


# The educational power of being wrong

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Did you know that all colours of Smarties taste the same? Standard food colourant is flavourless so different colours are indistinguishable. I discovered this quite recently but have been hesitant to share it, because I suspect it's common knowledge. This happens to me periodically. I rush to share something tremendously interesting and most people wonder why I am bothering them with something so obvious.

Staying with colours. Did you know that you can't see them in the moonlight? I was twenty when I discovered this fact in an English tutorial on Keat's poem, *The Eve of St Agnes*: "... in the moonlight gleam/Broad golden fringe upon the carpet lies." This was a jarring error of the poet's, explained the tutor, to talk about "gold" in the moonlight, because you can't see colour by moonlight. We were all stunned and, to this day, I don't know if it is because we discovered that moonlight was monochromatic, or that we were allowed to criticise the poet.

Anyway, moonlight and poetry linked in me somehow and 20 years later I wrote *Pretoria Zoo After Closing*.

## Pretoria Zoo after Closing

She eyes me like I am the stranger,  
That oddball creature,  
Not sure if it is even antelope or bear.  
Yet I was born in Africa  
Born quite near this capital city, in fact,  
And she is all the way from Mongolia!

Still, this is their time I violate,  
Their own time to ramble ungaped  
On their own scraps of savannah  
Tufting messily between walls  
Like weeds in an unsold plot.

Nothing hostile in her look,  
Just a query,  
Why here little pink one?  
When the moon rises  
There are no colours or words  
And nothing for you to judge.

Frankly, I am not sure what the last lines mean, but I can tell you I was thinking of the zoo signage which was bright and arresting during the day (with clever colour-coded charts and zoological classification) but it all became bland and featureless by the light of the moon.

But why? Why can't you see colour in the moonlight? Here is something I don't mind sharing, because I am sure it is not common knowledge. I thought that the moon was some sort of reflective filter, not exactly made of green cheese, but rather blue rock: everything a blueish grey that absorbed all other colours from the sunlight. That was my solution to the mystery, until last year (2018) I saw this in the middle of the night.



That is a lunar corona. When I saw this, I realised I was totally wrong about the blue-grey filter effect, because that red light in the clouds had to come from the moonlight, as the sun had set many hours earlier. I now know you can get all colours from the moon, a rainbow corona, or moonbow:



What is going on? Why can you see colours at some levels only? Here is a clue: a similar thing happens when you scuba dive. At snorkel level you are immersed in an explosion of colour from fish and coral and anemone. But the further you descend the blander it becomes, and you are tempted to think creatures at lower depths have no colouring. But they do have colours, you just can't detect them. And this also has nothing to do with colour filtering. Sea water transmits all colours equally and appears colourful only from reflection (blue on a clear day, gray on a stormy, etc.) So where does the colour go?

A final observation on colour and reflection before I try tie this up. This is the new Wireless Light Source from PASCO scientific.



The colours are specially configured for you to tell a real image from a virtual. A real image is inverted (like a telescope) and a virtual image is upright (like a mirror). Inversion swaps left with right and up with down, i.e. green with red, and blue with yellow, like so:



But how does a mirror swap left and right only, i.e. just green with red and not yellow with blue? Think about this for a moment – the writing on your T-shirt is reversed in a mirror, but your head is still on top. How does a mirror do that?

The answer is: *magic*, or as commercial magicians say, *illusion*. A mirror image is not inverted, it only *seems* inverted because of human symmetry and letter orientation:

<http://physicsgirl.org/> - Why do mirrors flip horizontally but not vertically?

Similarly in moonlight, the colours are still all there, but you can't see them because of the light receptors in your eyes. Cones pick up colour and detail; rods are much more light sensitive but can't detect colour. In low light conditions, you are effectively colour-blind, because your cones aren't active. So while a fish may appear brightly coloured at a certain depth, it will lose its colour as you descend because there isn't enough light available for your cones to work. As you follow Nemo back up to the shallows, you will again see both his clownfish colour and lucky fin!

Problem solved? Not quite. Close your eyes and picture a rural winter scene in the moonlight, maybe some trees, a gravel track, an old barn. It is blueish isn't it? Try again. It is blue! Why? No one really knows. It could be because rods are most sensitive to blue light and this stronger signal, somehow 'bleeds' into the cones. Or is it because movies use blue filters for moonlight and this power of suggestion alters our actual experience, reality following art:

<https://www.skyandtelescope.com/astronomy-blogs/struck-moonlight12312014/>

Maybe the same thing happens with taste. I am old enough to remember the introduction of blue Smarties, hunting the box for the elusive blue. Now blue Smarties really do taste different, don't they?

So here's the wonderful thing I've realised: *I am wrong*. Maybe very wrong (as in the blue rock moon) or a little less so (as in the rods and cones). But, to some extent, my explanation is a little off. Why is this wonderful? Well, I've discovered that presumption of error is a properly scientific state. Scientists spend their days trying to prove something wrong, usually the theory of an older or rival scientist, but sometimes even their own theory. A scientific theory is really a proposition that has thus far withstood every attempt to refute it. Scientifically, you have to believe that there is some flaw somewhere, else you are wasting your time.

This has been such a mindshift for me. It is not just that I am more at ease with my ignorance, and therefore likely to share 'foolish' questions and observations (as you may have noticed!) I am also less intimidated by maths and science. If you think of science as reality itself which you are not able to properly comprehend, then you sometimes feel stupid or excluded. But if you think of science as an extraordinarily powerful invention, which allows you to engage with the universe on a deeper and deeper level, then you feel inspired and motivated to grapple with it. And if you are worried that you don't quite get it, it helps to reflect that no one really does.

Trouble is, the beautiful mystery here, this wondrous and sometimes delicate progression is, by its very nature, open to abuse. "Can you say with any certainty?" draws the big politician in a Stetson, "that a cyclone in Mozambique is caused by Texas Oil and Gas." To which the scientist meekly responds that fossil fuel use contributes to global warming, which elevates sea level and worsens storms. This makes events like Idai statistically more likely. "Statistically, more likely?"

booms the politician. "There are billions of dollars and thousands of jobs at stake. We need more than that!" The trick here is to realise that this politician is not really acknowledging uncertainty. Quite the contrary. He is taking the very dangerous position of *certainly*, because he rejects international treaty and his donors continue to pollute. In fact, what he is saying is: *the science is certainly wrong so we can carry on regardless*. This is terribly selfish and arrogant! I would submit, if there is any uncertainty, the correct attitude is a careful and *charitable* one. In a letter to the Corinthians, the Apostle Paul likens our state of uncertainty to a reflection in a mirror (a glass darkly) and concludes with the supreme eternal certainty: love. He describes some of love's features. It is not boastful or proud. It does not demand its own way, but is instead patient, kind, trusting and persevering. Love always *protects*. Unfortunately some of our leaders smell uncertainty and do the opposite.

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