The Visual System

Understanding the impact on Trauma Informed Care
Trauma happens when any experience stuns us like a bolt out of the blue

The antithesis of empowerment

The younger the child, the more overwhelmed a child may become in every day experiences

The stressor is important, but it does not define trauma – not the event, but where it resides in the nervous system

Our brain’s main function is for survival – trauma activates an enormous amount of energy with intricate amount of physiological responses.

Blood clotting ability increases, while verbal ability decreases
Long range effects

• Depends on what happens during and after the potentially overwhelming event
• With traumatic events, the imprint of neurological patterns is dramatically heightened
• Energy is never fully expended while trauma is lingering in the body, so more easily triggered when reminded
• Fight, flight and freeze is too readily available and pre-frontal cortex pathway to first think things through unavailable in times of stress
Antonio Damasio

• The emotion of fear has a very specific neural circuitry etched in the brain corresponding to specific physical sensations from various parts of the body.

• When something we see, hear, smell, taste or feel signals the original threat, the experience of fear helps the body to organize a “flight, or freeze” plan to remove us from danger quickly.

• Not reliant on memory, more primal response.
Functions

• Edge, contrast, and movement detector
• Perceived best when visual images are still
• Adjustment to movement in environment – combination of 2 reflexes: vestibulo-ocular reflex and optokinetic reflex
• Complex – three parallel pathways that need to be integrated
• The whole is much greater than a mere sum of the parts
Color Emotions

• Green - sickness
• Blue – sadness
• Red – strength or anger
• Yellow - happiness
More about Blue

• Skin may be cold
• Affected with fear, discomfort, anxiety; dismay, perturbed, discomfited, depressed, miserable, low-spirited
• Future prospects look glum
More about Purple

- Hue of the morning
- Color of blood frequently in descriptions
- Blood stained
More about Green

• Grean, pale complexion

• Fear, jealousy, ill humor or sickness
More about Red

- Healthy facial color
- Sudden feeling or emotion
- Flushed, blushing (anger, shame, etc)
- Embarrassment or shame
More about Yellow

- Affected with jealousy
- Craven, cowardly
Ocular Motor Skills

- Fixating on an object involves a combination of visual (retinal) information and coordinated control of the position of the eye (ocular motor).
- Ocular motor consists of control and coordination of the eye movements.
- 3 pairs of muscles control eye movement:
  - Medial and lateral recti (side to side movements)
  - Superior and inferior recti (up and down movements)
  - Superior and inferior obliques (rotational movements)
• **Ocular Motor Skill** relates to the physical structure of the six extra-ocular muscles that are responsible for the movements of the eyes and their ability to work together at similar speed.

• **Visual Pursuits** are the smooth tracking movement of the eyes used to follow moving targets or to track a stationary target while the body is moving.
Saccades

- **Saccades** are the ability of the eyes to shift rapidly from one position to another used for scanning spatial environments as well as reading on a page or copying from the board.
Relationship with Trauma

- EMDR – fairly quick paced side to side eye movements as client’s eyes follow therapist hand movement
- Meant to mimic the fast eye movement that occurs during deep REM sleep and where dreams from subconscious occurs
- Be careful in exercising the saccadic eye muscles in a way that could trigger the trauma and bring it to forefront.
Convergence/Divergence

- **Convergence** is the ability of the eyes to turn inward together to focus on an object at a close distance or coming towards the body.
- **Divergence** is the ability of the eyes to turn outward together to maintain focus on objects moving away from the body.
Difficulty with Eye Movement Control Could be Seen as:

- Loss of place when reading
- Re-reading
- Poor reading comprehension
- Poor or inconsistent sports performance
- Difficulty copying form one place to another
Binocularity Terms: eye teaming or eye alignment

• “phoria” – “tendency to”
  – Orthophoria – eyes tendency to stay in exact alignment
  – Exophoria – eyes tendency to drift outward
  – Esophoria – eyes tendency to drift inward
  – Hyperphoria – eyes tendency to drift upward
“tropias” – “is out of alignment”

- Exotropia – eye turned outward
- Esotropia – eye turned inward
- Hypertropia – eye turned upward
- Cyclotropia – eye is rotated
Other possible findings

• **Convergence insufficiency**: tremendous difficulty turning the eyes in to look close up

• **Convergence excess**: eyes reflexively turn in too far and want to cross when looking up close

• **Suppression**: brain neglects the imagery coming in from one eye

• **Diplopia**: double vision
Difficulty with Binocularity could be seen as decreased depth perception

- Difficulty with ball sports
- Double vision
- Difficulty with visually guided movement
- Difficulty with sustained attention, usually for close
Accommodation Terms

- Focusing for close work (not tested, but included here for information purposes).
- **Presbyopia**: inability to make close targets clear due to age
- **Accommodative insufficiency**: inability or lack of skill or endurance for making close objects clear; no age component
- **Accommodative infacility**: inability to fluently and effortlessly focus from far to near and back
Difficulty with Accommodation may be seen as:

- Inattention, especially for near work
- Difficulty with copying from one place to another
- Blurred close focus
- Headache
- Eye pain
- Takes too long to do homework
Acuity

• Cellfield does not attack or change a difficulty in far or near distance vision for clarity
• Checked by school systems or optometrists
• Does not prescribe glasses or have an opinion on regular optometry
Receptors and Transduction

• Located in the neural retina at the back of the eye
• Photoreceptors – rods and cones – transduce light energy into electrical energy to CNS
• Cones – day vision, color and higher acuity
• Rods – night vision, light sensitive and able to amplify light signals to enable vision in dim light
• Rod cell respond slowly, allowing us to adjust to dim light, cones respond rapidly, allowing us to see quick flashes of light
More on Cones and Rods

• Three types of cone cells, responds to different spectrum of color; red, green, blue
• Other colors dependent on differential information from these three receptors
• Rod cells do not respond to color, responds to wavelengths of light
• Fovea in center of retina – light reaches receptor cells more readily and acuity is enhanced – no rods in fovea, only dense concentration of cones
The Eye

Conjunctiva
- Ora serrata
- Ciliary body
- Aqueous
- Iris
- Anterior chamber
- Cornea
- Pupil
- Lens
- Posterior chamber
- Canal of Schlemm
- Conjunctiva
- Vitreous
- Sclera
- Choroid
- Retina
- Macula
- Artery (central retinal)
- Optic nerve
- Vein (central retinal)
- Rectus medialis
Retina

• 10 layers, outer layer consists of pigment epithelium; neural retina forms other 9 layers
• Light travels through 8 layers to receptor cells
• Receptor cells synapse into bipolar cells found in inner nuclear layer – to ganglion cells, the axons of which form the optic nerve, project to thalamus and superior colliculus
• Horizontal cells – lateral inhibition, sharpening the edges of visual fields, increasing accuracy to CNS
Contrast sensitivity

- 2 categories of ganglion cells
- One class activated by light directed at the center of its receptor field (on center)
- Other class is turned off by light directed at the center of its receptor field (off center)
- Two parallel routes to CNS, combined detects contrast in the visual image
- Used to detect shape, movement, color
- Processed before it reaches the CNS
Central Connections

- Gangliar projections form the optic nerve
- First pathway: Fibers from the nasal region of the retina cross at the optic chiasm
- They join with fibers from temporal retina of the opposite eye to form the optic tract
- Projects to Thalamus
- Allows each hemisphere to receive visual information from the contralateral half of the visual world
Two Groups of Ganglion Cells

- Magnocellular cells have large receptor fields, respond briefly to sustained light
- General features of objects and object movement
- Parvocellular cells are smaller, greater in number, small receptor fields – finer details of vision, form and color
- Different functions: M-cells – understanding of where an object is in our environment
- P-cells – our understanding of the “what” of an object
- On to the visual cortex maintaining their differentiation
Visual Cortex

- Three columns
- Neurons within a single column respond to a single axis or orientation
- Blob regions interrupt – sensitive to color rather than axis
- Ocular dominance columns – receive input from either left or right eye; and they alternate at regular intervals, leading to binocular vision
Second Visual Pathway

- Fibers from optic tract projecting to superior colliculus
- Large receptor fields – no specifics of visual world
- Respond to horizontal movement in the visual field
- Converges with somatosensory system in SC
- SC plays a role in the visual coordination of posture and control of eye movements
Third Visual Pathway

- Accessory optic tract is smallest projections to oculomotor nucleus, medial vestibular nucleus, the thalamus
- Efferent to the inferior olive – projections to vestibular component of cerebellum
- Plays a role in oculomotor adaptation
Visual Perception

• **Visual Perception** is an integrative activity involving the understanding of what is seen.

• It is not about acuity or related to motor processes, but more related to how the brain perceives and processes visual stimuli.
Visual Spatial Relations

• **Visual Spatial Relations** is the ability of the visual system to discern the relationship of oneself to others in an environment or the relationship between oneself and objects in an environment.

• It can also relate to handwriting skills, in the relationship between character letters on a written page, writing on lines, etc.
What is going on behind us?

- Different from many animals – forward facing eyes
- Forward facing eyes are better at depth perception and for searching in clutter in front of us
- Quick connection to cognitive to use visual trigger as prompt for limbic memory
- Use visual system to pre-empt a potential situation at the expense of motor planning, problem solving experiences
- Essentially affects robustness of visual spatial skill and development of motor planning skill – “visual learner”
Visual Discrimination

• Relates to the ability of vision being able to see differences and similarities in objects, to ensure more attention to detail, and to enable the person to identify objects as being the same even when presented in various ways, such as in different positions on the same page and / or embedded in written text as letters that may look the same, but is not, therefore requires a different interpretation.
Visual Figure-Ground

• **Figure-ground** relates to the ability of the brain to process that one object is in the foreground, while another is background.
• the ability to identify objects in a visually busy background.
• It also relates strongly to depth perception, though binocular vision also has a part to play in the skill of depth perception.
Visual Closure

- **Visual closure** is the ability of the brain to enable the person to take a part of a picture or visual symbol and identify the object as if the whole picture or symbol was presented.
The Vision Revolution – Mark Changizi

• Light reaches your eye at time T1
• Brain builds perception of it at a later time, T2
• Your perception of the world is like at T1, does not occur until T2
• Your perception ends up being about the past rather than the present
• If you know what is going to happen in the future, you can prepare for it. The child uses this visual perceptual ability, linking it to past experiences and goes into flight and flight before the actual situation occurs in reality
Visual Memory

- **Visual memory** is an important function of creating memory files of visual images, pictures events, symbols and being able to retrieve if for later use.

- As important as this function is in all academic learning, it is frequently a grossly underestimated system when it comes to early life experiences.

- Emotional connections related to memory are strongly linked to the limbic system and children rely heavily on their past visual experiences to guide their way, which can frequently inhibit their functional progress.
Visual motor integration vs. Eye-hand Coordination

- **Visual motor integration** is the process of incorporating visual perception and a motor output directly related to the visual stimulus, for example copying/drawing shapes, writing letters, or building with blocks.

- **Eye-hand coordination** is precise visual guidance of goal-directed arm and hand movements, such as the movement involved with catching and throwing a ball.
Visual-Spatial Abilities

• Magnocellular level
• Pathway terminates in posterior parietal cortex and serves the sensori-motor function of that area
• Further associated with motion and depth detection, stereoscopic vision and interpreting spatial organization
• Some evidence that implicates this pathway in dyslexia
Development of Spatial Relations

The **first period** is up to 5 months of age and is divided into five spatial relationships:

- **Proximity** is the nearness of objects.
- **Separation** is when one object is separated from another.
- **Succession** is when two neighboring, though separated, elements are arranged one before another (the relation of order or spatial succession), such as the sight of a door opening and a figure appearing.
- **Enclosure** would be, for example, an object in a box.
- **Continuity** is the quality of being continuous, for example, unbroken lines on a surface.
Second phase

The **second period** of spatial relations is from 5 months to 12 months.

– It is the result of sensorimotor development.
– It is marked by the coordination of vision and the child’s ability to distinguish his own movements from an object’s.
– This period starts the development of constancies of shape and size.
– At 8 to 9 months the child is also able to reverse a feeding bottle that is presented to him the wrong way.
Third phase

The **third period** begins at 12 months, and consists of bringing out the relationships of objects to each other. This is the stage where the first attempts to draw are initiated due to the start of the mental image.

- **Up to 4 years**: The only shapes that are recognized or drawn are closed, rounded shapes that are based on simple topological relations such as openness, closure, proximity, and separation.

- **4 years to 7 years**: In this stage, we encounter the beginning of recognition or drawing of Euclidean Shapes (e.g. a diamond).

- **7 years to 8 years**: In this stage, one finds the child capable of being able to use a point of reference. Also at this stage, the child can draw an object by deriving a mental image of it by using tactile and kinesthetic information (Piaget, 1948)
Visual control of movement in space

• Vision guides our movements
• Works in concert with other systems
• Auditory – can compensate partially when vision is lost; enhances vision by signaling the direction of noise
• Touch – confirms location and characteristics of objects; the qualities of surfaces we walk on
• Vestibular – we are upright, direction of gravity
Vision and Body Schema

• An unconscious mechanism underlying spatial motor coordination that provides the CNS with information about the relationship of the body and it’s parts to environmental space
• The proprioceptive-motor-spatial structure of our bodies defined by our orientation to gravity and the position of our head and limbs
• Involves auditory, tactile, proprioception, vestibular and visual information
• Posterior parietal lobe and its connections to pre-motor area of frontal lobe is primary
4 mechanisms

• Optic Flow – differentiate self from object movement; helps guide our movement so we can navigate without bumping into things
• Spatial Constancy – stable vision; the world around us appear stable when eyes are moving – words seem to “jump” on a page
• Motion Parallax and Optic expansion – depth perception or distance of stationary and moving objects; the closer the object, the larger representation in visual field; crucial for sports such as ball skills
If we lack visual-spatial skills

We may feel threatened with everyday occurrences as the following may occur:

• Objects may appear larger in size
• Faster in speed
• Lower in contrast
• Closer in distance
Depth Perception

- Visual system, stereoscopic vision, and linear perspective
- Converts two dimensional retinal images into 3 dimensions
- Depth perception as direct as color perception
- Not stored in memory
- Processed repeatedly and directly into action or perception (or both)
Visual Motor abilities

- Reach and preparation to grasp highly coordinated, but separate and distinct subsystems
- Influence of vision on balance is secondary to the integration of vestibular, proprioceptive and tactile input
- Postural response to peripheral vision is very rapid
- The motor response must be precise in time and place so perception and motion coincide as to where and when the object arrives – timing in ball play
- The motor system is driven by feedforward and must be timed for the hand to be in the position at the moment judged for the ball’s arrival – experience dependent
Spatial Cognition

• Higher order visual spatial skills
• Recognize and remember the relationships between features within an object or design, between 2 or more objects, between oneself and objects
• To mentally manipulate objects; to see parts to a whole
• Finding direction in a new place
• Conscious analysis – pre-frontal cortex
Topographical Orientation

• Go from place to place in familiar surroundings without getting lost; to learn how to find the way in new environments

• Highest level – spatial schema or mental map of the spatial relationship between multiple locations – allows for the use of shortcuts, perspective taking and making models and maps
Object Focused Spatial Abilities

- Block designs, assessment, not function dependent
- Spatial analysis – spatial properties of objects – chess game, predicting several moves in advance
- Construction – requires replication of the spatial aspects of objects
Constructional Ability

• Perceptual activity with a motor response that includes drawing and assembling
• Drawing or copying: includes imitation, copying with model present, copying from memory
• Handwriting – spatial errors, messy legibility
Handwriting

- Accomplished hand writer uses vision for spot checks horizontally
- Beginners use vision for guidance
- Manuscript writing requires spatial analysis similar to copying geometric forms – a layer of earlier development
- Requires organization in placement of writing on a page – top to bottom, left to right
Visual Motor vs. Eye Hand Coordination

• **Visual motor integration** is the process of incorporating visual perception and a motor output directly related to the visual stimulus (example: copying/ drawing shapes, writing letters, or building with blocks). This process is taking internal registration of the visual stimulus and translating it for external motor planning.

• **Eye-hand coordination** is precise visual guidance of goal-directed arm and hand movements, such as the movement involved with catching and throwing a ball. This process takes external visual stimulus and translates it for internal, responsive motor movements.
Functional Implications

- Ocular motor dysfunction is one of the main causes of inefficient reading and directly affects reading speed, fluency, decoding, comprehension, etc.
- Children with dyslexia often have ocular motor problems, poor visual-motor integration, poor visual spatial skills, and tracking difficulties.
- Gross Motor Skills as it relates to eye–hand coordination (i.e. ball skills)
- Fine Motor Skills: handwriting, fasteners, etc.
- Balance difficulties
- Clumsiness
- Difficulty with ascending / descending stairs.
- Fear of heights
- Understanding visual space: i.e. spatial boundaries.
Therapeutic Resonance

- Happens with eye contact in typical situations

- Children may avoid eye contact and need the therapist to find other ways of resonance and creating an intersubjective response that will speak to the child.

- Spending time on regulation and co-regulation through therapeutic alliance becomes critical for ongoing work

- Relationship first, then therapy goals
Visualization

- Visualization is result of good visual perceptual skill in combination with good visual spatial skill.
- Start with visualizing a physical object in a closed bag by asking descriptive questions.
- Proceed to visualize the therapy room before entering the room and plan physical goals in sequential steps in preparation for reality.
- Proceed to visualize a story with a beginning middle and end that could be in narration or physically using room, toys and equipment.
- Understand that the mind’s eye can be triggered by past experience, therefore important to scaffold with strong trusting relationship and ability to physically contain concrete structure.
- Use imagery to create a “calm” soothing story together that can be used in times of stress, also for bedtime routines.
- Give the neural circuitry a positive pathway that could be engaged in order to avoid the negative imagery from past experiences.
Therapy Ideas
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