DNA can carry memories of traumatic stress down the generations

Animal and human investigations indicate that the impact of trauma experienced by mothers affects early offspring development, but new research is also discovering that it is also actually encoded into the DNA of subsequent generations.

Violent acts, such as those encountered during warfare or terrorism, obviously have a profound impact on mental health, not only for the surviving victims but also for the perpetrators. The individuals involved are often at the mercy of a pernicious cycle of destructive thoughts and behaviours.

In an effort to enable more effective humanitarian interventions, the EU-funded MEMOTV project (Epigenetic, neural and cognitive memories of traumatic stress and violence) is investigating the full scale of the mechanism by which these stressful experiences actually shape memories. The team’s recently published findings indicate that individuals undergoing a negative response to traumatic stressors, can actually pass this on to subsequent generations through DNA processes.

The role of DNA methylation in stress transference

The MEMOTV team is investigating the transference mechanism at the epigenetic, neural and cognitive levels in humans, as well as exploring how these traumatic memories contribute towards mental suffering within different cultural settings.

Publishing recent findings in the journal Translational Psychiatry the researchers outline how they investigated genetic changes seen in epigenetic patterns, by studying maternal stress experienced during pregnancy in the favelas of Rio de Janeiro, Brazil. The researchers gathered saliva samples from a total of 386 people – grandmothers, their daughters and grandchildren. They also collected information from the grandmothers and daughters about their experience of violence within their partnerships and communities before, during and after pregnancy.

Combining both datasets the researchers were able to make predictions about the DNA of the grandchildren of those grandmothers who had experienced violence while pregnant with the mothers, for five locations within circulatory regulation genes. They were able to conclude that violence experienced during pregnancy leads to different DNA activity in children, known as methylations, whereby the genome reacts to the environment by activating or deactivating genes. The methylation took place regardless of whether the violent source was a partner or came from within the wider community.

Methylation is considered an epigenetic mechanism as it is not the genetic sequence itself which is altered but rather the legibility or activity of the coded information. Methylation patterns are an evolutionary device which make it easier for an organism to adapt to its environment. In this instance the researchers hypothesise that the methylation patterns might result in children more fearful or alternatively more aggressive as an adaptive
behavioural response. The researchers suggest that in the future prenatal DNA methylation patterns could be used as biomarkers for psychological health and risk to psychiatric disorders.

Remoulding ‘maladaptive plasticity’

The starting point for the MEMOTV project was an understanding that the entire human organism, including the parts responsible for information processing – principally the brain, immune and endocrine systems – are shaped, not only by original experiences, but also crucially by the memories of these experiences. By employing the ‘epigenome-wide association studies’ (EWAS) approach to determine DNA methylation patterns, the team has been able to offer evidence that exposure during pregnancy to violence, influences genetic activity which is carried into the grandchildren's generation. This lasting change in the brain's organisation and function can be self-perpetuating whereby a stage dubbed the ‘defence cascade’ can be triggered by events, often subtly, resulting in undesirable behaviour.

With obvious implications for the rehabilitation of the perpetrators and victims of violence, MEMOTV hopes that more knowledge about the mechanism by which this maladaptive plasticity unfolds, will result in the prevention and even reversal of its consequences. Towards this end, the team is also pursuing its investigations within a German trauma clinic, the townships of South Africa and a Burundi peace corps. Information gleaned from these settings is viewed as being representative of human response at large, and with high data variability, it is anticipated that the findings can then be meaningfully applied to the rest of the population.

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