

Australian Early Development Census

## Brain development in children



A child's brain develops in response to both genes and the environment. It is the interaction between the genes and environment that really shape the developing brain; a dance between biology and experience.

While genes provide the initial map for development, it is the experiences and relationships babies and children have every day that literally shape their brains. Families have an extremely important ongoing influence on children's development. The community and service environments in which children and families interact also play a key role in supporting optimal development.

The Australian Early Development Census (AEDC) is a national measure of children's development, providing a community-based snapshot of how children have developed before they start school. This helps communities, schools and governments pinpoint the services, resources and support children need to give them the best start in life.

### Brain development

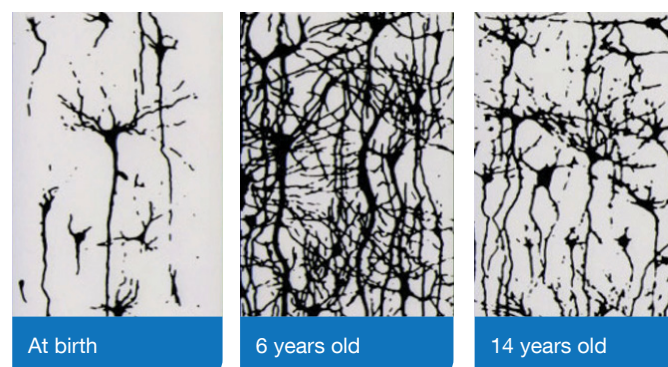
Genes provide the initial map for brain development, beginning with the basic connections in the brain from birth. Significant 'wiring' occurs during the first years of a child's life and this effectively programs child development. At three, a child has around 1000 trillion brain connections or synapses, which in later development are selectively pruned. When adolescence is reached, brain synapses will number around 500 trillion, and this number remains relatively stable into adulthood (Figure 1).

The pruning of brain synapses indicates the tremendous influence experience and environment play in shaping a young brain. It is the experiences and relationships that infants and young children have that continuously develop their brains and build the neural circuits that will be the foundation for later development. New research in an area called epigenetics, even suggest that a person's genes can potentially develop in response to some environmental factors.

### Stress and brain development

Stress is a feature of the normal development of positive and adaptive coping. Everyday stress responses of a moderate and brief nature can result in mild increases of hormone levels (cortisol) and short-lived increases in heart rate. These kinds of 'tolerable' stress responses help in the

**Figure 1** – The pruning trajectory of brain synapses.



**Table 1** – Key features of early brain development.

Brain development period	Key features
Ante-natal	<ul style="list-style-type: none"><li>• All five senses begin to function before birth.</li><li>• Prenatal sensory experiences actually help shape the brain and nervous system.</li><li>• Prenatal experiences prime the attachment behaviours of the infant.</li></ul>
0–3 years	<ul style="list-style-type: none"><li>• A rapid period of brain development which can be:<ul style="list-style-type: none"><li>◦ fostered by relationships with caregivers, and</li><li>◦ supported by optimal community environments for families and children.</li></ul></li><li>• Brain development is vulnerable to toxic stress (depending on length and number of stressors for the child).</li></ul>
By school age	<ul style="list-style-type: none"><li>• Children build on the solid foundation of the first five years.</li><li>• It is more difficult for children to take advantage of the learning environment of schools if:<ul style="list-style-type: none"><li>◦ they have not had an optimal home environment</li><li>◦ there is restricted access to quality early childhood services</li><li>◦ they have experienced a poor quality community environment.</li></ul></li></ul>
Adolescence	<ul style="list-style-type: none"><li>• Brain development prioritises the connections used most often, resulting in ‘pruning’ of brain networks or circuits.</li><li>• As children enter this period, more intensive resources are required if children have missed the opportunities for optimal caregiving and environments in the preceeding years.</li></ul>

development of adaptive coping when buffered by stable and supportive relationships and are an important part of healthy development.

Excessive or long-lasting stress is known as ‘toxic stress’ and can have a negative impact on brain development. Examples of toxic stress include: physical or sexual abuse, neglect or lack of affection, parental mental illness, family violence, poverty, and lack of adequate housing. Ongoing stress factors that are not buffered by caring and positive relationships disrupt brain architecture leading to a lower threshold of activation of the stress management system, which in turn can lead to life long problems in learning, behaviour, and both physical and mental health.

Although manageable levels of stress are normal and growth-promoting, toxic stress in the early years can damage brain development. It is in situations where ongoing stress is likely, that intervening as early as possible is critical to achieving the best possible outcomes for the child. Caring and positive relationships are essential to ensure stress levels promote resilience for babies and children.

## Sequenced development

The architecture of the brain (the neural circuits) is built in a hierarchical ‘bottom-up’ sequence. This means the foundation is paramount, as higher level circuits are built on lower level ones. Each newly acquired skill aides in the sequential development of the next.

Attaining the more complex and higher order skills becomes much more difficult when the foundation is shaky. As the foundations are built upon, brain circuits stabilise making them much harder to change and this highlights the importance of getting them right the first time.

Positive early experiences result in optimal brain development, which in turn provides the foundation for the other skills and abilities children need for success at school and for life. Table 1 outlines key features of early brain development from the ante-natal period to adolescence.

## Prime times

There are critical periods, or ‘prime times’ for various aspects of brain development. The brain is programmed for events and experiences to happen at particular times for the best wiring and brain development. For example, language development depends on adequate hearing and if hearing loss is not diagnosed at an early age and the brain cannot receive the sounds that lead to language development, the language parts of the brain begin to ‘close up’. The quality of a child’s earliest environments and the availability of appropriate experiences at the right stages of development are crucial to brain development and the foundation for learning in later life.

## Further reading

The following is a brief list of freely available material relevant to brain development and impact of stress factors:

Garner et al (2012). Early childhood adversity, toxic stress, and the role of the pediatrician. *Pediatrics*, 129(1).

Moore, T. (2006). *Early childhood and long term development: The importance of the early years*. Australian Research Alliance for Children & Youth.

National Scientific Council on the Developing Child. (2012). *The science of neglect: The persistent absence of responsive care disrupts the developing brain: working paper 12*.