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Illustrating your research: design basics for junior clinicians and scientists

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Communication in the fields of science, technology, engineering, and mathematics has historically been dominated by text based mediums. Scientific articles, textbooks, reviews, conference proceedings, and posters rely heavily on text to communicate scientific findings. Our current method of communication is framed primarily for those who conduct research, and we generally make little use of visual aids, which are arguably more effective.¹ However, scientists and clinicians may struggle to translate scientific data into clear and informative graphics. As a group of biomedical postsecondary students and scientific illustrators interested in graphic design, we have consolidated and summarised the eight steps we use for creating eye-catching illustrations. These steps are intended as a practical resource for junior clinicians and scientists to use when creating scientific graphics, including manuscript figures, scientific poster presentations, and slides for oral presentations.

Why use visual communication?

Most people interested in finding information now use online resources. The internet is full of relevant search results, so being able to capture an audience's attention is crucial for knowledge translation. Some high impact journals, including *Cell*, now feature and request graphical abstracts, creating a prime opportunity to incorporate visual communication into scientific data presentation.² Data suggest that clinicians and medical trainees respond more favourably to visual communication methods such as infographics rather than to traditional text based information. For trainees and junior clinicians, designing effective and clear visuals improves communication, knowledge dissemination, and application to real-life scenarios. Visual illustrations are more memorable than words, as stated in the "picture superiority effect." Several hypotheses have been developed as to why visuals are more memorable.³

Catching readers' attention is especially crucial when sharing scientific pieces on social media platforms, a key part of knowledge dissemination in today's society. Scientific illustrations on social media are more accessible than text-heavy articles; a thorough illustration enables a much wider audience to understand the main points of a publication. Because of widespread sharing and retweeting, images on social media can be disseminated at a much greater rate than would typically be achieved by publishing

in a journal. Platforms such as Twitter are becoming a method for knowledge translation and scientific communication, especially in the current #scicomm era. Research has shown that tweets with images get 18% more clicks, 89% more favourites, and 150% more retweets compared with the typical 140-character tweet.⁴ However, illustrations must be made thoughtfully and deliberately: tweets with images surely get more clicks, but they may not always be deserved. There is always the risk of misinterpretation when graphics are taken out of context, thus care must be taken to create an image that can stand alone and accurately represent the results of a study.

The reality is that illustrations and attention-grabbing figures are critical to effective science communication and dissemination, therefore we have outlined eight simple steps for creating an effective visual illustration.

Step 1: Understand the target audience

The level of detail you should provide for an illustration needs to be determined and should frame all the following choices (and you have a few to make). An illustration designed for an undergraduate student's biology textbook is going to look very different from a scientific publication in a disease-specific journal. Take the time to determine how and where your illustration will be used and who will be viewing it. If your graphic is for a poster presentation at a medical conference, it is safe to assume that the audience will be highly educated, so more complex schematics are appropriate. In contrast, an infographic intended for community use should use lay language and clear icons to ensure that it can be understood by individuals of diverse backgrounds. It is important to leave opportunities to insert additional context and simplify when required. This is particularly useful for scientists who use the same graphical representations for teaching students and explaining their research to peers at conferences or in publications.

Step 2: Identify an illustration platform

Many platforms are available to create figures and graphics: some of these programs require some technical skills, but many are user friendly. [Table 1](#) shows three commonly used platforms that can yield highly effective illustrations categorised by the skill level needed for use.

Table 1 | The three most commonly used platforms for creating scientific illustrations

Platform	Description	User friendliness	Customisability	File format
Microsoft PowerPoint	Part of the Microsoft suite and arguably the most popular among scientists	Moderate	Moderate	PDF, PNG, JPG
Canva	A free online drag-and-drop design tool with a large selection of layouts, shapes, and text to choose from. Contains some graphics, photos, and illustrations available for purchase	High	Low	PDF, PNG, JPG
Adobe Suite (Photoshop and Illustrator)	Part of the Adobe suite and commonly used by artists and graphic designers	Low	High	PDF, PNG, JPG, SVG

Step 3: Pick the most important points to communicate

As a rule, when starting an illustration, identify three main points and no more than 10 “sub-points” you want the audience to take away. The rest of the details can be added in afterwards. At this step, it is critical to decide how you will make your points as clear as possible to prevent misinterpretation. If this image may be taken out of context (for example, shared over social media for promotional or educational purposes), you must include everything needed to adequately communicate the key information. Think about these points as your “main results” titles. Or, if you are illustrating a concept, think about the main players in the schematic and how those relate to each other. Determining these points before embarking on the rest of the illustration will save you time later.

Step 4: Layout and composition (the A-to-E of basic design)

Whether you are illustrating a cell signalling pathway or demonstrating themes in a qualitative study, it is important to follow some key principles.

Alignment (positioning elements in a straight line)—Keep it clean. Alignment can take an image from disorganised to organised in a few simple steps. While sometimes it is effective to have overlapping and differently aligned objects for more complex designs, it is usually best to keep the illustration clean and simple. Alignment tools exist on most illustration-synthesising platforms, including the programs listed in [table 1](#).

Balance (symmetry of objects, colours, and space)—Limit proximity and consider white/negative space. We have all seen illustrations that look too busy, confusing, and hard to follow. Sometimes these issues can be addressed by playing with the balance between proximity (grouping things that are similar and/or related close together) and white space (space that helps separate groupings). This can help an illustration go from overwhelming to easily understandable.

Contrast (arranging opposite elements)—Highlight the key points while keeping everything else in the background. Contrast in design is essentially using a variety of different strategies to emphasise key concepts. This can be done by using bold or coloured fonts, or objects to highlight key portions of the design. This approach is especially helpful if there are multiple “less crucial” concepts to the structure.

Duplicate (repeating elements and styles)—Aim for internal consistency. Maintaining the same graphic look and feel throughout allows readers to focus on your science rather than trying to follow differences in your figures. Using too many styles or graphics can detract from other key aspects of the illustration, decreasing the

readability and coherence of the illustration. If possible, use the same colour scheme, fonts, and methods of contrast and hierarchy throughout the illustration. Repetition is especially important in a paper with multiple figures or key concepts.

Efficiency (using clear and concise visuals, symbols, and text)—Plan where to begin and where to go next. In any scientific discipline the demonstration of hypotheses and data requires important considerations for conceptualising hierarchy. Visual hierarchy refers to using design characteristics to communicate to the reader which information is important. There are different ways to draw the reader’s attention the key points of the illustration, including size, alignment, colour, and repetition. For example, making key points larger will draw the reader’s gaze, whereas minor details can be minimised and/or use muted colours to signify that less attention should be paid to them. It is important to organise concepts in a logical manner and to consider using arrows to demonstrate interactions (but beware of overusing of arrows; do not use more than 10). This is also a great opportunity to use white or negative space to emphasise separate processes.

Step 5: Pick an appropriate colour scheme

Colours are extremely useful when used properly. Colour schemes should include no more than four colours to maintain a consistent style throughout the illustration and prevent distractions. It is essential that colours in the illustration are used to convey the important concepts. In physiological schematics, for example, blood is often represented with red or maroon and is easily understood by the audience and does not necessarily require labelling. This decreases the time required to interpret the illustration. There are consequences of using confusing or misleading colours including the introduction of bias.⁵ Colours can be subconsciously associated with specific concepts, so do not try to challenge these norms. For example, red is often used to represent positive charges while blue is negative, and switching these functions may result in misinterpretation of the image. In the age of social media, most people do not look thoroughly at illustrations, so all possible instances of introducing bias should be avoided.

Depending on your intended audience, an additional consideration when selecting colours is accessibility. This may be challenging for illustrations with many elements or data requiring differentiation; however, solutions such as combining colours with symbols, textures, or patterns may be possible. If you cannot incorporate those additional elements, try avoiding the following colour combinations as they cannot be easily differentiated by individuals who are colour-blind: red and green, green and brown, green and blue, blue and grey, blue and purple, green and grey, and green and black.

Colour schemes used in illustration vary depending on the intended medium of the design. The two possible categories are RGB (red, green, blue) and CMYK (cyan, magenta, yellow, black). RGB designs are intended for emitted light from digital screens which have red, green, and blue diodes that change in intensity to create the desired colour. This form of light is classified as additive since the emitted light blends together, with all three making white. However, RGB colours may end up looking pale when printed. CMYK is needed for print design; unlike RGB, CMYK colour is subtractive, where applied ink reduces the amount of light that would be reflected from the white background. Although most illustrations will primarily be presented online, designs should be initially made in a CMYK colour scheme as it is easier to transition to RGB without any loss of colour. The default of most design software is RGB but can be changed to CMYK in case the illustration will need to be printed in the future.

Step 6: Typography (font)

The choice of font can have a large impact on how people initially respond or perceive your illustration. The font used can frame something as professional or fun. You want to choose a font that speaks to what you are trying to convey. Fonts are broadly classified into either serif or sans serif based on whether they contain “serifs”—small horizontal lines added to the tops and bottoms of letters. The classic examples of serif and sans serif fonts are Times New Roman and Arial respectively. Serif fonts have typically been used in books and newspapers, giving them a classic and traditional feel. In contrast, sans serif fonts appear more modern and approachable, and are often used by newer companies and websites. For scientific illustrations, simple and minimalistic fonts such as Helvetica or Arial are always safe. For graphics with two fonts, it is typically best to use a serif font with a sans serif font of a different weight and size and assign a distinct role, such as body text, for each font. If you feel like being creative and exploring different options, Google Fonts (<https://fonts.google.com/>) has over 900 free typography packages to download. Pick a font that is clear, readable, and fits the target audience of the illustration.

Step 7: Labelling

Labelling is the basis of an informative and understandable illustration. Adequate labels can provide details that would be too difficult to include in the illustration. Do not over- or under-label

as either will lead to confusion. Labels themselves should be accompanied with pointer lines, arranged horizontally, vertically, or at a 45° angle. Lines should not cross over others unless absolutely necessary, in which case different colours should be used to distinguish between labels. Ensure all lines are of equal thickness and text is properly aligned.

Step 8: Shapes, illustrations, images, and simplicity

Depending on the platform, a variety of tools can be used to create shapes and lines or import premade graphics. Several websites allow you to download free “clip-art” style illustrations. Using pre-created illustrations can be great, but remember to keep them consistent if possible or alter their colour to match the rest of your illustration.

Simplifying complex illustrations can be achieved through several methods. Most simply, where you can substitute words with numbers, images, symbols, or graphics, do so. Simplifying a graphic will allow the reader to interact with your research more deeply. This is especially true for graphics that will be accompanied by verbal communication during a presentation or to supplement a poster or text.

Conclusion

Visuals and graphics provide a quick and efficient way of disseminating knowledge to the scientific community, as well as to the general public. As social media continues to be a widely accessed form of communication, it is essential for scientists and researchers to find ways to conform to this method of knowledge translation. Visuals must be strategically presented in a way that is memorable and creative, while still accurately representing the research.

Creating a scientific illustration can seem daunting but it does not have to be. We transformed our [figure 1](#) to [figure 2](#) pretty quickly by applying the simple steps described in this article. Constructing a visual representation of your work is not always intuitive, but, by following the eight steps we describe, you are well on the way to developing an attention-grabbing illustration. If this is not possible, we encourage you to collaborate with a graphic designer to transform your research into a clear and effective illustration. As Anne Roe stated, “Nothing in science has any value to society if it is not communicated.”

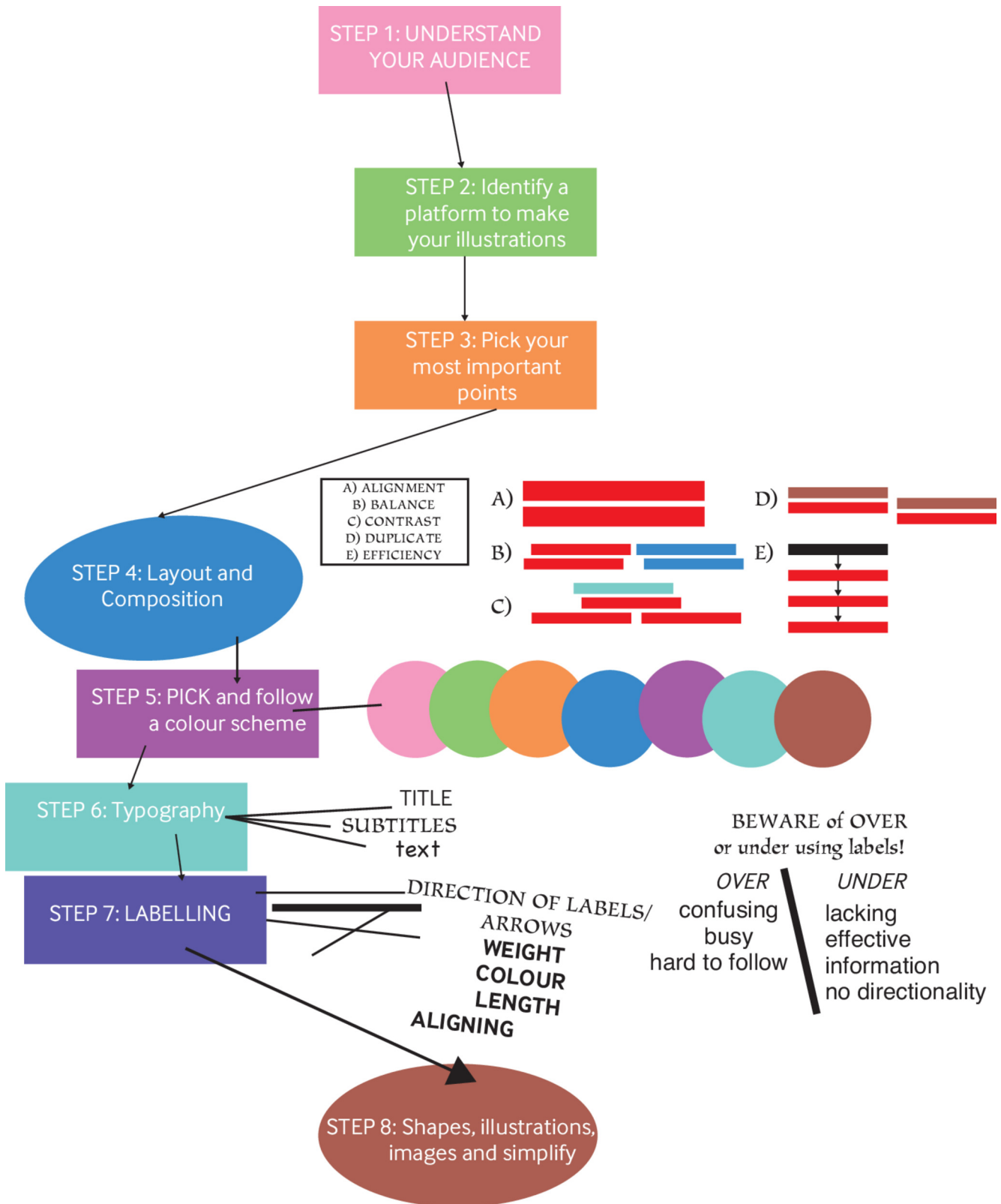


Fig 1 | Diagram demonstrating common mistakes seen in scientific illustrations

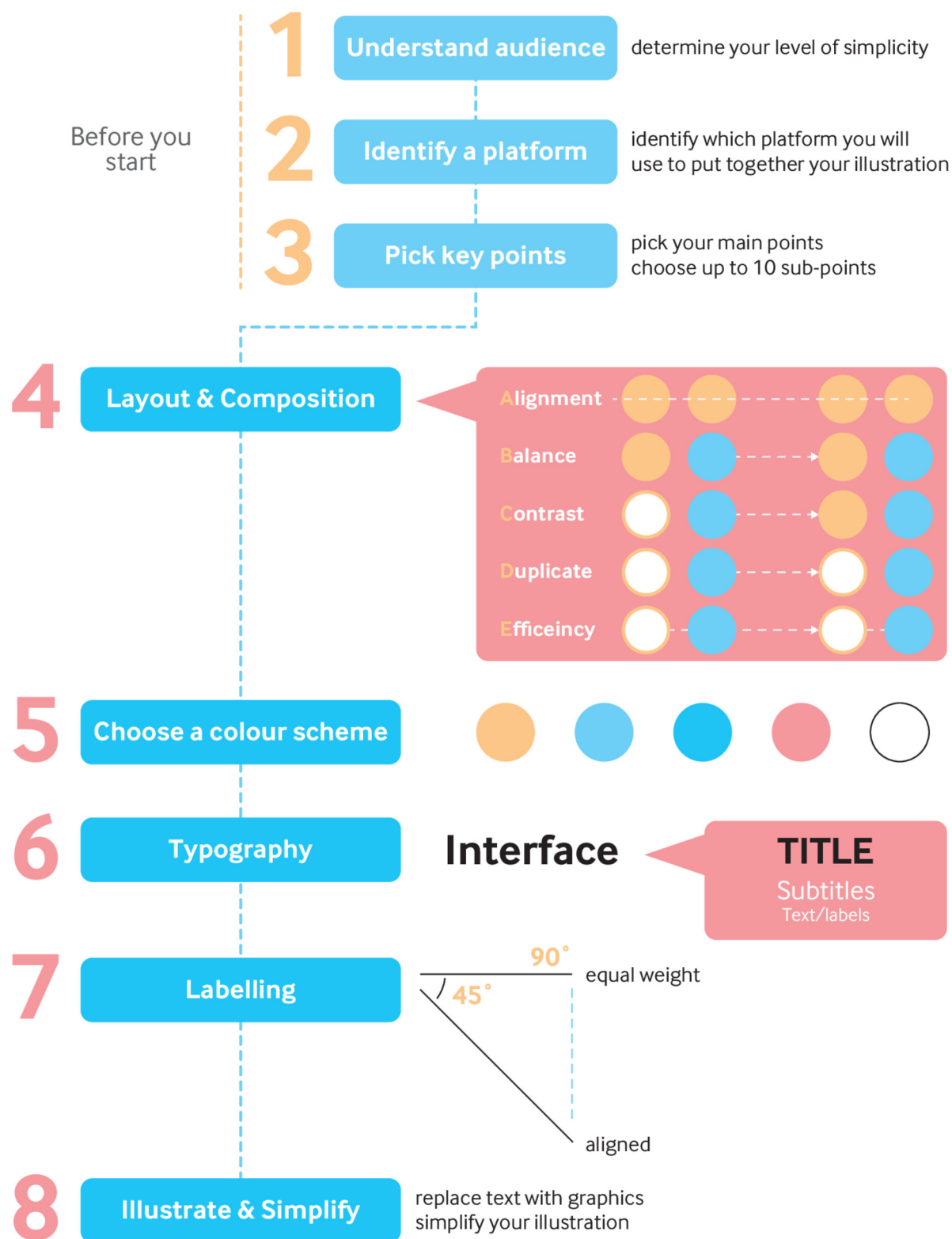


Fig 2 | The eight steps to creating an effective scientific illustration

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