Visualisations in science communication: Friend or foe?

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Abstract

An image is worth a thousand words. This saying is easily disregarded as a cliché in today's extremely visual world, but it may ring truer than ever. With the vast amounts of information reaching us every day, visualisations are increasingly important to make sense of (big) data and to aid fast decision making in science and healthcare. An effective visualisation satisfies both a scientific and a design perspective, a balancing act that requires two different skill sets. Science communicators can play a key role in translating scientific data into good visuals, but there are several common pitfalls to watch out for.

Understanding data through visualisation

Huge amounts of information reach us every day and the speed with which we collect, and process data is rapidly increasing. Visuals are an excellent way to quickly communicate new ideas. Especially for those who are not well-versed on a particular subject, visualisation is a valuable tool to quickly assess and absorb new information. In science and healthcare, the public image is suffering, and we increasingly see that scientific information is distrusted or misinterpreted, particularly by the lay public.[1,2] This can have far-reaching consequences, such as the current vaccine crises in Europe and the USA.[1,3] Sound scientific evidence is difficult to spot among the huge amounts of information and faux news that reach us daily. Traditional news channels, which make use of trustworthy sources and thorough fact-checking, are being replaced by social media, which is often sparsely sourced and opinion-based. Hyped reports of scientific fraud in the media coupled with the (perceived) closed demeanour of scientists exacerbate the problem. To make matters worse, scientific information is often not presented in a way that aids understanding. The lack of visualisations and a storytelling approach makes it harder to understand the value of scientific developments, both for lay audiences and those with a scientific or medical background.

As science communicators, we want our message to reach the right audience and to convey the right information. But to make an impact, our message needs to jump out from the vast amounts of information out there. Visualisations have a strong role to play in this respect. Numerous studies show that people learn more efficiently from visual input than from auditory input or written text and that short- and long-term recall improves with visual learning.[4–7] Creating an image (especially drawing something yourself) increases the understanding and retention of scientific concepts.[8] By effectively incorporating visualisation, we can increase the effectiveness of science communication, optimally exploit the potential of big data, and begin to change the negative image of science and medicine among the general public.

A visual by any other name

For the sake of simplicity, I'll use the terms "visual" or "visualisation" as collective terms to describe a wide array of graphical representations. To name a few: Medical illustrations, infographics, animations, and data visualisations.

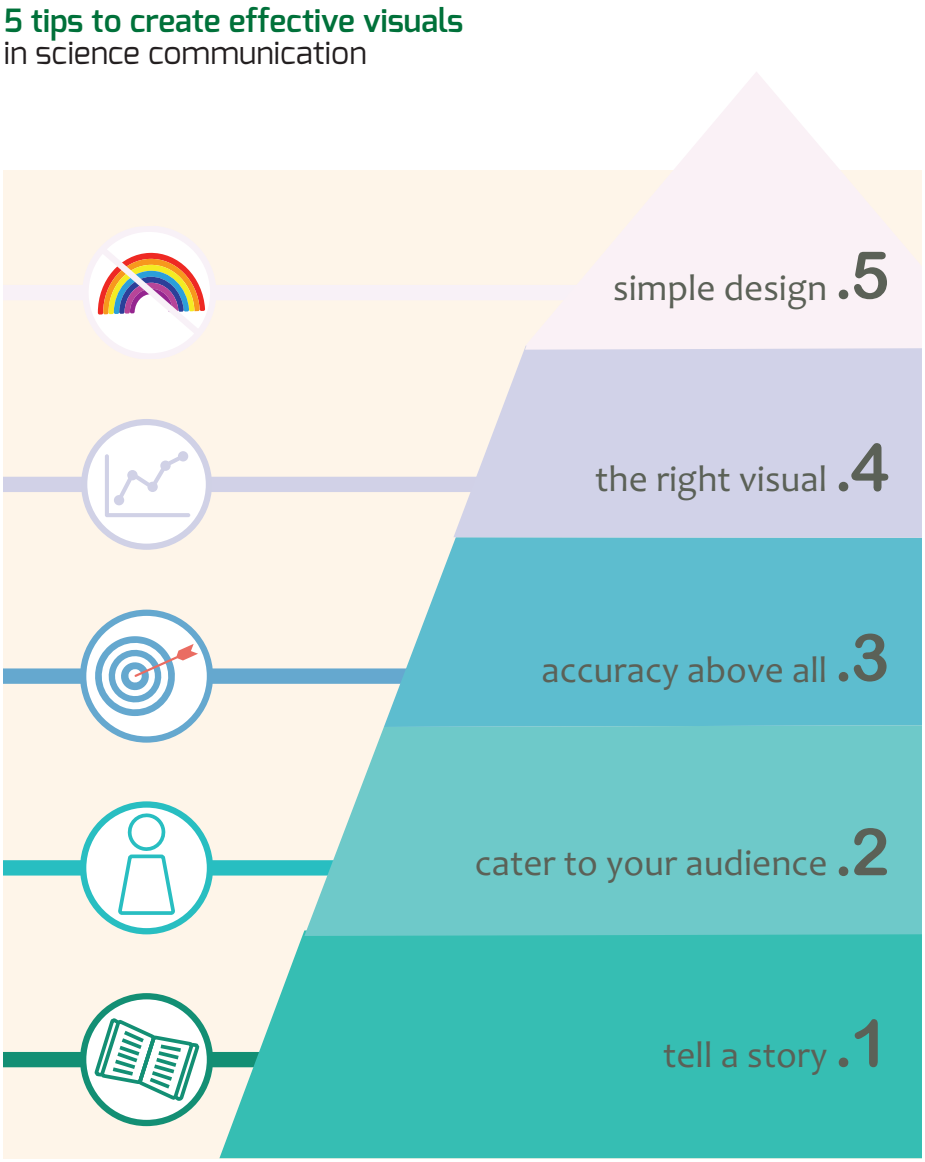

Figure 1. Infographic: Five tips to create effective visuals in science communication
Visualisations have a strong role to play in science communication but watch out for these common pitfalls. The pyramid grows from the bottom to the top and each of these aspects builds on top of the last. This infographic was designed using resources from Freepik.com.
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Think of examples such as the graphical abstract of a manuscript, the user instructions for a medical device, or the simplified scheme of a study design in a patient consent form. There is no real consensus on where one category ends, and categories will often overlap in practice. A medical or scientific illustration typically illustrates a medical or scientific principle, concept, or procedure in a single image.[9] An infographic combines several charts and illustrations and minimal text to give an easy-to-understand overview of a topic.[10] Data visualisations are visual representations of (big) data to help people understand the significance of the data. More so than other forms of visualisation, data visualisations are used to measure and consequently steer performance.

Today, we have a plethora of tools at our disposal to create a wide variety of visualisations. Designs can be made by hand or computer rendered in 2D or 3D and can be animated. The possibilities for creating visualisations are endless and limited only by our creativity.

Common pitfalls of visualisations

Using visualisations in science offers a world of possibilities, but there are several pitfalls to watch out for. Creating an effective visual is a true interdisciplinary practice and marries the worlds of science and design. These two worlds require different skill sets. In the next section, I will illustrate several important features to keep an eye on when it comes to visualisations.

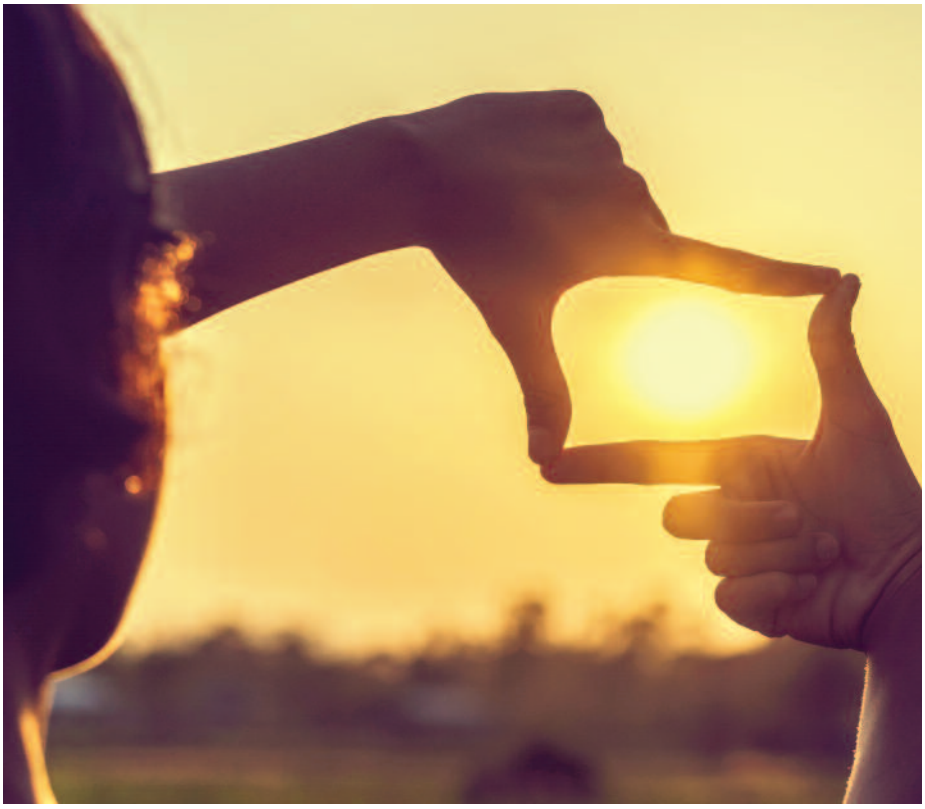
1. Tell a story

Before you start with any piece of communication, visual or otherwise, it is essential to know where you are going. Without a clear message, the piece becomes ineffective. A good storyline is even more important when it comes to visualisations and is one of the hardest things to get right. In a visual, we often do not have the luxury to add a box or to take a detour to provide the reader with more context. Very little (or no) text is used and we need to be able to convey our message with images as much as possible.

Storytelling is the most effective way to communicate because people are wired to think in stories. An increasing number of studies support the use of storytelling and narrative in science communication.[11–14] **Stories engage us and make it much easier to comprehend and remember** concepts (think plots), facts (think events), and players (think characters).[15] It is an invaluable tool that is widely used in fields like business and marketing but not yet fully utilised in science.

2. Cater to your audience

The storyline and the target audience tie in closely together. The target audience will define how to present the message, which story we can use to do so and what type of visual or even colours to use. Is this a novice audience or does the audience already have a lot of background knowledge? For a medical specialist, a comprehensive graph may be appropriate, whereas a patient will gain more from a well-designed infographic. Remember that **most audiences will take the path of least resistance**, so the information must be tailored for that audience and presented in a clear, simple way. This is true



for lay audiences who are unfamiliar with the concepts and for busy scientists and doctors who don't always have time to decipher a complicated visual. A few things to consider when investigating your target audience: How accustomed are they to seeing data, i.e., numbers? Where will the audience see the visual, for example, in a presentation or in print? How much time will they typically spend to understand a visual? How will the visual add to the information that your target audience already has?

3. Accuracy above all

This next topic may be one of the reasons why many are still suspicious of visualisations in science: maintaining scientific accuracy. It is a common fear that **scientific concepts become oversimplified in visualisations and that accuracy will always suffer**. These concerns should not be taken lightly. In an improperly structured or oversimplified visualisation, the message can get lost or the data is taken out of context. It can confuse the audience, or worse, cause (huge) misconceptions.[16,17] There must be a balance between presenting a conclusion to the audience on one hand and presenting facts so that the audience can draw its own conclusion on the other.[18,19] Although design and accuracy seem contradictory at first, they go hand in hand. To achieve the right balance, an adequate understanding of the science by the designer is needed and close collaboration between scientist and designer is essential.

4. Choose the right visual

There are infinite possibilities when it comes to choosing which visualisation to use and each will influence how the message is perceived. The elements of the visualisation must fit the data and are not merely decorative. Specifically, graphs should be treated with great care. When choosing a graph type, ask yourself **what you want your audience to learn from the graph**. Imagine looking at the graph as if you have never seen this type of graph before. Is your message still clear? For example, pie charts are excellent for simple data that breaks down into percentages but are useless for pretty much any other data set. Again, your audience will dictate, for a large part, how the data is presented. More complicated graphs can be used for audiences with a lot of background knowledge. But be careful: Even seasoned audiences will often not spend time to "decipher" a complicated graph, so stick to a single, clear message.

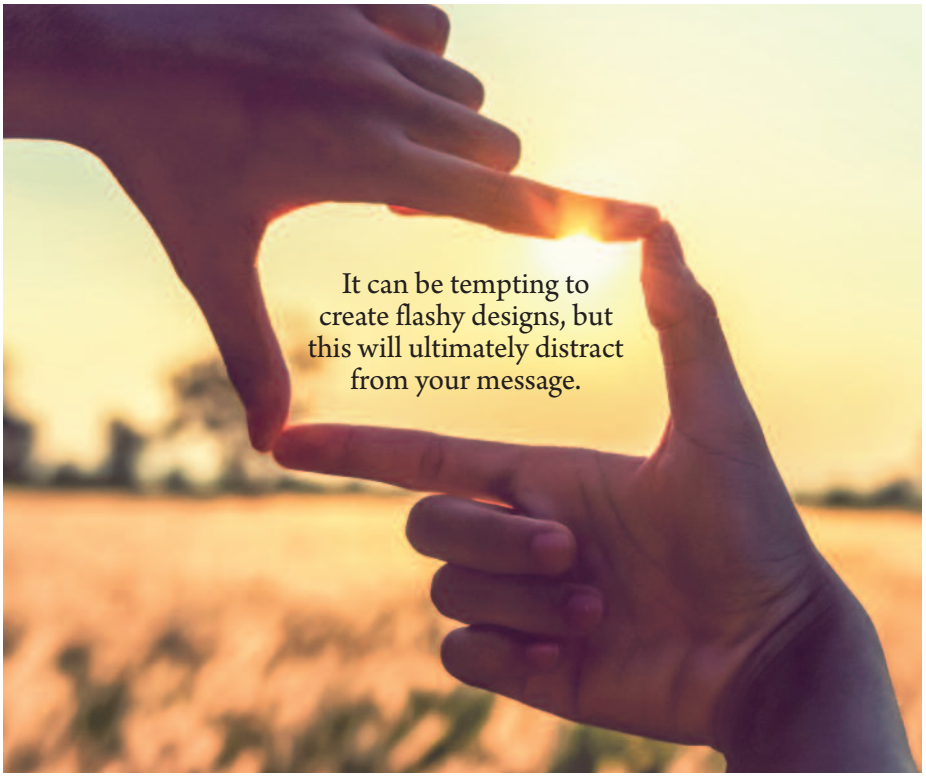
5. When it comes to design: Less is more

Think of the early PowerPoint days when slides were overloaded with flashing texts, items flying from various angles and a different transition after every slide, and you will know exactly what to avoid. From a design perspective, scientific visualisations are often overcrowded with information and not enticing to look at. This causes them to miss the mark with their intended audience. **When it comes to design: less is more**. It can be tempting to create flashy designs, but this will ultimately distract from your message. By now, we should have a clear idea of the main message and the target audience, and these will be leading for the design. An educational poster for kids about hand hygiene will require a different design approach than a poster for medical students showing the stages of ovarian cancer. General design rules of thumb exist. For example, use no more than four distinct colours in a single visual and think of complementary colour choices. The Gestalt principles of visual similarity and grouping also provide some guidance: "The whole is different than the sum of its parts."[20] There are, however, no one-size-fits-all solutions. Close collaboration with a designer is thus invaluable to strike the delicate balance between a creative design that will be noticed and a design that serves your message.

Finally, also when it comes to text, less is more. Text should support a visual, not the other way around. Constantly ask yourself if the visual can be understood without any text.

6. Bonus tip: Be aware of cognitive bias

The five pitfalls mentioned above are common and are easily controlled for with a well-thought-out design. Another aspect that is harder to control for is cognitive bias. We are often unaware of its effects, but we have undoubtedly all fallen victim to it. Cognitive bias is when our established thinking patterns influence our judgements and decisions. There are different types of cognitive bias e.g. confirmation bias – when people tend to search for or interpret information in a way that confirms their beliefs – or familiarity bias – when people tend to estimate something as more likely or true if they are already familiar with it.[21,22] I deem cognitive bias the sixth pitfall, and it can affect the person creating the visualisation and the person viewing the visualisation. Since visualisations rely so heavily on imagery, interpretation of a visual is subjective. As the one designing the visual or choosing the data to include, we must be careful not to select just the data that agrees with our own viewpoint. In this way, we can create a bias or a misleading conclusion without meaning to. On the flip side, every person that sees our



visualisation also has his or her subjective interpretation. We cannot, of course, correct for each individual's potential cognitive bias, but **by looking closely at the target audience and taking into account their background, we can adjust the visualisation to minimise bias**.

Friend or foe ... or both?

To answer the question: Are visualisations in science communication friend or foe? I say friend. Visualisation is a vital communication tool that is becoming increasingly important to make sense of the huge amount of data that is collected in science and healthcare today. Presenting data in a visual way helps us to make connections and easily recognise patterns within data sets. The importance of visuals is underlined by publishers and regulators. Elsevier, Cell Press, and *Journal of Cell Biology* call for graphical abstracts when submitting manuscripts and offer some brief guidelines.[23–25] Lay summaries are now mandatory in clinical trial reports and visuals are encouraged to make the information more accessible to this audience. The EU clinical trial regulation includes some general instructions.[26,27] It is, however, the responsibility of the trial sponsor to develop a lay summary and science communicators who can make this translation will be an important asset.

Although visualisations offer a world of possibilities, improperly designed visuals can cause huge blunders and become a big foe. While aspects such as maintaining accuracy and catering to the right audience may be obvious, others such as storytelling and design aspects may come a bit less natural to science communicators and medical writers. However, the need for skilled people who can combine these two worlds is increasing. There is a lot of opportunity in this area, and I would argue that every science communicator should know the basics about graphic design and how to create an effective visual.

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Conflicts of interest

The author declares no conflicts of interest.

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Fun initiatives on the topic of science visualisation

- The Picturing to Learn programme[28] features hand drawings made by science students and faculty from Harvard, MIT, Duke University, and Roxbury Community College, along with design students and faculty from the School of Visual Arts, New York. Students were asked to create a freehand drawing to explain various scientific phenomena to a high school senior.
- Science and Engineering Visualisation Challenge in USA co-sponsored by National Science Foundation and *Science* magazine.[29]
- "The Sackler colloquia: The science of science communication"[30] advocate the science of science communication as a unique discipline and includes topics such as "Communicating uncertainty in policy analysis" and "Science audiences, misinformation, and fake news". Organised by the National Academy of Sciences and published in a special issue of the *Proceedings of the National Academy of Sciences*.[31]
- The Health Care Foundation offers a nice collection of tips and guidelines on how to implement storytelling in healthcare. The Health Care Foundation is an independent charity committed to bringing about better health and health care in the UK.[32]
- A guideline from Arts and Humanities Research Council (AHRC) and University of Leeds with many excellent tips for health care infographic designs for the lay public.[33]

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