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# Multiple Pie Charts: Unreadable, Inefficient, and Over-Used

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*A pie chart is a common way of presenting simple statistics—for example, the amount of time devoted to teaching, researching, and administration by the faculty can be illustrated by dividing a circle ('pie') into three appropriately sized segments. There has been much discussion about the strengths and weaknesses of such pie charts for a long time, and it is not likely to end soon. 3D pie charts show the same statistics, but in three dimensions. Multiple pie charts can be found where the data for groups to be compared are presented in adjacent pies. Here we argue that, even if a simple pie chart may have some advantages, the same cannot be said for multiple pie charts. Multiple pie charts are difficult to analyze and interpret, especially when comparing adjacent pies.*

*Keywords: graphical perception; interpretation; pie charts; visualization*

## INTRODUCTION

In his recent taxonomy of visuals in scientific communication, Luc Desnoyers classified pie charts as circular proportional histograms.<sup>1</sup> Such pie charts are often used in business and mass media presentations and sometimes in scientific publications. They are probably the easiest charts to understand by children, especially when it is suggested that they see them as real pies. That said, pie charts are generally considered to be inefficient for representing quantitative information because they are difficult to read, interpret, and compare.<sup>2</sup> Three-dimensional (3D) pie charts are even worse.<sup>3</sup> They do not provide any additional information, and the third dimension is used only to enhance their presentation. 3D pie charts share the same disadvantages as two-dimensional (2D) pie charts, but their layout and appearance make them even harder to read. Their 3D layout affects our perception of the relative sizes of the pieces

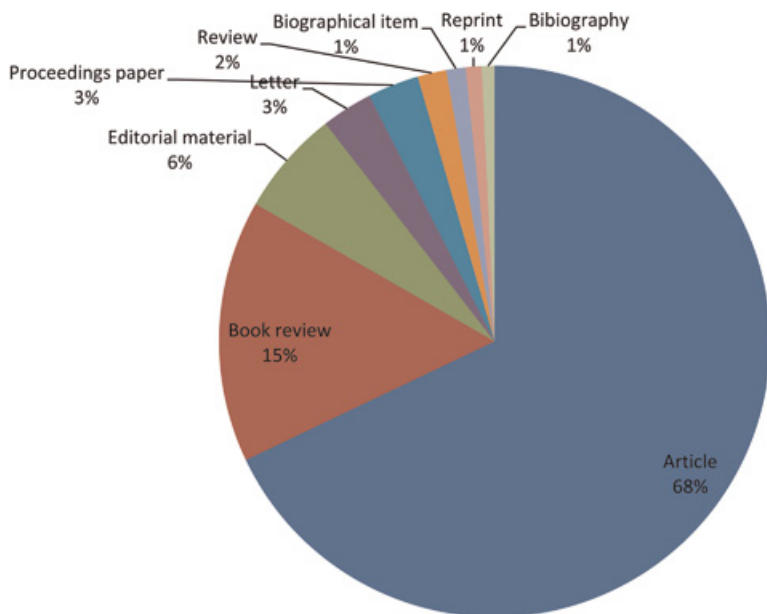


FIGURE 1. A Simple Pie Chart: Share of Document Types Assigned to Items Published by the *Journal of Scholarly Publishing* in 1994–2012. Note that for this journal each paper has been assigned only one document type, hence a pie chart is correct for these data.

in the pie, which makes them harder to compare. And yet so many students, as well as many others—love to add the third dimension to their pie charts, likely thinking that it makes their graphs more ‘attractive.’

We argue that these visual effects are confusing. Nonetheless, 3D pie charts are often present in scholarly publications, even though they add no advantages. We have been surprised to find during a brief literature search many modern papers containing 3D pie charts.<sup>4</sup>

2D pie charts, however, can sometimes provide a fair enough representation for very simple comparative proportions (see Figure 1). But such charts are often used to present more complex data, and then these are additionally grouped into ‘multiple pie charts.’ Basically, multiple pie charts contain a set of at least two or more pie charts that present the same ways of categorizing the data for two or more groups (see Figure 2).<sup>5</sup> One has only to look at these examples to see that multiple pie

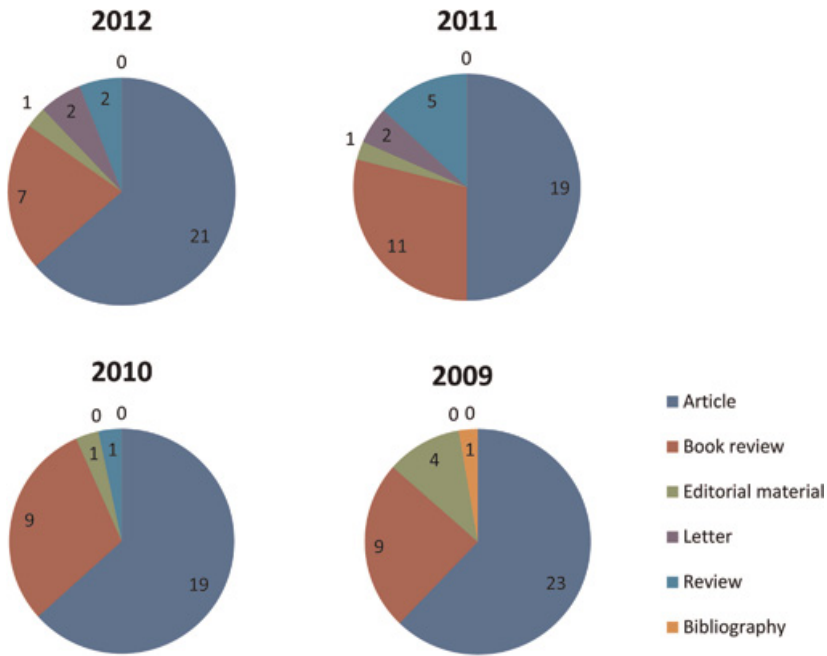


FIGURE 2. A Multiple Pie Chart: Share of Document Types Assigned to Items Published by the *Journal of Scholarly Publishing* in 2009–12. Note that for this journal each paper has been assigned only one document type, hence, a pie chart is correct for these data.

charts are far from effective at conveying information, especially when the main interest lies in group-to-group comparisons. Edward Tufte claims, ‘the only worse design than a pie chart is several of them, for then the viewer is asked to compare quantities located in spatial disarray both within and between pies.’<sup>6</sup>

The aim of this article is to illustrate how poor multiple pie charts are at presenting multi-dimensional data in scholarly publishing. Our discussion, nonetheless, also applies to publications in mass media, business, and technical communications.

#### ILLUSTRATIONS

Figure 2 presents another example to reinforce the earlier discussion. Figure 2 is a multiple pie chart that shows the annual numbers of various

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TABLE 1. Share of Document Types Assigned to Items Published by the *Journal of Scholarly Publishing* in 1994–2012

Type of document	2009	2010	2011	2012
Article	23	19	19	21
Book review	9	9	11	7
Editorial material	4	1	1	1
Letter	0	0	2	2
Review	0	1	5	2
Bibliography	1	0	0	0

Note: This is the same data as represented in Figure 2 but in a simple tabular form—the table is much easier to read than the pie chart.

types of contributions to the *Journal of Scholarly Publishing*, according to the Web of Science. Figure 2 has used an ineffective way of coding. To decode this information one needs to distinguish between the angles of the slices of the pie. William Cleveland pointed out that such procedures are neither simple nor overly accurate.<sup>7</sup> And this becomes a difficult task to do for pies that are not adjacent to each other. For these reasons, multiple pie charts are often far from effective at conveying group-to-group and within-group comparisons. This graph is difficult to read for the reasons discussed earlier.

In our opinion, a table presenting these data would be more readable because it is easier to count the number of items in a table than it is to see where these numbers are shown visually in the graph. Table 1 is the easiest tabular design to represent the same data as Figure 2. Is it easier to read than the figure? ‘Well, the figure presents raw numbers and visualizes percentages, while the table offers only raw numbers,’ one might say. The table, then, can include both, as does Table 2. Is it difficult to read? Note that in Table 2 percentage values—which, in our opinion, are less important—are presented in smaller font, thereby emphasizing raw numbers (a similar approach has been proposed for various applications).<sup>8</sup>

CONCLUDING REMARKS

As noted earlier, multiple pie charts can be found in various publications. And Dong-Hoon Shin and his colleagues present multiple 3D pie

TABLE 2. Share of Document Types Assigned to Items Published by the *Journal of Scholarly Publishing* in 1994–2012

Type of document	Count (%)			
	2009	2010	2011	2012
Article	23 (70%)	19 (58%)	19 (58%)	21 (64%)
Book review	9 (27%)	9 (27%)	11 (33%)	7 (21%)
Editorial material	4 (12%)	1 (3%)	1 (3%)	1 (3%)
Letter	0 (0%)	0 (0%)	2 (6%)	2 (6%)
Review	0 (0%)	1 (3%)	5 (15%)	2 (6%)
Bibliography	1 (3%)	0 (0%)	0 (0%)	0 (0%)

Note: The same data represented by Figure 2 and Table 1 but here with raw numbers and percentages.

charts that are particularly difficult to read by combining the disadvantages of a multiple layout for pie charts with their 3D effect.<sup>9</sup>

However, to be fair, not all experts in graphics share this critical opinion of pie charts.<sup>10</sup> Leland Wilkinson, for example, claims that visualization efficiency is not always the main concern of the designer, because some elements of a graph, although not strictly correct from perceptual point of view, may serve other important purposes.<sup>11</sup> Thus, for example, meaningful pictograms can present redundant information in a graph but, alternatively, they can help people to remember the information.<sup>12</sup> However, pictograms serve a negligible role in scientific communication compared with the mass media.

In this case, Wilkinson disagrees with Cleveland, who feels that figures must be efficient in terms of graphical perception. Tufte also takes a different approach from Wilkinson. Tufte incorporates the term ‘chart-junk’ to describe visual elements in charts that do not add any information to the chart but, rather, distract the viewer from this information.<sup>13</sup> Tufte claims that such elements should be removed from a graph and that some of the graph types—multiple pie charts included—are themselves examples of chartjunk. However, Wilkinson replies: ‘There may be good reasons to dislike chartjunk ... but the crusade against chartjunk is not supported by scientific research and psychological theory.’<sup>14</sup> For interested readers, C.W. Ervin provides a more detailed discussion of these issues.<sup>15</sup>

Our aim here is not to enter into this more detailed discussion of pie charts but, rather, to reinforce the statement that, whether or not simple pie charts are efficient in conveying information, multiple pie charts are not. Indeed, multiple pie charts can be spectacular, with all of their colors, circles, and dimensions, but, in most situations, because they do not convey their information clearly, they should be avoided in scholarly communication.

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