How do you wear your genes?

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Scarcely a day goes by without the papers breaking the news of some dramatic new gene. It's always described as a gene "for" some very specific thing. A gene for religion, a gene for sodomy or a gene for skill in tying shoelaces.

I made those examples up, but everyone is familiar with the kind of thing I mean. I want to explain why it's easy to be misled by such language. I also want to explain what "gene for" really means. I have deliberately chosen examples that are psychological or behavioural, and heavily influenced by culture, (as opposed to, say, " gene for haemophilia", or "gene for colour blindness", whose effects are entirely physical).

You can easily translate "gene for religion" as "gene for developing the kind of brain that is predisposed to religion when exposed to a religious culture". "Gene for skill tying shoelaces" will show itself as such only in a culture where there are shoelaces to be tied.

In another culture the same gene - which would really be responsible for a more general manual dexterity - might show itself as, say, a "gene for skills in making traditional fishing nets" or a "gene for making efficient rabbit snares". I'll come back to the more controversial idea of "a gene for sodomy" later.

First, there is a quite separate difficulty. Many people make a hidden, and quite wrong, assumption of a one-to-one mapping between single genes and single effects. We shall see in a moment that it is almost never really like that. Another equally wrong assumption is that genetic effects are inevitable and inescapable. Often, all they do is change statistical probabilities.

Cigarettes can give you cancer. So can genes. We'd expect insurance actuaries to be interested in both. We all know the cigarette effect isn't inevitable: heavy smokers sometimes reach an advanced age before dying of something else. Smoking just increases the probability of dying of cancer. Genes are like cigarettes. They, too, change probabilities. They (usually) don't determine your fate absolutely.

Some people find the following analogy helpful. Imagine a bedsheet hanging by rubber bands from 1,000 hooks in the ceiling. The rubber bands don't hang neatly but instead form an intricate tangle above the roughly horizontal sheet.

The shape in which the sheet hangs represents the body - including the brain, and therefore psychological dispositions to respond in particular ways to various cultural environments. The tensions up at the hooks represent the genes. The environment is represented by strings coming in from the side, tugging sideways on the rubber bands in various directions.

The point of the analogy is that, if you cut one rubber band from its hook - equivalent to changing ("mutating") one gene - you don't change just one part of the sheet. You re-balance the tensions in the whole tangled mess of rubber bands, and therefore the shape of the whole sheet. If the web of criss-crossing rubber bands and strings is complex enough, changing any one of them could cause a lurching shift in tensions right across the network.

A gene doesn't zero in on one single bit of the body, or one psychological element. It affects the way other genes affect the way... and so on. A gene has many effects. We label it by a conspicuous one that we notice.

The genes are sometimes described as a blueprint, but they are nothing like a blueprint. There is one-to-one mapping between a house and its blueprint. If I point to a spot in a house, you can go straight to that unique spot on the blueprint.

You can't do that with a body. If I prick a particular point, say on the back of your hand, there is no single spot in your set of genes corresponding to that point. If the genes are not a blueprint, what are they? A favourite simile is a recipe, where the body is a cake. There is no one-to-one mapping between words of the recipe, and crumbs of the final cake. All the sentences in the whole recipe, if executed in the proper sequence, make a whole cake. For a baby to develop, a complicated genetic recipe has to be followed, with the right genes turning each other on in the right sequence, and interacting with the right environmental triggers.

Given such a complicated recipe, with lots of participating genes, a simple change of a single gene can cause an apparently complicated change in the way the brain ends up behaving - just as a key change of one word in a recipe can produce an interestingly different cake.

Now let's look at the hypothetical "gene for sodomy" again. Homosexual desire might seem too complicated to be put down to a single gene. But the implausibility dissolves when you realise we are talking about a change of a single gene, in an already complicated cascade of multi-gene influences.

In order to have its particular effect, such a gene needs make only a small modification in an existing brain mechanism, the mechanism that gives us our normal heterosexual desires. And that mechanism will have been put together by a consortium of co-operating genes, favoured over millions of years of Darwinian selection.

The problem as far as public perceptions are concerned, is that, if a gene for sodomy were discovered, people might simply assume that its effects would be as inevitable on an individual as, say, a gene for haemophilia.

In fact there is no way of telling, in advance, whether a gene for sodomy would be like haemophilia in being inevitable, or like shoelace-tying in being culture-dependent, or like cigarettes in being a matter of probabilities.

It is worth bearing this in mind next time you read of a newlydiscovered "gene for X". It will almost certainly be a much less momentous discovery than it sounds and it correspondingly should be less alarming - and less controversial.