Plotting Likert and Other Rating Scales

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Abstract
Rating scales such as Likert scales and semantic differential scales are very common in marketing research, customer satisfaction studies, psychometrics, opinion surveys, and numerous other fields. We illustrate, review, and critique several forms of graphical presentation of results from studies using rating scales. These graphical forms include tables, bar charts of means, grouped bar charts, divided bar charts, ribbon charts, multiple pie charts, waffle plots, radar plots, and diverging stacked bar charts. We show the advantages of and recommend diverging stacked bar charts. We demonstrate how to create diverging stacked bar charts in R and Tableau.

Key Words: psychometrics, diverging stacked bar charts, graphics

Introduction

Likert scales result when survey participants are asked to rank their agreement with survey items on a scale that includes *strongly disagree*, *disagree*, *neither agree nor disagree*, *agree* and *strongly agree*. Some authors also include scales with other numbers of categories about attitude. Semantic differential scales include other opposites such as *not interesting* to *interesting*. Cox (1980) discusses the debate about the optimal number of response alternatives. We make recommendations for graphing the number of response alternatives you use.

Section 1 critiques a number of types of graphs that are often used to present rating scales. Section 2 presents a new R package for computing and plotting diverging stacked bar charts, our recommended method.

1. Graph forms used to present results of rating scales

1.1 Tables
Survey results are often presented in tables. Table 1 presents a data set published in the October 2005 issue of Amstat News by Luo and Keyes (2005) that will be used throughout this paper. It provides the results of a survey of ASA members with 6 to 15 years membership. The respondents were asked whether they agree that their primary position is professionally challenging. Tables are excellent for providing exact values. Tables do not make it easy to see the distribution of subsets of the sampled respondents.

	Total Count*	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Total
All Survey Responses	*565*	*50.1*	*40.7*	*4.8*	*3.7*	*0.7*	*100*
Employment sector							
Academic (nonstudent)	253	64.0	30.8	3.2	2.0	0.0	100
Business and industry	176	40.6	50.0	2.8	6.3	0.0	100
Federal, state, and local government	71	38.0	47.9	7.0	4.2	2.8	100
Private consultant/self-employed	28	39.3	53.6	7.1	0.0	0.0	100
Other (including retired, students, not employed, etc.)	34	29.4	44.1	14.7	5.9	5.9	100
Race							
White	400	50.0	41.8	4.5	2.8	1.0	100
Asian	122	53.3	40.2	3.3	3.3	0.0	100
Black or African American	10	40.0	30.0	20.0	10.0	0.0	100
Other	17	47.1	35.3	5.9	11.8	0.0	100
Education							
Associate's and Bachelor's	175	37.1	49.1	5.7	6.9	1.1	100
Master's and Above	388	55.9	36.9	4.4	2.3	0.5	100
Gender							
Male	356	50.6	41.0	4.2	3.4	0.8	100
Female	200	51.0	39.0	6.0	3.5	0.5	100

General Note: Due to a small number of respondents in some cells, we combined some of the response categories.
* The total count does not include nonrespondents.

Table 1: Percentages for Agreement that primary position is professionally challenging by demographics characteristics.

1.2 Bar Charts

Luo and Keyes also asked respondents if they felt increasing professional recognition was important. Figure 1 shows the survey responses for those who did and did not think increasing professional recognition was important. Robbins (2005) discusses perceptual problems with pseudo-three-dimensional charts such as Figure 1. A similar chart could be drawn for each of the demographic categories in the table.

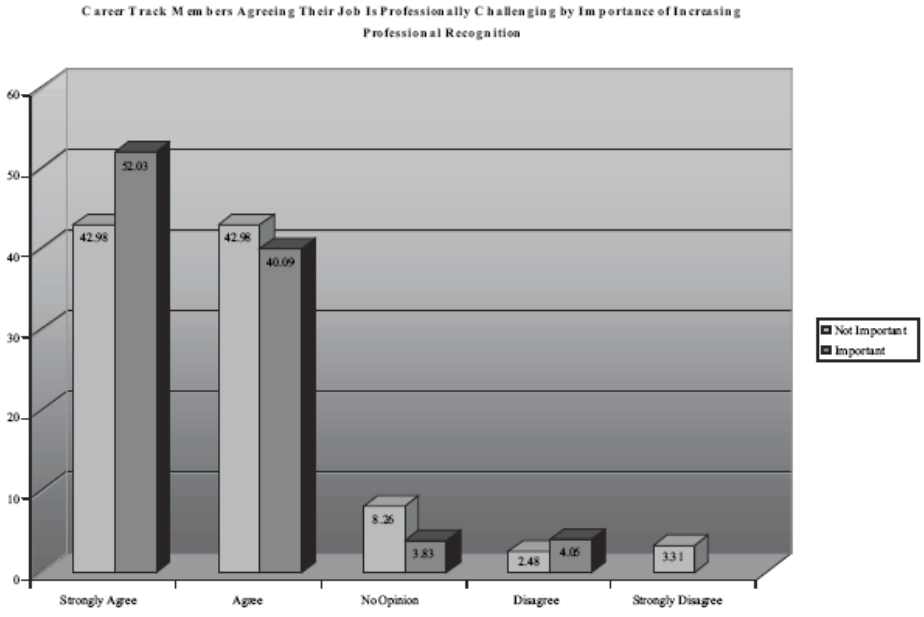

Figure 1: Bar chart of survey by Lou and Keyes showing whether members who thought increasing professional recognition was important or not important agreed that their primary job was professionally challenging.

We find it confusing to have some of the survey results in a table with other similar results in a graph. Our recommended presentation in Section 1.3 places all results in a single graphical presentation.

1.3 Diverging Stacked Bar Charts

Figure 2 shows a diverging stacked bar chart. The percentages of respondents who agree with the statement are shown to the right of the zero line; the percentages who disagree are shown to the left. The percentages for respondents who neither agree nor disagree are split down the middle and are shown in a neutral color. The neutral category is omitted when the scale has an even number of choices. The categories within each sector are ordered by the percentages who agree. It is difficult to compare lengths without a common baseline. In this situation, we are primarily interested in the total percent to the right or left of the zero line; the breakdown into strongly or not is of lesser interest so that the primary comparisons do have a common baseline of zero.

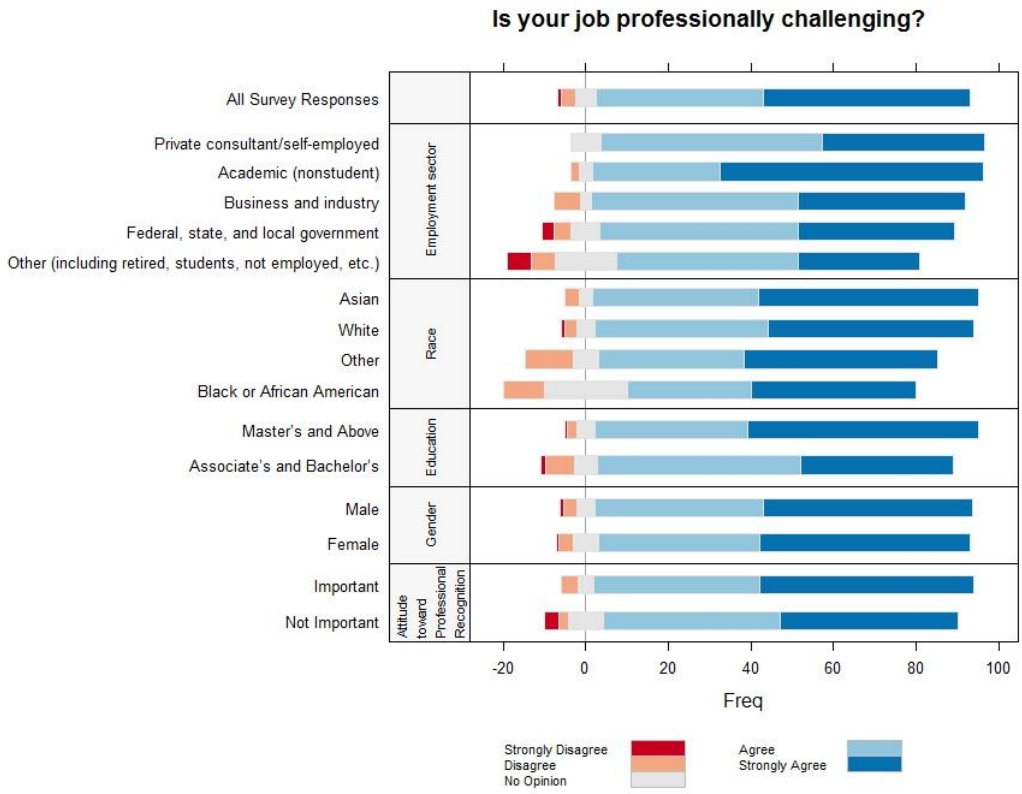

Figure 2: Diverging stacked bar chart: Our recommended method for presenting results of rating scales.

Diverging stacked bar charts make it easier to compare the attitudes of respondents in different demographic categories or who differ on the importance of increasing professional recognition than do any of the other figures discussed. Figure 2 contains the information of both Table 1 and Figure 1, yet it takes no more space than one of these. We have seen survey reports where each category is in a separate window at a Web site so that comparing categories is difficult. Figure 2 solves these problems. For these reasons, we recommend diverging stacked bar charts to present the results of surveys with rating scales.

1.4 Grouped Bar Charts

Now that we have shown our recommendation in Figure 2, we show and discuss many displays that we do not recommend, as indicated by the not recommended symbol. Figure 3 shows bar charts for the categories in the employment sector drawn with two-dimensional bar charts. Since graphs usually increase from left to right, we prefer having strongly agree on the right hand side. The format of this chart encourages comparisons within an employment sector; e.g., it is easy to see how strongly agree compares with agree within the academic sector. However, comparing the percentage of respondents who agree or disagree across employment sectors is a more interesting comparison, one that these charts do not facilitate well.

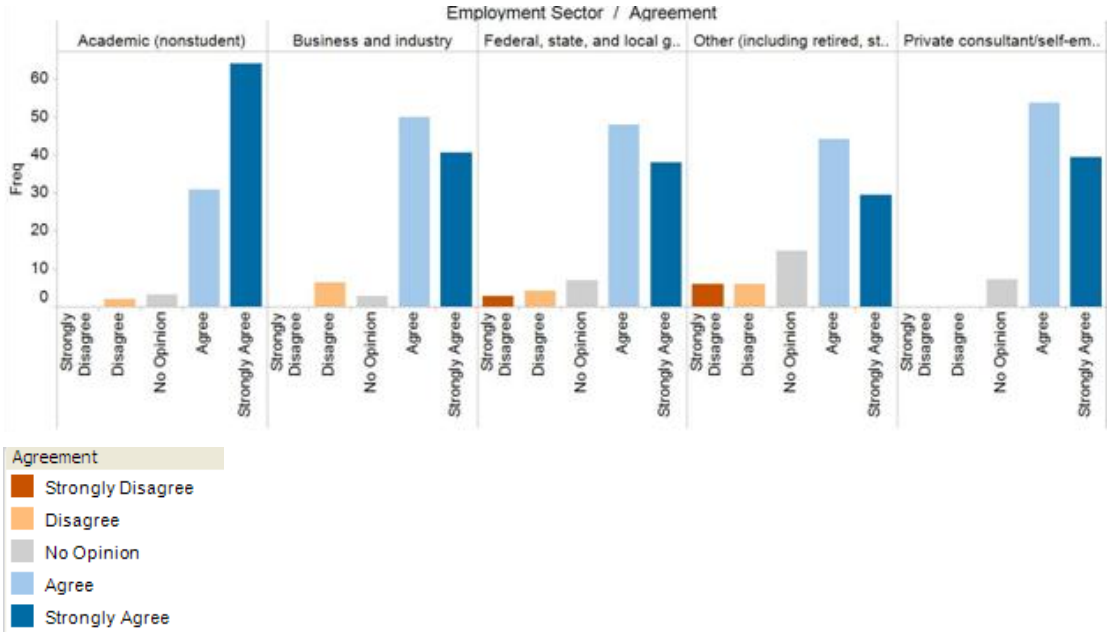

Figure 3: Bar charts showing agreement that their primary position was professionally challenging by employment sector.

1.5 Bar Charts of Means

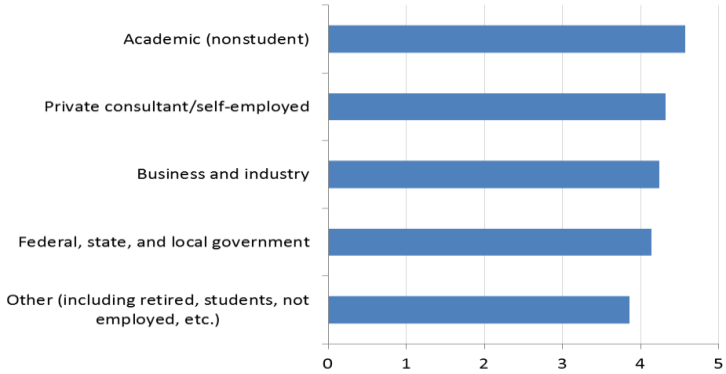

Figure 4: Bar chart showing mean for each category.

Assigning the value 5 to *strongly agree*, 4 to *agree*, and continuing down to 1 for *strongly disagree* and then taking means is a common practice. However, it is controversial since there is no assurance that there is even spacing between the descriptions of attitude. There is no reason to assume that the distance between *agree* and *strongly agree* is the same as the distance from *agree* to *neither agree nor disagree*. Even if it were acceptable to take means, it is not very useful. One hundred respondents giving a score of three tells a very different story from 50 respondents giving a score of five and 50 respondents giving a score of one, yet these two situations both have a mean of three.

1.6 Divided Bar Charts

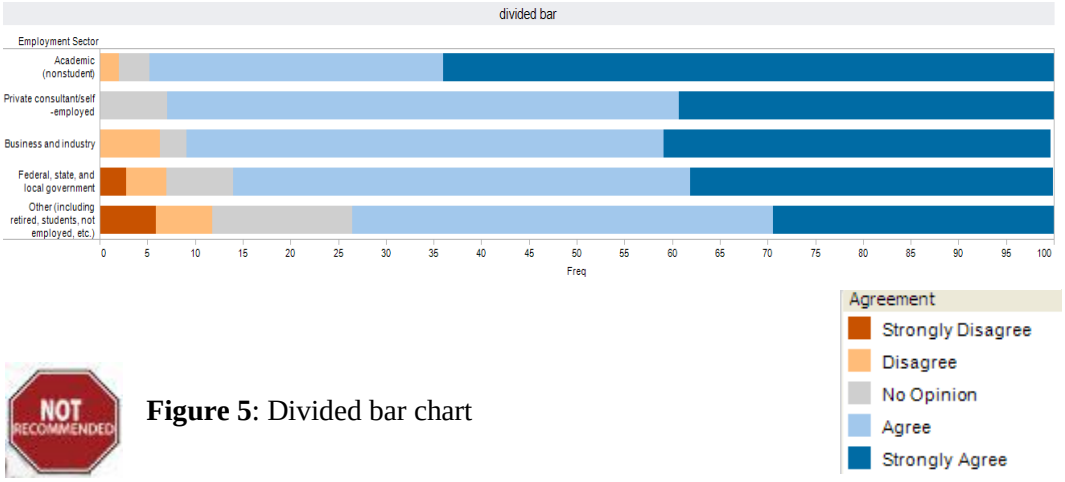

Figure 5: Divided bar chart

It is very difficult to compare lengths without a common baseline. The *Strongly Agree* segments have a common endpoint of 100 and the *Strongly Disagree* segments have a common baseline of zero. However, it is difficult to compare the *Agree* and other middle attitudes. Also, it is easier to compare the total percentage of those who agree or disagree with diverging stacked bar charts than with divided bar charts. Therefore, we do not recommend divided bar charts.

1.7 Multiple Pie Charts

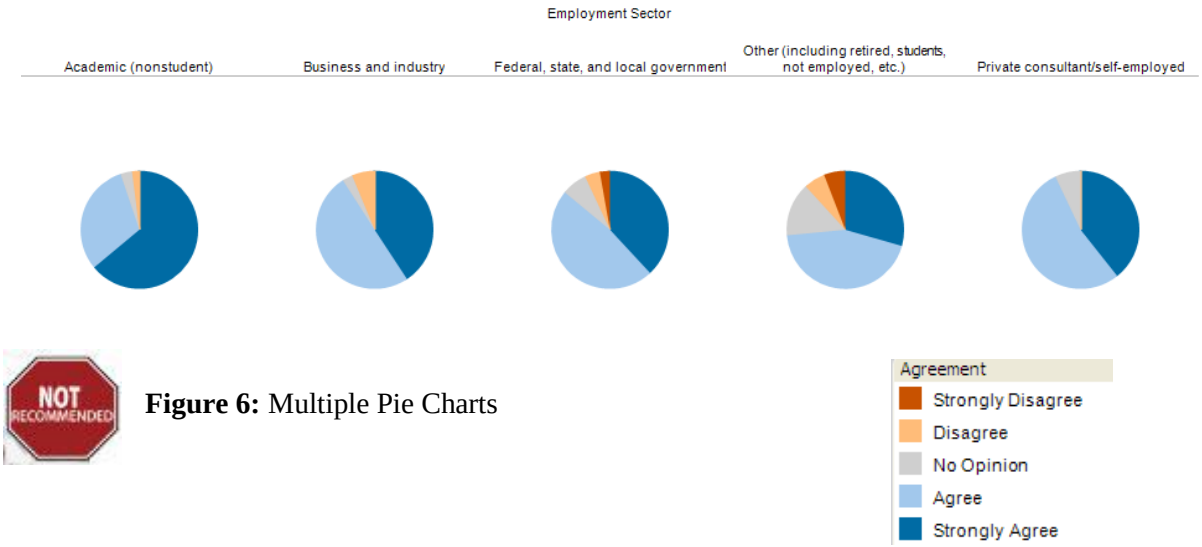

Figure 6: Multiple Pie Charts

Robbins (2005) shows that pie charts do not communicate very well. Comparing the size of wedges across different pie charts is even more difficult and is not recommended.

1.8 Waffle Charts

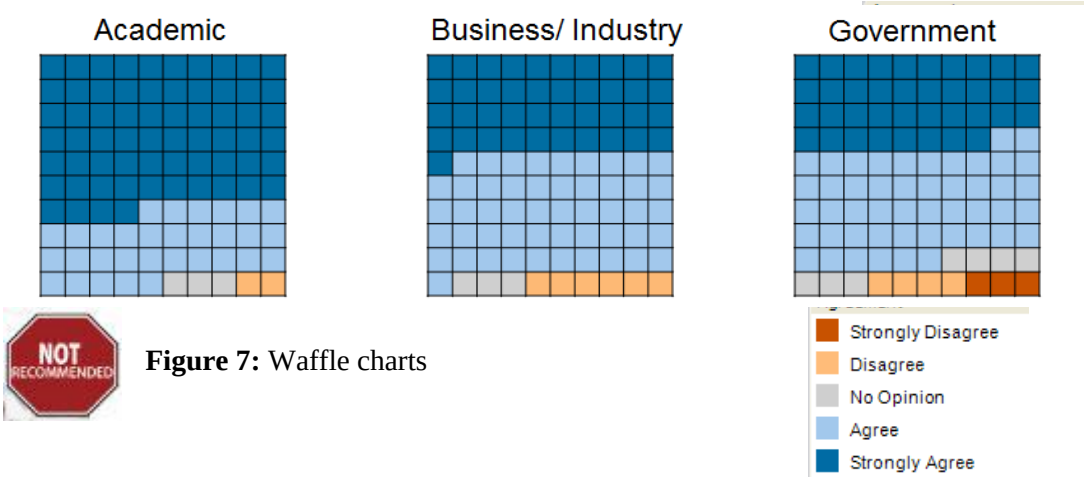

Figure 7: Waffle charts

Waffle charts, also called square pie charts, do not facilitate comparisons as well as some other charts do. The only property of them that matters is the number of squares of each color. The squares themselves have no meaning. Counting the number of squares of each color is a sequential task rather than a preattentive one. Waffle charts work better when there are two choices rather than five, and even then stacked bars would be much easier to read.

1.9 Ribbon Charts

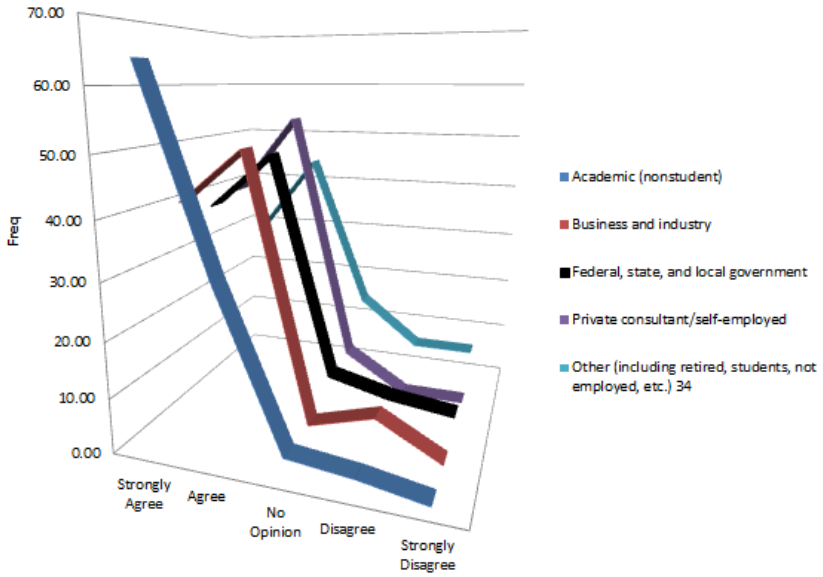

Figure 8: Ribbon chart drawn using Excel.

The ribbons imply continuity of the Agreement scale. In reality the Agreement scale represents discrete values on an ordered factor. In this example the (Academic, Agree) = 30 point is invisible as it looks like an interpolated point. The emphasis of this chart is attracting attention rather than communicating clearly.

1.10 Radar Charts

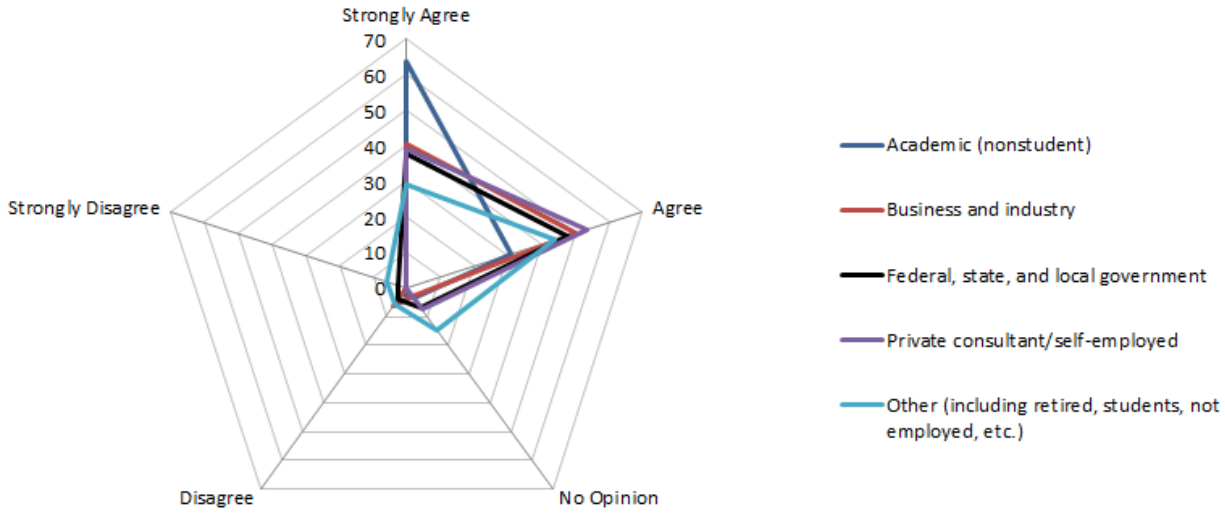

Figure 9: Radar chart drawn using Excel.

Radar charts are difficult to interpret. This chart implies that the Agreement scale is circular—that the *Agree* and *Strongly Disagree* categories are close to each other. There is no sense of a linear relationship among the labels and the endpoints are actually in opposition.

1.11 Diverging Stacked Bar Charts with Counts Added

Figure 10 shows an option for adding counts to the diverging stacked bar charts.
We did this by appending two plots, one based on percentages within each category and one based on counts for the entire category.

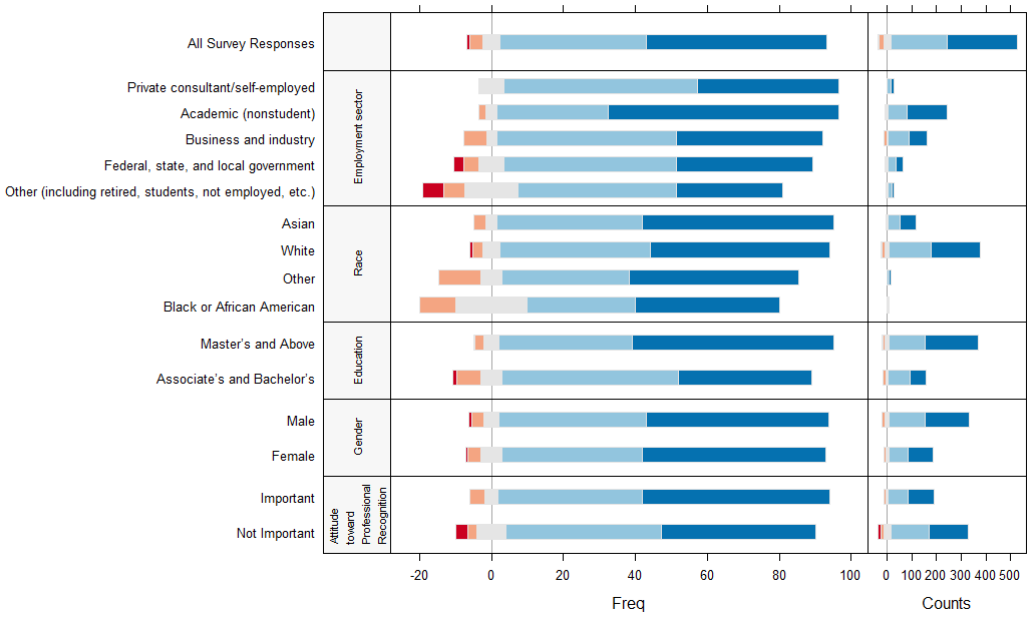

Figure 10: Diverging stacked bar chart with counts shown

2. Software for Computing Diverging Stacked Bar Charts

2.1 R

A set of new functions for producing diverging stacked bar charts will be available in the version of the HH package for R to be released in September 2011. The primary function takes a table of rows (groupings of respondents) by columns (levels of agreement)—for example the Employment Sector section of Table 1—and produces a single-panel diverging stacked bar chart—for example the Employment Sector panel in Figure 2—using the lattice plotting capabilities. Secondary functions, also to be in the HH package, take multiple single-panel charts and plot them with coordinated axes--the complete Figure 2—using functions in the latticeExtra package.

The functions for diverging stacked bar charts can be used from the command line, from a new menu item in Rcmdr for all versions of R (with the RcmdrPlugin.HH package), and in RExcel for R on Windows.

The diverging stacked bar charts are centered at zero with a reference line at zero. It is important that the reference line lie behind the bars; otherwise, the neither agree nor disagree group is split and appears to be two groups. Colors are chosen that are accessible to those with color vision deficiencies. We use a diverging color scheme from RColorBrewer. The name "diverging color scheme" motivated our name for the charts. In

this type of color scheme, the intensity of color increases with the intensity of attitude in each direction. The default sequence for presentation of the bars is determined by sorting by the percent positive; i.e., the right hand side.

As important as what we do is what we do not do. There are no pseudo-three-dimensional bar charts. There also is no inappropriate conflation of discrete and continuous variables as we saw in the ribbon chart.

2.2 Tableau

Readers who use Tableau should send an email to naomi@nbr-graphs.com for a copy of a worksheet with the calculated values shown.

3. History and Acknowledgment

Brinton (1939) describes bilateral bar charts which include population pyramids, charts with some bars to the left and some to the right of a common line (or above and below), as well as what we call diverging stacked bar charts. His examples do not include the results of survey data. Since his examples are taken from other documents, this was not the first use of these charts. Stouffer et al. (1949) make extensive use of both vertical and horizontal diverging stacked bar charts including examples with rating scales. They do not name the charts; Schmid (1983) includes horizontal and vertical diverging stacked bar charts in his classification of bar charts, calling the horizontal sliding bar charts and the vertical floating bar charts. Thanks to Nick Cox for helpful comments and alerting us to the early references.

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