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WARMING TO YOU –  
FALLING FOR ME

Chapts  
17-19

*Draft for  
Comment  
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A DIALOG

## Chapter 17

# 50 SHADES OF GRADIENT

In which Jane and Bruce find themselves on the last last slippery slopes of the road-less-travelled to scientific abstraction. Pascal has a wager and Newton backs a winner by a hair's breadth.

Woodcut from the 1489 Spanish edition of *Aesop's Fables (Fabulas de Esopo)* depicts [Aesop](#) surrounded by images and



So – **Descartes completed the journey into abstraction, Bruce? You say that he separated space into different directions and gave time a place as well.** He then reduced Galileo's fairly believable pictures of masts, towers and cannonballs to graphs **and then further reduced these graphs to squiggles that are called 'algebra'** – which doesn't look in the least like anything real – more like our pre-schooler's attempts at writing half-words – little twos and threes perched on the shoulders of x's and y's. **You don't get much more abstract than that – do you?** To me it's like saying that a circle in a Kandinsky painting represents the world and the chequerboard vanishing into it represents...



You've got the right idea, there, Jane. It's all about **representation**. Those *squiggles* as you call them *represent* things – **at least to people who agree that, for the purpose of scientific discourse, they will use those squiggles as a short-hand to represent things – they are symbols.**

**But the things that they represent aren't real, Bruce. It's like looking down the tunnel formed by two mirrors facing each other. It's unreality stacked on unreality!**

You guess right, Bruce – **fourteen isn't a good time for most kids....**

Perhaps that's why Alice went *through* the looking glass, Jane – **to break through the infinite regression of illusion.** Certainly algebra can be used to represent graphs and graphs can be used to represent vectors, **but the thrust of my approach to understanding is that this chain of representation eventually leads back to the physical reality of the child or Zen monk, or even our perceptions of things.** People who have a good grasp of physics can look at the algebra and immediately see the physical reality that it represents without consciously going through the chain of symbols that we have been talking about. I guess that it looks nonsensical to you, Jane. **I suspect that algebra caught you at a bad time at school and you took fright at the apparent nonsense of it.**





**In my case, I was pubescent.** Before that, I had been happy in my make-believe world of dolls and play-acting. I could exercise my imagination and then return to my real-world where I was growing incrementally and everything seemed smooth and steady. **God was in His heaven and all was right with the world.** Then my body started changing suddenly and differently. My thoughts were scattered and then my parents pulled me out of the convent because they had heard rumours of sexual misconduct somewhere. **A very confusing mixture – puberty blues, ugly sex-talk and algebra!** Not to mention that my class at my new school was months ahead of the convent in maths, **so I missed some vital steps, I think.** Something had to give – and it was algebra. **I figured that I could live without those little squiggles** – my new school had a good drama teacher and I soon found a place in the class play. **No contest – Shakespeare 1, Descartes 0.** Game over! I guess that I hid behind my theatricality a bit – **drama queens aren't expected to be maths-whizzes as well.** So, by the next year, maths was an option and I opted out. No more **Mr Sqiggle!**



**That's a shame, Miss Jane.** I always liked that TV program – **Mr Squiggle could make sense out of a few lines – even upside down.** In my case I guess that I took the **road less travelled.** My reality on a farm was pretty immediate and brutal – with sheep, roos, rabbits, frequent accidents, floods, droughts, **death and destruction were everywhere** – not to mention Dad giving me a pretty hard time. To preserve my sanity, **I escaped into the other-world of my encyclopedias and the mysterious and fantastical world of science and maths.** It was my very own world in my own head and nobody could go there without my permission – so that's where I spent my spare time. **As you said, we are what we repeatedly practice. You practised your acting and reading plays and I practised manipulating letters and numbers – algebra.** No magic in those squiggles, Miss Jane – just practice and familiarity...**Practice makes progress.**

...Mr Squiggle – the man from the [Moon!](#). But I still get anxious when I see an open maths book.



*So should the lines of life that life repair,  
Which this, Time's pencil, or my pupil pen,  
Neither in inward worth nor outward fair,  
Can make you live your self in eyes of men.  
To give away yourself, keeps yourself still,  
And you must live, drawn by your own sweet [skill](#).*

Ah! [Maths anxiety](#) – the curse of our times – and our times-tables!

You make it sound like a psychiatric disorder, Bruce. **It's just the way I am.**

No – that would be [dyscalculia](#) – an **innate inability to do maths** – I doubt that you have that.

Oh – *Dr Squiggle Freud!* **How come you're an expert on dys – whatever you call it?**

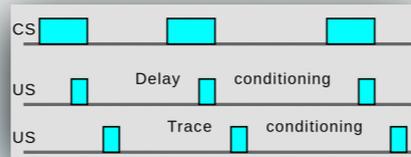
Certainly not an expert – just that I first came across this when I used to tutor a lot of school-kids. Before starting a tutorial, I would often chat with their **parents**, who would frequently say something like ***Jack/ Jill is pretty hopeless at maths – just like me – aren't you – Jack/ Jill?*** And they would then draw the poor kid closer in a desperate hug. **What a dilemma!** What was the kid to do – reject maths or their parents?

**So how did you get to know so much about this problem, Bruce?**

But my parents didn't do *that* to me...

What do you mean – *style*? Nothing stylish about it – it was **rigid discipline** – it reminded me of learning the catechism and other religious stuff – all rote and no reason – and a harsh response for non-performance or 'getting it wrong'.

All very morbid – it upsets me just to think of those early experiences. But let's be positive – **what did you do to overcome these reflexive attitudes in your students?** I need to know!



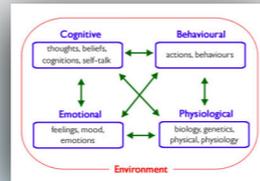
I then read up a bit on the subject. You start with a pretty normal kid of average abilities and subject them to a classic operant conditioning situation – **you know** – giving a reward or punishment for some particular behavior – in this case acceptance or rejection – and presto! **The kid responds by sweating every time they even think of maths.**

**But what happened at school?** You said that the convent was miles behind your new school in maths, **but what was the teaching style?**



Indoctrination is the common name for it. At least Pavlov's dog was given the positive reward of food – although what we call negative rewards, or punishment, can produce the desired result if non-performance can be paired with the punishment. **But often the risk is that the subject gives up**, as you did and then spends the rest of their life trying to avoid confronting the experience again.

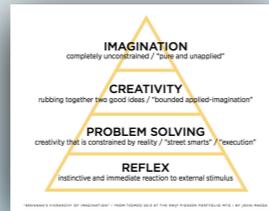
You're a natural, Bruce! **What was the recipe?**



Well – **at the time I thought that I was just taking a sensible and decent approach to helping anxious kids.** Later, when I started reading about this stuff, I found that my approach was pretty close to the methods used by **cognitive behavioral therapists** to reduce anxiety.

Just like that? You make it sound easy and obvious. **If it works so well, why don't all teachers use it all the time?**

As I said, at the time **I didn't see it as a *recipe* – just *my way*.** But **the process is pretty straightforward** – you chat for a while with the student to get them relaxed and then assess their current situation with regards to their understanding of the topic, **find a way for them to re-imagine the topic**, then set out on **a path for transforming their imagination into a method for understanding and solving problems.** After that, its just consolidation of the new approach, generalizing it to a wider range of problems and then matching their skills to their conventional test methods.



**I think that some try to – and succeed,** but faced with a bunch of kids with varying abilities **and many with dysfunctional conceptual frameworks,** not to mention their personal anxieties and **the demands for instant results** by the community in general and parents in particular...

Bruce – **you've just described me and maths and science at school** – except for the parent bit – as you know, mine were hopeful, but not demanding. **But there's something missing in your recipe – how do you get an anxious kid started on a new path when they freeze up at the thought of the subject – a la Pavlov?**



I was enthusiastic about acting.... That's a long way from maths and science. **How would you have gone about tutoring me as a maths-and-science-phobic fourteen-year-old?**

Sometimes it's not easy – indeed, there were kids that I couldn't get through to, **but the trick that I used that worked most of the time was to get them talking about something that they liked** – most people are enthusiastic about something...

Uh?

Hmm... well, maybe in a cut-down version of what we've been doing since we started this conversation.

I guess so.

*Then need I not to fear the worst of wrongs,  
When in the least of them my life hath end.  
I see a better state to me belongs  
Than that which on thy humour doth depend.*

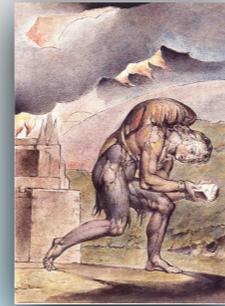


...How do you propose to advance my understanding of algebra from here, Bruce?

Well, haven't we been pretty well following my 'recipe' – **relating all these science ideas to things that you know and love** – literature, theatre, art – and chess.

Well, *in principle*, we could start from anywhere that you **feel happy**, but let's use chess.

Yep, I'm happy when I'm playing chess against the computer – **but what has that got to do with algebra and all those other squiggles** – other than some computer nerd probably used a lot of maths to program the computer?



That's **progressing** a few steps ahead of where we are at the moment – **in fact in the Land of Probability** – we might visit there later if you like.

I think that shining light is on the other side of the my **Slough of Despond, Bruce. Let's stick to chess for a moment.**



Yes... I was thinking more about the chess-page in the newspaper more than the realistic-looking computer-based chess. **From a distance, it looks like algebra** – a mid-game picture, a few words and a lot of coded squiggles of **chess notation** that tell you how to get to 'check' in five moves. As you know, I've never been a keen chess player, but *you* are – **I've always been impressed by the way that you can skim down those codes and say I know a better way or they're wrong in line five, and so on. It's aptitude, but it's also practice.**

#	Algebraic	Figurine algebraic	Long algebraic	Reversible algebraic	Concise reversible	Smith	Descriptive	Coordinate	ICCF
1.	e4 e5	e4 e5	e2-e4 e7-e5	e2-e4 e7-e5	e2e4 e7e5	e2e4 e7e5	P-44 P-44	E2-E4 E7-E5	3224 3224
2.	Nf3 Nc6	f3 f6	f3-f3 f6-f6	f3-f3 f6-f6	f3f3 f6f6	f3f3 f6f6	N-43 N-20	C1-F3 B6-C7	7103 2836
3.	Bb5 a6	o-o a6	g1-g5 e7-e8	g1-g5 e7-e8	g1g5 e7e8	g1g5 e7e8	B-46 P-20	F1-B6 A7-A6	8125 1718
4.	Bxc6 dxc7	fxc7 dxc7	f3-fxc7 e7-e8	f3-fxc7 e7-e8	f3fxc7 e7e8	f3fxc7 e7e8	B-46 P-20	C1-F3 B6-C7	3236 4736
5.	Qd3 Bb4+	o3 o4+	o3-o3 Bb4+	o3-o3 Bb4+	o3o3 Bb4+	o3o3 Bb4+	P-23 B-46	C2-C3 F8-F4	4243 8824
6.	Nc3 Nf6	o3 o6	o3-o3 f6-f6	o3-o3 f6-f6	o3o3 f6f6	o3o3 f6f6	N-43 N-20	B1-C3 G8-F9	2123 7964
7.	O-O Bxc3	o-o bxc3	o-o bxc3	o-o bxc3	o-o bxc3	o-o bxc3	P-20 B-46	C1-F3 B6-C7	3171 2423

I just looked at it as something that I did for enjoyment and relaxation – **not a prelude to algebra.** What's the connection?

GAME XVI.

The original chess was played at the Chess Warehouse held at Leeds on 10th June, 1968, between Mr. A. B., President of the Liverpool Chess Club, and Mr. J. R., Secretary of the Club at Leeds. We have selected several games played on this interesting occasion, the form of which will appear in our Chronicle.

Black: (Mr. J. R.)

1. K. P. one
2. K. P. to R. fourth
3. B. to R. 3d
4. P. one
5. P. to R. third
6. K. P. to R. fifth
7. K. P. to R. fifth
8. Queen
9. K. P. to R. fourth
10. K. P. to R. fourth
11. Q. to R. third
12. B. to R. 3d
13. Q. P. one
14. K. to R. second
15. K. to R.
16. K. to R. second
17. Q. to R. second
18. K. to R. 3d
19. K. to R. 3d
20. Q. to R. 3d
21. B. to R. 3d
22. K. P. one
23. K. to R. second
24. K. to R. second
25. Q. to R. third
26. Q. to R. third
27. Q. to R. fourth
28. Q. to R. fourth
29. Q. to R. fourth
30. Q. to R. fourth
31. Q. to R. fourth
32. Q. to R. fourth
33. Q. to R. fourth
34. Q. to R. fourth
35. Q. to R. fourth
36. Q. to R. fourth
37. Q. to R. fourth
38. Q. to R. fourth
39. Q. to R. fourth
40. Q. to R. fourth
41. Q. to R. fourth
42. Q. to R. fourth
43. Q. to R. fourth
44. Q. to R. fourth
45. Q. to R. fourth
46. Q. to R. fourth
47. Q. to R. fourth
48. Q. to R. fourth
49. Q. to R. fourth
50. Q. to R. fourth

Well – those symbols for chess pieces and chess moves *are* a form of algebra – they don't look like *real* chess pieces – so they're abstract symbols. And, like algebra, there's agreed rules for using these symbols. With familiarity and practice, you can look at the symbols and 'understand' the chess game that is going on in your mind. Chess is a **game** – and this kind of game has *rules and tools* that are much the same as algebra.



You mean it isn't? **I made a sincere and conscious decision to try to learn algebra at high school – but it didn't seem to work for me...**

That sounds plausible. **But how does that connect to missing half-metre putts?**



Okay. **You claim that maths anxiety can be overcome – how do you overcome the yips?**



Ahh! **The yips!** I don't mean just missing a short putt because you misjudged the slope of the green, or you simply hadn't practiced enough to get good hand-eye coordination. **The yips is a sudden, unexplained, loss of previous skills – in this case the skill to make a fairly easy putt. There's some argument as to what causes it, but the theory that fits with our present conversation is that a few coincidentally – missed putts can lead to an anxiety about failure: tension and then more failure. Soon, the situation of addressing a short putt invokes fear and tension and guaranteed failure.** More than a few famous golfers have quit because they couldn't overcome the yips.

Success is never guaranteed. **But the basis of the attempted cure is the same – you've got to take the road less travelled.**

Yes, Jane – the *decision* was the conscious part. **The part that you didn't consciously decide was the on-going activity of pairing of unpleasant experiences with your effort to learn algebra.** Before long, you had a textbook case of *operant conditioning* – **as soon as you saw algebraic squiggles, it invoked all the unpleasant feelings of the classroom.** So you eventually learned to avoid the situation that gave you unpleasant feelings.

You've been down this path before, Bruce. **Where are we going this time?**

Very poetic! **And the yips?**

Oh yeah? **A bad workman always blames his tools.** That just sounds like an excuse for **getting a new toy to show the boys.**

So these work because the golfer feels okay **and has to learn something quite new, leaving the old rutted yips-road aside?**

Then *thinking* your way through it won't work?

Well, as I said, **overcoming maths anxiety starts with *calming the student*, then *creating a different path strewn with pleasant experiences* and at the same time *letting the well-travelled road of anxiety fade by not travelling over it and reinforcing the wheel-ruts.***

There's a range of options. **One is to get a new putter.**

And sometimes it is, Jane. Quite often a new putter will help for a while, then the yips re-appear. **It seems that is because – in many cases – the new putter is *not a sufficiently different path*.** The putters that seem to work are the ones that are *radically* different – like *broom-handle putters* or *belly putters*. But another approach is to cross the hands over, or take a *claw grip*.

**Exactly, Jane.**

**Mind-set. Mind-set.** A mind that is set – a mind that is *made-up*. Funny – we hear these phrases so often and kind-of take them for granted – but when you reflect on them, they are quite horrifying. **What are people meaning when they say these things? They've turned their left-brain off? They are beyond help? Good grief!**

*O! change thy thought, that I may change my mind:  
Shall hate be fairer lodged than gentle love?*

Well, Bruce, **why do you think that we reflexively first look for information that seems to support our present beliefs?**

**Dr Squiggle Freud writes again!  
How so?**

**Weighing up?**



As I said, Jane, sometimes you can, **but often thinking about it will only reinforce it** – whatever *it* is – some kind of unconscious reflex to previous behavior patterns. **There's been a lot said and written recently about this question as to whether we can think our way out of our present mindset.**

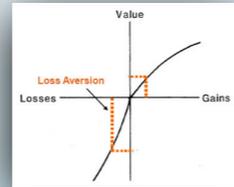
I think you've gone to the heart of it, Jane – **can we change our mind?**



It's often called **confirmation bias**. But it seems to me that we are trying to understand confirmation bias as though it was a just an *honest mistake in reasoning*. **I think that it can be better understood in terms of what we have just been discussing – operant conditioning.**

It seems that people show confirmation bias because they are weighing up the apparent **personal costs** of the options that are presented, rather than investigating them in a **neutral, objective or scientific way**.

....So – if our feelings are based on our previous conditioning, we are not likely to change our views *unless we can overcome our conditioning.*



By *weighing up*, I don't mean a conscious, cerebral evaluation – it's *unconscious* – *intuitive* if you like. ***They fear the possible pain of loss – that's anxiety.*** Their present mindset is working okay for them – at least in the short-term – no pain. Adopting a new idea could bring pain through losing something. It's what behavioral economist [Daniel Kahneman](#) calls **loss aversion** – we give a greater weighting to a loss than we do to a similar sized gain. He thinks that most of our reasoning is just rationalizing our feelings.

That's a pretty gloomy view, Bruce. **Is there any hope?**

That's the way I see it, Jane.

**Whoa!** A moment ago you were missing half-metre putts, now you're driving your tee-shots into the deep rough! **Religion** is a **whole bag of clubs**, Bruce – morality, ethics, the meaning of life.... **What club are you thinking of to get yourself back onto the fairway?**

Gee, Jane! You're in a better position than I am to answer that – you're the one with the direct experience with religion. **Isn't that what *religion* is all about?**

**Heavens!** With that shot I think that you're even deeper in the rough, up against a tree.



My **quintessential** five-iron, Jane – **Transcendence.**

You really *are* Dr Squiggle Freud!

More likely a cross, really. Seven-iron, please! No, seriously – from my point of view **religion has two purposes – one social and one personal**. The social one uses a whole bunch of **threats and rewards** to maintain social cohesion. **The personal purpose is to overcome – or transcend – compulsively repetitive behavior.**

What about Christianity, Islam and Judaism?

Well Freud had a lot to say about the subject – **but it seems to be fundamental to pretty well every religion that I've looked at**. For example, there's the Samsara of Hinduism -the continuing cycle of birth, life, death and rebirth – with the hope of achieving Moksha-the final extrication of the soul through good karma. The idea of Nirvana in Buddhism is much the same, if you follow the Noble Eightfold Path you might **transcend the suffering caused by 'desire'** – stress, anxiety or dissatisfaction – whatever you might like to call it.



Oh? Like 'be still and know that I am God'?

**Much the same, basically**, but it's very hard to cut through the layers of *authority and personification* to see that **their God is the perception of the universe by the *still mind*.**

Gulp!

Exactly, Jane. **And a lot of the activities like prayer were designed to be meditation**, rather than a request for an invisible bearded magician to perform some trick or personal favour. **Perhaps what distinguishes one religion from another are their different meditative practices**. Some chant loudly, others keep quiet; some jump, whirl or sway, others sit still. Different strokes for different folks. All have worked, but not all the time.

Well – while we're hacking around in the bushes and bunkers of your spiritual golf course, **what club corresponds to faith? Where does that faith fit in the bag?**



...Or miss half-metre putts. **But *thinking* – not *believing* or *hoping*?**

**Hope springs eternal – or vice versa.** Well, how does it play out here, Bruce?



Are you betting on a trick-shot, Bruce? **You seem to be a fair way off the fairway.**

**Play your shot, Bruce.**

Hmm... maybe it isn't like a club – **it's more like what gets you out on the course, *thinking* that you'll *not* do all or any of those things that make up the catalog of excuses as to why you didn't do the course in *par*, or better. **Maybe today I won't slice, hook or gouge...****

Yep – that's optimism – *secular faith*, perhaps. **It all comes back to the same-old-same-old – *faith versus reason*.**

**One way would be to consider Pascal's Wager, my sweet.** It might also help to get us back on course with **our quest for understanding and explanation.**



Nope. Blaise Pascal was, like so many people, troubled by the ideas of *belief* and *non-belief* in God, so he devised a proposition for people who like to use logic and reason to sort things out. **Bear in mind that he lived in that exciting era of the pre-Enlightenment** – in Galileo's and Descartes' latter years and just before Newton got busy – **it seemed that *all* ideas were up for grabs – at least outside Italy.**



Sounds a lot better than a [Faustian Bargain!](#)

Sounds like [an offer to good to refuse](#) Bruce – odds of **infinity to zero!** What's the catch?

Bruce, I know you too well – you would have taken up the wager if it were that good.

What!



Well, simply, **betting on God is a no-brainer** – Pascal argued that it is simply unconscionable, by comparison, to bet against an eternal life of happiness for the possibility of gaining nothing. The wise decision is to wager that God exists, since ***If you gain, you gain all; if you lose, you lose nothing***, meaning one can gain eternal life if God exists, but if not, ***one will be no worse off in death than if one had not believed***. On the other hand, if you bet against God, win or lose, you either gain nothing or lose everything.

		Believe?	
		YES accept wager, believe in God	NO reject wager, don't believe in God
Possibilities	God's existence	False Belief & ~God Limit case: Hard penance for no reward	~Belief & ~God No penance; just dead
	True	Belief & God Belief well spent; eternal salvation	~Belief & God Limit case: eternal damnation

You bet! The ***Faustian bargain*** is paying for a ***finite amount of pleasure with an infinite amount of pain***. Contrary to Pascal's bargain, where he is purchasing the ***infinite amount of pleasure with a finite amount of pain***.

Hey! Who's the ***skeptic*** now? I thought that I'd offered you the perfect deal for any wavering soul.

Perhaps I did, Jane.

Well, you've got to look a bit closer at the ***God*** that Pascal was offering. He talks about coming to God by ***the abatement of your passions*** – that is, ***stilling the mind***. Given his strong interest science and maths, I suspect that his notion of ***God*** was more like the mind freed of ***repetitive compulsions*** than an ***omniscient magician***.

Okay, Bruce! Let's now assume that we're back on the fairway. **What's the other connection with Pascal?** We seemed to have strayed a long way from Galileo, Descartes and Newton, Bruce. **I'm keen to hear the rest of their story.**

What kind of questions, Bruce?

Nothing to do with the [Warrior Princess](#)?

Oh yes! That's in the books that I've been reading to the kids. **But it seemed to be more of a moral problem than a mathematical problem – talented, but lazy people will always lose out to perseverance.**



See – it wasn't just the Catholics – the Protestants were in on it as well. But that's enough revolutionary talk, Bruce – just how is the tortoise-and-the-hare story a paradox? **I thought that the tortoise won the race fair and square.**

Well, Pascal seemed to be particularly absorbed in the ideas of the *infinitesimal and the infinite*. They seemed to be pretty popular pastimes in the seventeenth century. The problem was, that even with the symbolic algebra that Descartes had developed, **there was still no effective abstract tool for dealing with questions about the very large and the very small.** Even as a mathematician, Pascal was using *rhetoric* to argue about the infinite.

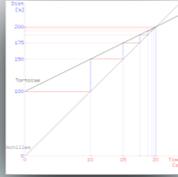
One of these questions had been around for thousands of years – **it was called '[Zeno's paradox](#)'.**



Not really, Jane. It was also known as the 'Achilles and the tortoise paradox', which shows up again in [Aesop's fables](#) as the [tortoise and the hare](#) story.



Hmm... I think that's a bit of a con on the working class by the privileged elite – the [Protestant work ethic](#) for kids. **More operant conditioning!**



Indeed, the tortoise got across the line ahead of the hare, or Achilles – depending on the story. **But when you look hard at the situation, it appears that the tortoise is aided by a *mathematical paradox* more than *Protestant perseverance* – how can the hare ever catch up? Every time it gets to where the tortoise was, the tortoise has moved on. **He might get closer, but he never catches up, according to Zeno.****

I know the feeling – there's a variation called *the-mother-and-the-housework*.

Okay – I can see the *apparent paradox*, Bruce, but we know from everyday experience that faster cars *do* pass slower cars, sprinters who are slow out of the blocks *sometimes* win the race, and so on. **It's just common sense.**



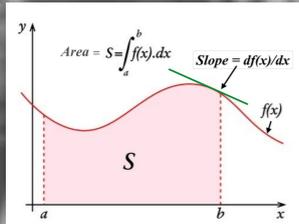
*Ah! yet doth beauty like a dial-hand,  
Steal from his figure, and no pace perceived;  
So your sweet hue, which methinks still doth stand,  
Hath motion, and mine eye may be deceived.*

How so? Just as well it wasn't a race between mathematicians – it would have been hare-raising.

That's why it's such an enduring problem. **Everyone has their own version.**

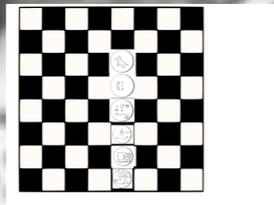


Of course it's common sense – **but how do we explain it?** You know – starting with a concrete image, going stepwise into increasingly abstract descriptions, finally showing that the maths works and **then returning to base with the bunny out in front.**



Well, if it was a race between pre-Newtonian mathematicians, it would have stalled. Galileo talked about this problem, as did many philosophers. **But the explanation, as such, operates on two levels – common sense and observation – the things that we see every day – and in the mathematics of calculus.**

Aghh!



Calculus!

What, Jane?

Well?

Well! If you think that *algebra* was *terra incognita* for me, just think of the **terror that calculus strikes in my heart.**

Again, Jane – ***unfamiliarity breeds terror.***

Some of my school drama friends were also doing **applied maths** – they said it was OK – **just like a bunch of shake-and-bake recipes.** But they said that the kids – **mainly boys – who were doing calculus looked with disdain at applied maths.** It seemed to be a secret world that they weren't going to let the uninitiated into.

Yes – that's a pity – I remember those days – **the calculus kids were like a cabal – secretly sharing the mysteries of the infinite and the infinitesimal.** Actually, **I just thought that it was an amazing world that you could visit in your mind, using your own mental microscope and telescope, but could never visit in reality – you could only see the results of what happened on that world.**

Yeah – we called that world *Nerd-land*, with its secret words and signs. It was like the [Freemasons](#) – and just as blokey. It was more than a step or two away from *Bard-land*.



Too bad. The problem with explaining calculus is that it is not a one-step process – like all of these explanations that we have explored, you have to be familiar with the previous steps to understand the next step. In this case, by my reckoning, we are seven steps away from reality.

You mean that we're in [Seventh Heaven](#), Bruce?



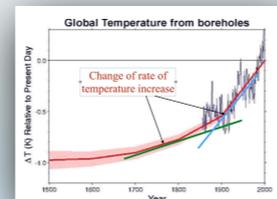
That's your sphere more than mine, Jane. Do you want to know about calculus?

At this stage I'd like to know *about* calculus, rather than *know* calculus. At this rate we'll never get across the chessboard.

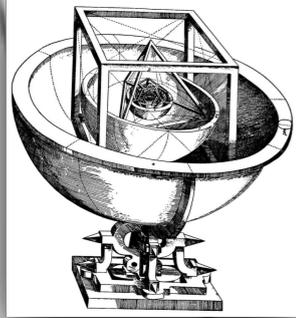
Well, calculus is mainly about rates.

No roads and rubbish? Counsel me!

I wondered when golf would come in again – but let's move on – at a faster rate. How did calculus come into the picture?



Maybe – if you include the path not taken and the vanquishing of superstition. In the case of calculus, rates are a kind of abstraction on top of an abstraction. You're familiar with rates at the human level – people are always saying that the climate is changing at a faster rate than ever, the kids are growing at a great rate and the rate of improvement of my golf is negative....



We need to step back a few squares to appreciate this next step. Historically, Copernicus broke things open on the astronomical scale – **claiming that the sun, not the earth, was at the centre of the universe.** Amongst other things, Copernicus was a Catholic priest. **His ideas were treated more as a convenient fiction for the purpose of calendar-calculations than a threat to the rigid Aristotelian cosmology of the mid-sixteenth century.** Although he was steadfastly non-Catholic, Kepler was devoutly religious and **also held to a lot of Platonic and astrological mumbo-jumbo.** Nonetheless he insisted that Copernicus' theory of *heliocentrism* was correct. **Moreover, he also insisted that the planets moved in ellipses, rather than circles.** At about the same time, Galileo was promoting heliocentrism in Italy – to his personal cost – **but curiously, held to the idea that the planetary orbits must be perfect circles.** He pretty well ignored Kepler. Meanwhile, back on Earth, Galileo had established solid foundations for kinematics – the motion of objects. **Later, Descartes perfected the algebra for describing these motions concisely.**

Wow! A hundred years of science in less than a minute! So what was missing?

But I understand that he was *also* deeply religious and a cranky nutter to boot. How on earth did he sort it out?

A few things – but mainly that they had a *description* of how things moved in the heavens and on Earth – celestial bodies moved in ellipses and Earthly bodies either moved in parabolas or straight lines. **But they didn't have a *consistent explanation* for these observations. The supernatural kept on being invoked. And then along came Isaac Newton.**

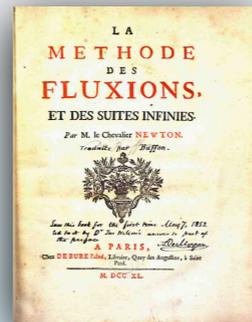
He certainly was a character. Maybe he believed that God wanted to keep things simple and therefore the universe didn't have different rules for different places.



Furthermore, **Newton accepted the empirical evidence of the astronomers** – if the planets were seen to move in ellipses, then so they did. **The breakthrough was that he assumed that the force that acted between the sun and the planets was the same as the force that acted between the Earth and a cannonball and that this force diminished as the square of the distance between the objects.**

You mean twice as far reduces it to a quarter, three times to one-ninth, and so on?

That was nice, Bruce. So – the belief in an omnipotent force called God was replaced by the belief in an omnipresent force called gravity? Is that what they call scientific progress?

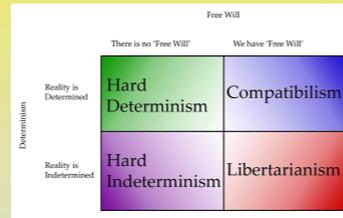


Exactly, Jane. **He then showed mathematically that if that were the nature of the force, then the orbits would have to be ellipses.** He then calculated the force that was necessary to keep the moon in orbit around the Earth **and that force was what would be expected at that distance if it were the same force as between a cannonball and the Earth.** Bingo! The universal law of gravitation! His **mathematics of fluxions** – as he called calculus – had been used to unify the universe with one algebraic equation.

Whoopee! Pawn takes both Bishop and King in five moves: Copernicus – Kepler – Galileo – Descartes – Newton – check!

I think that it was a lot more than that, Jane. God may have still been in His heaven, **but His self-appointed agents – the peddlers of fear and superstition in the churches and castles – had essentially lost their authority.** Not only was the Earth *not* the centre of the universe, **but also, the observations of ordinary people could contribute to a greater understanding of everything** – and that understanding could be used to improve their lives. **Bring on the Age of Enlightenment!**

So that's it, Bruce? **Having progressed, square-wise from the concrete to the abstract, all the little rationalist pawns can now scamper around the board at their own free will?**



I think that there were a few more moves than that, but the pawns certainly won. **And we're not quite there, yet, Jane.**

**And where is Love in all of this, Bruce?**

I'm not sure, Jane, but I think that love can only exist in the absence of fear. **The heart has reason that reason cannot know.**

*Let me not to the marriage of true minds  
Admit impediments. Love is not love  
Which alters when it alteration finds,  
Or bends with the remover to remove:  
O, no! it is an ever-fixed mark,  
That looks on tempests and is never shaken;  
It is the star to every wandering bark,  
Whose worth's unknown, although his height be taken.  
Love's not Time's fool, though rosy lips and cheeks  
Within his bending sickle's compass come;  
Love alters not with his brief hours and weeks,  
But bears it out even to the edge of doom.  
If this be error and upon me proved,  
I never writ, nor no man ever loved.*



## Chapter 18

# BUT A MAN'S REACH

The penultimate Scene, in which Jane and Bruce are in sight of the ultimate goals of virtue and diligence, only to find that even the view from the shoulders of giants – or from on one's knees – may never be clear enough.

*Nicholas Poussin (1594-1665) Landscape with Orion or Blind Orion Searching for the Rising Sun (1658)*



Bruce – we seem to have scuttled pawn-wise across the chessboard of explanation at a pretty fast pace. By my count, we've illuminated the first seven squares or stages – that means that we've made it across to the *eighth* – and last! But – surely – that seventh square of algebra seemed to be about as far as anyone could go on the path to abstraction – what could be more abstract than a jumble of numbers and squiggles? What *could* be next?

Yes, Jane – we've almost done it – although you've actually been part-pilgrim-pawn and part-knight – moving across our chessboard to greater generality, as well as along the path of greater abstraction...

More like a knight-errant – on a quest for the Holy Grail of Understanding – although I feel more like a Guinevere than a Lancelot. What say you, my Merlin?



One more step, Jane and you can have your wish – your petty pawn can be promoted – perhaps your Guinevere will become a Red Queen!

Whoopee! I'll be entitled to slip and slide around the board at will!



Entitled? You'll be able to... like the queen that you really are.

Thank you, Bruce – you're really kind – but I'm more like Alice than the Red Queen – going faster and faster – but I'm not sure that I've really gone anywhere yet. Why, I do believe we've been under this tree the whole time! Everything's just as it was!



Of course it is, Jane, what would you have it? What kind of tree do you think it is?

Oh! I **get it**. But there's something that I don't get...



What's that, Jane?

Well, you've described the plodding pawn's perspective on explanation and understanding, but is this how your *heroes* really saw it?

What do you mean, Jane?

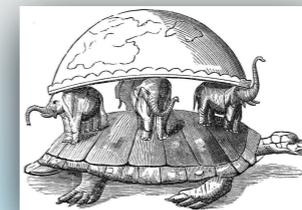
I mean, did **Galileo** or **Newton** or **Descartes** or **Einstein** or any of your **pantheon** of proto-scientists *really* go stepwise through all of this – **these seven steps** – so that they could then take one more step? Did they *really* think like that?



Well – Newton summarised it as **seeing further by standing on the shoulders of giants**.

Each member of the pantheon – as you call them – **couldn't have made their particular contribution without the contributions of those who**

Yeah, yeah! I've heard that before. **Every celebrity and CEO and politician uses a version of it these days** – like: *I would like to acknowledge all the little pygmies and **munchkins** who toiled tirelessly and anonymously to make this blockbuster movie/smash-hit song/humungous-quarterly-profit/landslide election victory – **for which I alone will be rewarded and remembered***. Well – that last part is said **sotto voce**. Maybe they were just the glory-grabber on the top of the **pygmy-pyramid** or **munchkin-mountain** – or the **queen** on top of a **house of cards**....



...or the **elephant on the back of the turtles**?

Yeah – that too – with turtles all the way down!

Lots of things, Bruce. I'll return to the foundation-turtle-problem later. **My concern at the moment** – if you'll pardon my mixed metaphors – **is turtle-thinking versus elephant-thinking.**

Maybe, Bruce. **The poor old turtle/tortoise usually gets a mixed rap in the literature** – apparently dull and slow, but persistent, learning from a long life of experience. **Small steps, with at least three feet on the ground at all times. But he/she gets there, eventually, wherever *there* is.**

Exactly, Bruce.

It's about incremental thinking, Bruce.

What are you getting at, Jane? **There's something still worrying you?**



You're pardoned – I won't mock your mixed metaphors. Stir away! **Is this anything to do with our afore-mentioned hare-and-tortoise?**



**No hare-brained theories from him!** No leaping to conclusions – not even bunny-hopping hypotheses! No Oscars or Nobels. Noble, but not nimble. And no leaps of faith!

**So what has the turtle taught us?**

More thinking, fast and slow?

Quite possibly, Bruce. **The way that you've described understanding and explanation** is in terms of – what *you* consider to be – ***small steps from square to square***. I think that they are *giant steps*, if they are steps at all.



Are we talking about what's *in* each square, or the *step* between each square?

Both.

You mean, after all this time, you think that this *model* is wrong?

No, Bruce, not *wrong* – **it all makes a kind of sense, in an idealistic way**, but, historically, it all didn't really unfold that way, **and I wonder whether either ordinary people or geniuses think like this.**

**I suspect that I probably agree with you there.** We need to look at this aspect in detail if we are to have any hope of coming to any agreement. **How do you see it unfolding, Jane?**

**Suspect! Probably! Can't you ever make a commitment, Bruce?**

**I guess that I was warned.** I love you, too, Bruce. **But this isn't about love, is it?**



**I tell you that I love you every day, Jane.** And I love our kids. Everything else is provisional, to some degree. **I said before that I am an empiricist-probablist, if I'm any *-ist* at all.**

You're certainly attached to your science – **looks like a weird kind of love to me.** But – **do you apply these same -isty criteria to your choice of science as a way of dealing with the world?** Maybe some alternative to science might turn out to be more satisfying.



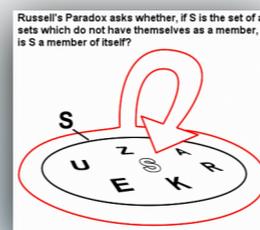
Well, **love** is an **attachment** that involves a **commitment**, but not all commitments are what we call love. As you know, I *do* make commitments, issue by issue – after considering the available, relevant information. That's what scientists do. We live or die by our assessment of probabilities.

Groan! A paradox! A paradox! **A most ingenious paradox!** How did we get here?



Hmmm... an interesting example of **Russell's Paradox**, my Love.

I kind of get it, Bruce. But paradoxes aside, **how do you explain why you use your approach to dealing with the world, rather than some other approach?** Not everybody thinks like a scientist – **probably not even most scientists when they're not writing their scientific papers** – but they still seem to be able to survive – and even flourish.



Russell's Paradox asks whether, if S is the set of all sets which do not have themselves as a member, is S a member of itself?

You were asking whether I used scientific thinking to choose whether I used scientific thinking or some other kind of thinking. That's a paradox of a particular kind – called Russell's Paradox. **If I was already using scientific thinking, I wouldn't be choosing...**

What do you mean by *works*?

Simple – it works for me.

... and you'd like our kids to think this way, too?

It enables me to do the things I want to do – **efficiently** – and it doesn't fail me unexpectedly – **it's reliable**. As **Ziman** called it 'reliable knowledge'.

**Russell's Paradox strikes again!**

*Cleopatra, know,  
We will extenuate rather than enforce:  
If you apply yourself to our intents,  
Which towards you are most gentle, you shall find  
A benefit in this change; but if you seek  
To lay on me a cruelty, by taking  
Antony's course, you shall bereave yourself  
Of my good purposes, and put your  
children  
To that destruction which I'll guard them*



I'd like them to be able to **make up their own minds as to how they make up their own minds.**

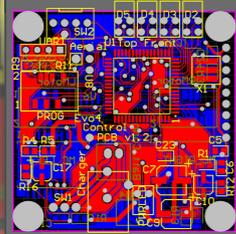
Fixed Mindset	Growth Mindset
Capacities are primarily seen as inherent talents which are barely changeable.	Capacities are seen as malleable by effort and effective learning strategies.
Tendency to try to appear as capable as much as possible.	To try to learn and improve as much as possible.
Are worried because, in case of failure, they can give an impression of lack of talent.	Are motivated because you can learn from them and they can lead to growth.
View an effort to seem as an indication of a lack of talent.	It seems as a normal and necessary step to growth.
Response to adversity or failure: often looks to going up every failure.	It seems as an indication that more effort and better strategies are needed.
Response to criticism: Self-defeating demonstrations are not recognized and admitted.	Inquisitive and interested, eager to learn and open to feedback and suggestions.
View on others: seen as a threat because those other people might be viewed as more talented.	It seems as an inspiration because someone can learn from their further learning.
Response to development: Potential is under-utilized which is seen as a confirmation of one's own fixed talent.	Potential is developed which is a confirmation of one's own growth mindset.
Effect on other people: Can impede cooperation, feedback, and growth.	Can invite cooperation, feedback and help and stimulate growth.

**Steady, Jane!** – all that I'm saying is that **I don't think that forcing kids into a particular mindset is the best way of preparing them for life in the twenty-first century.**

So your way of thinking *isn't* a particular **mindset**? It seems like a **Claytons** mindset to me – the mindset you're having when you're not having a mindset. *Everyone* has a mindset!

Of course you're right, Jane. **We've all got a bunch of fixed responses to variable stimuli.**

Uh?



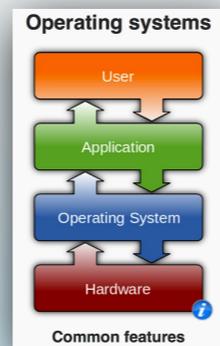
**Hard-wiring! Soft-wiring! You make us sound like robots!** Okay – I know what you mean by hard-wiring, **but soft-wiring?**

But, Bruce – aren't you saying that we are responding **reflexively** one way or the other – **just different strokes for different folks?**

Hmmm... **But aren't these skills just conditioned reflexes, too?**



What I'm saying is that nobody – indeed – **no living thing – responds to what they perceive ab initio – just using the laws of physics and the mathematics of probability to figure out what to do.** We're all the product of a billion years of evolution that has hard-wired a lot of basic reflexes into us. **We can't do much about our *biological* hard-wiring – our *animal-nature* – even if we wanted to.** But we *can* do something about our so-called *human-nature* – **the *psychological* soft-wiring that we impose on our children** – and on each other as adults for that matter.



Well, I could have said operating system or firmware, or something like that, as a more consistent metaphor. **What I am trying to say is that the way that we react to the world around us isn't just a given.** Evidence? – different people respond differently to the same situation – why? -because they derived different lessons from previous experiences that were similar to the present one. **Our soft-wiring or firmware is our operant conditioning.**

Maybe. But I think that we can look at it this way – **mindset** is when a simple basic programming – or conditioning – covers a wide set of situations. Alternatively, rather than a *mindset*, one might have a skill set – a **wider range of successful ways to respond to situations that are broadly similar, but not the same.**

Take it to the bike shop! At least it will get fixed before the kids grow up **and there will be no parts left over when it's fixed.**



Okay. **Pedal on with your metaphor, Bruce.**



And the alternative, in this bizarre metaphor?

Just like the ones that you leave scattered around the house?



Sure, but it plays out quite differently. **To mix my metaphors, you can think of the *fixed mindset* approach as having only one tool – say a large wrench – to try to fix a bike.** There's a few things you might be able to fix readily with it – like a loose handle-bar or sprocket, **but it's hard – but perhaps not impossible – to fix a lot of other things on the bike – like loose spokes, gears and brakes. So what do you do?**

**Ouch!** I think that you're deliberately missing the point, Jane.

There seems to be a range of possibilities – and maybe outsourcing it to the bike shop is one of them – **just shifting the responsibility of thinking to someone else** – if you're prepared to pay the price. I was thinking that, metaphorically, one might deny that the bike needs fixing, or say that broken bikes simply can't be fixed, or find ingenious ways of using a large tool to do small jobs, or maybe make sure that bikes only have parts that can be fixed with a large wrench – **it could be done, but the bike would be pretty clunky.**



A reasonably-sized tool-kit – a few shift-wrenches, screw drivers and two pairs of pliers – one pointy, the other, snub. And maybe a hammer....

Sure – but as I said, a lot of people would say that about *their* way of thinking. What's different?

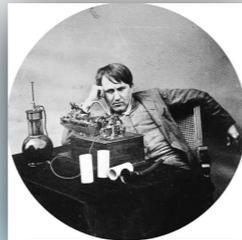
But you just can't summon up successful ideas by the use of your plodding empiricism.

....And getting one's ideas widely accepted....?

I thought that entrepreneurs were rascals who made zillions from mining and banking scams. Most members of your scientific pantheon were far from rich.

The very same ones, Jane. You are most observant.

Indeed, Jane. It all depends on what they want to achieve, or what they expect. In my case, I want to achieve new things – and achieve *lots* of new things. Life is short!



Of course not. It's not *summoning* up ideas – that's the easy part – it's getting one's – or anyone's – ideas to *work* – that's the difference between *invention* and *innovation*.

That's called *entrepreneurship*, Jane.



That's true, but most of them were rascals who – like the miners and bankers – **were selling ideas that weren't wholly their own invention.** To them, the important thing was that a wide range of people *bought* the ideas that they were promoting. **Remember, they were building on the shoulders of the giant body of information that was the life's work of many people.** They turned that information into knowledge – *real knowledge*.

**Real knowledge? What other kind is there?**

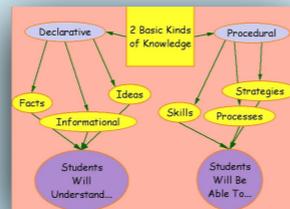
**So is the capacity to act on a stage considered to be *real knowledge*, Bruce?**

**I'm so relieved! But – knowledge *without* words? Sounds like an oxymoron!**

***All the world's a stage  
And all the men and  
women merely players...***



Well – there's knowledge that is just *words* and there's knowledge that is *action* – **declarative knowledge** and **procedural knowledge**. One might be able to recite – or declare – how to do something, or some particular facts, without necessarily being able to *do* anything with that information that you have recited. And until somebody *does* do something based on those words – then they're just so many words – real *words*, but not what I'd call real *knowledge* – **real knowledge is a verified capacity to act – to achieve something intentionally. It may involve words, but not necessarily.**



Of course, Jane – **it's an intentional act for an intended purpose that happens to include, among other things, the vocalising of words.** That's quite different from reciting Newton's equations of motion without being able to use them in any way.

I guess that most people's first impulse is to see it that way, Jane – **particularly when we live in such a word-intensive world where more people are employed to say things than to do things...**

...or *she* really knows how to act...

Rather like Marcel Marceau, miming Youth, Maturity, Old Age and Death, compared with some hack actor **just strutting and fretting their way through Jacques' monologue on the seven ages of man.**



Exactly – but we – all of us – often say: **he really knows how to play football, or he really knows how to play the violin...**

... Yes – and – in many cases – without any of these players necessarily being able to say how they kick, fiddle or spruik. **They often have the capacity to act, and not be able to give an account of how they do it.** So they have *procedural* knowledge without declarative knowledge.

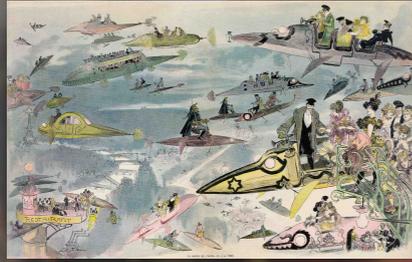


**If that's the way you like it, Jane – yes.**

Well, doesn't that all fly in the face of your chessboard-hopping antics, Bruce? I mean – **doing it is what really counts, doesn't it?**

**But knowing about acting isn't the same as being able to act, or knowing how to answer a quiz question isn't the same as being able to make a cellphone.**

**We need both, Jane, particularly if we are going to try to transmit what we know through space and time – the big idea of science is to transcend the limits of local, informal learning in apprenticeships by establishing a universally understood language.**



And sometimes they just remain in *squiggle-land* – squiggling away. Always squiggle, squiggle, squiggle! [Another damned thick book!](#)

Like your esteemed *Mr Newton*?

Which brings me back to my question about the likes of *Sir Isaac, Professor Einstein et al* – **did they inch their way across the chessboard as well? I think not!**

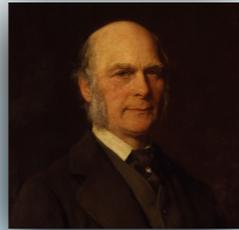
I agree, Jane. But it's the challenge that we always have with abstraction – **first, we have to *know something* – in the sense that we can *do something*.** Then we have to translate that thing that we know into some abstract form – from photos to algebraic squiggles. **Then the receiver has to be able to comprehend those abstract symbols and lastly, transform those symbols back into their own actions.** There are challenges all the way along that chain of events. **The biggest criticism of our so-called education system is that the student is left at the second-to-last stage** – they can say the words or reproduce the squiggles – but they can't do anything useful with the squiggles. **They haven't been taken back along the chess board to their own senses and body.**



But that can be the beauty of the squiggles, Jane – **we** – or at least **theoreticians** – can extend the squiggles into realms that hadn't been squiggled before – and then they might say: ***what do these squiggles mean in the real world?*** That gives science the power of [prediction](#): **They can make their squiggles around the falling of apples and then predict the correct orbits of moons and planets.**

***Sir Isaac*, until you know him better, Jane.**

So – I've been conned?



I'm sure that you're right, Jane. **They were scientific geniuses. They mainly inhabit the eighth square.** Although there were plenty of shoulders for him to stand on, **Newton's unifying theory was a stroke of genius.**

Well – I'm no genius – scientific or otherwise. I can never get to the eighth square. It's all a big con – struggle with these squiggles and one day you'll wake up as a new Newton! Not! You've gotta be born there!

Uh?

Hmmm...interesting proposition, Jane. **You might have just undermined all our efforts since the Enlightenment.**

You mean that you've *actually* been holding out the 'Promise of the Eighth Square' as the reward for a life of squiggle-struggling and -wrestling? Talk about snake-oil salesmen!



Not quite, Jane, although I'd agree that some people have gotten carried away with the Enlightenment proposition.

You've got some defending to do, Bruce – enlighten me!

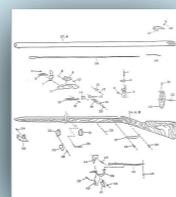
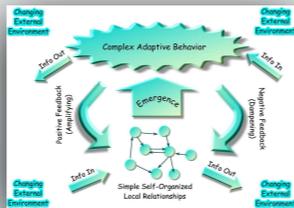
Exactly, Jane. **It seems as though two different propositions got muddled because of their common origins** – the start of the so-called 'Age of Enlightenment', in the mid-Seventeenth century, **was essentially a struggle against the Counter-Reformation** – the revisionist religious absolutism that was implemented after **the Council of Trent in the mid-Sixteenth century.**



Heavy stuff, Bruce.  
Swift reaction, I must say! Not!

...that's a new one: – **extended metaphor for causality**. What's that metaphor for?

I see the connection, now, Bruce.



Yeah – a bit of a slow burn to start with – and like all **complex systems**, it's probably impossible to pin down a beginning, or signal-event that started it, but my take is that Northern Europe became more interested in commerce than religion in Elizabethan times, and one thing led to another. Copernicus had set things in train with his heliocentric views, which led to a revision of the **Julian calendar** – paradoxically at the behest of the Council of Trent – as well as Galileo's stuff – which was more appreciated outside Italy. Prosperity in Northern Europe led to increased invention of elaborate mechanisms and I think that helped provide a clearer – and more extended – metaphor for causality...

Just think about those times, Jane – **one-step causality** has always been with us – push – and it moves, lever it and it will lift, hit it – and it breaks and so on. **But situations where it is clear that the effect of 'C' on 'D', say, came from 'A's effect on 'B', which then affected 'C', then 'D' requires a connected mechanism**, like a wind-up **clock** or trigger mechanism on a **flintlock musket**. When you start to deal with this kind of technology, you mind can start to wander and wonder as to **what other things might be causally connected, rather than being the work of some mysterious hand of fate**. By the beginning of the seventeenth century these technologies were pretty widespread, so these **extended mechanical principles became part of the language**.

When I do count the clock that tells the time,  
And see the brave day sunk in hideous night;  
When I behold the violet past prime,  
And sable curls, all silvered o'er with white...



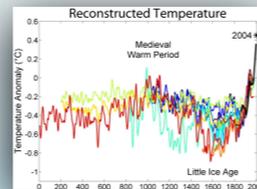
Exactly, Jane. Your timing is perfect. So, after the **Bard's alter ego, Francis Bacon** laid down the ground rules for empiricism in 1620, the way was clear for the Enlightenment to get into full swing.

So – where is this leading us, Bruce? It seems like a very tortuous path to enlightenment.



Well, as I said, Jane, it's not straightforward – **James Burke** gave a sample of this in his 'seventies TV series "**Connections**" – you can trace a plausible thread through historic events which precede an event of interest, but *history is not science*.

But isn't *climate change* as much *history* as it is *science*?



Agreed, Jane – *anything about the past can't be treated directly like an experiment* – all we can do is try to narrow down the web of events to a consistent, plausible thread.

...so the *Enlightenment thing*?

Do you mean that I *can* reach the eighth square after all?

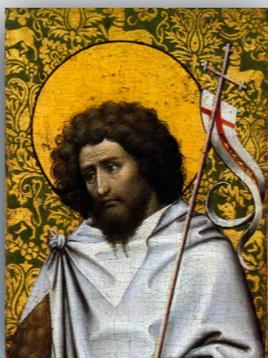
Well – as I said, two ideas have been conflated – the *outcome* and the *process*.

*Possibly.*

But not *probably*?

It's not pre-determined, my darling.

Great! Tell me more!



Well, first, my understanding of the outcome, or goal – **although I think that the whole thing is a bit miscast, as an outcome, rather than a process.** *Enlightenment*, in the European sense, seemed to have meant something like **sainthood** – and an automatic pass to heaven or paradise, as you had reached a state of virtue beyond reproach.

Mmm... my probability has gone to zero already.

Well, I think that you're divine, Jane.

Thank you, Bruce, but I don't know how much weight your recommendation holds – **I think that there is a mutual non-recognition between you and St Peter.**

Be that as it may... **I think that it's worth saying that Eastern belief systems have a similar goal** – Buddhism and Hinduism calls it **Nirvana**. Given the number of saints in the West and **Bodisattvas** in the East, **I would agree that, other things being equal, we have dim prospects of reaching this level of enlightenment.**

'Dim prospects' equals 'low probability'?



You're catching on, Jane. But this group of very excellent people seems to have served a greater purpose, related to the *process* part. ***You couldn't get to heaven without being good.*** Saints, Greek gods, Bodhisattvas – all models of possible perfection.

Well, I was told that often enough by the nuns at school. Mum and Dad were more mundane and promised lollies and dolls if I was good. The dolls bit seemed to work – at least sometimes.

And they forgave you when you were naughty?

Of course – after *due penance*, of course – like room-cleaning, dish-washing and so on.



And so it was, Jane – and still is – with the churches – behave yourself, work hard, be obedient to authority and you've got a chance of getting to heaven....

...a heaven that was something like the paintings in the Renaissance and Baroque churches...



...but much, much better – not to mention the eternal choirs, that were like the church choirs, but always in tune... and alternatively...

Oh, oh! – the fire and brimstone bit – I'd much prefer to go clean my room.



You've got the general idea – parental authority morphed into obedience to the church and its various agents – popes, priests, kings...

...so you think that it was all a big con, Bruce? And what did this have to do with *your* bright bunch of scientists?

I don't think that it was a *complete* con...

Bruce! You mean *you're* cutting them some slack?

A bit, Jane. In the absence of any other model, the old carrot-and-stick of heaven and hell enabled a fair degree of social cohesion. Just that as groups got bigger and formed towns and cities the carrots and sticks had to grow commensurately.

Okay – I get the general idea –at least the cardinal points. But while we're at it – **how did this idea play out in the East?**



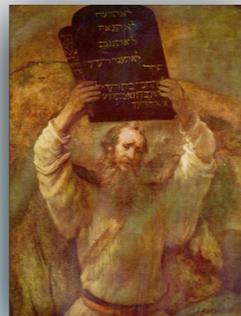
As I said, there was the possibility of Nirvana, which seemed more like a *state of being* than some astral real estate, like the visual cliché of the Western Heaven. Bodhisattvas were – or are – somewhat equivalent to saints, but still mundane. To achieve Nirvana, you generally had to first achieve Satori.

Sounds complicated – a two-step process...?

Even more detailed than that – Eight-fold Paths and all...

Being *good* isn't enough?

Okay... speaking of paths, can we get back on track with this Western Enlightenment thing?



Well, the Ten Commandments top the Eight-fold Path. Just that the Ten Commandments are mainly cast in the negative – telling you what to not do, rather than what actual actions you can usefully take...

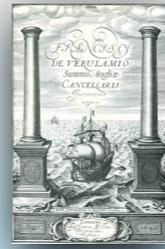
Groan!



And the value proposition being....?

That's rather couched in the negative, Bruce. That's what they *didn't* want – what did they want instead?

Quite ambitious! But not really secular – they seemed to want the best of both worlds – or at least the best of the World and Heaven as well – so long as it wasn't a *Catholic* heaven.



Yes, we're now in a position to bring home the Bacon....



I guess that it amounts to this: the Western Enlightenment, as a *process*, was essentially the development of the modern so-called 'scientific way of thinking' – there were plenty of players, but Bacon – and then Spinoza – were big players in setting up the ground rules of science – *a kind of Ten Commandments and Eight-fold Path of scientific principles* for others to follow.

*An Earth that is a bit like heaven – or at least, somewhat less miserable* – if the Enlightenment Way was followed. Its purpose was to reform society away from *irrationality* – specifically, away from superstition, dogmatism of all kinds, unfounded intolerance of all kinds and gross abuses of power by both the Catholic Church and by despotic kings.

Lots of things, Jane – democracy, racial and sexual equality, individual liberty of lifestyle, full freedom of thought, expression and the press, eradication of religious authority from the legislative process and education – and full separation of church and state.

That's a big leap, Bruce.



As I said, **the origins of this idea are complex** – and geopolitics seems to have been part of the early motivation – You can go back to **Henry VIII** and **Martin Luther** in the early-ish sixteenth century, **who were essentially wresting power from Rome**, rather than pursuing rationalist philosophies.

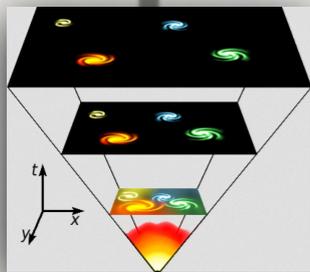
Yes- a leap of faith- sideways- I guess.

Groan! Again!

Okay, Bruce, but as far as I know, **pretty well all those Enlightenment characters were still religious – mainly Christians**. How did they – or you – reconcile *that* paradox?



Sorry about that, Jane. **It's this perennial problem of dealing with Aristotle's first causes, final causes and cosmological arguments** – we're always trying to find what happened first, why we're here and where we might be going. Probably futile – **although physicists keep on coming back to it with Big Bang Theories**.



Well, as I said, Jane, **it was complex – there was no script for it**. Most of them came had a religious upbringing, **because the church was all-prevailing** – *conditioning* as I've called it – and although they could come up with extended rational discourses on causality about mundane things, **they couldn't find an answer for the big questions – they had neither the intellectual tools nor the scientific instruments to do it**. So they consigned **God to the gaps** – of which there were many in those days.

Or the **God of the beginnings and ends...** So they really set up a **scientific-philosophical system that was modeled on the Judao-Christian system** – believers, liturgy...

So they were *believers*, then! Not *empiricist probablists*?

Secret squirrel societies?

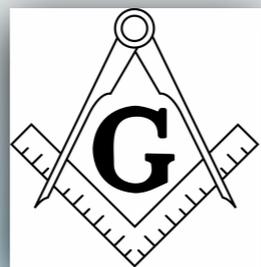
Which must have made them unpopular with the powers-that-were?



...I think that is imputing too much order to the events, Jane. Certainly Spinoza's ideals continued to echo through that period, but he was near the beginning, not the end of that period that is called *The Enlightenment*. **Spinoza was considered as an example of the Radical Enlightenment**, while most others were subscribers to the *Moderate Enlightenment*, who believed that there were two sources of Truth – *reason and experience* – and experience included much of the *status quo*.



They were *pragmatists*, as well, Jane – in the everyday sense of the word – they lived in absolute monarchies and didn't want to buy into trouble unnecessarily.



No – not really, as far as one can tell – **the nearest to a secret group were the Freemasons**, whose members included some of the prominent scientific thinkers of that time, and held a view that **God didn't interfere with everyday life**.

Anybody who contributes to the erosion of authority runs that risk. 'Twas always thus, and always thus will be.

So the Enlightenment wasn't a *unified* attempt to overthrow the existing order?



Nobody expects the French Revolution!

So that was the high point of Enlightenment thinking?

So we're all little *Enlighten-istas*, now?



Not as far as I can tell. Sure, there were **Societies**, ranging from the Freemasons to the **Royal Society of London** and its **French equivalents**, **salons**, **coffeehouses**, the **Republic of Letters** and other groups who were interested in finding things out and talking about them. **Grub Street writers** served to **popularize some of these ideas** as well as **promote literacy in general**. It seemed like the effect was the same as it is today – **accumulated knowledge** – **generated by intellectuals and experience** – **becoming widely accessible** – leading to a general feeling of unbearable contradiction between what was **widely known** and what was said by authority – **cognitive dissonance**, it's called.

I think that it was pretty widely expected, darling.



The Enlightenment thinkers certainly got a bad rap out of the French Revolution – **unfairly by some accounts**. But, with the benefit of hindsight, the **core ideas of the Enlightenment** continued to take hold and are still with us today.

Some more than others, from my **observation**, my dear.

And what, in this sense, makes for an *enlightened* person, Bruce?

All that fuss for *that*?

Well, that seems to be somewhat short of *sainthood*.

I get it – subscribing to chess-board hopping is rather like being a virtuous, religious person – it might keep you out of trouble, but it's a bit short of *transcendent*. So religions have their saints or what-have-you in the East – what have you got to offer, Bruce?

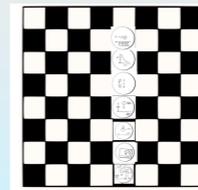
*Genius?* So that's your *secular sainthood*?

Just – I hadn't thought of it like that. In fact, I hadn't thought too much about geniuses, other than to recognize that many of the people who highlight civilization with their contributions **are far more talented than I could ever hope to be**. Shakespeare, Milton, Bach, Mozart, Monet, Picasso – all geniuses of the arts, I guess.

Simple, Jane – a *preference for traversing the squares of our explanatory chess-board, rather than relying on intuition and revelation as a guide to managing the material world*.

Well, I think that it is a pretty different than the alternative.

As I said, Jane, there seems to be *two* – somewhat different – interpretations of *enlightenment*....



*Genius!*

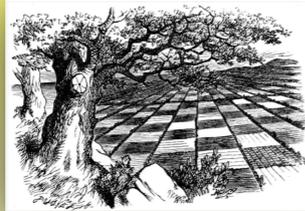
Yep. Why not?



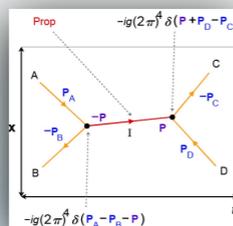
*Feynman?* I've heard of the others, of course – but who's he?

Okay! But what do we mean by the *greatest genius*? We throw these words around – not just scientists, but literary people as well. What makes a genius – and what makes one greater than another?

You mean that he didn't do a dance across the chessboard of explanation?



He was *in* it – but not *of* it, Bruce?



Not usually – it seems that he – like many other scientific geniuses – floated – dreamlike – above the chessboard. He had a profound feeling for all the squares or stages – from the sensual first square, through the various levels of abstracted reality all the way to the squiggly math. He'd only do the math to verify what he already *knew*. The math – or often his famous *neo-Cartesian diagrams* – were there to explain his knowledge to others – *non-geniuses*.

Well, I add in my group – Galileo, Newton, Einstein, Feynman... to name a few of my secular saints.



Like their religious equivalents – it sometimes takes a while for secular saints to be recognized.

Feynman is generally considered – or at least considered by physicists – to be the greatest genius of physics since Einstein.

Hmm... that's a tricky question. I might ask the same question of the *pious bunch* as well. There's lots of stories about geniuses, but I like the one about Feynman – describing his problem-solving method – *he'd write the problem down, then clench his fists on the sides of his head, and then write down the answer.*

Either way, we are not made of such stuff.

Or maybe *over* it but not *on* it, Jane. Sleepwalkers, Jane. Even *they* don't know *how* they know.

And what *stuff* are your celestial friends made of, Jane?

Saints seem to come in a number of flavours,

Bruce – some are great *exemplars* of the way that God would wish us to behave, some are **conveyors of revelations** and some **work miracles**.

In all cases, as far as the Catholic church is concerned, **saints are *revealed and recognised* – not *created* by following the church. They're *born*, not *bred*.**



I guess that it's the same **with *our* mob** – no amount of teaching will make a non-genius into a genius. **It's a bit of a con-job.**

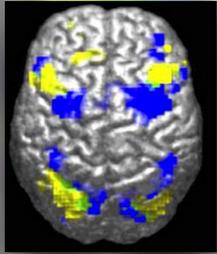
But we seem to be *defining by pointing*, Bruce – as Socrates used to say. How do they do what they do that is so different from the way that we do it?

You mean – what's the essence of *sainthood* and *genius*?

Exactly.

Like Rain Man?

First, I'd set aside the savants – people with an exceptionally deep, but very narrow abilities.



Yes – a lot of savants are like that – **autistic** – but not all of them – a lot are brain damaged in some way. **Most of them can do some trick or another** – like arithmetic, calendar dates, memory feats, playing music and so on – **but with no – or very little accompanying intellectual abilities**. We're talking about **intellectuals** – people who are extraordinarily inventive and can also express their reasoning and thinking abilities – in writing, music, science – things like that.



Aha!

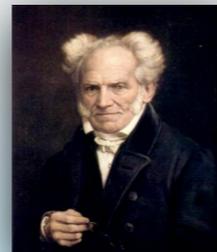
What?

So there are two parts to this genius thing – *inventiveness* and *creativity*?

Yes – I'd say *inventiveness* and *innovativeness* – both **the ability to imagine something novel** – to have an original idea – **and the ability to transform that idea into something that works**. In this case, we're talking about a *something* that is writing, music, science, maths etc.

But lots of people do that – and we don't call them geniuses.

That's a bit **metaphysical** for you, Bruce!



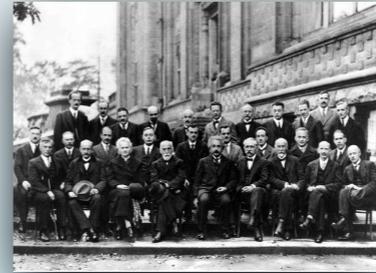
That's *everyday talent*. I think that **Schopenhauer** summed up the difference:

***Talent hits a target no one else can hit; Genius hits a target no one else can see.***

I guess that is where saints and geniuses depart, Bruce. Saints become perfect or perform miracles by the grace of God. They transcend scrutiny.



You're probably right, Jane. **The fact is that we simply don't have a good grip on the phenomenon of genius.** We can point at it, but we can't explain it very adequately – either behaviorally or at a biochemical level. **Perhaps we need a genius to look at the subject.** But the important thing here is that whatever paradigm shift or the scientific genius performs, it is **subject to the same rules of scrutiny by objective empiricism as the work of the plodding researcher** – as much as we might admire them, in science, **geniuses have no God-given authority or immunity from scrutiny.**



You could put it that way. I think that I'm beginning to see the light.

A kind of diplomatic immunity?

*When most I wink, then do mine eyes best see,  
For all the day they view things unrespected;  
But when I sleep, in dreams they look on thee,  
And darkly bright, are bright in dark directed.  
Then thou, whose shadow shadows doth make bright,  
How would thy shadow's form form happy show  
To the clear day with thy much clearer light,  
When to unseeing eyes thy shade shines so!*

*How would, I say, mine eyes be  
blessed made  
By looking on thee in the living day,  
When in dead night thy fair imperfect  
shade  
Through heavy sleep on sightless eyes doth stay!  
All days are nights to see till I see thee,  
And nights bright days when dreams do show  
thee me.*



## Chapter 19

# WARMING AND FALLING

Over a morning soy-latte and coffee, Jane and Bruce review their recent journey. Bruce thought he'd given Jane the drum on understanding science, but it remains an open question.

*Oil drums.*  
**Photograph by the  
Author**



So we've come full-circle, Bruce – here we are again, Saturday morning in the kitchen, with the kids finger-painting with Grandma, **the shiny hybrid in the car-port**, me with my decaf soy-latte, you with your fair-trade long-black – **and my questions about climate change still, essentially, un-answered!** It's been a head-spinning few weeks!

Well, Jane – **I did say that there's a short, simple answer, but the full explanation would be quite lengthy.**

But, for all those words and *fol-de-rol*, **I haven't got a 'full explanation' of climate change.** I've had a few glimpses, but I'm still in no position to confront the nay-sayers at the dog-park and pre-school.



But you *have* got something now that you didn't have before – surely?

I guess that I have, Bruce, **but I'm not quite sure what it is and if it's useful.**

Perhaps if we **quickly review where we've been**, we can then see whether it's useful. First, **what do you think is at the heart of those frustrating dog-park and child-care-centre conversations?**

Well – **it seems easy for everybody to hold onto their preferred opinion on such a tenuous matter.** I mean, if, for example, there's a huge, new, warm doggy-doo in the park, it's pretty obvious that it's the Great Dane's. If a child is crying with a bloody knee at the centre, it's pretty obvious that it needs to be attended to. **Climate change is different. It's small, slow and often hidden by other events and circumstances.** So how can one be confident that one side is right and the other wrong?

Did I say that *anybody* was 'wrong', Jane?

Okay! Most likely – indeed, *very likely* – to be wrong. *Probably* wrong. Err – *has less data supporting it*. Sounds pretty weak, doesn't it? Using that sort of language just gets you beaten into a corner.

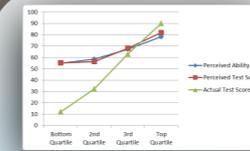
Groan! I thought that we'd finished with these curious phenomena and effects. Just when I thought that it was safe to go out into the rising waters, you spring another one! Okay – elucidate!

*I see their knavery: this is to make an ass of me; to fright me, if they could.*



... My *belief in belief* has certainly taken a hit, too. It's still a bit uncomfortable, but I think that I can live without that level of enthusiasm for things that are intrinsically uncertain. It seems that those who know do not speak – and those who speak do not know.

You've put a strong case to support both their *competence* and the integrity of their *intentions* – at least compared with the noisy, alternative viewpoint. That does give me some confidence, I must say.



The Dunning-Kruger effect is everywhere to be seen – and experienced, Jane.

Well, the *DKE* just clarifies what we *suspect* – unskilled individuals suffering from illusory superiority, mistakenly rating their ability or knowledge much higher than is accurate, because of their inability to recognize their ineptitude.



That's it in a nut-shell, Jane. So, despite their comparative silence, do you *trust* the climate scientists?

So you are confident that they are speaking the truth – that is, when they *do* speak?

Ah! **The *truth***! You can't catch me on that one, now, Bruce. *Lovers* might talk about *truth*, *Al Gore* might talk about *truth*, but **you scientists just have crowd-sourced-concurrence-of-observations**.



So you are confident that they are speaking the *truth* – that is, when they *do* speak?

Spoken like an *empiricist-probablist!*. Welcome to the light-side, Jane.

Indeed, the empiricists are striking back! Forcefully!

And what do you feel about the *universal appeal* of science, Jane?

Or its appeal to Platonic universals, my love? You certainly like to give the *post-modernists* a hard time.

Quite rightfully, too, Jane, but what point in particular?

It seems that *your science is a Pre-modernist-slash-Enlightenist* – construction of a linear narrative that tries to arrive at *universal statements* – like a *cannonball hitting a castle-wall!* The *po-mo's* just keep it local and personal and then claim that their local, personal experience is universal.



Linear? Do you just mean logical and reasoned?



More than that, Bruce. The way that you progress from the *personal* to the *universal* was quite a new trip for me.

Oh – you mean the *chess-board*? Personal-to-universal... I called it *concrete-to-abstract*. Quite a trip. Yeah.

Three trips for the price of one, too! Quite a bargain!

Well, you were trying to boil it down to *one* head-trip – constructivist empiricist cognition. But it was also a trip through *history* and a trip through *personal development, a la Piaget*. *Three* trips, but *one* destination.

Wonderland! Paradise! Hades, perhaps! What's the price of a fare, my dear Ferryman?

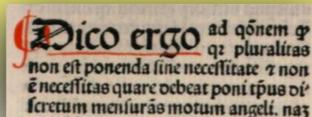


And every fair from fair sometime declines,  
By chance, or nature's changing course  
untrimmed...



You riddle me, Bruce.

Oh – the *KISS!*



Three?

A trip to *Wonderland* that anyone can take – if they are prepared to pay the fare.



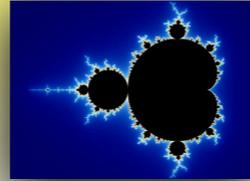
A ticket to the fair? A shared fare. A fair share! Are you prepared to pay the price, Jane?

The answer to your riddle is in the *ants*. We'll all have a fair share in the fare if we share the fare – if we slice the fare with Ockham's Razor.



Kissing in public, too. A simple kiss. Or an exchange of pheromones.

So what seems like frenzied *complexity* is actually a drive for *simplicity*, Bruce?



And simple truth miscalled simplicity...

That's nice, Bruce. Did you come up with a formula for art?

Care to share, my fair one?

"... to simple truths. And what else, my love?"

Just like the *ants*, Jane.

Indeed, Jane, with the usual reservations about **truthiness**. But, before the kids rush in with paint from head to toe, I must say that, although you asked me about science and climate change, I **learned a lot about poetry and painting, too.**

Not at all, Jane. Well – a few generalisations, but hardly an equation.



First, I think that the *cognitive journey of art* is similar to the *cognitive journey of science* – I particularly liked the nineteenth century trip from *romantic realism* to *visual abstraction*. Like science, it seemed to be trying to simplify its symbols.

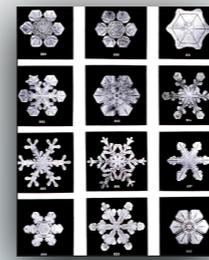
*"...But from thine eyes my knowledge I derive,  
And, constant stars, in them I read  
such art*

*As truth and beauty shall together  
thrive,*

*If from thyself, to store thou  
wouldst convert;*

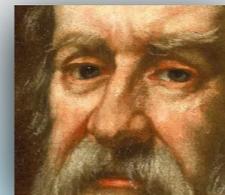
*Or else of thee this I prognosticate:*

*Thy end is truth's and beauty's doom and date.*



It seems to me that **although one can analyse art and poetry – one *can* pull it apart and look for sense and allusion – but its real purpose is in its *whole* – the emotional feelings and impressions from the senses of sight and sound from experiencing it. Its *truth* – if I dare use the word – is in its whole, not its parts – **its whole is greater – and different – than its parts** – an emergent property, no less. Rather unpredictable, I might say, Jane.**

Indeed – **it has been a surprising *journey***, Bruce. A **real head-trip** – if that isn't an oxymoron.



I couldn't have said it better! **So how would you summarise our journey, Jane?**

Who knows, Bruce? If you mean: **can I *do* science now, the answer is *certainly not***. I doubt that I could ever do that – **I'm wired differently**. But if you mean: ***do I understand how scientists understand science***, then I think that I've now got a ***feeling*** for it.

**Play Me!**

So – **do you *understand* science now, Jane?**

**It looks as though our young painters have arrived!**

## Understanding *understanding*

What is it, to *understand*  
The nature of a flower  
Or why  
The sky is blue,  
That all things change  
And that  
So many  
People cry and  
So few  
Can stand against the wind?

We think, perhaps,  
That to understand  
We must explain  
That there are parts,  
And that they connect  
By logic and reason,  
With time and cause  
Providing movement.

Thus separated,  
Us from it,  
The parts proliferate  
Connections multiply  
Thin threads of logic  
Weave a tangled web  
And reason creates  
A past that severs  
Time's circle.

Who is it who explains  
Me to you  
Or me to me?  
Duality and words –  
We take each other's experi-  
ences  
As our own –  
As if my shoes,  
Having trod so many paths  
Would fit your feet.

So –  
To wish to understand  
Is to wish,  
And then to hope  
That once separated,  
All will become as one  
again  
When we know.

No!  
Understanding will not  
Come this way like that.  
Only by leaving  
Words and cause behind  
By being here and now  
Will we breathe out  
And see  
That it is so.

*Love is all*  
We need to know.....

The End.....