

## Media Fellow Report 2006

# Natasha Tian – Selected Articles from The Scotsman

### Size isn't everything ...it's all in the mind

NATASHA TIAN

Saturday 5th August, The Scotsman

IT is arguably nature's most complex invention, capable of everything from formulating Aristotelian logic and solving sudoku puzzles to breathing and blinking. The human brain has emerged from tens of thousands of years of evolution to reign supreme as the most intelligent device in the known universe, still leaving all man-made computers in its wake.

Early scientists had something of an obsession with size and indeed brains have grown larger throughout evolutionary history. But increasingly there has been a realisation that size isn't everything and the way the brain is 'wired' is as important as a large brain to support intelligent thinking.

As science advances, more and more is being learned about the nature of our minds, but given the brain's astounding complexity, not to mention numerous interactions with its surroundings, can we ever hope to comprehend how the different parts of the brain and its components work?

"If the human brain were so simple that we could understand it, we would be so simple that we couldn't," was the judgement of author Emerson Pugh. He may well have a point, but that has not stopped people trying and progress is being made in understanding this extraordinary organ.

And much of it suggests brain development depends crucially on external influences from even before birth. Pregnant women who drink alcohol, smoke or catch rubella may give birth to children with learning difficulties. Most expectant mothers are aware that smoking or drinking is not the best thing for baby but the environment continues to have a significant impact on the brain in the early years of childhood.

For instance, ignoring or failing to stimulate infants can even prevent the development of certain brain areas. In contrast, providing youngsters with a stimulating environment with plenty of social interactions has been shown to boost intelligence.

Scientists are beginning to unravel the reasons behind all this. The heavily wrinkled cerebrum or cortex is the largest part of the human brain and is responsible for higher brain functions, including emotions, memory, reasoning, speech and movement.

People are born with over 100 billion brain cells or 'neurons', each of which forms thousands of contacts with other neurons via long spindly 'wires' called axons that grow to connect with their appropriate partners in a structure similar to a large plate of tangled spaghetti. The speed at which axons send electrical signals between neurons rivals the best sports cars at over 200 miles an hour.

In the developing embryo, there is an over-proliferation of connections, which are then pruned and refined after birth depending on how heavily a circuit is used, conforming to the 'use it or lose it' idea. This explains why London taxi drivers have a larger hippocampus, which is a region of the brain that deals with spatial memory, since they form lots of new connections to deal with the enormous number of routes they have to recall.

Most neuroscientists describe the brain as being like a computer with a set of components that take information in, process it and produce actions, but this is merely a simple way to describe something they don't really understand.

"Modern brain research is really a bit like physics or astronomy in the 16th Century," comments Colin Blakemore, chief executive of the Medical Research Council.

"At the moment we are overwhelmed by data ... without a clear theory to hold it all together.

"The problem is that we don't know what the essential computing elements are. Are they the individual connections onto nerve cells – over 10,000 per cell – are they nerve impulses or sets of nerve impulses in a coded form or groups of nerve cells working together?"

Dr Thomas Pratt, of the genes and development group at Edinburgh University, is one of those trying to make sense of this 'spaghetti', researching how the brain wires up during development and what signals nerve axons to connect with the correct part.

"This type of research is important since many brain disorders caused by accident, illness or genetic disorders involve damage to axon tracts," he says.

"The infant brain develops according to a strict timetable and problems early on, for example being cross eyed, can have disastrous effects on later vision.

"By understanding how the brain develops normally we can better understand what has gone wrong and, although this may be some way ahead, put it right."

How these wires and cells interact can be visualised to a certain extent using MRI scans and other such devices. Images can be obtained which show which parts of the brain are active during specific tasks, from visual perception to recalling memories.

Using this approach coupled with animal studies, a key discovery has been that there are short time-windows called 'critical periods' in brain development during which key senses such as vision are established.

For example, if a child is deprived of light during the critical period for sight, this can result in impaired vision. These critical periods are also responsible for the fact that between the ages of three and 10, the brain is most adept at learning new skills such as music and language as the neural connections can be remodelled more easily than in later life.

A research team at Edinburgh headed by Dr Peter Kind is investigating this type of brain-environment interaction, which is known as 'cortical plasticity'. This deals with how brain connections are altered in response to environmental experience, a key process in learning and memory.

Dr Kind says scientists are making good progress towards improving learning for individuals suffering from mental disabilities like Fragile X Syndrome, a family of heritable diseases, which includes autism. It might be possible to treat some of these conditions with some effect, if this is done early enough in the brain's development while the cortex is still plastic and able to rewire itself.

Scientists are also attempting to induce local plasticity in a specific region of the cortex to repair spinal cord injuries and other forms of nerve damage. However, Dr Kind warns against any dreams of some future ability to keep the brain plastic beyond its critical period to help adults learn new languages or become the next Mozart.

“If your brain was permanently plastic, you would have to re-learn everything from scratch every morning as you would constantly forget information that you had learned in the past,” he says.

But the size of the task involved in trying to solve Emerson Pugh’s conundrum has driven some scientists to seek understanding of the human brain from a rather unlikely source: the humble nematode worm. However, despite having just 120 brain cells, they have come up against unbelievable complexity in the workings of its tiny mind.

“If we can’t understand these [simple organisms], what chance have we got with understanding the workings of 100 billion nerve cells in human brain?” says Prof Blakemore.

## **Stem-cell science cannot deliver miracle cure-alls**

**Natasha Tian**

Saturday 12th August, The Scotsman

WHEN Dr James Thomson isolated cells from the inner cell mass of the early embryo and developed the first human embryonic stem-cell lines at the University of Wisconsin, nobody could have predicted the flurry of interest that would follow.

Since his discovery in 1998, stem cells have been hailed as the "holy grail" to put an end to a host of diseases including Parkinson's and Alzheimer's diseases, spinal cord injury, stroke, burns, heart disease, diabetes, osteoarthritis and rheumatoid arthritis.

Six years ago, Ronald McKay of the American National Institutes of Health predicted: "In two years people will be routinely reconstituting liver, regenerating heart, building pancreatic islets, putting cells into the brain that get incorporated into the normal circuitry."

These extraordinary claims come from the unique ability of stem cells to transform themselves into all the different cell types that make up our bodies, from skin to brain cells. Scientists and clinicians around the world have been trying to develop therapies in which these cells are introduced into a diseased area to replace tissue that has been lost or damaged.

However, Professor Colin Blakemore, a brain researcher and chief executive of the Medical Research Council (MRC), recently told The Scotsman that stem cells will not provide miracle cures that will banish Alzheimer's disease or strokes. "Stem cells are not the ultimate approach to curing degenerative diseases [of the brain] such as Alzheimer's... nor for stroke", he said.

His justification is that cells die in huge numbers "and I think it is not feasible [for stem cells] to replace them". He also pointed out that even if stem cells are able to fill diseased gaps in the brain, there is no guarantee that they would rebuild functional connections. In the case of Alzheimer's, Prof Blakemore thinks that drug treatments offer the best hope for sufferers.

In reaction to Prof Blakemore's pessimistic view, a spokesman from Alzheimer Scotland commented: "Stem cells can have wider uses than a simple transplantation approach."

Baroness Susan Greenfield, a brain pharmacologist and the director of the Royal Institution of Great Britain, said: "It's unfortunate that stem cells have been overhyped." She described using stem-cell therapy in Parkinson's disease as "not trivial" due to numerous safety factors that have to be taken into account.

In her view, a more promising approach would be to discover the chemical signal that converts stem cells into neurons: "If you knew what the chemical signal was, you could use that as a therapy... which would be more ethical and far less hazardous and expensive than transplanting stem cells."

Prof Blakemore does believe that stem cells may lead to a cure for degenerative diseases, such as Parkinson's or motor neurone disease, where the damage is confined to a particular, small region of the brain. "Animal studies of brain injury have demonstrated benefits on motor control and learning, for reasons that are not yet understood," he said.

In recent years, neurons and glia - the two main cell types that are lost in brain disorders - have been produced from stem cells cultured in the laboratory, fuelling hopes for stem-cell transplantation-based therapies.

Scientists have extended their efforts towards stimulating the brain to produce its own neurons from "endogenous" stem cells already present inside the brain.

Despite these advances, the majority of scientists working in the field believe that experimental stem-cell therapy in humans is still dangerously premature. This is exemplified by the poor survival of transplanted human embryonic stem cells in animal models of Parkinson's disease, which needs to be drastically improved before any human clinical trials can be attempted.

Prof Blakemore's comments coincide with research from the University of California that neural, or brain, stem cells, derived from human embryonic stem-cell lines, suffer from a genetic abnormality that leads to hypoglycaemia in humans.

This could limit the usefulness of federally approved human embryonic stem-cell lines. Stem cells derived from embryos do not appear to suffer from the same problems, although the process of harvesting cells from embryos remains deeply controversial.

Prof Blakemore said: "It would be wrong at this stage to be either foolishly optimistic or totally dismissive about stem-cell therapy.

"One thing is certain: a great deal more research is needed before we shall know exactly what the potential is for new treatments."

## Experts find new ways of charting the rise of original singing stars Natasha Tian

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THEY may not be your conventional pop stars, but those pinholes in the curtain of night can sing, according to a leading astronomer.

To prove their theory, astronomers had to compensate for the vacuum of space. They measured the vibrations induced by sound waves produced deep within stars, including the Sun. The use of ultrasound techniques enabled them to calculate precisely the composition, density and temperature of a star.

"Stars have natural vibrations that are sound waves, just as musical instruments do," says astronomer and astrophysicist Professor Don Kurtz.

"For the star, the vibrations start by changes in the passage of energy from the nuclear inferno in the heart of the star on its way to the surface, and escape into space."

In the case of an instrument such as a horn, Prof Kurtz says, the cause of the vibrations is the musician blowing on the horn and buzzing his or her lips at a frequency that matches the natural vibrations of the horn. For the star, the vibrations start with changes in the passage of energy from the nuclear inferno in the heart of the star on its way to the surface, and escape into space.

Prof Kurtz adds: "Understanding the sounds of the stars is important for our understanding of the formation of the solar system and the Earth. We can even monitor dangerous 'active' regions on the far side of the Sun which might later send out coronal mass ejections [flares] and create geomagnetic storms, leading to power failure and radio disruption." Sun flares can occur several times a day and release more power than all of our power stations combined in a million years.

Prof Kurtz converted the usually inaudible frequency of "star music" into one that humans can hear during a public lecture at Sheffield Hallam University on Tuesday, called Songs of the Stars. The stars produce eerie whistling, African drumming, humming or rumbling sounds. He also played classical compositions by Bach using only stars as instruments of the orchestra, projected by computer, producing music that he describes as "very modern sounding but interesting." The lecture was the highlight of an international astronomy conference in Sheffield that brought together experts from around the world.

The ancient Greeks were the ones who originally predicted that planets and stars hummed as they rotated around the Universe, but the final proof that stars "sing" appeared only as recently as the 1970s, with the use of "asteroseismology".

This technique enables astronomers to look deep within the cores of stars as clearly as you can see a foetus inside a womb using ultrasound. By listening to stars, astronomers are able to keep an eye on Sun flares that may be hidden when parts of the Sun pass out of the Earth's view. These flares can actually kill astronauts.

But the power unleashed by these massive ejections is so incomprehensibly huge that nothing can be done to prevent or counteract them in the foreseeable future.

"We can't do anything about them... this is power beyond anything you can control," says Prof Kurtz.

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## It takes brains to understand an IQ's value

NATASHA TIAN

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What is 'intelligence'? Is it a mind-boggling capacity for general knowledge or the ability to solve novel problems? Perhaps it is original thought, the ability to formulate witty remarks or learn multiple languages? Although all these criteria can be used to describe intelligence to some degree, this capacity is impossible to summarise in one sentence, let alone put a number on. So is it appropriate to rank individuals on a numerical sliding scale using the 'intelligence quotient' or 'IQ'?

Historically, teachers have used IQ tests to measure a child's ability and potential. Back in 1905, French psychologist Alfred Binet developed the 'Binet-Simon' test to identify under-achieving school children. The concept of 'mental age' as distinguished from 'chronological age' was introduced in 1911, such that a 6-year-old who performed as well as an average 8-year-old was assigned a mental age of 8. The ratio between mental age and chronological age remains fairly constant throughout life and forms the basis for measuring IQ. The Binet-Simon test was revised into the 'Stanford-Binet', which now forms the basis of present IQ tests, which have become extremely popular with educators and employers.

However, does the IQ score accurately measure intelligence? "If you are interested in how creative someone is or how they can link together unusual ideas, then IQ tests are not so useful," said Baroness Susan Greenfield, Professor of Pharmacology at Oxford University and Director of the Royal Institution of Great Britain. Professor Colin Blakemore, Chief Executive of the MRC and leading neuroscientist remarked: "Conventional IQ tests are not full measures of the brightness of an individual". Even a spokesperson from Mensa, the society whose requirement for membership is that an individual's IQ falls within the top 2% of the population, admitted: "IQ tests can only measure a narrow field of intelligence ... that which they are designed to measure."

The problem with defining intelligence is that it is inextricably linked to culture and educational background. "Every IQ test is immediately loaded against some people and therefore psychologists are generally wary of the idea," Dr Colin Gill of the British Psychological Society warned. The problem with IQ testing is that a person with a good educational background will have a significant advantage in IQ tests over someone who has never attended school, even if they are brainy. Similarly, different cultures value specific types of intelligence. The number-crunching prowess of a high-flying city banker could not be farther from the ability of a tribesman to hunt successfully and feed his family. However, both these individuals use different abilities that are considered 'intelligent' in their own cultures. A way around this problem of culture and education contaminating intelligence comes from separating 'crystallised intelligence', which depends on your educational attainment and experience, from 'fluid intelligence', which refers to innate ability - the capacity a person is born with.

Despite breaking down intelligence into 'learned' and 'innate' components, can we still hail University Challenge experts as 'super-brains'? Baroness Greenfield believes that the ability to memorise facts is very different to 'understanding', which is the process of linking those facts together. A five-year-old who can recite Shakespeare is not necessarily super-intelligent as they may not understand the prose. In Dr Gill's view: "Anyone can learn things but intelligence is how you apply it."

Several brain researchers are attempting to unveil the secrets of intellect by studying cells at the micro-level of genes and molecules. "We understand how brain cells form, make connections and disband but we cannot explain how this translates into intellectual ability at present," commented Baroness Greenfield. Nevertheless, scientists led by Dr Tony Payton at

Manchester University's Centre for Integrated Genomic Medical Research (CIGMR) set out to compare the DNA sequence variations of 1000 Mensa members to those of individuals of average IQ in an attempt to identify genes associated with intelligence. "A greater understanding of the role that genes play in regulating intelligence may help in the development of new diagnostic tests and more effective treatments designed to combat cognitive impairment in the elderly," says Dr Payton.

However, genes alone only partly shape our intellect. Environmental factors, from parental input to environmental toxins, can have long-lasting effects on the brain, including intelligence. "Experience modulates gene expression, which leads to substantial behavioural differences," said psychiatrist Charles Nemeroff from Emory University, Atlanta. In the last decade, learning a musical instrument and listening to classical music have been linked to enhanced IQ. Keeping the mind active by constant challenges, such as doing crosswords or sudoku is said to prevent or delay the onset of mental decline and illnesses such as Alzheimer's disease. It is thought that all of these activities strengthen the connections between different parts of the brain to enable it to work efficiently. However, the precise way in which nurture affects brain power remains a mystery.

All these findings are very interesting, yet could our present obsession with intelligence-based learning and IQ be contributing to the lack of Scottish entrepreneurs? Gordon Thomson, director for Scotland and Ireland at technology company Cisco, thinks so. "We need to also look at how we make youngsters passionate and curious about their learning," remarked Gordon Thomson at this year's 15th International World Wide Web Conference in Edinburgh.

So what is our current understanding? It is clear that both nature and nurture contribute to intelligence and that IQ tests have their limitations and should be interpreted cautiously in the context of culture and educational background. There are also many different types of intelligences and each of us 'shine' in particular ways. "The mind is like a swiss army penknife and although you might not have specific strengths in one area, you could have fantastic strengths in another," said Dr Gill. And finally, there is a glimmer of hope for those of us who worry that we are not the brightest kids on the block. Psychological evidence strongly indicates that motivation plays a key role in developing expertise in any field from chess playing to music. Experts are made, not born.

## **Having worms can help eat away at allergic diseases**

**Natasha Tian**

Saturday 19th August, The Scotsman

A dose of worms promises to cure allergic diseases, such as asthma, diabetes and inflammatory bowel disorders, reveal scientists at a major international conference in Glasgow this week. Allergies are relatively unheard of in developing nations, like Africa, in which parasitic infections are part of normal life. However, in the western world "super-clean living" has reduced our exposure to disease-causing organisms and has been blamed for the increase in allergic disorders, resulting in enormous health and economic burdens. The "hygiene hypothesis" explains how, without foreign invaders to attack, the immune system over-reacts inappropriately to harmless substances, such as pollen, causing symptoms such as a runny nose and itchy eyes. In severe cases, this hypersensitivity can lead to autoimmune diseases in which the immune system attacks the body.

The observation that people with worm infections have fewer allergies compared to those who do not have worms has led scientists to investigate the reasons for this. In order to protect themselves from attack by their human hosts, worms suppress an arm of the immune system that is overly sensitive in those suffering from allergy. This thursday at the International Conference of Parasitology in Glasgow, experts will reveal their latest research, which promises to put an end to diseases, including type one diabetes and irritable bowel syndrome, by using worms.

"The results we have show that a chemical identified in worms can prevent the onset of the conditions that can lead to type one diabetes," said Professor Anne Cooke of Cambridge University, in a press release today. "If this chemical is injected into children it will calm their allergic reactions and prevent the triggering of type one diabetes." Her research could lead to a vaccine that makes type one diabetes a disease of the past.

Scientists at Nottingham University are currently recruiting for a clinical trial, funded by Los Angeles-based Broad Foundation, that involves infecting Crohn's inflammatory bowel disease patients with hookworms, in the hope that it will lead to effective therapies. Dr Paul Fortun, one of the study leaders from the Wolfson Digestive Diseases Centre said: "In order for the parasite to survive, it induces a 'state of tolerance' in the host [which counteracts] the immune system." "There is a lot of evidence that inducing this state of tolerance would reverse the problem that causes Crohn's disease." At the Glasgow conference, Prof Bob Summers from the University of Iowa will report findings of clinical trials on patients with inflammatory bowel disease, showing that injecting pig whipworm eggs produced a 70 percent success rate in the treatment of Crohn's disease and 50 percent success in ulcerative colitis. He said: "Worm therapy has profound ramifications for the treatment of MS, asthma, diabetes and all immuno-inflammatory diseases."

Present treatments for allergic diseases only relieve symptoms but these worm studies could lead to eventual cures. Dr Fortun said that the successful elimination of allergic symptoms using worms paves the way for the development of drug therapies from the chemical products worms use to dampen down the immune system.

Similar clinical trials using hookworms for the treatment of hayfever and asthma will follow on from research by Nottingham University scientists Professor John Britton and Professor Pritchard, who deliberately infected himself with hookworms in the past.

In Scotland, one in five children has asthma, diabetes sufferers have trebled in the last thirty years and Scots have the highest percentage of MS sufferers in the western world.

The National Association for Colitis and Crohn's Disease (NACC) claims that in the UK, around one in 1,200 people are affected by Crohn's and up to one in 600 have ulcerative colitis. Together, that adds up to an astonishing 180,000 people in the UK. Thousands of new cases are thought to seek medical help every year.