

Fears can be inherited, gene study proves

By Steve Connor

NZ Herald, 5:30 AM Saturday Dec 7, 2013

Fearful experiences, such as trauma from being in a war zone, may be passed on in sperm to children and grandchildren conceived at home. Photo / AP Fearful experiences, such as trauma from being in a war zone, may be passed on in sperm to children and grandchildren conceived at home.

Scientists have shown for the first time that fear can be transmitted from a father to his children through his sperm alone.

In a ground-breaking study into a new kind of genetic inheritance, experiments on mice have shown they can be trained to associate a particular kind of smell to a fearful memory and that this fear can be passed through subsequent generations via chemical changes to a father's sperm cells.

The findings raise questions over whether a similar kind of inheritance occurs in humans, for example whether men exposed to the psychological trauma of a foreign war zone can pass on this fearful experience in their sperm to children and grandchildren conceived at home.

The researchers said their carefully controlled study was carried out on laboratory mice and there are still many unanswered questions, but they do not discount the possibility that something similar may also be possible in people.

"I think there is increasing evidence from studies that what we inherit from our parents is very complex and that the gametes - the sperm and eggs - may be a possible mechanism of conserving as much information as possible from a previous generation," said Kerry Ressler, professor of psychiatry at Emory School of Medicine in Atlanta, Georgia.

"The biggest interpretation of this research, if it holds up across mammals, is that it may be possible for certain traits such as the fearful experience of a parent to be transmitted to subsequent generations."

The findings also lend some support to a discredited theory known as the "inheritance of acquired characteristics", promulgated by Jean-Baptiste Lamarck in the 18th century.

Lamarck postulated that organisms could pass on physical features they developed during their lifetime to their offspring, such as the long neck of giraffes which stretched to reach the highest leaves on a tree.

But this idea was later supplanted by Charles Darwin's theory of natural selection, further supported by the discovery of genes and Mendelian inheritance.

The latest study, however, shows that a kind of Lamarckism may in fact exist in nature as a result of environmental influences directly affecting epigenetic changes to an organism's DNA.

The study, published in the journal *Nature Neuroscience*, told how male mice were trained to associate the smell of the chemical acetophenone, which smells like cherry blossom, with a mild electric shock.

These mice soon displayed fear whenever they were exposed to acetophenone on its own.

Breeding experiments showed that this fear of acetophenone could be transmitted to two further generations, the sons and grandsons of the original male mice. This inheritance must have passed on in sperm as the original males were not allowed to come into contact with offspring.

Further experiments involving the fertilisation of mouse eggs using IVF techniques confirmed that fear trait, which resulted in specific changes to the brains of the mice involved, was transmitted in the sperm as "epigenetic" changes to the proteins surrounding the DNA of the sperm cells.

"While the sequence of the gene encoding the receptor that responds to the odour is unchanged, the way that gene is regulated may be affected," Ressler said.

"There is some evidence that some of the generalised effects of diet and hormone changes, as well as trauma, can be transmitted epigenetically," he said.

"The difference here is that the odour-sensitivity-learning process is affecting the nervous system - and, apparently, reproductive cells too - in such a specific way."

Similar studies on female mice, where their pups were immediately fostered by other females, showed that the same kind of mechanism may also occur through egg cells.

But it is more difficult in this instance to eliminate the possibility that the changes occurred in the fetus rather than in the DNA of the females' eggs.

The study concluded that "ancestral experience before conception" may be an under-appreciated influence on the behaviour of adults, particularly when psychological conditions such as post-traumatic stress disorder, phobias and anxieties are involved.

"Knowing how the experiences of parents influence their descendants helps us to understand psychiatric disorders that may have a trans-generational basis, and possibly to design therapeutic strategies," Ressler said.

Professor Marcus Pembrey, a paediatric geneticist at University College London, said the study was important because it provided compelling evidence for the biological transmission of the "memory" of a fearful ancestral experience.

"It is high time public health researchers took human trans-generational responses seriously," he said.

"I suspect we will not understand the rise in neuropsychiatric disorders or obesity, diabetes and metabolic disruptions generally without taking a multi-generational approach."

The head of epigenetics at the Babraham Institute in Cambridge, Professor Wolf Reik, said: "These types of results are encouraging as they suggest that trans-generational inheritance exists and is mediated by epigenetics.

"But more careful study of animal models is needed before extrapolating such findings to humans."