

Childhood Cognitive Impairment **Ghaydaa Ahmed Shehata**

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Summary

Cognitive function is a group of functions includes memory, general intelligence, learning, language, orientation, perception, attention and concentration, judgment. Cognitive impairment can result from conditions that occur during fetal development, at birth, shortly after birth, or at any point in life. Sometimes, the cause of cognitive impairment cannot be determined, especially in a new-born or small child. Some medical conditions could lead to cognitive impairment in children such as epilepsy, ADHD, Diabetes mellitus, β -thalassemia, Hepatitis etc. It is very essential to understand the cognitive function in children and early intervention to stop deterioration in cognition.

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Definition

Cognitive impairment occurs when problems with thought processes occur. It can include loss of higher reasoning, forgetfulness, learning disabilities, concentration difficulties, decreased intelligence, and other reductions in mental functions. Cognitive impairment may be present at birth or can occur at any point in a person's lifespan [1].

Anatomical Distribution of Cognitive Function

A-Cortical structures which include

- The medial temporal lobe, which includes the hippocampus and adjacent brain areas, play a role in converting memory from a short-term to a long-term form [2].
- Infero-lateral temporal cortex: Semantic memory.
- Hippocampal formation: Encoding of new episodic memory [3].
- Declarative knowledge requires processing in the medial temporal region [4].
- Frontal lobe concerned with selective appropriate behavioral response and inhibit non-appropriate behavioral.
- Working memory, a type of transient memory that enables us to retain what someone has said just long enough to reply, depends in part on the prefrontal cortex [5].
- Parietal lobe concerned with selective attention.
- Occipital lobe concerned with visual attention and perception of vision.

B-Subcortical centers

- The amygdala influences the stored material and whether the action is followed by rewarding or punishing consequences. Also it determines what behaviors will learn and remember.
- The locus coeruleus is a small structure on the upper brain stem under the fourth ventricle and is involved in the regulation of wakefulness, attention and orientation [6].
- The basal ganglion has an important role in cognitive function.
- Thalamus, bilateral lesion → disturbances of attention.
- Reticular activating system → attention and awaking.
- The pineal gland is thought to modulate sleep-wake cycles.
- The cerebellum [7] has a very important role in cognitive function through cerebro-cerebeller circuits which include.
- Parieto-ponto-cerebellar → integrating information, coordinating behavioral responses to environmental and internal stimuli.
- Temporo-ponto-cerebeller → complex behavior.
- Prefronto-ponto-cerebeller → planning & attention.
- Occipito-ponto-cerebeller → 1-dorsal stream concerned with spatial events and 2-ventral stream concerned with identification of objects and their characteristics [8].

General Mechanisms Underlying Cognitive Dysfunction

Cellular mechanisms underlying cognitive function

Synaptic plasticity is critical for learning and memory, and may

also underlie other higher cortical functions such as language, visuo-spatial function, executive function and praxis [9].

Hormonal mechanisms

The Hormonal substances which have a detrimental effect on brain function include: Steroid, SEX hormones, other hormones such as inadequate levels of thyroid and growth hormone have all been implicated in cognitive decline [10].

Neurotransmitter mechanisms

Such as Acetylcholine, Dopamine-Norepinephrine and Epinephrine, Serotonin, Histamine receptors, 5-N-Methyl-D-aspartate (NMDA) receptors and The γ -amino butyric acid (GABA) receptors [11].

The role of mitochondria and free radicals

The mitochondria are especially vulnerable to free radical damage because of their heavy oxygen utilization. In a healthy mitochondria neighborhood there are plenty of free radical scavengers; anti-oxidants prevent its damage [9] such as vitamins C and E, β -carotene, super oxide dismutase, glutathione, Co-Q 10, selenium, zinc, lipoic acid, melatonin, and acetyl-L-carnitine. However, if the anti-oxidant pool is in poor supply – the mitochondria have no defense. Once enough oxidative damage is done to the mitochondria by free radicals, the cell dies. Free radicals directly kill brain cells.

Phospholipids-Supporting Healthy Cognitive Function

There is little membrane surrounding the cell which is providing both protection and a means for communication for the contents of the cell protects each of these neurons. The major structural components of these cell membranes are Phospholipids, In addition to holding cell membranes together, Phospholipids coordinate the activities of enzymes, receptors, and other proteins involved in healthy cognitive function [12]. As with progression of age, membrane functions slow down, and the membranes themselves are highly susceptible to damage. Brain cell membranes are especially at risk, with wear and tear resulting in poor neuron communication, and decline of memory and cognitive function [13].

1. Genetic disorders: It cause different forms of cognitive disorders are seen in; Turner syndrome, Duchenne muscular dystrophy.
2. Protein (RNA) mechanism: a) The activities of the cell are governed by RNA which in turn, receives its instruction from the genetic memory material DNA. b. The learning causes certain changes in RNA in which bases replaced by other bases (base-ratation change \rightarrow release neurotransmitter \rightarrow change the pattern of firing in a neuronal network). c. Experiments have shown that when we increase the protein synthesis or RNA this facilitate learning and opposite is true [14].

Cognitive Plasticity in Children

Clinical disorders of brain plasticity are common in the practice of child neurology. Children have an enhanced capacity for brain plasticity compared to adults as demonstrated by their superior ability to learn a second language or their capacity to recover from brain injuries or radical surgery such as hemi-spherectomy for epilepsy. Basic mechanisms that support plasticity during development include persistence of neurogenesis in some parts of the brain, elimination of neurons through apoptosis or programmed cell death, postnatal proliferation of synapses, and activity-dependent of neuronal connections [15].

Causes of cognitive impairment

1. Cognitive impairment can result from conditions that occur during fetal development, at birth, shortly after birth, or at any point in life.
2. Sometimes, the cause of cognitive impairment cannot be determined, especially in a new-born.
3. Some medical conditions could lead to cognitive impairment in children such as epilepsy, cerebral palsy [16,17], ADHDc, Diabetes mellitus [18], β -thalassemia, Hepatitis etc. [19].

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