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Dynamics of neuroendocrine stress response: bistability, trauma and PTSD

The hypothalamic-pituitary-adrenal (HPA) axis is a neuroendocrine system that regulates numerous physiological processes. Disruptions are correlated with stress-related diseases such as PTSD and major depression. We characterize *normal* and *diseased* states of the HPA axis as basins of attraction of a dynamical system describing the main hormones regulated by the HPA axis. Our model includes hormonal self-upregulation, release, synthesis; interaction, delay and feedback mechanisms. External input is associated to psychological trauma, while parameter changes represent physiological damage. We show that transitions between the *normal* and *diseased* states may be induced solely by external input, with all physiological parameters unchanged, emphasizing the severe consequences of psychological trauma. We also find that the timing and duration of the traumatic event is an important determinant of if and how stress disorders will manifest. Finally, we propose mechanisms whereby exposure therapy may act to normalize downstream dysregulation of the HPA axis.