It Takes Change to Make Change: Good Publication Practice—Image Handling

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Aristotle said it best: “We are what we repeatedly do. Excellence, then, is not an act, but a habit.” This insight is profound. Let us just zoom in to our brain for a moment. Even though it has no will of its own, we know what it is repeatedly doing. Processing information. Our brain processes information all the time. Sensory information, auditory information, but most importantly visual information. Up to 90% of all information that enters our brain is visual. Our brains are trained to process visual information fast and effectively, and are excellent at it. Our brain can process an image, any image, in just a matter of milliseconds. We are not even aware of it, unconscious processing indeed.

But more important is what our brain does with that information. Many studies show that what we see has a profound effect on what we do or how we feel. Remember the last time you saw a horror movie? Or, a romantic movie for that matter. Images are powerful. Especially because of the unconscious processing. Your unconscious mind controls your emotions, mood and perception.

Think about it. The figures of your publication will greatly affect how your research is perceived. Your reader will process this information in a split second and (unconsciously) judge the quality of your research. Poor figures devalue the perceived quality of your work. You want to avoid this at all cost. Here are a few tips to help.

Technical requirements

Before even going into the design of the figure, you should be able to make a figure with the correct size and resolution for printing. This sounds obvious, still very often authors will get a message like this after submission of their figures: “For the print version of our journal, production-quality figures are required. Can you

please update your files according to our standards.” The standards command that you need to prepare your figure at the desired print size (1 or 2 columns) and at 300 ppi (pixels per inch). In other words, knowing that a single column is about 9 cm (or 3.5 inch) wide and a double column about 18.5 cm (or 7.3 inch), you should have around 1050 pixels (1 column) or 2190 pixels (2 columns) in your final figure. If that is not the case, you should not submit. Bear in mind that presentation software, like Microsoft Powerpoint, exports at 72 or 96 ppi by default. This can cause many headaches and frustrations. These software packages have no option to specify the pixels per inch. A safer alternative is software that has control over ppi, such as Adobe Photoshop and Illustrator, or the free alternative GIMP. Before you submit your figures for publication it is advised to print them out on your office printer. If the quality is suboptimal, you cannot expect it to be better when the publishing company will print it. This is the easiest way to detect resolution problems and will save you a lot of time down the road.

Editing of images

Images are data that can be affected in the editing phase before publication. There is a thin line between what is considered editing and what can be considered manipulation of an image. The use of powerful software can make you cross this line without even noticing. You can avoid this by applying common guiding principles for image editing. The online learning tool for Research Integrity and Image processing from the Office of Research Integrity (ORI) explains what is appropriate image processing and what is not¹. It also explains how best practices in image handling intersects with other best practices.

Editing of digital images should always be done on a copy of the unprocessed image and the original must be retained. Do not forget to back-up your data!

Keep in mind that, as Nature explains in the instructions for authors “If the original data cannot be produced when requested by an editor or in cases of deliberate misinterpretation of data, the acceptance of the manuscript may be revoked, and will be reported to the home institution or funding agency.”

Remember to not create pixels with software by up-sampling your images or using filters that can degrade your data. If you want to apply some simple adjustments like changes to the brightness and the contrast, this is fine as long as these adjustments are applied to the entire image, and do not obscure, eliminate, or misrepresent any information present in the

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original, and is applied equally to controls. The use of nonlinear adjustments like changes in the gamma settings will affect some pixels more than others and should be disclosed in the manuscript.

The gray area of questionable research practices is very broad and includes practices like neglecting negative outcomes, using inappropriate statistics to support one's hypothesis, inappropriate research design, leaving out relevant controls or removal of "outliers" among others. This needs to be avoided and replaced by good research practices. Keep in mind that we all expect and assume basic scientific honesty and deserve that all the images that are published are accurate representations of our results.

Color

Some industries are more dependent on visual content than others. Think about the graphic design business, or the advertising business. Without good visuals, these industries would simply not exist. We as scientist can learn quite a bit from them.

Take color for example. Scientists pick colors randomly, reflecting more their current mood rather than a conscious decision of how to use color effectively in their figure. The result is a cacophony of colors that does more harm than good. Designers, on the other hand, will decide on a color palette before they start. This color palette is created following some simple rules of color theory. Nothing complex, but very effective. Now it is virtually impossible to make huge color mistakes. When you stick to a color palette, all colors are harmonious and work well together in any composition.

When designing a color palette, make it colorblind proof too. As many as 8% of men and 0.5% of women are affected with the common form of red-green color blindness. Your aim should be

to make your figure as accessible as possible for everyone. You cannot ignore this part of your audience. Most commonly reds and greens give problems, but also blues and yellows might be difficult to distinguish for some people. To make sure your newly designed color palette is colorblind proof, you could use simulation tools like Color Oracle: a free color blindness simulator that runs on every computer. It applies a full screen color filter, so you can see in real time how a colorblind person would see your design.

Text

Most figures include pieces of text to help the reader understand what is displayed in the figure. It is your job to ensure that the text is smooth, flowing and pleasant to read.

Sans-serif typefaces are the ones recommended for this purpose since they have simpler letterforms, are informal and appropriate for short bursts of text such as headings and labels. Some examples are Avenir, Helvetica, Arial, Gill sans or Myriad. All of them are adequate but have subtle differences. For example, Helvetica is a versatile typeface but at small sizes and low resolution it loses readability since ink or pixels can obscure its fine detail and fill in small apertures. Myriad pro is straighter and the curves do not close.

For text that is smooth, clear and readable, the operative word is medium. Keep in mind where your figure will be displayed. If you are preparing a graphical abstract that will only appear online, pick a size big enough to be readable on the screen. Cell press recommends size 1 to 24 since smaller fonts will not be legible online. If we are instead preparing a figure for a manuscript that will be printed, do not make the font too small and force the reader strain to read it. Text that is too big will also look bulky and draw too much attention. Optimal size is between

Figure 1. Before and after: good publication practices applied to a representative example figure.

8 and 12 points. Avoid text with size lower than 6 points or higher than 14.

Arrows, labels, and callouts

Arrows are one of the most commonly used graphical elements in scientific figures. They are highly efficient instruments of visual communication because they guide us through complex information. Therefore, arrows should be used sparingly and clearly.

Reserve the use of lines with heads shaped like arrows when you need to indicate sequence or direction. If you need to label a protein or emphasize the structure of a system, you can use lines without heads shaped like arrows or other variations like a dot or a square.

Keep labels simple and easy to compare by removing common text and aligning related components.

Captions and annotations are not optional and should be integrated seamlessly in the figure. Images with many callouts and labels improve if the lines have a consistent length and constant angles and a uniform spacing and alignment².

Aesthetics

Aesthetics do matter. We all tend to see beautiful objects and designs as better quality. This perceived quality does not always reflect the real quality, but the association is made already in our head. Knowing this, you better pay attention to the looks of your figures. If you can put the same information in your figure, but just a little bit more attractive, you will have more eyes looking to your research.

Beauty is a subjective matter, but there are some factors that will give you a higher probability of making a beautiful figure. Have you ever heard about the contour bias? It is our tendency to favor objects with contours over objects with sharp angles or points. Sharp angles activate our fear processing center in our brains. This triggers an unconscious message to detect potential threats. Experiments show that this has a direct effect on aesthetic perception. It is for this reason that most watches are oval or round. People just like it more. Knowing this, it is easy to always use curved arrows in figures instead of angled ones, or have round edged boxes. Removing as many sharp angles from your composition will make your figure more likeable (Fig. 1).

Compound effect

Isolated improvements on image handling and good publication practices are not difficult. Most of the ideas discussed in this article are small changes and improvements everyone can apply easily. But when applied in isolation, the net effect will be marginal. However, when added up to a series of small and smart choices, the rewards will be substantial. There is a compound effect going on here. This is an ongoing process and more a mindset than a skill. Remember how Aristotle phrased it: “We are what we repeatedly do. Excellence, then, is not an act, but a habit.”

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