

How early trauma influences behavior

December 1 2014



Extreme stress in early childhood changes how people deal with challenging situations later in life. (Photo: Ocskay Bence / Fotolia Extreme stress in early childhood changes how people deal with challenging situations later in life. Credit: Ocskay Bence / Fotolia/ETH Zurich

Traumatic and stressful events during childhood increase the risk to develop psychiatric disorders, but to a certain extent, they can also help better deal with difficult situations later in life. Researchers have studied this phenomenon in mice to learn how these effects could be transmitted to the next generation.

Traumatic events leave their mark. People exposed to a traumatic experience early in life are more likely to be affected by illnesses such as [borderline personality disorder](#) or depression. However such experience

can also have positive effects in certain circumstances. Thus, moderate stress in childhood may help a person develop strategies to better cope with stress in adulthood.

Further, it has long been recognised by psychologists and psychiatrists that the negative effects of trauma experienced by parents can be seen in their children, but the molecular mechanisms underlying such transmission are only beginning to be identified. A research team led by Isabelle Mansuy, Professor of Neuroepigenetics at the University of Zurich and ETH Zurich, has for the first time tested in [mice](#) the degree to which the beneficial effects of stress can be passed to following generations.

Flexible and goal-oriented in critical situations

The researchers subjected newborn male mice to traumatic stress by removing them from their mother at irregular and frequent intervals and by severely stressing the mothers in addition. They then used tests to analyse the behaviour of these pups when adult and their [offspring](#) in comparison to control mice not subjected to stress. They observed that the offspring of the stressed mice handled complex tasks more efficiently than the control group.

For example, one test revealed that the offspring of stressed fathers adapted better to changing rules on a task to earn a drink reward when they were thirsty. They reacted more flexibly. In another test, the mice had to poke their nose into a hole when prompted by a light signal but only after a pre-determined delay of 6, 12 or 18 seconds to get water. The stressed mice and their offspring performed the task better than the [control mice](#) at the long time interval of 18 seconds, which was especially challenging. This result was interpreted by the researchers as evidence for improved goal-oriented behaviour in difficult situations. Since the fathers were kept apart from their offspring and the mothers,

the young animals cannot have learned this behaviour. Rather, they must have inherited it via molecular pathways in germ cells.

To determine how this behaviour is expressed and transmitted to the next generation, the researchers examined the activity of a gene, a mineralocorticoid receptor gene previously implicated in flexible behaviour. Mansuy's team discovered that 'epigenetic' marks, which determine how much a gene is expressed, were altered on this gene, both in the brain and sperm of the stressed mice when adult. The altered marks were passed on to the next generation probably through the sperm, and may partly be responsible for the altered behaviour. The mineralocorticoid receptor in question binds signal messengers such as the stress hormone cortisone which initiates a signalling cascade in neurons.

Help in overcoming problems

"Our results show that environmental factors change behaviour and that these changes can be passed on to the next generation," explains Mansuy. This finding - that not only a parent's susceptibility to psychological disorders can be passed on to its offspring, but also its improved goal-oriented behaviour in difficult situations - might prove to be of value to the clinic. Doctors could help post-trauma patients suffering from depression to build on these sorts of strength. The implication of the mineralocorticoid receptor gene could also be a good starting point for potential future medical therapies.

"We are not in any way suggesting that early-childhood trauma is somehow positive," says Mansuy. But she adds that her study on mice demonstrates how extreme stress can positively or negatively affect the brain and behaviour across generations.

More information: Gapp K, Soldado-Magraner S, Alvarez-Sánchez

M, Bohacek J, Vernaz G, Shu H, Franklin TB, Wolfer D, Mansuy IM: Early life stress in fathers improves behavioural flexibility in their offspring. *Nature Communications*, 18. November 2014. [DOI: 10.1038/ncomms6466](https://doi.org/10.1038/ncomms6466)

Provided by ETH Zurich

Citation: How early trauma influences behavior (2014, December 1) retrieved 7 May 2024 from <https://medicalxpress.com/news/2014-12-early-trauma-behavior.html>

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