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SCIENCE OR ART? THE CREDIBILITY SPECTRUM OF IMAGE MANIPULATION

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Abstract

Photographs and other images are essential in teaching and learning in most fields of knowledge. Getting images right in educational settings promotes clarity and student understanding; getting them wrong subverts knowledge itself, and is confounding for teachers and students alike. However, for students, (and even some educators), assessing the ability of images to be trusted as true representations of people, places, events, and information, and preparing their own images in a credible way, is complex and often poorly understood. This impacts upon knowledge production and use; one study suggests that there may be as many as 35,000 papers indexed by PubMed alone so seriously affected by image manipulation problems that they may be candidates for retraction. [1] Online, there is still a clear lack of understanding of image credibility. [2] As far as securing image rights in an open source, online world, few students have even heard of Creative Commons image licenses, let alone understand how these licenses can control how their images can be used by others. In a project underway at the Australian National University, we have been collecting data on university student image manipulation perspectives and assembling an Image Credibility Teaching Suite for use across the breadth of the University. The data shows that there is a lack of consensus in views on image credibility amongst university students and researchers. From these data and other associated research we present factors central to supporting credible use of photographs and images in education.

Keywords: image manipulation, knowledge credibility, fake photos

1 INTRODUCTION

Since long before digital photography was introduced, photographers have not just been both creating important records of historical people, places and events, but also staging images or creating seemingly real but actually false images crafted from disparate negatives in photographic darkrooms. Digital photography, introduced in the late 20th century, spawned 'digital darkrooms' to which photographers' photo manipulation activities easily transferred and extended.

Image manipulation software has become inculcated into photographer's post-processing of photographs, offering easy access to an extensive palette of image tampering tools. Such manipulated images are now common; and although often manipulated for fun or art, just as in the past many photos are manipulated for commercial, political or other ends.

On a moment-to-moment basis, our skewed perceptions as we absorb these manipulated images may not be consequential. But our attitudes, choices and actions can at times be based on the information we receive in visual form, especially photographs. For example, it is well-known that women and girls' perceptions of their own body image have been significantly impacted by comparing themselves to the idealized women whose photos have been slenderised and airbrushed prior to publication. It is this area that attracted the most attention in respect of image manipulation last century.

The reason people manipulate images is precisely this: to alter our perspectives of the information being displayed in the image from what we might be expected to perceive from the original, to what it is desired that we perceive from the altered version. The motivations for image tampering and thus changing our perceptions of an image may be beneficent, benign or maleficent.

It is important to acknowledge the positive benefit of image manipulation in many fields. Through enhancement of images we can often see better and differently into some of the important images we capture. In fact, some frequencies of electromagnetic radiation are outside the range of human perception, and *require* false colour representation to be visible to us. In other cases, simply looking at an image *after* it has been post processed provides benefits.

As an example of the beneficial use of image enhancement, Figure 1 shows an enhanced image of 2005's devastating Hurricane Katrina. The image was generated with a silhouette enhancement technique to preserve the key features of the hurricane – eye, eyewall and rain bands – while removing obscuring features that may make it difficult to predict the hurricane's impact and direction. [3] Image manipulations like these can have positive benefits and can even save lives.

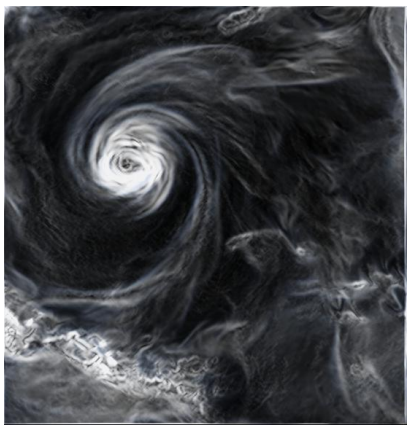

Figure 1: Hurricane Katrina, edited for silhouette enhancement

But there are also many issues arising in respect of our ability to easily alter our images. Consider the unauthorized splicing of the head of Oprah Winfrey, of one of the most powerful women in the US media, onto the body of white actress Ann-Margret (Fig. 2). There are multiple ethical and cultural issues raised by such a manipulation – perhaps most significantly this spliced image subverts Winfrey's status as a high-achieving black woman role model. Further, the image reinforces body image stereotypes (Winfrey's normal body-type is not similar to Ann-Margret's idealised figure), and by also splicing a pile of cash into the montage, seems to give evidence that Winfrey possesses large quantities of cash and is willing to display herself with it; something that is at odds with her public image as a caring champion of society's disadvantaged and disenfranchised.

The impacts of manipulated images can extend into altered perceptions of reality. Tampered images presented to people of purported past events in their lives or of public events have been shown to change the way people remember events, in short, they implant false memories. Frenda et al led their study subjects to 'recall' having seen Obama shaking hands with former Iranian President Mahmoud Ahmadinejad after being shown a doctored photo of this event purportedly happening. (Frenda, Knowles, Saletan, & Loftus, 2013). Wade et al led people to 'remember' a fictitious balloon ride from their childhood, a ride they never took. [6]

Ultimately, the common place 'adjustment' of photographs affects all aspects of human knowledge production and dissemination. Seemingly innocent 'adjustments' in photographic images can have significant consequences when those images purport to represent experimental outcomes in scientific papers. In a recent study by Bik et al, it was suggested that there may be as many as 35,000 papers indexed by PubMed alone so seriously affected by image manipulation problems that they may be candidates for retraction. [1]

Figure 2: 1989 Oprah Winfrey cover of TV Guide [4]

However, it is not logical that a photograph must be assigned to one or the other of two categories: real or fake. In fact, the most authentic of photographs are usually just a little contrived, and the most manipulated photographs still contain a modicum of reality. As a result, the veracity of any given image is more a point on a continuum. At one end lies representative photography (science), in which a photo is a captured reflection of actual people, places and events, a set of "numerically sample data that represents the state of a specific sample when examined with a specific instrument." [7] On the

other end is artistic rendering of photographs and images, or art. In between are all the various things one might do to a photograph that change it from a data sample to an interpretation, from simple resizing to creating a photo montage (Fig. 3).

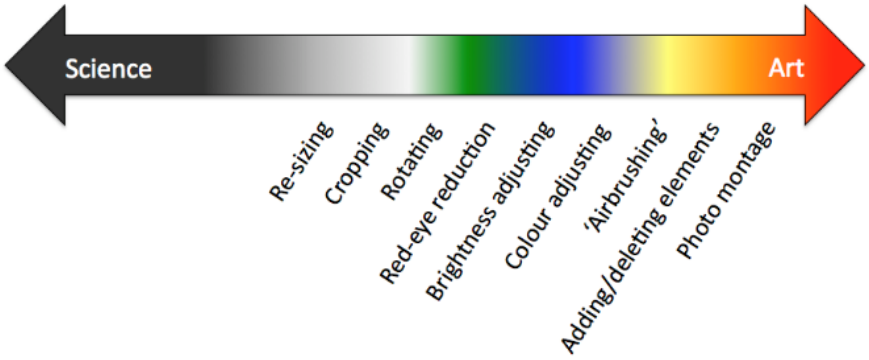

Figure 3: Continuum of photo alteration on a Science vs Art scale

However, it appears that even attempting to place a ranking on the impact of the main ways in which we manipulate images is a matter of perspective, and it is interesting to explore these different perspectives.

2 A SMALL EXPERIMENT - METHODOLOGY

We undertook a qualitative exploration of student perspectives in respect to nine different photo editing techniques. During the course of three workshops, 15 groups of 4-5 students were given an A3-sized (42.0cm x 29.7cm with landscape orientation) colour printed page containing the graphic illustrated at Figure 3, with the photo editing technique labels removed. These labels - re-sizing, cropping, rotating, red-eye reduction, brightness adjusting, colour adjusting, airbrushing, adding elements, deleting elements and photo montage - were printed onto separate strips of paper, and one set was given to each group and the photo editing techniques were described to participants.

Table 1: Image manipulation techniques workshop attendees

Workshop	Description of attendees	# of groups
ANU College of Science International Research Training Group (IRTG) October 2018	PhD and other postgraduate students both domestic and international	5
ANU College of Science BIOL3203 February 2019	Summer session students of microbiology and electron microscopy imaging	6
Vice Chancellor's Unravelling Complexity Workshop May 2019	Invited undergraduate students participating in the Vice Chancellor's Unravelling Complexity series	4

Each group was given 15 minutes to discuss and decide where each technique ranked along the continuum ranging from a more representative photograph on the left (science) to a more interpreted/changed image on the right (art). Purposefully, no gradations were marked on the ribbon in order to provide greater freedom of discussion, decision and placement.

Completed diagrams were collected (see examples at Fig. 4), and the position of each label was assigned a number from 1-12, depending on the position of the label in an even gradation of 3.5cm each across the width of the A3 paper. This scale was chosen because in some cases students affixed labels outside the width of the continuum ribbon. Each label was assigned a value according to its position relative to the 12 gradations. Where it was not possible to determine which gradation a label fit best, it was assigned a value halfway between the two gradations. For example, a label fitting equally within the spaces assigned to 4 and 5 was given a value of 4.5. The lower the ranking, the

more likely the technique is to have a *low* impact on the overall credibility of the resulting image; the higher the ranking, the more likely the technique is to have a *high* impact on the overall credibility of the resulting image.

3 A SMALL EXPERIMENT - RESULTS

Different groups took different approaches to completing the exercise (examples below in Fig 5) and ranking order of the different photo editing techniques differed for all groups; no two were alike. In some instances, groups clearly ranked the importance of photo editing techniques in changing a photo from representative to interpretive (Fig. 5a) and in others, some techniques were viewed as equivalent and therefore placed in clusters along the continuum (Fig. 5b).

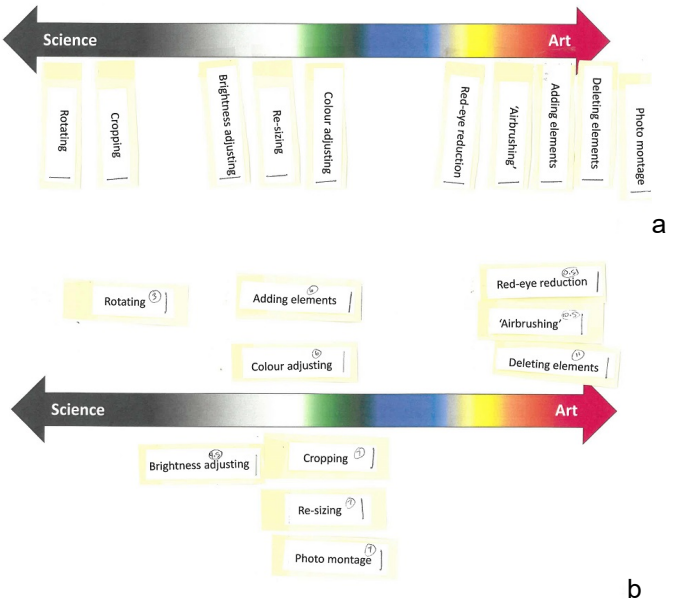

Figure 4: Two example results demonstrating diverse approaches and views

There was a significant lack of consensus at the most basic levels about which photo editing techniques are more impactful than others. Different groups made quite different choices as to the importance and impact of each technique, and that can be seen in the average ranking for the different techniques, especially in the standard deviations, in Table 2 below, which are quite high, indicating a broad spread of opinion. This spread is clearly visible in the graph of the results at Fig. 5.

Table 2: Average ranking of photo editing technique impact by group and overall

Mean value and SD of each group and overall	Re-sizing	Cropping	Rotating	Red-eye reduction	Brightness adjusting	Colour Adjusting	Air brushing	Adding elements	Deleting elements	Photo montage
BIOL3203 Group	**4.5**	**4.6**	**3.2**	**9.3**	**4.8**	**6.8**	**10.1**	**9.4**	**10.7**	**8.3**
SD	2.2	2.4	1.9	2.0	0.3	2.2	1.1	2.3	0.9	3.9
IRTG Group	**4.8**	**4.8**	**4.2**	**9.2**	**6.4**	**6.1**	**10.3**	**7.9**	**9.7**	**6.2**
SD	1.0	1.6	0.8	1.9	2.1	0.9	0.7	2.1	0.4	2.3
VC UC Group	**4.8**	**5.1**	**3.4**	**6.5**	**4.5**	**8.1**	**9.6**	**10.4**	**9.8**	**7.0**
SD	1.5	1.3	0.8	3.1	1.0	2.2	1.8	1.1	1.9	3.5
Overall mean	**4.7**	**4.8**	**3.6**	**8.5**	**5.2**	**6.9**	**10.0**	**9.2**	**10.1**	**7.2**
Overall SD	1.6	1.8	1.4	2.5	1.5	1.9	1.2	2.1	1.2	3.2

Not surprisingly, minimally invasive photo editing techniques such as re-sizing were generally ranked lower, while techniques such as air-brushing were ranked higher. One of the more surprising

outcomes was that the widest variance of students' opinions was for photo montage. As an agent of image manipulation, photo montage, in which several different photographs are pieced together into a new overall whole image, is one of the most disruptive techniques, normally yielding a highly manipulated image comprising many disparate elements, yet some students ranked photo montage from as low as 2 out of 12, while others assigned it the highest ranking - 12 out of 12.

In Fig. 5 below, each red bar marker indicates one or more group rankings across the scale of 1 to 12 for each of the photo editing techniques. The mean ranking given by groups to each technique is also noted (blue diamond) together with its value. After photo montage (mean ranking 7.2, SD 3.2), red-eye reduction was the most equivocal (mean ranking 8.5, SD 2.5), indicating that for some students simply replacing reddish reflections in the pupil with dark pixels was significant, while others felt it wasn't. Additionally, an interesting result was that adding elements to a photo (mean 9.2) was deemed less manipulative than deleting elements (mean 10.2), and groups felt more conviction about their determination in respect of deleting elements (SD 1.2) than they felt about adding elements (SD 2.1).

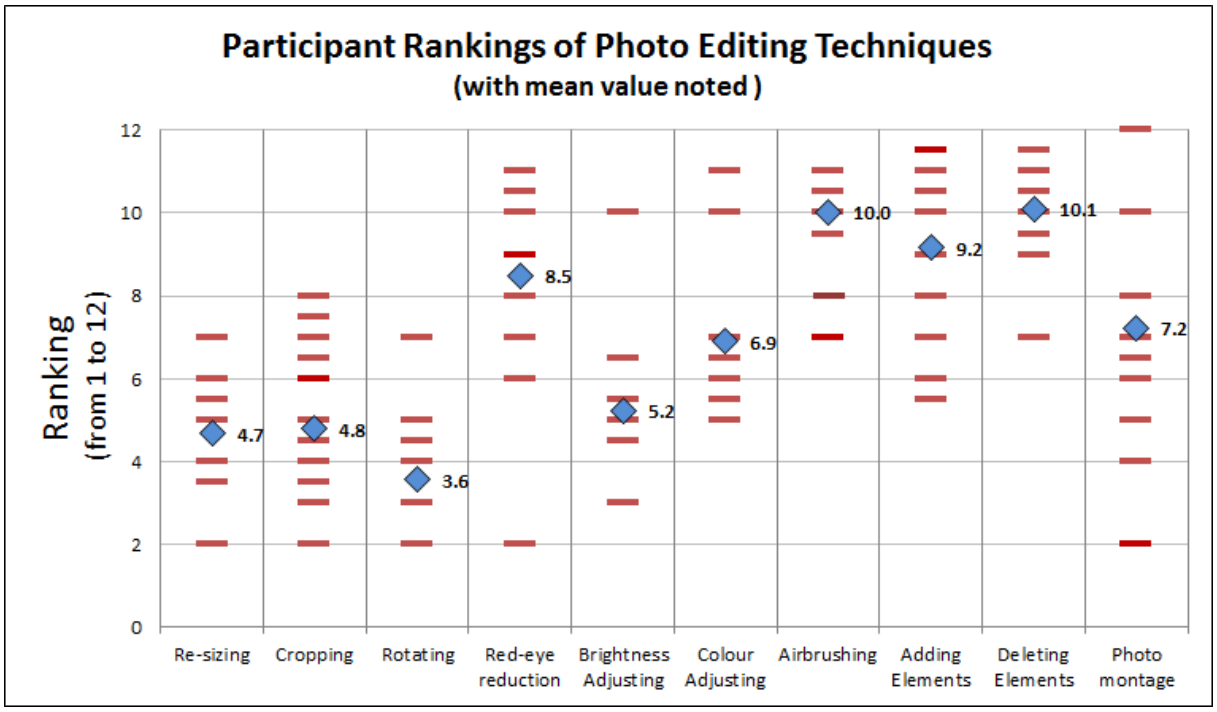

Figure 5: Group rankings of photo editing techniques

4 KEEPING IT REAL

These unclear expectations of credibility of resulting photographs when different photo editing techniques are applied illustrate only a small part of the problem of understanding the meaning of the images we see every day in our work and home. While the entire landscape of image credibility is complex, some other factors include the context of an image, attributions which may or may not accompany the image, and the sheer number of images we now consume every day, particularly online. In the online setting there is still a clear lack of understanding of image credibility [2], and younger people are particularly at risk given their restricted capacity to think critically about the images they see. [8]

In recent times several techniques for detecting changes in digital photographs have been developed. In large part these exploit the relationships of pixels in a photograph to one another. Changes in light intensity, abrupt local shifts in pixel colour values, and discontinuities of pixels enable forensics technicians to identify image splicing, in which elements of different photographs are combined in a single image, and tampering, in which a photograph is photo-processed to change local areas of the photos. However, these are all image forensics tools outside the realm of the day to day experience of image consumption by lay people. Far less emphasis has been placed on proactively asserting the authenticity of an image.

4.1 Thinking critically about the images we view

There are currently no tools or standards to assert the credibility of images online, although some sites (Snopes, First Draft and other fact checkers) are beginning to call out fake photos. While we await such facilities to be widely adopted, there are some steps we can take to discern fake images, chief amongst which is to look to the shadows.

Looking at the shadows in a photograph has been used as a method of determining manipulated photographs for some time. For example, the famous Australian photographer Frank Hurley was well known for creating manipulated images in the Antarctic at the turn of the last century, and although no computer technology eyes were available to cast doubts upon them at that time, these manipulations were easily spotted by interested people who noticed an odd thing about the shadows in the image.

Figure 6: Frank Hurley, Shackleton expedition 1915

In Fig. 6 it is possible to see that the penguins in the foreground of the image do not cast a forward shadow while the sled dogs in the mid-ground do – a physical impossibility even in the Antarctic. (Hurley later admitted as much, but said that it was impossible to capture the scope of the camp because everything was too spread out to capture in a single scene. [9])

Interestingly however, human vision does not tend to focus on shadows [10] and therefore we do not immediately see shadow clues to an image's inauthenticity, so not everyone thinks to look at this aspect of an image.

Beyond the shadows, we can have more trust in an image if it is endorsed by reputable organisations such as collecting institutions or in peer reviewed publications. Informative information accompanying the image, such as metadata, photographer's name, dates and locations listed are all helpful in establishing a sense of credibility. Another simple test is to consider how 'amazing' a photo is; if a photo 'looks to good to be true', it may not be.

4.2 Securing our own images

By the same token, our own images can be more credible if we publish them through reputable channels, and with accompanying context and/or metadata (information about an image that is embedded in the image file and travels with the image as a digital file. If we need to alter a photograph to make important details more apparent, then it is a small matter to also describe the way in which the photo has been altered and why.

One relatively simple and free way of at least securing our own work and retaining credit for it is to use Creative Commons image licenses. This is a rigorous and widely adopted standard for issuing images with specified freedoms and restrictions of use, though few students (or even some educators) have even heard of Creative Commons image licenses, let alone understand how these licenses can control how their images can be used by others.

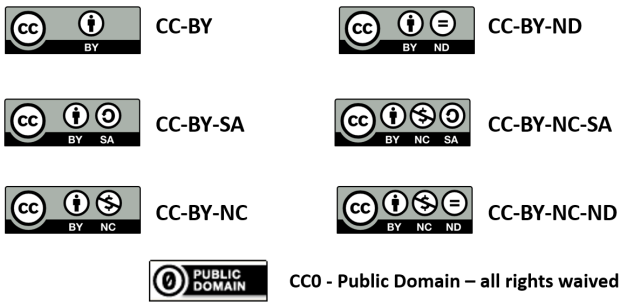

Figure 7: Creative Commons licences

Creative Commons provides several types of licences for control of how others can use the images we create (Fig. 7). These range from CC0, which indicates a public domain image and allows complete freedom of use, through to the most restrictive: CC-BY-NC-ND in which others can use the image as

long as it is attributed to the photographer (BY), not used for commercial purposes (NC), and not changed in any way (ND or 'no derivatives'). This last restriction is particularly relevant to preserving images in their original state. At present there are no other standards proposed that address issues of image use once the image has been uploaded for online use.

5 CONCLUSIONS

It is interesting to see that the question of photographs as 'science' or 'art' is still playing out today, even when there has been almost two centuries for this to be settled. To an extent, it is similar to the argument of 'nature' vs 'nurture' in which we continue to debate whether a person's character is formed by genetics or upbringing, even when countless studies have shown that our characters are formed by both of these factors. Not surprisingly, it appears that photographers argue in favour of artistic freedom in photography, and consumers of images as evidence of real people, places and events argue for truth in their visual information. It is unlikely that this debate will reach a conclusion satisfactory to all parties, and so this tension between photography as an art or science is likely to remain entrenched in society far into the future, with no resolution in sight other than a guarded truce.

However, it is also likely that the future holds an ever-greater demand from society for increased image security and preservation of the meanings inherent in the images we produce so profligately today. With further research, and development of standards such as Creative Commons and frameworks for asserting image credibility, we may just be able to address this demand effectively. Ultimately future photographs may not just be 'born digital,' but also 'born credible' – and stay that way. In the meantime, it is up to us to ensure that we are thoughtful about how we manipulate our images, how we use them, and how we preserve knowledge about what the photograph means so people in the present and perhaps even the far future to understand them as we wish them to be understood.

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