income for People With and Without Disabilities." The bar chart is selected, and the properties for the chart are shown. The chart includes a meaningful name, title, and description.

The screenshot shows the SAS Visual Analytics Designer interface. The main workspace displays a bar chart titled "Average Income for People With and Without Disabilities". The chart has two bars: a blue bar for "No disability" and a green bar for "Has a disability". The y-axis is labeled "Average Income" and ranges from \$0 to \$40,000. The x-axis is labeled "Disability".

The "Properties" panel on the right shows the following details for the "Average Income Bar Chart":

- Name: Average Income Bar Chart
- Title: Average Income for People With and Without Disabilities
- Format: Arial, 16
- Description: Bar chart showing average income for people with and without disabilities. Supports drill-down.
- Graphs: Enable selection in the viewers (checked)
- Bar: Show data labels (unchecked), Direction: Vertical, Grouping style: Cluster, Grouping scale: Display actual values, Set baseline (unchecked)

Below the chart, there are two list tables:

Disability	Average Income
No disability	\$40,000
Has a disability	\$21,000

Disability Type	Average Income
Hearing	\$43,000
None	\$40,000
Vision	\$28,000

A text box next to the chart states: "People with disabilities earn, on average, about half as much as people without disabilities. People without disabilities earned about \$40,000 per year on average. People with disabilities earned about \$21,000 per year on average." A note below the text says: "Note that this section only includes data for people age 16 to 65 (inclusive)."

Display 8. The Income and Disability Section of the US Disabilities 2014 Report Shown in SAS Visual Analytics Designer

In SAS Visual Analytics 7.3, you can only include titles for prompt controls (including drop-down lists, lists, button bars, text inputs, and sliders) if they are included in the report canvas, rather than in the section- or report-level prompts. You can include prompt controls in the report canvas and manually configure them to filter other objects in your report using the **Interactions** tab in SAS Visual Analytics Designer. Give meaningful and descriptive titles to all your prompts, and then refer to those titles in your text instructions for each section.

Avoid using acronyms and jargon in names, titles, or descriptions. If you cannot avoid them, define acronyms and jargon words in a section guide (described below) or in an introductory section of your report.

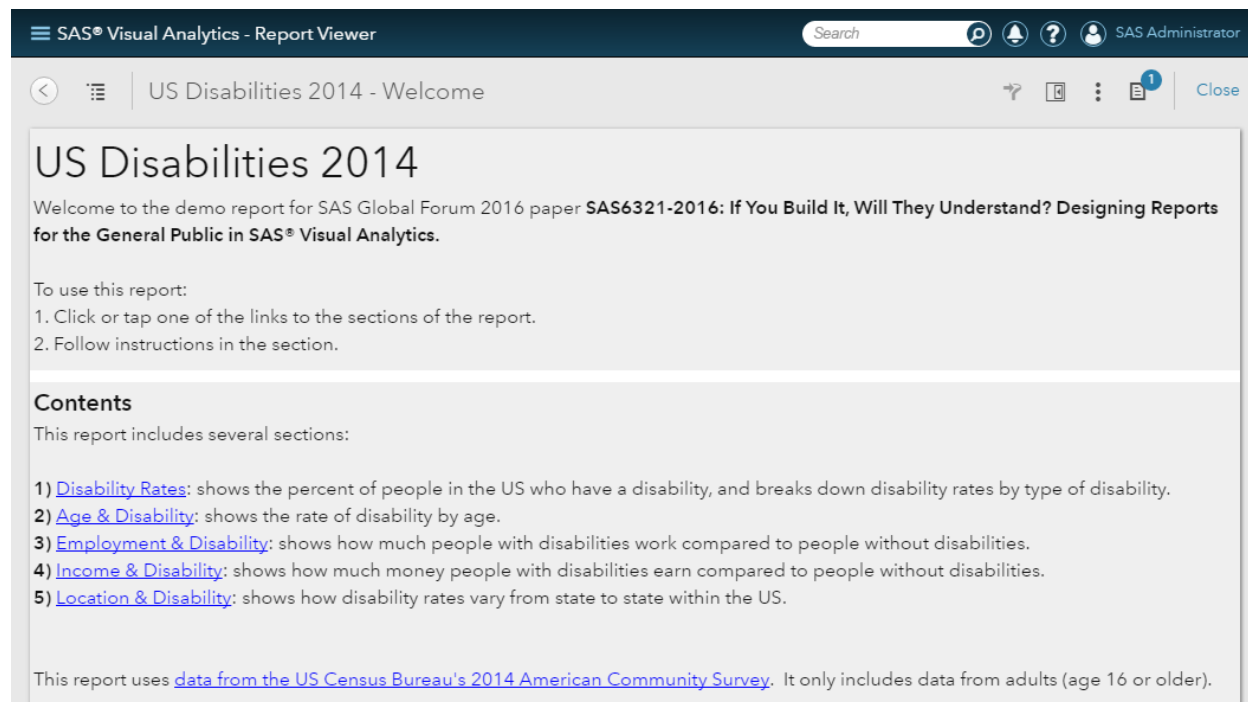
This guideline benefits people with cognitive impairments, older adults, and screen reader users (NIA, Aphasia Alliance).

### Provide a Welcome Section

Consider providing a “welcome” section as the first section of your report. Your welcome section introduces your audience to your report. This section can contain the following:

- an overview of the report, including its name
- basic instructions on how to use the report, including how to open sections
- a table of contents
- navigation links to jump directly to sections of the report
- background information such as the source of the data.

Display 9 shows an example welcome section. The section includes two text objects. The first text object lists the title of the report as well as basic instructions on how to use it. The second section lists the contents of the report. It includes links to the five other sections of the report and an explanation of the content of each section. It also includes a note about and a link to the source data used in the report.



### Display 9. The Welcome Section of the US Disabilities 2014 Report

This guideline benefits everyone, especially people with cognitive impairments and older adults.

## Include a Guide about How to Use Each Section

If the design of your report allows for it, include a text object in each section with the following information:

- the point of the section—that is, the part of the story this section tells.

For instance, in the example report, the point of the section Income & Disability is, “People with disabilities earn, on average, about half as much as people without disabilities.” If you are using data that will be refreshed, the conclusions drawn from your data might change in the future. In this case, state the question the section answers, such as “Do people with disabilities earn as much as people without disabilities?”

- the contents of the section: the report objects and their purposes.
- how to use the section and its objects to answer questions. Include instructions on how to use prompts, linking, brushing, and so on.

If the content of your section guide will not reasonably fit in a text object, consider putting your instructions in an Info window and linking to it. Follow these steps in SAS Visual Analytics:

1. Create a new section. This will become the Info window for the section to which you want to add a guide.
2. Add a text object to the new section.
3. Write your section guide in that text object.
4. On the section tab, click the menu and select **Display as Info Window**.
5. Open the section to which you want to add a guide.
6. Add a text object to the section.
7. Add the text that will serve as a link. For example, “How to use this section.”
8. Select the text to highlight it and click **Hyperlink** in the floating toolbar.
9. Under **Type**, select **Info Window Link**.
10. Select the Info window that you created in step 1 from the list.
11. Click **OK**.

If each section of your report is very similar, you could use this technique to create a single Info window that includes a guide for all sections. You can then link to that Info window from each section instead of writing a separate guide for each section.

This guideline benefits everyone, especially people with cognitive impairments and older adults.

## Advertise Filters

Use filters freely, but point them out in section guides. Some of your audience will not be familiar with the concept of filtering report data. For sections with filters (including section-level or report-level prompts), point out the existence of the filter controls, their purpose, and how to use them. Your audience might be more likely to discover and understand filters if you use the standard filter controls (button bars, text inputs, and so on) to filter objects like charts and tables. It is harder for people to discover that a chart or table filters another chart or table.

This guideline benefits everyone, especially people with cognitive impairments and older adults.

## Link and Drill Down with Care

Use linking and drill-down functionality cautiously, and help your audience discover these features. Your audience might not expect that clicking on something that does not look like a standard text link—such as a region in a geo map—will activate a link or drill down. They might not discover links from report objects such as tables, and might not realize that they can drill down in some charts. Plan for this in the design of

your report. Present information in an additional form that does not require drill-down functionality—for example, a list table. In the text instructions for the section of your report that includes linking or drill-down features, call out these features explicitly. For instance, in the example report, in the section Disability Rates, you can drill down in the bar chart to view rates for particular types of disabilities. The instructions for this section include a step that explicitly introduces the drill-down feature and explains how to use it.

This guideline benefits people with low or no vision, people with cognitive impairments, older adults.

### **Include Context in Link Names**

Some people, including those with low or no vision who use a screen reader, will encounter your links without context. This might happen in a list of links or when navigating from one link to another in a special navigation mode. These users will not hear the text before or after your link, unless they go out of their way to do so. For that reason, your links need to stand on their own.

The typical “click here” link falls flat. If there is more than one “click here” link on a page, when a screen reader stated a list of links there is nothing to distinguish one link from another. A better approach is to include more information in the link name. For example:

- The OECD published [data on the literacy, numeracy, and problem-solving skills of residents of 22 countries](#).
- For more information about accessibility of SAS products, [visit the SAS accessibility home page](#).

Link names like these that include context stand on their own when separated from the text that surrounds them.

This guideline benefits people with cognitive impairments, older adults (NIA), and screen reader users.

### **KEEP IN MIND LOW AND NO VISION AUDIENCE MEMBERS**

#### **Use Animation with Caution**

People with low vision or no vision likely will not be able to use animation in your charts. If you do use animation, provide an alternate way of understanding the data. One option is a text object with a description of what happens in the data over the course of the animation.

This guideline benefits people with low or no vision.

#### **Avoid Using Color Alone to Convey Meaning**

When you apply a red/yellow/green scheme to sales numbers to indicate poor, marginal and good sales, for example, you can exclude a fairly large segment of men and a small number of women who cannot distinguish reds from greens (NEI). To prevent this, use color along with another indicator to convey meaning. You could vary another aspect of how the text is presented, such as font type, weight or italics.

Some operating systems, such as Mac OS X and iOS, offer an accessibility setting that renders the entire display using gray scale instead of colors. You can use this setting to test for issues related to using color alone to convey meaning. If you can understand all aspects of your report when rendered in gray scale, and you do not miss any information conveyed, then this is a good indication that you are not using color alone to convey meaning.

This guideline benefits people with low vision.

#### **Avoid Using Images of Text**

To include text in your reports, use the text object. Images of text are generally not readable by screen reader users. They are also likely to appear poorly on devices with small screens, because text will not reflow based on the width of the screen. They can also look poor when magnified using browser-based magnification or an external screen magnification program.

This guideline benefits people with low or no vision, people using devices such as tablets or phones.

## Describe Images Used in Your Report

Adding descriptions to images has multiple benefits. For people with low vision who might not be able to see all aspects of an image, descriptions provide clues that help them interpret what they are seeing. People who cannot see the image at all will also benefit in the future. As SAS adds screen reader support to future versions of the SAS Visual Analytics Viewer and SAS® Mobile BI for iOS and Android, screen reader users will be able to read descriptions attached to images. If you do not include descriptions, screen reader users will get no information about the image, other than the fact that it is an image.

This guideline benefits people with low or no vision.

## Offer a Version of Your Report That Uses the High Contrast Report Theme

Some people with low vision (for example, those with advanced cataracts) will have trouble viewing low- or medium-contrast text and graphics (WebAIM e). For these people, a special high-contrast version of the report is very helpful. SAS Visual Analytics makes this easy for you. Simply save a version of your report using the high contrast report theme. This option is available on the **Styles** tab in the report designer. When publishing your report, include both the regular version and the version that uses the high contrast report theme. If your report includes an introductory section with information and instructions in a text object, you can also include a link to the high contrast version of your report from within the introductory section of the regular version of your report.

This guideline benefits people with low vision.

## Avoid Using Sensory Characteristics

Some people are not able to perceive relationships based on sensory characteristics. See Table 2 for examples of these characteristics.

Characteristic Type	Example
Directional	above, below, to the right, or beside
Color	the red line
Size	the largest bar

**Table 2. Examples of Types of Sensory Characteristics**

Avoid using sensory characteristics in any text that you add to your report. This includes text objects, titles, descriptions, names, or tooltips of report objects. Instead, to identify parts of your report, use their titles or object types or both. For example, instead of referring to a chart showing prevalence of disabilities as “the bar chart on the right,” refer to it as “the Disability Rates bar chart.”

Another reason to avoid using sensory characteristics is that your report might be rendered in a different layout on smaller devices, such as phones.

This guideline benefits people with certain cognitive impairments, people with low or no vision, and people using devices with small screens.

## GIVE YOUR AUDIENCE ACCESS TO REPORTS ON THEIR PREFERRED DEVICE

Reports that are designed in SAS Visual Analytics can be viewed on desktops, laptops, tablets, and phones. Make sure that your audience is aware of the SAS Mobile BI apps for iOS and Android. Provide your audience with the server information they need in order to connect the app to your server. Then your audience can locate, subscribe to, and view their reports. You can also email your audience links to specific reports. When designing reports that contain links to other reports or web addresses, test the links by viewing the report in the app to make sure the links work as expected for your audience on mobile devices.

As of the publication of this paper, people with low vision or no vision will generally get the best experience using SAS Mobile BI on iOS. Basic VoiceOver screen reader support is available in the iOS version of the app. VoiceOver users can access report objects, including charts. There is not yet support



for crosstabs, and there is incomplete support for KPIs. SAS plans to add support for these object types in a future release of SAS Mobile BI for iOS. For more information about VoiceOver support in SAS Mobile BI for iOS, see the video [SAS® Mobile BI 7.31 for iOS: Quick Tour of VoiceOver Support](#) on YouTube.

SAS is in the process of adding full screen reader support to all SAS Visual Analytics viewers, including the web-browser-based viewer, SAS Mobile BI for iOS, and SAS Mobile BI for Android. For more information about accessibility of SAS products in general, see [the SAS Accessibility YouTube playlist](#).

People with motor impairments will also generally get the best experience using SAS Mobile BI on iOS. SAS is working to add full support for keyboards and alternative input devices, such as Braille displays and switches, to all SAS Visual Analytics viewers so that people with motor and vision impairments will have a consistently excellent experience regardless of device.

This guideline benefits everyone, especially screen reader users and people with motor impairments who use alternative input devices.

## BUILT-IN ACCESSIBILITY FEATURES

SAS Visual Analytics provides a number of other features that can improve accessibility for your audience. There is nothing that you need to do to enable these features in your reports. The features are available for everyone automatically (depending on which viewer they use to view your reports). These features include:

- **Color inversion:** Some people are able to see content on their screen more easily with the colors inverted. SAS Visual Analytics includes a color inversion feature that users can activate within the SAS Visual Analytics Viewer. For example, if your report includes white text on a black background, this feature inverts the color to black text on a white background. In the web-browser-based SAS Visual Analytics Viewer, this feature is activated by pressing Ctrl+~ on Windows and Command+~ on Mac OS X.

This feature benefits people with low vision.

- **Customizable focus indicator:** The focus indicator is the visual ring that appears around whichever object on screen has focus. An object receives focus when you move the focus indicator to it using the Tab key on a keyboard or by clicking it with the mouse (when you use the mouse, you might not notice the focus indicator). In the web-browser-based SAS Visual Analytics Viewer, users can customize the color, thickness, and opacity of the focus indicator to make it easier to see. To change these settings, go to **Settings > Global > Accessibility** and make the desired adjustments. There is a preview image that shows you how the focus indicator will look based on the settings you've chosen.

This feature benefits people with low vision and people with mobility impairments.

- **Audio indicators:** When people cannot see the screen well or at all, it might not be easy to tell when a report is loading, when it finishes loading, if an error appears, or if anything else changes in the interface. It can be helpful to hear an audible indication that something has happened. SAS Visual Analytics includes an optional audio indicator for loading a report. SAS will add more audio indicators for a number of other situations in future releases. To turn on audio indicators, go to **Settings > Global > Accessibility** and select the **Enable sounds** option.

This feature benefits people with low vision.

- **Landmarks:** When users navigate the interface by using a keyboard, it can be tedious to navigate through a complex interface. SAS Visual Analytics includes a landmarks feature to enable faster keyboard navigation. When users activate this feature, a window opens and lists significant landmarks in the interface. In the Modern SAS Visual Analytics Viewer, the application bar, Search field, and main content area are landmarks. A user selects the landmark that they want to go to and the keyboard focus jumps to that location. Users can activate this feature by pressing Ctrl+F6 on Windows and Command+F6 on Mac OS X.

This feature benefits people with mobility impairments and people with low or no vision.

- **Browser-based zoom:** when text or images on screen are too small to be read comfortably, it can be difficult to understand the content of a report. SAS Visual Analytics includes support for browser-based zoom in the Modern SAS Visual Analytics Viewer. A user can increase the size of text and images included in the report using the built-in zoom feature in their browser. The keyboard shortcut for this depends on the browser. It is generally Ctrl+plus sign on Windows and Command+plus sign on Mac OS X.

This feature benefits everyone, especially people with low vision.

## CONCLUSION

Many factors influence people's ability to understand and use the information presented in your reports. By optimizing the factors you can control, you ensure that as many people as possible benefit from your reports. From tightly focusing your reports on telling a single story, to choosing the right report objects for your data, to including instructions about how to use your report, there are a number of things you can do to make your reports understandable to the widest possible audience.

Some factors depend on the software that presents the reports—SAS Visual Analytics. SAS is committed to the accessibility of SAS Visual Analytics, and all of its products. There are many new accessibility features in development, including full screen reader support in all SAS Visual Analytics viewers. Some of the other new features will give report authors more control over the accessibility of their reports, while other new features will simply improve accessibility automatically. Check [www.sas.com/accessibility](http://www.sas.com/accessibility) for more information and news about accessibility of SAS Visual Analytics and other SAS products.

## REFERENCES

Aphasia Alliance. "Top Tips for 'Aphasia Friendlier' Communication." Aphasia Alliance. 2012. Accessed February 5, 2016. Available <http://www.aphasiaalliance.org/top-tips/>.

Common Core State Standards Organization. "Grade 8 » Statistics & Probability." Common Core State Standards Initiative. Accessed February 17, 2016. Available <http://www.corestandards.org/Math/Content/8/SP/>.

Few, Stephen. "Eenie, Meenie, Minie, Moe: Selecting the Right Graph for Your Message." Perceptual Edge. September 8, 2004. Accessed January 29, 2016. Available [http://www.perceptualedge.com/articles/ie/the\\_right\\_graph.pdf](http://www.perceptualedge.com/articles/ie/the_right_graph.pdf).

Few, Stephen. "Effectively Communicating Numbers." Perceptual Edge. November 2005. Accessed February 1, 2016. Available [https://www.perceptualedge.com/articles/Whitepapers/Communicating\\_Numbers.pdf](https://www.perceptualedge.com/articles/Whitepapers/Communicating_Numbers.pdf).

Gabrielle, Bruce. "Why Tufte Is Flat-Out Wrong about Pie Charts." Speaking PowerPoint. March 18, 2013. Accessed February 16, 2016. Available <http://speakingppt.com/2013/03/18/why-tufte-is-flat-out-wrong-about-pie-charts/>.

Mobley, Karen, Rich Hogan, and Pratik Phadke. "Designing SAS Visual Analytics Reports: Write Once, View Anywhere." In *Proceedings of the SAS Global Forum 2016 Conference*. Cary, NC: SAS Institute Inc. April 2016. Available <http://support.sas.com/resources/papers/proceedings16>

National Eye Institute (NEI). "Facts About Color Blindness." National Eye Institute. February 2015. Accessed February 5, 2016. Available [https://nei.nih.gov/health/color\\_blindness/facts\\_about](https://nei.nih.gov/health/color_blindness/facts_about).

National Institute on Aging (NIA). "Making Your Website Senior Friendly." National Institute of Aging. March 2009. Accessed February 4, 2016. Available [https://www.nia.nih.gov/sites/default/files/Sr\\_Web\\_tips\\_forweb\\_final\\_032509\\_0.pdf](https://www.nia.nih.gov/sites/default/files/Sr_Web_tips_forweb_final_032509_0.pdf).

Nielsen, Jakob. "Seniors as Web Users." Nielsen Norman Group. May 28, 2013. Accessed September 6, 2015. Available <http://www.nngroup.com/articles/usability-for-senior-citizens/>.

Organisation for Economic Co-operation and Development. *OECD Skills Outlook 2013: First Results from the Survey of Adult Skills*. Paris: OECD, 2013. Accessed February 16, 2016. Available [http://www.oecd-ilibrary.org/education/oecd-skills-outlook-2013\\_9789264204256-en](http://www.oecd-ilibrary.org/education/oecd-skills-outlook-2013_9789264204256-en).

W3C World Wide Web Consortium. "Three Flashes or Below Threshold: Understanding SC 2.3.1." Understanding WCAG 2.0. Accessed February 5, 2016. Available <https://www.w3.org/TR/UNDERSTANDING-WCAG20/seizure-does-not-violate.html>.

W3C World Wide Web Consortium Education and Outreach Working Group (W3C EOWG). "Situational Terminology." W3C Education and Outreach. Accessed January 29, 2016. Available [https://www.w3.org/WAI/EO/wiki/Situational\\_terminology](https://www.w3.org/WAI/EO/wiki/Situational_terminology).

W3C World Wide Web Consortium Web Accessibility Initiative (W3C WAI). "Legal and Policy Factors in Developing a Web Accessibility Business Case for Your Organization." W3C Web Accessibility Initiative. September 7, 2012. Accessed February 4, 2016. Available <https://www.w3.org/WAI/bcase/pol.html#risks>.

Web Accessibility in Mind (WebAIM) (a). "World Laws: Introduction to Laws Throughout the World." WebAIM: World Laws. Accessed February 4, 2016. Available <http://webaim.org/articles/laws/world/>.

Web Accessibility in Mind (WebAIM) (b). "United States Laws: Introduction to US Laws." WebAIM: United States Laws. August 26, 2013. Accessed February 4, 2016. Available <http://webaim.org/articles/laws/usa/>.

Web Accessibility in Mind (WebAIM) (c). "Cognitive: Introduction." WebAIM: Cognitive. August 9, 2013. Accessed January 29, 2016. Available <http://webaim.org/articles/cognitive/>.

Web Accessibility in Mind (WebAIM) (d). "Motor Disabilities: Introduction." WebAIM: Motor Disabilities. April 22, 2014. Accessed January 29, 2016. Available <http://webaim.org/articles/motor/>.

Web Accessibility in Mind (WebAIM) (e). "Visual Disabilities: Low Vision." WebAIM: Visual Disabilities. August 28, 2013. Accessed January 29, 2016. Available <http://webaim.org/articles/visual/lowvision>.

World Health Organization. "Visual Impairment and Blindness." World Health Organization. August 2014. Accessed January 29, 2016. Available <http://www.who.int/mediacentre/factsheets/fs282/en/>.

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## RECOMMENDED READING

- [Accessibility at SAS](#)
- [SAS Accessibility YouTube Playlist](#)
- [SAS® Mobile BI 7.31 for iOS: Quick Tour of VoiceOver Support](#) on YouTube
- Few, Stephen. 2012. *Show Me the Numbers: Designing Tables and Graphs to Enlighten*. 2d ed. Burlingame, CA: Analytics Press.

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