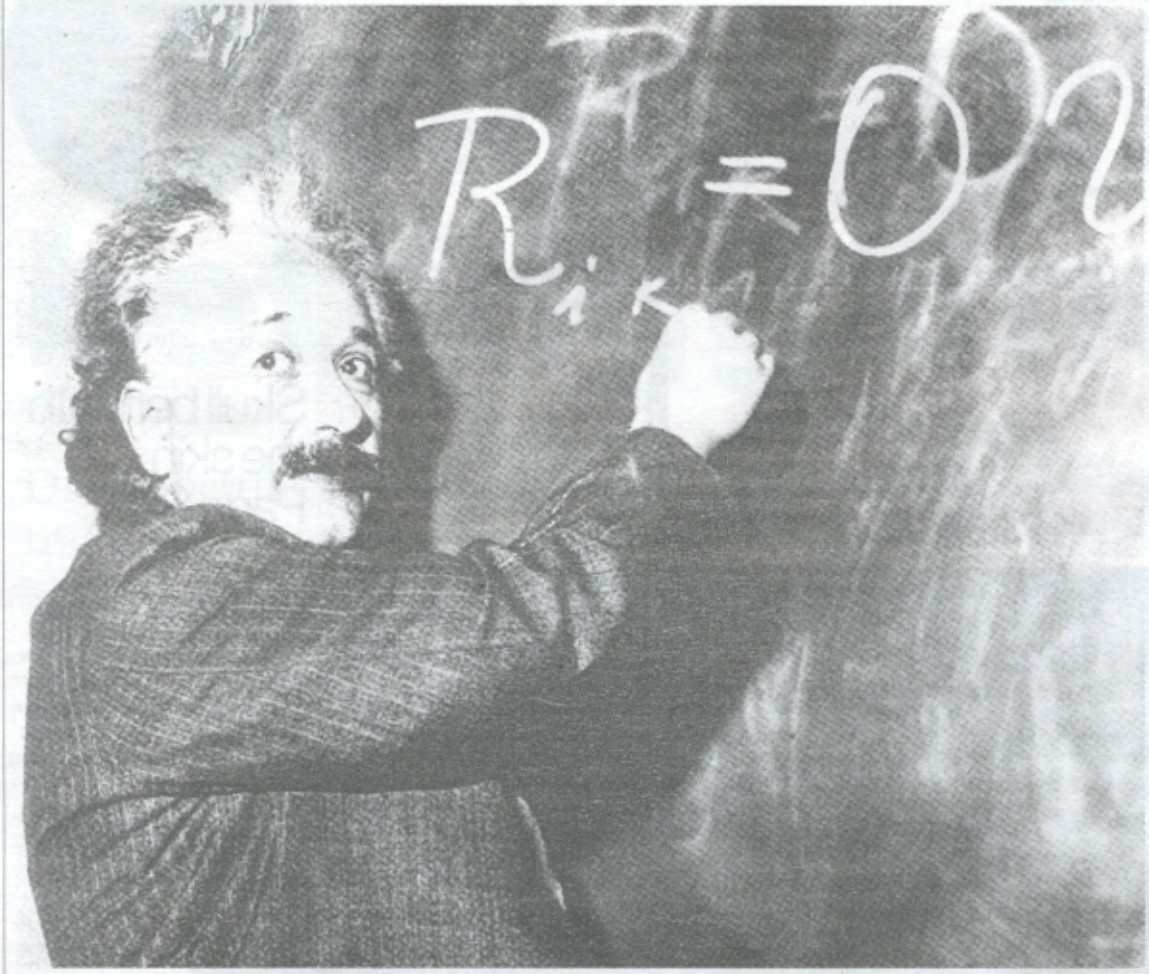

Einstein probably used different parts of his brain from 'normal' people when doing maths

PHOTOGRAPH: CORBIS

Fruity genes

With twice as many genes as a fruit fly, can we be as clever as we think we are? **Michael Morgan** does the sums

What is 99 raised to the fifth power? Most people could only reply like the computer Deep Thought: "It's going to take a little time." Rudiger Gamm is a famous calculating prodigy from Germany who can solve such problems in his head. A recent paper in Nature Neuroscience has analysed just what goes on his head when he is doing so. Using the fact that calculation is to the brain what sex is to the penis, scientists observed blood flow to the parts of the brain that were most active during arithmetic exertion. They found that the expert used different parts of the brain from normal people.

Psychologists say that the Victorian phrenologists were wrong to measure people's abilities by feeling bumps on the skull. But phrenologists were right in thinking that different parts of the brain carry out different tasks. The specialisation can be quite astonishing. The brain responds to the sight of fear in another person by increased activity in an almond-shaped structure called the amygdala. The pulvinar region is involved in directing our attention (*pulvinus* is Latin for a couch, so presumably it is also involved in watching television).

Another article in Nature Neuroscience describes different areas of the brain responding to "monetary

rewards and punishments." When someone gives us money one part of the brain expresses our delight, while if they take it away, another part of the brain indicates our displeasure. Chris Tarrant, please note. More astonishing still, is the claim that a highly specific part of the temporal lobe is activated when people are naming vegetables: could this be the long-awaited answer to whether a tomato is a fruit or a vegetable?

One's brain is powerfully activated by learning that there are only 30,000 genes in the human genome. That is only twice as many as in the fruit fly, not renowned for its calculating ability, and about as many as a garden weed. Geneticists are sorely vexed that so few genes are required to make something as complex and clever as a geneticist. Even if 15,000 extra genes made our brain, how many would be devoted to the naming of vegetables? At the Millennium Evening at the White House one scientist said: "If I gave you a parts list for the Boeing 777 and it has 100,000 parts, I don't think you could screw it together and you certainly wouldn't understand why it flew."

But what is the parts list for the brain? Would it specify each neurone and its connections with every other neurone (impossible, since there are 10 to the 14th power connections and you don't need to be a mathematical prodigy like Rudiger Gamm to see that this is more connections than genes)? Or is it a list of vegetables? Even the latter seems unlikely, because the number of genes needed to programme a set of several million neurones to recognise a vegetable would be enormous.

The difference between the human brain and a Boeing 777 is that the growth of the brain can be guided partly by experience. If the 777 emerged from its shed in Seattle as a bicycle, which got better and better at flying by accumulating more parts and flying hours, we might have a better analogy. What we know about the development of our brain is that it begins growing like the undisciplined first draft of a book. Huge numbers of cells and connections between cells are grown which have no function in the final product. The brain then obeys the wise advice of Dr Johnston: "Read over your compositions, and where ever you meet with a passage which you think is particularly fine, strike it out." The exuberant cells and connections are gradually weeded out until the sparse, adult structure is complete.

Meanwhile the brain is receiving input. Even in utero, the baby hears sounds, and since it receives no light, the retina invents virtual reality to send nerve impulses back to the brain. How important are these signals for development? We don't know, but it is a fair bet that natural selection has discovered a cunning plan to make a few genes stretch a long way. Our immune system can recognise literally millions of foreign proteins. It uses only 300 genes. You can make a lot of different permutations from 300, as football pools addicts know, to their cost.

Calculation is to the brain what sex is to the penis

Rudiger Gamm has trained his prodigious arithmetical ability for several hours each day for years. Somehow he has altered the wiring diagram of his brain. We won't find the "parts list" for his achievement in the human genome.

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