Adverse childhood experiences

Greater understanding, early detection and remediation of the effects of adverse childhood experience are paramount, because it can lead to health-harming behaviours and the intergenerational transmission of violence, the development of mental illness, premature death or even suicide.

Author/s:

María Castelló

Researcher, Instituto de Investigaciones Biológicas Clemente Estable, Uruguay

Theme/s:

Quality, equity, and relevance of education and learning

This report arises from Science of Learning Fellowships funded by the International Brain Research Organization (IBRO) in partnership with the International Bureau of Education (IBE) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The IBRO/IBE-UNESCO Science of Learning Fellowship aims to support and translate key neuroscience research on learning and the brain to educators, policy makers, and governments.

Executive summary

- Adverse childhood experiences occur in most countries regardless of culture, class, education, income, and ethnic origin during wars, forced migrations, and in everyday "normal" circumstances.
- Despite global recognition of children's rights and international declarations stressing the need for prevention and early action, the incidence of adverse childhood experiences is astonishingly high.
- Childhood stress can cause longlife physical and mental illness including depression, anxiety disorders, and post-traumatic stress disorders.
- Alternatively, resilient children, despite suffering adverse childhood experiences, grow up displaying minimal or no physical or mental consequences in adulthood.
- Teachers and schools can contribute to early detection of adverse childhood experiences and promotion of resilience.

Introduction

More than a half billion of the world's children live in unacceptably disadvantaged situations. According to the Multidimensional Poverty Index 2018[1], these children experience multidimensional poverty, being simultaneously left behind in terms of health, education, and standard of living—which are three dimensions of the constellation that allow the identification and description of poverty (along with empowerment, work, environment, safety from violence, social relationships, and culture[2]). Poverty involves not only the lack of indispensable material well-being, but also shortened lives and lives made hard, painful, or hazardous, robbed of dignity, confidence, and self-respect[3]. One billion of the world's youth suffered from maltreatment* and/or violence** in 2017[4], in one or all of its various forms (physical, mental, sexual, or due to neglect), regardless of the country, culture, class, education, income, and ethnic origin, either in wars or as part of forced migrations or in normal circumstances[6,7,8].

Maltreatment and violence causing children victimization are adverse childhood experiences which may coexist with household dysfunction (as may sometimes occur to children who live with someone displaying alcohol, drug, or substance abuse; who has mental illness; who is or has been in prison; or experiencing parental separation, divorce, and/or violence[4]).

Despite the global recognition of children's rights almost a century ago, and the ample declarations of commitment to protection of children's rights[9,10]and to prevent maltreatment[4,6,11], both poverty and violence (separately or concurrently) still constitute sources of acute and chronic stress.

Adverse childhood experiences may cause diverse lifelong effects such as adoption of health-harming behaviours that can result in the development of mental illness, premature death, or suicide. In addition, it may lead to intergenerational transmission of violence, exacerbating inequality and perpetuating cycles of deprivation[4]. For all these reasons, prevention and the early detection of adverse childhood experiences are desirable. Interventions should be coordinated promptly that are holistic, family-centered, and multisectoral, including a central role of schools and teachers[4].

Stress response

Stress is the reaction toward potentially harmful acute stimuli or stressors (see Figure 1). It may provoke short-term physiological and psychological adaptive responses, also called the "general alarm reaction" or "stress response" by its discoverer, Dr. Selye[12]. The stress response elicits coordinated physiological processes which maintain most of the steady states of an organism in the face of environmental change (i.e., it maintains *homeostasis*[1][3]). The stress response involves the coordinated activation of the nervous and endocrine[#] systems in response to harmful stimuli. This stress response elicits behavioural responses that mediate adaptation and survival (see Figure 1)[14].

The first step of the stress response is the identification of harmful situations, either real or potential (see Figure 1A), involving different neural networks for physical or psychological stressors (see Figure 1B). Physical stressors mainly activate structures on the brain stem and, in the brain, the hypothalamus. These structures relate to control of vital functions such as the solitary tract nucleus and the locus coeruleus as well as part of the prefrontal cortex. The prefrontal cortex is a critical brain region for

appropriate responses to environmental changes. In fact, its disruption is related to reduced motivation or ability to experience pleasure (anhedonia) and aberrant reward-seeking behaviour. The prefrontal cortex integrates different stress responses and coordinates top-down control of the stress response. The amygdala and the hippocampus participate in adapting the stress response to incoming stimulus. (The amygdala responds particularly in the stress response elicited by psychological stress, whereas the hippocampus responds particularly in the response to both physical and psychological stressors.)

The paraventricular nucleus of hypothalamus and locus coeruleus are the main output channels of the stress response activating the hypothalamic-pituitary-adrenal (HPA) and the sympathetic-adreno-medullar (SAM) axis, respectively.

HPA and SAM elicits the release of different molecular mediators: glucocorticoids by HPA axis or noradrenaline and norepinephrine by SAM axis.

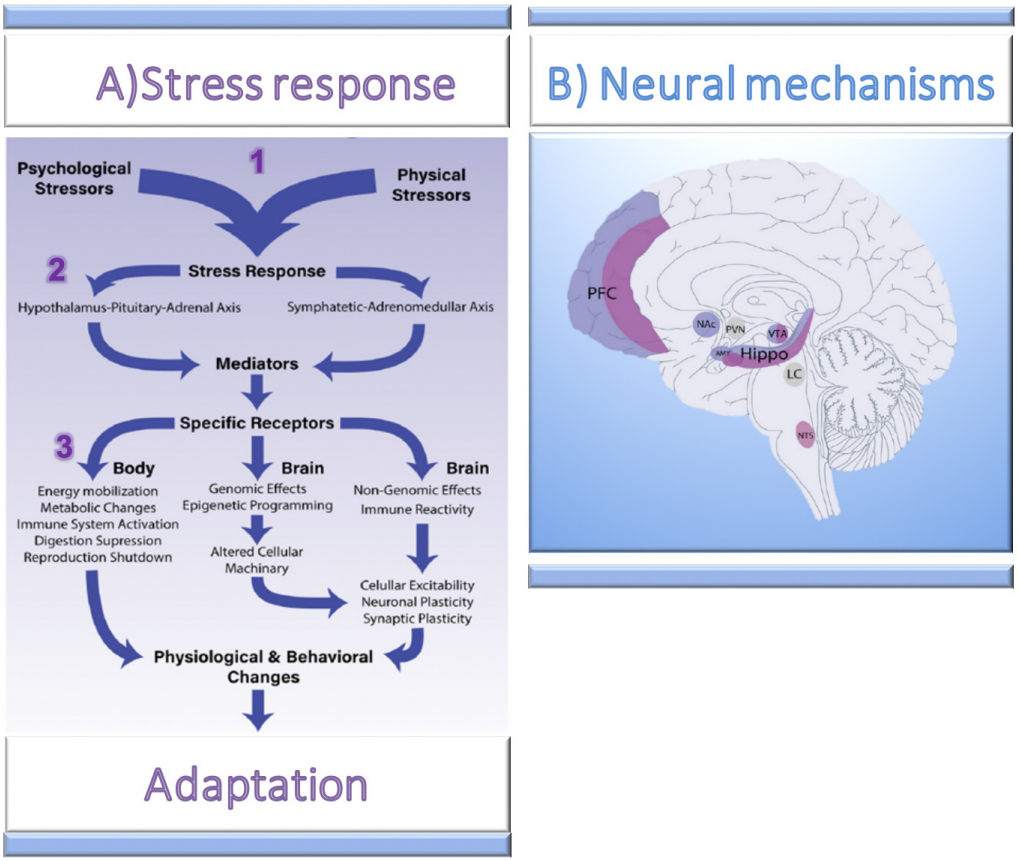

Figure 1. Stress response. (A) Diagram of the main components of the stress response: (1) types of triggering stimuli; (2) neuroendocrine mechanisms that produce mediator molecules that act on effectors; (3) to produce mechanisms sub-serving adaptation to stress. (B) Brain regions involved in the response to psychological (blue) and physical (pink) stressors. Amygdala (AMY), hippocampus (HIPPO), locus coeruleus (LC), nucleus accumbens (NAc), nucleus of the solitary tract (NTS), paraventricular nucleus of hypothalamus (PVN), prefrontal cortex (PFC), ventral tegmental area (VTA). Modified from ref. [12].

This dual HPA/SAM activation generates a coordinated response, involving fast and short-term (seconds) as well as slower and longer-term effects (days) enabling an almost immediate systemic response that affects energy mobilization, elicits metabolic changes, as well as activation of the immune system and suppression of the digestive and reproductive systems. The stress response also induces short- and long-term effects on the brain through non-genomic, genomic, and epigenetic mechanisms.

Under normal circumstances, all these functional alterations are followed by homeostatic restoration.

Chronic effects of child exposure to stress

Chronic child exposure to stressors may produce overloads of the physiological mechanisms and produce an adaptation through long-term changes (allostatic) of the nervous, endocrine, and immune systems[15-20]. The response to those changes is decisive for the progression into pathology or alternatively to the accomplishment of a resilient response to stress. When homeostatic capacity is overcome by chronic stress, it can coexist or be the cause of other disorders such as depression, anxiety disorders, post-traumatic stress disorder (PTSD), and noncommunicable diseases such as obesity and diabetes.[14,20]

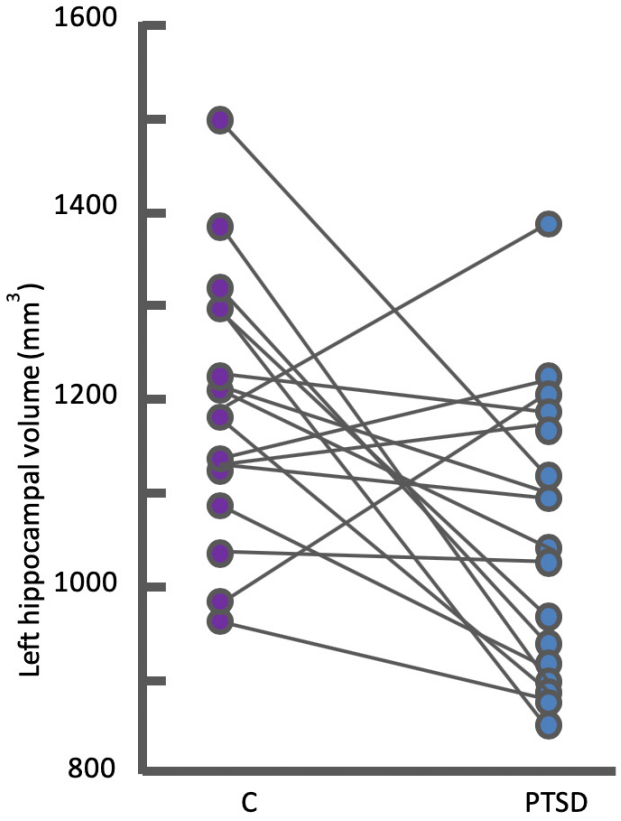

Figure 2. Effects of child abuse-related post-traumatic stress disorder (PTSD) on hippocampal volume. Symbols represent magnetic resonance imaging-based measurement of left hippocampal volume in PTSD patients (N=17) and matched controls (C) (N=17). ($p<0.05$). Modified from ref. [22].

The characteristics of the stressor play a role in the evolution of the stress response. Under certain circumstances, the stress response decreases over time (habituation response) as upon exposure to repeated stressors of similar characteristics and moderate intensity. Conversely, the stress response persists over time or is even enhanced when the intensity of the stressor is high, or the type of stressor varies and becomes unpredictable, or the outcomes of stressor exposure are uncertain—as occurs in social stress. These types of stress are associated with sustained changes in some physiological variables indicative of the persistent activation of neuroendocrine mechanisms (HPA and SAM axes), particularly the secretion of hormones known as glucocorticoids[21].

Glucocorticoids reach several brain targets, particularly those that express high levels of steroid receptors as the hippocampus, amygdala, prefrontal cortex, and other limbic and midbrain structures. There, glucocorticoids regulate cellular functions for extended periods of time, much further than the moment of occurrence of the stressor, and modulate the neural circuitry and neuroendocrine systems that underlie behavioural responses to stress[22].

Brain imagenology studies show that sustained glucocorticoid levels may produce damage, dendritic atrophy (death of neuron branches that receive signals from other neurons) and neurogenesis suppression (reduced birth of new neurons) in the amygdala and hippocampus[23] (see Figure 2). Persistent alterations associated with these changes are observed in stress sensitivity and emotional regulation in later life[20]. These alterations appear during childhood and persist up to adulthood affecting not only normal development but also aging[18]. Chronic stress can elicit persistent neurological organic alterations, disturbing cognitive (such as memory and functioning) or affective skills (such as the regulation of emotions and the

processing of rewards, social, and affective stimuli). Chronic stress may also increase the risk of mental and physical diseases such as depression, post-traumatic stress disorder, borderline personality disorder, obesity, and diabetes[17-20].

Figure 3. "Wall of dreams," photograph of Diala Brisly's mural in a refugee camp in Lebanon by Youssef Doughan (2016; https://tintosofresilience.com/). Reproduced with permission from the artist.

Resilience

Fortunately, the long-term impact of stress is not a rule of thumb since, despite being exposed to extreme childhood stressful experiences, it is common that people do not display significant symptoms of psychological illness[15,16,22]. This evidences the capacity of stress-resilience, which is the ability to avoid negative social, psychological, and biological consequences of extreme stress. Resilience is not only the absence of pathological response to extreme stressful situations, but also an active, adaptive process. Differences in stress response amongst individuals derive from interpersonal variations in neural and genetic, as well as epigenetic, components of individual responses[15]. Thus, it is desirable to induce mechanisms of natural resilience in individuals who appear to be more vulnerable[16]. This may be achieved by promotion of strengths acquisition[24] and/or by various interventions involving play, art (see Figure 3), as well as behavioral approaches such as exercise, yoga, and meditation[15], all of which can be implemented in the classroom.

Definitions

*__Child maltreatment__ constitutes all forms of physical and/or emotional ill treatment, sexual abuse, neglect, or negligent treatment, or commercial or other exploitation resulting in actual or potential harm to the child's health, survival, development, or dignity in the context of a relationship of responsibility, trust, or power[16,17]. Children may be subjected to more than one type of maltreatment in their childhood.[4]

** __Violence against children__ is defined as the intentional use of physical force or power, threatened or actual, against children under 18 years that either results in, or has a high likelihood of resulting in, injury, death, psychological harm, maldevelopment, or deprivation. These acts of violence may be committed by adults, whether carers, relatives, strangers, or by peers—other children[16,17]. Child maltreatment is a major type of violence against children[4].

[#] __The endocrine system__ is a chemical messenger system comprising feedback loops of hormones into the blood released by glands (e.g., thyroid and adrenal) of an organism directly regulating distant target organs (e.g., heart, stomach, lungs).

References

1. Alkire, S. & Jahan, S. The New Global MPI 2018: Aligning with the Sustainable Development Goals, HDRO Occasional Paper, United Nations Development Programme (UNDP) (2018).

2. Alkire, S. & Santos, M. E. Measuring acute poverty in the developing world: robustness and scope of the multidimensional poverty index. *World Development* 59, 251–274 (2014).

3. Anand, S. & Sen, A. Concepts of Human Development and Poverty: A Multidimensional Perspective. *Poverty and Human Development: Human Development Papers 1997* 1–20 (1997). doi:10.1016/j.neuron.2007.05.028

4. Sethi D., Yon, Y., Parekh, N., Anderson, T., Huber, J., Rakovac, I. & Meinck, F. European status report on preventing child maltreatment. Copenhagen: WHO Regional Office for Europe. (2018).

5. United Nations Children's Fund, Hidden in Plain Sight: A statistical analysis of violence against children, UNICEF, New York, (2014).

6. Pedro-viejo, A. B. *et al.* European report on preventing child maltreatment. *Psicothema* 14,124–129 (2002).

7. Nations, U. *World report on violence against children. World Report on Violence Against Children* 387 (2006). doi: Artn 114801\nDoi 10.1143/Jpsj.76.114801.

8. Santa Barbara, J. Impact of war on children and imperative to end war. *J. Croat Med* 47, 891-894.

9. Geneva Declaration of the Rights of the Child. UN, Geneva, (1924). http://www.un-documents.net/gdrc1924.htm

10. United Nations Convention on the Rights of the Child. Retrieved from: https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

11. European report on preventing child maltreatment. World Health Organization. Retrieved from: https://www.euro.who.int/__data/assets/pdf_file/0019/217018/European-Report-on-Preventing-Child-Maltreatment.pdf?ua=1.

12. Selye, H. A syndrome produced by diverse nocuous agents [13]. *Nature* 138, 32 (1936).

13. Cannon, W. B. (1932). *The wisdom of the body. The wisdom of the body.* (p. 312). W W Norton & Co. https://www.panarchy.org/cannon/homeostasis.1932.html)

14. Godoy, L. D., Rossignoli, M. T., Delfino-Pereira, P., Garcia-Cairasco, N. & de Lima Umeoka, E. H. A comprehensive overview on stress neurobiology: basic concepts and clinical implications. *Frontiers in Behavioral Neuroscience* 12, (2018).

15. Osório, C., Probert, T., Jones, E., Young, A. H. & Robbins, I. Adapting to stress: understanding the neurobiology of resilience. *Behavioral Medicine* 43, 307–322 (2017).

16. King, A. Neurobiology: rise of resilience. *Nature* 531, S18–S19 (2016).

17. Hughes, K. *et al.* The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(8):e356-e366. doi:10.1016/S2468-2667(17)30118-4

18. Pechtel, P. & Pizzagalli, D.A. Psychopharmacology (2011) 214: 55. https://doi.org/10.1007/s00213-010-2009-2

19. Danese, A., & McEwen, B. Adverse childhood experiences, allostasis, allostatic load, and age-related disease *Physiology & Behavior* 106(1), 12 April 2012, 29-39.

20. Herzog, J. & Schmahl, C. (2018) Adverse childhood experiences and the consequences on neurobiological, psychosocial, and somatic conditions across the lifespan. *Front. Psychiatry* 9:420. doi: 10.3389/fpsyt.2018.00420

21. Herman, J. P. Neural control of chronic stress adaptation. *Frontiers in Behavioral Neuroscience* 7, (2013).

22. Russo, S. J., Murrough, J. W., Han, M. H., Charney, D. S. & Nestler, E. J. Neurobiology of resilience. *Nat Neurosci* 15, 1475–1484 (2012).

23. Brenner, J. D. *et al.* Magnetic resonance imaging-based measurement of hippocampal volume in posttraumatic stress disorder related to childhood physical and sexual abuse – A preliminary report. *Biological Psychiatry* 41, 23–32 (1997).

24. Pollard, E. L. & Davidson, L. Foundations of child well-being. *Action research in family and early childhood* 18, 1–43 (2001).

25. Wu, G. *et al.* Understanding resilience. *Frontiers in behavioral neuroscience* 7, 10 (2013).