

How the Early Environment Influences Stress Responses in Adulthood

Professor Tara Perrot



HOW THE EARLY ENVIRONMENT INFLUENCES STRESS RESPONSES IN ADULTHOOD

Professor Tara Perrot and her team at Dalhousie University, Canada, are working to better understand how early development – including the experiences of parents before their offspring are even born – may influence the stress reactions and resilience of their offspring later in life. This research involves not only looking at the brain and hormones but also the gut, and holds important implications for understanding human stress reactivity in the current day.

What Makes Some People Resilient?

High levels of stress for a prolonged duration can have severe and devastating effects on individuals' mental and physical health. In the developed world, we are seeing increasing rates of anxiety and depression, and need to better understand what may influence levels of resilience if we are to better help those affected.

Stress is an inevitable part of life, yet some people seem able to better cope with it – they seem to have better resilience. Professor Tara Perrot and her team at Dalhousie University in Halifax, Nova Scotia, are working to explain why this is the case. In outlining the overarching purpose of her work, Professor Perrot explains, 'Our goal is to understand the sources of variability in how individuals respond to stress – why do some suffer from stress-related illnesses while others are resilient?' More specifically, Professor Perrot and her team are investigating how it is that early-life events influence

later-life responses to stress. Critically, uncovering the sorts of environments that lead to better resilience later in life could help us to build the right environments to set up our offspring for lives with a lesser impact from stress.

Professor Perrot and her team work primarily with rats to model various behaviours, environments, and stressors to better understand the role that these different influences may play in the development of better – or worse – responses to stress in offspring when they have reached adulthood. Professor Perrot's team use this approach to explore their key areas of interest – various hormones and responses in the brain and, more recently, gut bacteria and diet and its influence on these factors – which are similar to those found in humans. From an experimental perspective, it is relatively easy to adjust the environment that rats live in to test how such changes can influence stress in mothers both at the time, and in their offspring later on in life.



Early Life Influences

The researchers have gone right back to the start of the life cycle in their bid to better understand the factors that influence our reactions to stress. One stressful event that can be measured and tested in the laboratory in animal models is exposure to predators (this may even be just the scent of a predator). Exposure to predators may indicate an ongoing threat and so increases the stressfulness of the environment. Professor Perrot and her team have shown that exposure to this stressor can change the way that mother rats behave when their offspring are young. Interestingly, this was the case whether it was the mother that experienced the exposure to the predator, or the father.

‘Our goal is to understand the sources of variability in how individuals respond to stress - why do some suffer from stress-related illnesses while others are resilient?’



One recent study by Professor Perrot's research team found that the father being exposed to this type of stress, even before mating, had an effect on the behaviour of the mother rat. The female rats somehow had a way of detecting this previous experience of stress in the males, and adjusted their behaviour toward the males' young. Specifically, they continued to treat the environment as a potentially high-stress environment with possible predators afterwards, which affected their maternal behaviours towards their offspring.

There are two types of behaviour in mother rats that occur within the first week after giving birth that have been shown to affect the way that a particular hormone system within the brain responds to stress in the pups later on in adulthood, as well as how anxiety-prone these adult offspring are, and whether their thinking and memory are affected by stress. These are all relevant responses to stress in humans, too. These are the behaviours that the researchers were interested in measuring to identify any changes in behaviour on the part of the mother.

This work has important implications. As Professor Perrot explains, 'The quality of a mother's care has profound effects on the development of the stress response system in the offspring... anything that alters her care can alter her offspring's future stress responding.'

As well as monitoring maternal behaviour following predator stress for either of the parents (including exposure of a pregnant mother to the scent of a predator in a separate experiment), the researchers also investigated the role of the environment the rats were housed in, to see if this could be a further source of stress and could tell us more about how the animals responded to this.

The mothers' behaviour was influenced by both types of stress – predator presence (in the lives of either parent) and the quality of the housing they were in. Better housing partially offset the increase in stress-responses of the offspring, either through the improved environment at an early age or better quality maternal behaviour towards the pups when they were young.

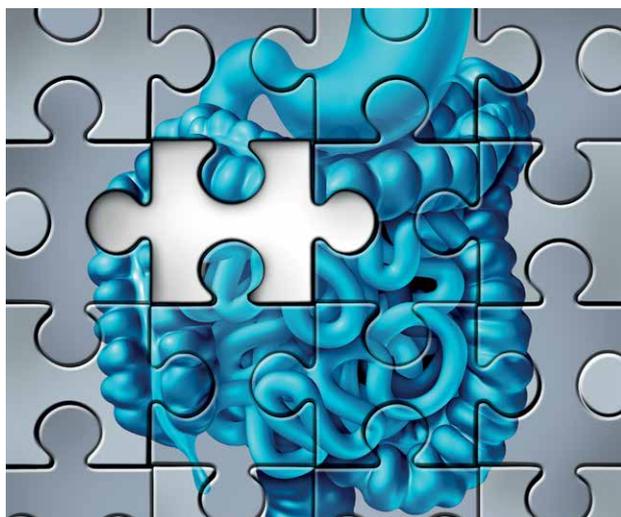
Beyond the Brain

More recently, Professor Perrot and her team have expanded their investigations to look beyond the brain – that is, investigating the hormonal responses produced within the brain, and anxiety and depressive behaviours as the result of input from a wider system. They have begun to look at the effects that could occur through changes in other areas of the body, primarily the gut, and the effects that poor diet may have.

For humans, obesity and poor diet are increasing problems in the developed world, and Professor Perrot's team are investigating the role that diet may play on stress resilience – this includes the diet of both parents before and, in the case of the mother, during pregnancy.

Recent work by Professor Perrot's team has found that, similar to the stress of a predator as described earlier, exposure of the father rat to a high-fat diet affected the female's preference for a mate, and had subsequent effects on her behaviour to their offspring and the stress responses of those offspring. The

‘The quality of a mother’s care has profound effects on the development of the stress response system in the offspring...anything that alters her care can alter her offspring’s future stress responding.’



high-fat diet seemed to act as a stress in the father’s life and resulted in similar problems to the more apparently obvious stressful environmental factor of the presence of a predator.

Research has also shown how high-fat diets and obesity in human mothers may act as a source of stress and detrimentally affect the development of their foetuses, leading to neurodevelopmental problems – including anxiety and depressive disorders. In collaboration with their industrial partner, Rosell Institute for Microbiome and Probiotics by Lallemand, Professor Perrot’s team is actively exploring the interaction of diet and stress, including the potentially beneficial effects of probiotics.

Implications for Coping with Stress

All of these findings provide important clues about our environment, both external and internal, and how these may interact to impact on our later ability to cope with stress. Critically, our ability to cope with stress, and our resilience to the effects of stressful life events, seem to stem from very early experiences and influences.

These findings are of importance because they demonstrate some of the ways through which the stresses experienced by parents may be exhibited or passed along to their offspring, and the subsequent impacts that these behaviours have. If we can identify equivalent behaviours in people, we may be able to prevent the development of such environments or stop them from having such a significant and damaging effect. Paying attention to living environments and their impact on producing or relieving stress is also important, and one that has important implications for public health.

Another important finding arising from Professor Perrot’s work is the increasing evidence for sex-related differences in the levels of stress-related hormones, and anxiety- and depressive-related behaviours seen in the rats raised during these types of experiments. These findings suggest that there is some further role that sex hormones may play in the development of susceptibility to stress or resilience, and that warrants further investigation.

Professor Perrot and her team always include male and female pups in their experiments so that they can identify any differences and test whether different factors affect each sex differently. Given the differences in the numbers of men and women who display low levels of resilience and anxiety- and depressive-related behaviours, as well as the types of behaviours shown in response to stress, research such as Professor Perrot’s that routinely investigates these differences is essential.

This is not to say that we cannot overcome the influence of our early environment with respect to coping with stress as adults. One of Dr Perrot’s passions outside of the lab is researching and sharing information about activities that individuals can undertake to reduce the unhealthy effects of stress on the brain and body. These activities include consuming a healthy diet, taking regular exercise, and engaging in mindfulness-based activities such as yoga and meditation. Over the next few years, Dr Perrot plans to increase the number of presentations and workshops she gives in her effort to provide the general public with tools to effectively deal with daily stress.

The research of Professor Perrot and her team has important implications for public health bodies, the guidance given to prospective and new parents, and for the development of strategies to overcome these differences and help individuals with lower levels of resilience.

Meet the researcher



Professor Tara Perrot
Dalhousie University Life Sciences Centre
Halifax, Nova Scotia
Canada

Professor Tara Perrot received her PhD in neuroscience in 1998 from Western University, Canada. Following her progression through a range of academic positions, Professor Perrot is now Professor at the Department of Psychology and Neuroscience at Dalhousie University, Canada. Her research focuses on the factors that affect the development of resilience to stress, and in particular, understanding the responses to stress from a variety of perspectives, including behavioural, hormonal, and neural in both animal models and humans. Professor Perrot has published more than 50 peer-reviewed journal articles and several book chapters in her field of expertise, with many of these including undergraduate and graduate trainees she has supervised over the years. She has given numerous invited presentations, and is an active reviewer of grants, manuscripts, and other scholarly activity. Finally, Professor Perrot has a demonstrable commitment to scientific outreach, including participating in an interview for a Telefilm Canada-funded documentary in 2015 and public lectures on keeping your brain healthy. Aligned with these professional interests, Dr Perrot has a registered company called Fit Brain, the goal of which is to provide individuals with tools to combat stress and maintain brain and body health. The company is in its infancy, but to date, Dr Perrot has provided stress management workshops to management professionals and graduate students in the Halifax area and most recently, nature retreats to the general public that focus on stress-reduction. She is a 200h certified yoga practitioner and an active yogi. She is currently working toward her Atlantic Master Gardener certificate, which will enable her to include horticultural activities in future offerings. She invites you to visit her recently launched website for more information and to contact her with questions or to enquire about a workshop or retreat.

CONTACT

E: Tara.Perrot@dal.ca (professional email);
brainbodybalancehfx@gmail.com (Fit Brain email)
W: https://www.dal.ca/faculty/science/psychology_neuroscience/faculty-staff/our-faculty/tara-perrot.html
W: <https://fbmahonebay.com>
<https://www.dal.ca/sites/ear.html>

FURTHER READING (trainees underlined)

EM Myles, ME O'Leary, R Smith, CW MacPherson, A Oprea, EH Melanson, TA Thompkins, TS Perrot, TS, Supplementation with combined *Lactobacillus helveticus* R0052 and *Bifidobacterium longum* R0175 across development reveals sex differences in physiological and behavioural effects of Western diet in Long-Evans rats, *Microorganisms*, 2020, 8(10), 1527, doi:10.3390/microorganisms8101527

EM Myles*, ME O'Leary*, ID Romkey, A Piano, V de Carvalho, TA Tompkins, TS Perrot, Guidelines for best practice in placebo-controlled experimental studies on probiotics in rodent animal models, *Beneficial Microbes*, 2020, 11(3), 245–254, doi:10.3920/BM2019.0144) (*contributed equally to this work).

A Korgan, E O'Leary, J King, I Weaver, TS Perrot, Effects of paternal high-fat diet and rearing environment on maternal investment and development of defensive responses in the offspring, *Psychoneuroendocrinology*, 2018, 91, 20–30.

A Green, MJ Esser, TS Perrot, Developmental expression of anxiety and depressive behaviours after prenatal predator exposure and early life home cage enhancement, *Behavioural Brain Research*, 2018, S0166-4328(17)31465-1

A Korgan, E O'Leary, J Bauer, A Fortier, ICG Weaver, TS Perrot, Effects of paternal predation risk and rearing environment on maternal investment and development of long-term defensive responses in the offspring. *eNeuro*, 2016, 3(6), e0231-16.2016 1–14

A LeRoux, LD Wright, TS Perrot, B Rusak, Impact of menstrual cycle phase on endocrine effects of partial sleep restriction in healthy women. *Psychoneuroendocrinology*, 2014, 49C, 34–46.

LD Wright, TS Perrot, TS, Stress and the developing brain, 2013, Ebook as part of series: The Developing Brain, Ed. MM McCarthy, Morgan & Claypool Life Science Publishers, Princeton, NJ.

