Brain-Based Rehab

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Agenda

• The Prefrontal Cortex
• Affect Asymmetry
• Neuroplasticity and Neurogenesis
• The Memory Systems
• Anxiety and PTSD
• Hints for Forensic Neuroscience

The Past
Where is the anxiety? Here is the DMN

Brain-Based Therapy

The BASE of BBT
Psychotherapy and the Brain

Direct, observable links between successful CBT/IPT and brain changes

- Reduced amygdalar activity in treated phobics (Straube et al., 2006), panicikers (Prasko et al., 2004), and social phobics (Furmark et al., 2002)
- Reduced frontal activity in treated depressives (Goldapple et al., 2004)
- Increased ACC activation in PTSD clients (Felmingham et al., 2007)
- Increased hippocampal activity in depressives (Goldapple et al., 2004)
- Decreased caudate activity in OCD (Baxter et al., 1992)

Brain-Based Therapy

- BBT changes how we think about the relationship and change:
  - Need a “Safe emergency.”
  - Experience creates brain biology
  - Brain biology effects experience (e.g. depression)
Mind/Brain and communication

Brain-Based Therapy

• Discriminates between what is therapeutic and what’s not
• Includes techniques consistent with how the brain works
• Relies on the therapist’s alliance with the client
• Employs common denominator methods of psychodynamic therapy, CBT, IPT, mindfulness, etc.

Practical Neuroscience

• Prefrontal cortex systems
• Affect Asymmetry—set points
• The Amygdala—fast and slow tracks
• Default Mode Network
• Neuroplasticity
• Neurogenesis
• Social brain networks
• Nutritional Neuroscience
Pre-Frontal Lobes

- The “Executive” brain – Executive control center
- Motor pre-frontal lobes are last to myelinate – e.g., teenagers
  - Identity
  - Insight
  - Sense of Self
  - OFC part of the “limbic system”

Pre-Frontal Cortex

- Dorsolateral pre-frontal cortex (DLPFC)--- working memory: 7, plus or minus 2, .......... or 20-30 seconds of information
- Orbital frontal cortex (OFC)
  - Social brain
  - Affect regulator
  - Empathy
  - Attachment, warmth, and love
  - Connections with limbic area, i.e., amygdala
  - Phineas Gage
Phineas Gage

Deficits in OFC and DLPFC
• OFC deficits
  – emotionally disinhibited
  – insensitive to ambiguity
• DLPFC deficits
  – "pseudodepression"
  – aspontaneity and a lack of affect—rather then negative affect

PFC—ADD vs ADHD
• OFC impairment—ADHD
  – Difficulty with affect regulation
• DLPFC impairment—ADD
  – Difficulty maintaining attention
  – Working memory
Wisconsin Card Sorting Test (WCST)

Stroop Test

Task-Induced activity in the default mode network

Sheline Y I et al. (2009)
**DMN Variations**

- Increases when DLPFC is not engaged:
  - Stressed, bored, no novelty, or tired
- Malfunctions in the DMN:
  - Schizophrenia—defective mPFC—impaired self reflection—not sure where thoughts come from
  - Depression—obsessive ruminations over negative experiences
- Need meta-awareness for creativity (notice that they are doing it)

**Affect Asymmetry**

**LEFT FRONTAL LOBE**
- Positive emotions
- Approach behaviors
- Labeling thoughts and feelings and
- Developing new narratives (helps to alleviate anxiety and depression)

**RIGHT FRONTAL LOBE**
- Negative emotions
- Withdrawal behaviors
- Feeling overwhelmed

Alexithymic pts. have smaller right ACCs
larger right ACCs—more fearfulness and
**Left PFC:**

Suppressing Sadness

Activating Positive Emotions

**Left PFC:**

Activation & Approach Behaviors

(curiosity; assertion)

**Right PFC:**

Activating Behavioral Inhibition

Associated With negative Emotions
**Child Abuse and Neuropathology**

- Diminished left hemisphere and left hippocampal volume (Bremner et al., 1997)
- Accelerated loss of neurons (Simantov et al., 1996)
- Delays myelination (Dunlap et al., 1997)
- Abnormalities in developmentally appropriate pruning (Todd, 1992)
- Inhibition of neurogenesis (Coutel et al., 1997)
- Adults who were physically or sexually abused as children -- diminished left hippocampal development (Howe, Roth, & Cicchetti, 2006).

**100 Billion Neurons**

- **10,000 connections**

**Neuroplasticity**

- Neuroplasticity is a general term that describes changes in the brain as you experience and learn (Dusso & Merzenich, 1990)
- Neuroplasticity involves many changes to the brain including:
  - New synaptic connections
  - Strengthening of connections through LTP
  - The growth of new dendrites (dendritogenesis)
  - Neurogenesis (the growth of new neurons)
Yerkes Dodson arousal curve

DENDRITE SPINES & SYNAPSES

Spine Growth
one-half hour
Examples of Neuroplasticity

• London cabdrivers - larger right posterior hippocampus. The longer they were on the job, the larger the size of their hippocampus. (Maguire, et al, 2000)

• Adults who juggled three balls for 3 months increased grey matter in the midtemporal area and left posterior intraparietal sulcus. - 3 months of little or no juggling, -- grey matter decreased and approached baseline values. (Dragiški, et al, 2003)

• Musicians using specific fingers to play their instruments showed enlarged areas of their somatosensory strips associated with those fingers. (Pantev, et al, 2001)

• Blind Braille readers showed enlarged cortical areas associated with their reading finger compared to blind non-Braille readers and to sighted people. (Pascol-Leone & Torres, 1993)

Habits: Entrenched Neural Pathways
Increasing Neuroplasticity

- Tasks are of sufficient difficulty
  - Increased difficulty as you master each level
- Sufficient intensity
  - A few learning sessions each day
  - At least 3 learning sessions each week
  - Done for several weeks
- Like body building
  - Lift more than you can easily
  - 3 reps of 10
  - 3 xs per week
  - Several weeks

Examples of Neuroplasticity

Figure (11)

- a - Actual new synapse
- b - Simple new synapse
- c - New connections in neural network
BBT Strives to:

- Induce repeated states (weak attractors)
  - (i.e. positive moods)
- Repeat often enough so they become traits – (or strong attractors)

Brain Derived Neurotropic Factor

- BDNF plays a crucial role in reinforcing neuroplasticity and neurogenesis.
- BDNF is like Miracle Grow to help:
  - Consolidate the connections between neurons.
  - Turn on the nucleus basalis to focus attention, deciding what’s important for neuroplasticity
  - Promotes the growth of myelin to make your neurons fire more efficiently
  - Acts on stem cells in the hippocampus to grow into new neurons

Neurogenesis
BDNF: Impact on Dendrite growth: 24 hours

- Bad Diet
  - Simple carbs
  - Transfatty acids
  - Saturated fats
  - Food allergies
  - Bad oils
  - High dairy
  - High gluten
- No exercise
- Chronic illnesses
- Autoimmune disorders
- Chronic pain
- Chronic stress
- Being overweight
- Apple shape
- Leaky gut

Regulatory Networks of the Social Brain
Regulatory Networks of the Social Brain

• Bonding/Attachment
• Affiliation
• Fear Regulation
• Affect Regulation
• Safety

Systems of the Social Brain

• Brain Structures
  – Orbital Frontal Cortex (OFC)
  – Amygdala
  – Insula
  – Cingulate
  – Mirror Neurons
  – Spindle Cells
  – Facial expression modules

Systems of the Social Brain

• Neurotransmitter systems include:
  – Oxytocin
  – Dopamine
• Central Parasympathetic Nerve
  – “Smart” Vagus Nerve
On the market

The Vagus Nerve System

• Tenth Cranial Nerve -- a complex of sensory and motor nerve fibers.

Vagal tone - the ability to modulate target organs without sympathetic arousal

• allows attachment and sustained relationships.

Using the Alliance
Shift in Approach

**BBT:**

- Teaching people about their brains boosts confidence in therapy and externalizes the problem
- Encourages the alliance and discourages resistance
- “This is our common project”

Client --Take Home

**BBT:**

- “To rewire your brain, you will need to do some things you don’t feel like doing....”
- Moderate anxiety is a good thing....it helps neuroplasticity
- “Don’t worry, I’ll be there with you as your partner.”

The Inverted U

*Yerkes Dodson Curve -- relationship between pressure and performance*
Two LT Memory Systems

Implicit Non-declarative
- Procedural
- Emotional
- Generalized
- Classical conditioning

Amygdala and BG-driven

Explicit Declarative
- Episodic
- Autobiographical
- Semantic
- Context Specific

Hippocampus-driven

EXPLICIT DECLARATIVE KNOWLEDGE
IMPLICIT PROCEDURAL KNOWLEDGE
Procedural Memory

AMYGDALA

HIPPOCAMPUS
The Amygdala and Traumatic Memories

- Participants who were closer to the WTC showed decreased activation in the posterior parahippocampal cortex and increased activation in the amygdala bilaterally during retrieval of 9/11 memories relative to summer memories.

Threat Appraisal: Amygdala Level

- Goes from the Thalamus directly to the Amygdala
- Fight or Flight: HPA activation
- Emotional Learning
- Fear Conditioning
- PTSD, panic, etc.
- Flashbacks
- “Bottom up”
The Fast Track to Survival

- Rapid, crude, adaptive
- Cannot reality test
- Prone to false alarms

But!

Threat Appraisal
Cortical Level

- Goes from the Thalamus through the Cortex and Hippocampus to the Amygdala
- Worries and GAD
- Fears and Phobias
- Tames the Amygdala
- With exposure, New Thinking (cortex)
- “Top down”

The Slow Circuit to the Amygdala
The Snake Temple—Top Down Control?

The Dynamics of Fear

• Amygdala memories are hard to forget (“Stone tablet”)

• Hippocampal circuits tell us what to fear and in what context (“Etch-a-Sketch”)
The Amygdala and Traumatic Memories

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Amygdala-Hypothalamo-Pituitary-Adrenocortical (A-HPA) Axis: Cortisol Levels

Stress Response System

Locus Coeruleus (LC) source of NE which has extensive projections throughout the brain and can trigger the HPA axis (Aston-Jones, et al., 1994).

Neurodynamics of Anxiety

- Two routes to the amygdala, the fast and slow
- Right frontal bias in general for anxiety disorders
- Under-activation of the left frontal lobes and in Broca’s area explains why some people feel “speechless” when they’re scared (Rauch et al., 1997).
Beyond the alliance

PTSD Neurodynamics

- ↑ amygdala — ↑ false positives for threat
- ↓ mPFC -- especially the ACC (reduced neurointegration & cortical volumes -- inadequate top down inhibition of the amygdala
- ↓ hippocampus (cortisol, excitotoxity, blocking of neurogenesis)
- “vulnerability hypothesis” and the “cortisol-cascade hypothesis” co-occur. (Gilbertson, et al, 2002)

Hippocampal atrophy

temporal lobe  hippocampus  hippocampus shrinking
Possible Neurochemical Vulnerability of PTSD

- ↑ NE post trauma may predict PTSD (Yehuda, et al., 1998)
- ↑ cortisol in the evening
- ↑ cytokine post trauma
  - The secretion of IL-6 inflammatory cytokines can be triggered by B-adrenergic receptors with ↑ NE
  - Inflammation can occur post trauma via CRH/substance P/histamine axis with ↑ cortisol and IL-6 (Elenkov, et al., 2005)

Dual Processing Theory

- Limitations of the “fear network” – doesn’t account for implicit memory:
  - Verbally accessible memories (VAMs) on the conscious memory level. VAMs can be accessed in therapy through deliberate recall.
  - Situationally accessible memories (SAMs) unconscious. SAMs are only accessible through cues that activate the unconscious network (Brewin, Dalgleish, and Joseph, 1996)

Brain Healthy Factors

- Social
- Exercise
- Education
- Diet
- Sleep