

Why Asians Are Good At Math, Finally, A Legit Theory

February 19th, 2009 by Will

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Whether you admit it or not, being raised in America, we all know the racial stereotypes that have traversed through our colorful history. For Asian Americans, we are all good at math right? It's a stereotype, but a good stereotype right? Despite my frequent ramblings, political correctness concerns me little. Instead, I am interested in the roots and explanations to social phenomenon that we humans, out of ignorance, simplify with racial stereotypes.

What do people really think about the Asians-good-at-math stereotype? Oh, I know, it's because they're smarter. Well, no, if we accept Asians are good at math because Asians are smarter, we fall into the same whirlpool of ignorance the Conquistadors used to justify their dominance over Meso-Americans or 19th century American slave owners who believed African slaves could only become civilized through hard work. Fortunately, Malcolm Gladwell's most recent book, *Outliers*, has shed some light on the Asian math stereotype.

First, what we know. American grade school students have always trailed continental Asia in math. Some claim Asian students are better because they spend more hours in school. But comparing school systems fails to account for *Asian-American* success. Asians in America go through the same education system yet in the 2003 SAT exam, Asian-Americans averaged 575 in Math while White's averaged 534, American Indian's 482, Hispanics 464, and African Americans at 426.

So if it's not the schools, what accounts for Asians succeeding in math across different education systems? As English speakers, we may be unaware, but the English language is perhaps the most odd and irrational language around. Particularly with numbers, in English, after ten the teens each have an unique name and each tenth following that gets their own name. In fact, one would need to learn 28 unique words to count up to 100 in English while in any Chinese dialect, Japanese, or Korean, one only needs to learn 11 – one through ten and one hundred.

Outliers

Malcolm Gladwell

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In Asian languages like Chinese, numbers after ten follow a precise logic. Eleven in Mandarin is *shi yi* or ten-one, twelve is ten-two, thirteen is ten-three, and so forth. When we get to fifty-nine, the logic continues, five-ten-nine. Five tens and a nine, 59. The internal logic in counting numbers with Asian languages results in kids who speak Asian languages are able to count beyond a hundred before English speakers can even count to 40. But the Asian language advantage doesn't stop in counting. Remember those dreaded fractions? In English we would read $\frac{3}{4}$ as three-fourths. But for languages like Chinese, $\frac{3}{4}$ is literally translated, "out of 4 parts, take 3".

When you think how much more sense math makes for Asian-language speakers and considering how many frustrated 3rd graders go home with there hands crossed because multiplication doesn't make sense. How much fun would math had been if it did make sense? Wouldn't you do more homework? In turn wouldn't you pick up new concepts – in which case math heavily depends on learning piece by piece – easier. Quite simply,

The much-storied disenchantment with mathematics among western

children starts in the third and fourth grade, [...] perhaps a part of that disenchantment is due to the fact that math doesn't seem to make sense; its linguistic structure is clumsy; its basic rules seem arbitrary and complicated.

Asian children, by contrast, don't face nearly that same sense of bafflement. They can hold more numbers in their head, and do calculations faster, and the way fractions are expressed in their language corresponds exactly to the way a fraction actually is—and maybe that makes them a little more likely to enjoy math, and maybe because they enjoy math a little more they try a little harder and take more math classes and are more willing to do their homework, and on and on, in a kind of virtuous circle.

When it comes to math, in other words, Asians have built-in advantage. .

And as a child, you're not discouraged at math, it's likely you'll continue to take math classes growing up and continuing to do homework because it just all makes sense.

While extensive study on languages affect on math, Gladwell's assertions shed light away from simplistic racial explanations for which I personally rejoice over.

Deduction and induction compared

When we compare induction with deduction we can say that the former gives us more information in that it enables us to make generalisations about the world, but the latter is more certain. The difference between the two kinds of reasoning can be summarised in the table below.

Deduction	Induction
<i>Definition</i>	
Reasoning from general to particular	Reasoning from particular to general
<i>Example</i>	
All metals expand when heated. A is a metal. Therefore A expands when heated.	Metal A expands when heated; metal B expands when heated; metal C expands when heated. Therefore all metals expand when heated.
<i>Value</i>	
More certain, but less informative than induction	More informative, but less certain than deduction

In practice, however, deduction turns out to be no more certain than induction. This is because the premises on which deductive reasoning about the world is based must be derived from induction. To see this, go back to the example at the beginning of this chapter. The validity of Sherlock Holmes' conclusion that the thief was known to the dog depends on the truth of the premise that all watchdogs bark at strangers. And we can know that only by induction! Watchdogs A, B, C, D, E, ... bark at strangers. Therefore all watchdogs bark at strangers. So Holmes' conclusion is only as certain as the inductive premises on which it is based.

How reliable is inductive reasoning?

Since induction goes beyond the immediate evidence of our senses, we cannot always rely on it. This is because we tend to make *hasty generalisations* and jump to conclusions on the basis of insufficient evidence. For example, if a tourist is served by a rude French waiter, he may conclude that all French people are rude; and if a female fighter pilot crashes a jet her male colleague may conclude that women are unfit to fly. Neither of these conclusions is justified by the evidence, and this kind of faulty reasoning can easily lead to racist or sexist attitudes. The trouble, as the psychologist Gordon Allport (1897–1967) observed, is that, 'Given a thimbleful of facts, we rush to make generalizations as large as a tub.'

Sometimes even well-established generalisations can let us down. With reference to the examples mentioned above, it is always possible that tomorrow apples make me sick, my neighbour's dog savages me, and my chair collapses. Europeans used to believe that all swans are white until they went to Australia and discovered that

some swans are black. You might even question a well-established regularity, such as 'Water boils at 100 degrees centigrade.' After all, it is not true if you are at the top of a mountain!

The tendency to make hasty generalisations is made worse by a phenomenon known as **confirmation bias**. As we saw in Chapter 1, this suggests that people tend to remember only evidence that supports their beliefs and to forget evidence that goes against them. Thus once you have decided that the French are arrogant or that the English are cold, you may notice only examples that confirm your prejudice and overlook those that go against it. This may explain why it is so difficult to change the mind of someone who is in the grip of a prejudice.



- 1 Give three examples of your own of some hasty generalisations.
- 2 Why do you think that people are so quick to jump to conclusions?
- 3 What is the difference between a prejudice, a generalisation, and a scientific law?

To illustrate the extent to which we jump to conclusions on the basis of insufficient evidence, consider the following story, which was devised by the psychologist William V. Haney to illustrate precisely this point:

A businessman had just turned off the lights in the store when a man appeared and demanded money. The owner opened a cash register. The contents of the cash register were scooped up, and the man sped away. A member of the police force was notified promptly.



Given the information in the story, respond to each of the 11 statements below by writing next to each one either 'T' if the statement is definitely true, 'F' if the statement is definitely false, and 'U' if the statement is unknown.

- 1 A man appeared after the owner had turned off his store lights.
- 2 The robber was a man.
- 3 The man did not demand money.
- 4 The man who opened the cash register was the owner.
- 5 The store owner scooped up the contents of the cash register and ran away.
- 6 Someone opened a cash register.
- 7 After the man who demanded the money scooped up the contents of the cash register, he ran away.
- 8 While the cash register contained money, the story does not state how much.
- 9 The robber demanded money of the owner.
- 10 The story concerns a series of events in which only three persons are referred to: the owner of the store, a man who demanded money, and a member of the police force.

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- 11 The following events in the story are true: someone demanded money, a cash register was opened, its contents were scooped up, and a man dashed out of the store.

If you check your responses with the answers given at the end of this chapter, you may be surprised by the extent to which you jumped to various false conclusions on the basis of the information that was given to you.

What distinguishes good generalisations?

Since generalisations sometimes lead us into trouble, we need to think about how to distinguish good ones from bad ones. Here are some relevant general criteria:

- 1 *Number* You should look at a reasonable number of instances. If you see one example of a dog swimming, this is clearly not enough to conclude that 'all dogs can swim', and you should look at a lot more cases.
- 2 *Variety* You should look at a variety of circumstances. In the above example, you might look at different breeds of dogs, young dogs, old dogs, etc.
- 3 *Exceptions* You should actively look for counter-examples. You might, for example, ask if anyone has a dog that cannot swim. This will help to guard against confirmation bias.
- 4 *Coherence* You should demand more evidence to support surprising claims than unsurprising ones. It would take more to convince me that all dogs can walk on their hind legs than that all dogs can swim.
- 5 *Subject area* You should be aware of the subject area you are dealing with, and keep in mind that generalisations tend to be more reliable in the natural sciences than in the social sciences. For example, if you heat copper sulphate crystals they always turn from blue to white; but when you do experiments with dogs, the results are much less predictable. Indeed, according to the so-called Harvard law of animal behaviour, 'Under carefully controlled experimental circumstances an animal will behave as it damned well pleases.' And the behaviour of human beings – the most complex and contrary of animals – is, of course, the most difficult to predict of all. That is why there are a greater number of reliable generalisations in chemistry than in economics.

Although the above criteria can help us to distinguish between more and less reasonable generalisations, they are not precise rules. How many times should a team of scientists repeat an experiment before concluding that they have discovered a new law of nature? We can give some general advice, such as 'Many times if the experiments deal with complex phenomena or give unexpected results'. But there is not a number we can stipulate such as seven or twenty-three. All we can say is that the greater the number of confirming instances the more confident we can be about the generalisation.

- 3 In your cellar there are three light switches in the OFF position. Each switch controls one of three light bulbs on the floor above. You may move any of the switches but you may only go upstairs to inspect the bulbs one time. How can you determine the switch for each bulb with one inspection?
- 4 A landscape gardener is given instructions to plant four special trees so that each one is exactly the same distance from each of the others. How would you arrange the trees?
- 5 Connect the nine crosses below using only four straight lines and without taking your pen off the paper.

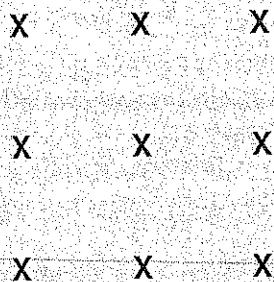


Figure 5.7



- 1 Give a rational explanation for each of the following situations. In each case you will need to question your assumptions and try to 'think outside the box'.
 - a A man walks into a bar and asks the barman for a glass of water. The barman pulls out a gun and points it at the man. The man says 'Thank you' and walks out.
 - b A man is lying dead in a field. Next to him there is an unopened package. There is no other creature in the field. How did he die?
 - c Anthony and Cleopatra are lying dead on the floor of a villa in Egypt. Nearby is a broken bowl. There is no mark on either of their bodies and they were not poisoned. How did they die?
 - d A man rode into town on Friday. He stayed three nights and then left on Friday. How come?
- 2 Two boxers are in a boxing match (regular boxing, not kick boxing). The fight is scheduled for 12 rounds but ends after 6 rounds, after one boxer knocks out the other boxer. Yet no man throws a punch. How is this possible?

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It is clearly stated that it does not keep making *ad hoc* exceptions when it comes across counter-examples.

- 1 Which of the following statements make scientifically testable claims?
 - a In 2010 you may or may not win the lottery.
 - b It always rains on Tuesdays.
 - c We have all lived past lives, but most of us are too unenlightened to remember them.
 - d Real men don't cry.
 - e Unlike magnetic poles attract each other.
 - f Everyone is selfish.
 - g Acids turn litmus paper red.
 - h Something surprising will happen to you next week.
- 2 To what extent do you think astrology consists of genuinely testable propositions?

The scientific method

In trying to distinguish science from non-science, you might list all the subjects that count as science – such as physics, chemistry and biology – and then say that everything else is non-science. However, this does not seem very helpful because it does not explain *why* some things count as science and other things do not. A better approach might be to say that what distinguishes science from non-science is a distinctive *method*. On this view, science is not so much a fixed body of knowledge as a way of thinking about the world.

- 1 Each of the elements below is relevant to the scientific method. Try to put them into sequential order and write a short description of how a scientist typically works.
 - a Experiment
 - b Induction
 - c Hypothesis
 - d Law
 - e Measurement
 - f Observation
 - g Repeatability
 - h Theory
- 2 How is each of the following similar to scientific activity and how is it different?
 - a Baking a cake by following a recipe.
 - b 'Experimenting' with ingredients and making your own recipe.
 - c Collecting and organising stamps from around the world.
 - d Repairing a car that has broken down.

- e Heating a fixed volume of gas to see what happens to the pressure.
- f Speculating on the origins of the universe.
- g Studying human anatomy before making a sculpture.
- h Doing detective work to solve a murder.
- i Inventing the light bulb.
- j Predicting rain because the clouds look threatening.
- k Solving a crossword puzzle.
- l Noticing that you always need something just after you have thrown it away.



Reading Resources

CRYSTALLINE TRUTH AND CRYSTAL BALLS

Richard Dawkins does not pull his punches in this trenchant defence of scientific thinking against the siren voices of pseudo-science.

A celebrated film star 'places four quartz crystal clusters in the four corners of her bathtub every time she takes a bath'. This doubtless has some mystic connection with the following recipe, found on the World Wide Web, for meditation:

'Each of the four quartz crystals in the meditation room should be "programmed" to project gentle, loving, relaxing, crystalline energy towards all those present within the Meditation group. The quartz crystals will then generate a field of positive crystalline energy surrounding everyone in the room.'

Language like this is a con trick. It sounds 'scientific' enough to bamboozle the innocent. 'Programming' is what you do to computers. The word means nothing when applied to crystals. 'Energy' and 'field' are carefully defined notions in physics. There is no such thing as 'loving' or 'crystalline' energy, whether positive or no.

New Age lore advises placing a quartz crystal in your water jug. Another Web site states: *'You will soon appreciate the sparkling purity of your crystal water'*.

See how the trick works? Somebody with no understanding of the real world could make a kind of poetic association with 'crystal clear' water. But that is no more sensible than trying to read by the light of a ('bright as a') button. Or putting ('hard as') nails under your pillow to assist an erection.

'Try the following experiment when you next suffer from flu: hold your personal quartz crystal and visualise yellow light radiating through it, then place your crystal in a jug of water and drink this water the next day; one cup of water at two-hourly intervals. You will be amazed at the result!'

Drinking water at two-hourly intervals is a good idea, anyway, when you have flu. Putting a quartz crystal in it will have no additional effect. In particular, no amount of 'visualising' of coloured light will change the composition of either the crystal or the water.

Pseudoscientific drivel like this is a disturbingly prominent part of the culture of our age. I have limited my examples to crystals because I had to draw a line somewhere. But 'star signs' would have done just as well. Or 'angels', 'channelling', 'telepathy', 'quantum healing', 'homeopathy', 'map dowsing'. There is no obvious limit to human gullibility. We are docile credulity-cows, eager victims of quacks and charlatans who milk us and grow fat. There is a rich living to be made by anyone prepared to prostitute the language – and the wonder – of science.

But isn't it all – crystal ball-gazing, star signs, birth stones, ley-lines and the rest – just a bit of harmless fun? If people want to believe in garbage such as

astrology or crystal healing, why not let them? But it is so sad to think about all that they are missing. There is so much wonder in real science. The universe is mysterious enough to need no help from warlocks, shamans and 'psychic' tricksters. These are, at best, a soul-sapping distraction. At worst, they are dangerous profiteers.

The real world, properly understood in the scientific way, is deeply beautiful and unfailingly interesting. It is worth putting in some honest effort to understand it properly, undistracted by false wonder and prostituted pseudo-science. For illustration, we need look no farther than crystals themselves.

In a crystal like quartz or diamond the atoms are arranged in a precisely repeating pattern. The atoms in a diamond – all identical carbon atoms – are arrayed like soldiers on parade, except that the precision of their dressing far outsmarts the best-drilled guards regiment, and the atomic soldiers outnumber all the people that have ever lived, or ever will. Imagine yourself shrunk to become one of the carbon atoms in the heart of a diamond crystal. You are one of the soldiers in a gigantic parade, but it will seem a little odd because the files are arrayed in three dimensions. Perhaps a prodigious school of fish is a better image.

Each fish in the school is one carbon atom. Think of them moving in space, keeping their distance from each other, and holding precise angles, by means of forces that you can't see, but which scientists fully understand. But if this is a fish school, it is one that, to scale, would fill the Pacific Ocean. In any decent-sized diamond, you are likely to be looking along arrays of atoms numbering hundreds of millions in any one straight line.

Carbon atoms can take up other crystal-lattice formations. To revert to the military analogy, they can adopt alternative drill conventions. Graphite (the lead in pencils) is also carbon, but is obviously nothing like diamond. In graphite, the atoms form sheets of hexagons like chicken wire. Each sheet is loosely bonded to those above and below it, and when impurities are present, the sheets slide easily against each other, which is why graphite is a good lubricant. Diamond is very much not a lubricant. Its legendary hardness abrades the toughest materials. But the atoms in soft graphite and hard diamond are identical; if you could persuade the atoms in graphite crystals to adopt the drill rules of diamond crystals, you would be rich. It can be done, but you need colossal pressures and high temperatures – presumably the conditions that produce diamonds naturally, deep in the earth...

Go into any museum and look at the collection of minerals. Even go into a New Age shop and look at the crystals on display, along with all the other apparatus of mumbo-jumbo and kitsch con trickery. The crystals won't respond to your attempts to 'program' them for meditation, or 'dedicate' them with warm, loving thoughts. They won't cure you of anything, or fill the room with 'inner peace' or 'psychic energy'. But many of them are very beautiful, and it surely adds to the beauty when we understand that the shapes of the crystals, the angles of their facets, the rainbow colours that flash from inside them, all have a precise explanation that lies deep in the patterns of atomic lattice work.

Crystals don't vibrate with mystical, loving energy. But they do, in a much stricter and more interesting sense, vibrate. Some crystals have an electric charge across them which changes when you physically deform the crystal. This 'piezoelectric' effect, discovered in 1880 by the Curie brothers (Marie's husband and his brother), is used in the styluses of record-players (the deforming is done by the groove of the turning record), and in some microphones (the deforming is done by sound waves in the air). The piezo effect works in reverse. When a suitable crystal is placed in an electric field, it deforms itself rhythmically. Often the timing of this oscillation is extremely accurate. It serves as the equivalent of the pendulum or balance wheel in a quartz watch.

Let me tell you one last thing about crystals, and it may be the most fascinating of all. The military metaphor makes us think of each soldier as a yard or two from his neighbours. But actually almost all the interior of a crystal is empty space. My head is 18 centimetres in diameter. To keep to scale, my nearest in the crystalline parade would have to be standing more than a kilometre away. No wonder the tiny particles called neutrinos (even smaller than electrons) pass right through the earth and come out the other side as if it wasn't there (on average, one passes through you every second).

But if solid things are mostly empty space, why don't we see them as empty space? Why does a diamond feel hard and solid instead of crumbly and full of holes? The answer lies in our own evolution. Our sense organs, like all our bits, have been shaped by Darwinian natural selection over countless generations. You might think that our sense organs would be shaped to give us a 'true' picture of the world as it 'really' is. It is safer to assume, however, that they have been shaped to give us a useful picture of the world, to help us to survive. In a way, what sense organs do is assist our brains to construct a useful model of the world, and it is this model that we move around in. It is a kind of 'virtual reality' simulation of the real world. Neutrinos can pass straight through a rock; but we can't. If we try to, we hurt ourselves. When constructing its simulation of rock, the brain therefore represents it as hard and solid. It is almost as though our sense organs are telling us: 'You can't get through objects of this kind'. That is what 'solid' means. That is why we perceive them as 'solid'.

In the same way, we find much of the universe, as science discovers it, difficult to understand. Einstein's relativity, quantum uncertainty, black holes, the Big Bang, the expanding universe, the vast slow movement of geological time – all these are hard to grasp. No wonder science frightens some people. But science can even explain why these things are hard to understand, and why the effort frightens us. We are jumped-up apes and our brains were only designed to understand the mundane details of how to survive the Stone Age African savannah.

These are deep matters, and a short article is not the place to go into them. I shall have succeeded if I have persuaded you that a scientific approach to crystals is more illuminating, more uplifting and also stranger than anything imagined in the wildest dreams of New Age gurus or paranormal preachers. The blunt truth is that the dreams and visions of gurus and preachers are not nearly wild enough. By scientific standards, that is.