Brain Development

Presented by:
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- "Early experiences are so powerful that they can completely change the way a person turns out."
  -- Harry Chugani, Pediatric Neurobiologist, Wayne State University

- Genetic make-up . . . is not the major determiner

- Environment and experiences write on the developing brain and shape the brain

The brain:
- is a self-organizing organ
- uses experiences from the environment to develop neural networks

Neural networks:
- are being formed even before birth
- form the foundation for future intelligence and functioning
A person’s ability to interact, perceive, and learn from the environment comes from the ability to process incoming sensory information and react to the information with a motor response which, in turn, feeds back sensory information.

The brain has two basic functions:

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  Brain receives sensory information from environment
  
  Information sent to body via spinal cord and peripheral nervous system
  
  Central nervous system (CNS) receives signals back from body
  
  Brain plans and sends signals back to environment
The brain has two basic functions:

- The first function is to communicate.
- The second function is to integrate incoming sensory information with information already stored in the brain's memory banks.
• Most of us are born with more neurons than we need, which is good because some die off even when there is no insult to the brain.
• Individuals who have suffered from severe neurological insult have more neurons killed off than would typically occur.
• Once a neuron is damaged or dies, it cannot be revived.
• Experiences and stimulations assist in promoting the dendrites of remaining neurons to branch out more.
Neuroplasticity

“A simple definition of neuroplasticity is the capacity of the nervous system to modify its organization.”

Jude Nicholas, Resource Center for the Deafblind, Norway

Adaptability of the Brain

“. . . In the absence of competition from visual inputs, the visual cortex may become recruited for auditory or tactile processing and in the absence of competition from auditory input, the auditory cortex may become recruited for visual/motion processing.”

Jude Nicholas, Resource Center for the Deafblind, Norway
The first priority of the brain is to keep us alive.

The second priority is to enable us to deal with our body and its interaction with the world it senses around us.

We are genetically imprinted to survive.

The Brain

- the conscious level problem-solving area
- where abstract higher level thinking takes place
- subconscious level responsible for autonomic functions
- guides our emotional behaviors
- evaluates incoming sensory information
- makes experiences individually and personally ours

How Does the Brain Use Information?

All the information we receive comes through one or more of our sensory systems - eyes, ears, nose, mouth, position in space, and nerve endings throughout the body.
Thalamus

- Determines which sensory information will receive the most conscious awareness
- All incoming sensory information, except for smell, is “sorted” by importance
- “Harmless” information is ignored
- New information requires more attention
- If incoming information contradicts existing information, rest of brain will be alerted to pay attention to it
- Helps the rest of the brain to know what is important to attend to and what is not
- Is vulnerable to insult, especially lack of oxygen early in life
- Is highly affected by medication

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**Limbic System**

- Subconscious emotional system; provides subconscious level perceptions
- Processes smells
- Evaluates incoming sensory information in two ways:
  - Subconsciously assesses information on a comfort continuum; finds familiarity comfortable; too much novelty results in stress
  - If a situation is perceived as threatening, a "fight or flight" response kicks in, sending warning signals to the hypothalamus which sends out other hormonal signals to prepare for battle

**Hypothalamus**

- Involuntary center for maintaining physiological equilibrium and life
- Hypothalamus and limbic system constantly influence each other
EXTREME STRESS ACTIVATES THE POWERFUL INTERPLAY OF LIMBIC SYSTEM AND HYPOTHALAMUS

- Bronchial tubes open for deeper breathing
- Heart beats faster; contracts strongly
- Digestion slows down to conserve energy
- Blood sugars increase for energy
- Surface vessels of skin contract
- Muscles contract and blood vessels widen to accommodate increased oxygen needs
- Blood pressure rises
- Eyes dilate for more focused vision
- Hair shaft may become erect
- Other vital organs aroused

**Amygdala and Hippocampus**

- Part of the limbic system
- Critical in the role of memory, in anticipation, and habituation
- Process events for storage in the subconscious memory bank
- Highly affected by anoxia at birth and susceptible to seizures
- Also affected by stress

**Brain Equilibrium**

- Brain evaluates experience
“Stress and constant threats rewire emotion circuits. These circuits are centered on the amygdala, a little almond-shaped structure deep in the brain whose job is to scan incoming sights and sounds for emotional content. Impulses from the eye and ear reach the amygdala before they get to the rational, thoughtful neocortex. If a sight, sound or experience has proved painful before - then the amygdala floods the circuits with neurochemicals before the higher brain knows what’s happening. The brain remains on high alert. In this state, more circuits attend to nonverbal cues – facial expressions, angry noises – that warn of impending danger. The cortex falls behind in development and has trouble assimilating complex information such as language.”

Sharon Begley
Stress and the Brain

- Brain is acutely vulnerable to trauma
- Experience provides the organizing framework for the brain of a child
- Neurochemical responses to fear and stress can become the most powerful architects of the brain

Effects of Stress

- Body’s physiological defenses have to work overtime
- Immune system will be affected
- Deficits in ability to learn

Stress Hormones

Released when the brain receives the signal that danger is near

Cortisol:
- Gets glucose into our bodies
- Revs up the sympathetic nervous system
- Increases our vigilance and attention to threat
- Decreases our attention for other things

High cortisol levels:
- Decrease memory and the ability to control behavior and focus attention
- Slow down the immune system
Trauma and Stress

Overwhelming experiences change the structure of the brain:

• cortex and limbic regions may be smaller
• regions have fewer synapses
• hippocampus is smaller
• increased activity in brain structure involved in vigilance and arousal
• brain regions may be reactivated by a reminder of the trauma
• scrambles neurotransmitter signals

The slightest stress can unleash a new surge of stress hormones. This can cause hyperactivity, anxiety, and impulsive behavior. Studies have shown that children with higher cortisol levels score lowest on inhibitory control. Children from high-stress environments have problems in attention regulation and self-control.

• For individuals with significant neurological insult, stress will result if the brain receives too much information too quickly.

• The brain can become confused.
Sensory Disorganization Can Effect Emotional Development

- Situations which exacerbate sensory disorganization can be scary.
- Difficulty in processing and understanding sensory information related to new environments, materials, activities, and motor patterns, can cause stress.
- When working with individuals, make situations predictable, interesting, and challenging but not overly stressful.
A person’s ability to interact, perceive, and learn from the environment comes from the ability to process incoming sensory information and react to the information with a motor response which, in turn, feeds back sensory information.

Learning occurs on both a conscious and a sub-conscious level. Learning includes the development of:
- orienting
- habituating
- anticipating

Rests on the ability to:
- discriminate
- associate
- remember consciously or sub-consciously

Orienting

- To be aware that an event is occurring
- Individual recognizes a new stimulus and does something to indicate recognition
**Orienting**

- To orient to a stimulus involves the ability to neurologically:
  - be prepared to receive, organize, and interpret incoming sensory information
  - inhibit some information via the thalamus
  - re-alert when there is novelty

**Orienting**

- Individuals with severe neurological challenges may orient, but . . .
  - may have difficulty recognizing and remembering a routine,
  - may demonstrate same level of arousal each time the same stimulus is present,
  - may not be learning,
  - may just orient to the stimulus and be aroused.
- The stimulus does not lose its novelty

**Habituation**

- A process in which a response to a stimulus becomes automatic
- The individual learns:
  - to recognize a stimulus that has been given repeatedly
  - to respond to it in an automatic manner
Habituation

- Brain gradually adapts to a new event or sensation and no longer consciously notices it.
- Involves sensory receptivity, sensory awareness, attention, discrimination, and memory.

Habituation involves being able to:
- receive sensory information
- be aware of that sensory information
- attend to, discriminate, and develop memory of that sensory information

Anticipation

- A higher level of subcortical neurological functioning
- Ability to guess what the next event will be
- Requires attentional processing and ability to remember an event
Anticipation

- The use of routines promotes the learning of individuals who are deafblind
- Individuals can anticipate when they perceive some pattern and remember it
- Routines facilitate feelings of security and reduction of stress

Orient Habituate Anticipate

References:
- *Communicating Research to Practice and Practice to Research: From theoretical contributions to therapeutic interventions.* Jude Nicholas, Resource Center for the Deafblind, Norway.