PAPER PENCIL PRINCIPLE FOR DATA VISUALISATION

Visual learning is one of the primary forms of interpreting information, which has historically combined images such as charts and graphs (see Box 1) with reading text.1 However, developments on learning styles have suggested splitting up the visual learning modality in order to recognize the distinction between text and images.2 Technology has also enhanced visual presentation, in terms of the ability to quickly create complex visual information while also cheaply distributing it via digital means (compared with paper, ink, and physical distribution). Visual information has also increased in scientific literature. In addition to the fact that figures are commonplace in scientific publications, many journals now require graphical abstracts3 or might tweet figures to advertise an article. Dating back to the 1970s when computer-generated graphics began,4 papers represented by an image on the journal cover have been cited more frequently than papers without a cover image.5

Box 1

Regarding terminology, the terms graph, plot, chart, image, figure, and data visual(ization) are often used interchangeably, although they may have different meanings in different instances. Graph, plot, and chart often refer to the display of data, data summaries, and models, while image suggests a picture. Figure is a general term but is commonly used to refer to visual elements, such as plots, in a scientific work. A visual, or data visualization, is a newer and ostensibly more inclusive term to describe everything from figures to infographics. Here, I adopt common terminology, such as bar plot, while also attempting to use the terms figure and data visualization for general reference.

There are numerous advantages to quickly and effectively conveying scientific information; however, scientists often lack the design principles or technical skills to generate effective visuals. Going back several decades, Cleveland6 found that 30% of graphs in the journal Science had at least one type of error. Several other studies have documented widespread errors or inefficiencies in scientific figures.7, 8, 9 In fact, the increasing menu of visualization options can sometimes lead to poor fits between information and its presentation. These poor fits can even have the unintended consequence of confusing the readers and setting them back in their understanding of the material. While objective errors in graphs are hopefully in the minority of scientific works, what might be more common is suboptimal figure design, which takes place when a design element may not be objectively wrong but is ineffective to the point of limiting information transfer.