Trauma and the Impact on Brain Development

Kristal N. Hankinson, LMFT
KY HANDS Moving Beyond Depression Coordinator
Overview

- Development of the Brain
- Attachment
- Trauma
- Treatment Options
- Applying knowledge to practical situations
# What Research Has Taught Us

<table>
<thead>
<tr>
<th>Past Thinking</th>
<th>Present/Future</th>
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</thead>
<tbody>
<tr>
<td>Brain development depends on genes.</td>
<td>Brain development hinges on complex interplay between genes &amp; experiences.</td>
</tr>
<tr>
<td>Experiences before age 3 have limited impact later in life.</td>
<td>Experiences before age 3 have decisive impact on adult capabilities.</td>
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<tr>
<td>Secure attachment creates favorable context for early development and learning.</td>
<td>Secure attachment directly effects the way the brain is wired not just an overall context.</td>
</tr>
<tr>
<td>Brain development is linear across all knowledge areas and skills.</td>
<td>Brain development is non-linear including prime times for different knowledge areas &amp; skills.</td>
</tr>
<tr>
<td>Toddler’s brain less active then adult’s, for example busy college student.</td>
<td>Toddler’s brain is twice as active as adult brain – activity drops during adolescence &amp; doesn’t recover.</td>
</tr>
<tr>
<td>Period of dividing zygote, implantation</td>
<td>Embryonic Period (in weeks)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Usually not susceptible to teratogens</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>Eye</td>
<td>Heart</td>
</tr>
<tr>
<td>Ear</td>
<td>Palate</td>
</tr>
</tbody>
</table>

Gray = highly sensitive
Pink = somewhat sensitive
Neocortex:
Rational or Thinking Brain

Limbic Brain:
Emotional or Feeling Brain

Reptilian Brain:
Instinctual or Dinosaur Brain
**Frontal lobe**
Executive functions, thinking, planning, organising and problem solving, emotions and behavioural control, personality

**Motor cortex**
Movement

**Sensory cortex**
Sensations

**Parietal lobe**
Perception, making sense of the world, arithmetic, spelling

**Temporal lobe**
Memory, understanding, language

**Occipital lobe**
Vision

**Medulla Oblangata**
Breathing, Heart, Respiration,
Neurodevelopmental Processes

- Synaptogenesis
- Myelination
- Synaptic Density and Pruning
- Neurotransmitters
Building Blocks of the Brain and Nervous System

• Each brain consists of 100 billion neurons, that on average, have 7,000–10,000 synaptic connections, creating 2 million miles of neural highways in our brains (Siegel, 1999).

• Gila (Greek for glue) are tiny cells outnumbering neurons at least 10–1, they wrap axons in myelin to provide stability and speed connections between neurons—act as a clean up crew and provide nutrition.

• It is now known that electricity can flow both ways, without neurotransmitters, and that glial cells are also implicated in the communication network by influencing the way neurons fire. (Fields, 2006).

• Not as neat, orderly and head-centered as we previously believed.

• This tango of rapidly firing, ever-changing electrical impulses produce the rich subjective experience of our lives.

Bonnie Badenoch, 2008
Newest Research

• Synapses are not the only means of communication in the brain.

• Glial cells
Glial Cells

• 1980–Einstein’s brain slides show same number of neurons as regular persons.

• But… he had an extraordinary number of glial cells, which were thought to only support (provide the glue) for neurons.

• Prompted research showing that all types of glial cells influence transmission of impulses across the synapse.
Glial Cells

**NEURAL THREESOME**

Several decades of study have focused on working out what is happening at the tripartite synapse.

1. Astrocytes, a type of glial cell, have extensions that wrap around the gaps, or synapses, between neurons.

2. One neuron signals to another by releasing neurotransmitters into the synapse.

3. These transmitters are also taken up by the astrocyte.

4. Once activated, astrocytes experience an increase in intracellular calcium and release transmitters of their own into the synapse. These can enhance or inhibit synaptic activity.

Astrocytes have thousands of connections with neuronal synapses, other astrocytes and blood vessels. Signals initiated at a single synapse may propagate elsewhere.
Synapses, Signals in a Storm

- Recent computer imaging technique using a model of the synapse.
- The Salk Institute has demonstrated the broad diffusion of neurotransmitters, contradicting the standard idea of the synapse and communicating between only two neurons.
- May alter our understanding of how information spreads through the brain.
Glial Cells

- Communicate slowly, relative to neuronal communication. Chemical vs. electro-chemical

- Communicate by broadcasting chemical signals widely. (See *Scientific Amer. 2011*, Article), so can cover wide areas of brain through chains of synapses.

- Where as, neurons are elegant cells, highly specialized, but most of the brain’s functions are carried out by glial cells.(formerly neglected).
Synapses

• The connections between neurons. (Protoplasmic kisses) As many as leaves on trees on the Earth.

• The main channels of information flow and storage in the brain.

• They make us who we are!

• There are about $100 \times 5,000,000,000$, in each of our brains. (each axon has about 100 dendrites)
Synaptogenesis

Sequential model

- Formation phase
- Elimination phase

Concurrent model

- Concurrent formation and elimination

New branch
Eliminated or transient branch
Stable branch
Synaptogenesis

• Formation of new synaptic connections, but also includes modification of previously established circuits.

• Research has shown that structure changes in response to the increased density of synapses that fire repeatedly (Lazar et al., 2005).
Myelination

• Sheath serves to speed the electrical impulses along the axonal fiber 100 X faster than without it.

• Certain experiences that occur during the brain’s vulnerable developmental stages can disrupt the ongoing myelination process and thereby worsen any underlying difficulties (hyperactivity, addictive tendencies, perhaps creating new challenges)

• Myelination is complete in certain brain areas within the first 3 years of life, other areas continue to wrap throughout life, peaking in our 40s and declining thereafter (Bartzokis, 2005; Paus et al., 1999)

Bonnie Badencoh, 2008
Myelination
“Use it or Lose it”

• The Brain is over wired and prepared for a lot of environmental contingencies!
• Concept of Pruning – new synapses form as the result of stimulation; however others weaken or remain the same. Weaker cells die off and are lost forever.
• At age 3, 1,000 trillion (Chang et al, 2004), another burst @ adolescents, which levels out at age 20, leaving us with 100–500 trillion synapses (Chang).
Sensory Stimulation

• Experiences of touch, sound, sight, taste, and smell all build synaptic connections.

• Some researchers believe that the number of words an infant hears each day is the single most important predictor of later intelligence, school success, and social competence.

• Touch is also key to brain development.
Attachment
Attachment and Intelligence

- Recent research reveals a direct link between attachment style and a child’s IQ.
- Children with a secure attachment exhibit significantly stronger verbal and perceptual-organizational abilities.
- These findings are consistent even after controlling for maternal education level.

(Busch & Lieberman, 2010)
Take Home Messages

• Human development hinges on an interplay between *nature and nurture*.
• Effects of *early care* and intervention.
• Human brain’s capacity to *change*, but timing is critical
• Negative experiences of abuse or *in_appropriate* stimulation are likely to have serious and sustained *effects*.
• Science shows us the wisdom and efficacy of *prevention and early intervention*. 
Adverse Childhood Experiences

The ACE Study
Adverse Childhood Experiences (ACE Study)

- Public/Private Partnership
- Started in 1985 – Ongoing
- 1995 CDC Partnership - Ongoing
- Largest of kind – 17,000

Changed Nation’s Views on Children’s Behavioral Health

Dr. Vincent J. Felitti, MD
Internist, Kaiser Permanente

Dr. Robert F. Anda MD (plus MS in Epidemiology)
Centers for Disease Control (CDC) & Prevention
Adverse Childhood Experiences (ACE) Study

- Kaiser study
- 18,000 middle class enrollees
- Categories of trauma experienced in childhood such as:
  - Physical abuse
  - Emotional abuse
  - Domestic violence
  - Substance abuse in home
  - Mental illness in parent
  - Lost parent due to separation or divorce
  - Household member in jail
Why is it important to know about this study?

- It is the largest study ever done to examine the health and social effects of these childhood experiences throughout the lifespan (17,421 participants).
- Because it provides compelling evidence that ACEs are surprisingly common, they happen even in “the best of families”, and they have long-term, damaging consequences.
• Nearly 18,000 involved
• Middle class, average age of 57
• 80% white, 10% black, 10% Asian
• 74% some college; 44% graduated college
• 49.5% men
“ACE Study”

Mechanisms by Which Adverse Childhood Experiences Influence Health and Well-being Throughout the Lifespan

http://www.cdc.gov/nccdphp/ace/
Adverse Childhood Experiences Scores

Number of individual adverse childhood experiences were summed......

<table>
<thead>
<tr>
<th>ACE score</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>36.4%</td>
</tr>
<tr>
<td>1</td>
<td>26.2%</td>
</tr>
<tr>
<td>2</td>
<td>15.8%</td>
</tr>
<tr>
<td>3</td>
<td>9.5%</td>
</tr>
<tr>
<td>4</td>
<td>6.0%</td>
</tr>
<tr>
<td>5</td>
<td>3.5%</td>
</tr>
<tr>
<td>6</td>
<td>1.6%</td>
</tr>
<tr>
<td>7 or more</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

64% reported experiencing one or more
37% reported experiencing two or more
Categories of Adverse Childhood Experiences

### Abuse

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological (by parents)</td>
<td>11%</td>
</tr>
<tr>
<td>Physical (by parents)</td>
<td>28%</td>
</tr>
<tr>
<td>Sexual (anyone)</td>
<td>22%</td>
</tr>
<tr>
<td>Emotional neglect</td>
<td>15%</td>
</tr>
<tr>
<td>Physical neglect</td>
<td>10%</td>
</tr>
</tbody>
</table>
## Categories of Adverse Childhood Experiences

### Household Dysfunction

<table>
<thead>
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<th>Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Substance Abuse</td>
<td>27%</td>
</tr>
<tr>
<td>Mental Illness</td>
<td>19%</td>
</tr>
<tr>
<td>Parental separation/divorce</td>
<td>23%</td>
</tr>
<tr>
<td>Mother Treated Violently</td>
<td>13%</td>
</tr>
<tr>
<td>Imprisoned Household member</td>
<td>5%</td>
</tr>
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</table>
Adverse Childhood Experiences Scores

<table>
<thead>
<tr>
<th>ACE Score</th>
<th>Women</th>
<th>Men</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>34.5%</td>
<td>38</td>
<td>36.1%</td>
</tr>
<tr>
<td>1</td>
<td>24.5%</td>
<td>27.9%</td>
<td>26.0%</td>
</tr>
<tr>
<td>2</td>
<td>15.5%</td>
<td>16.4</td>
<td>15.9%</td>
</tr>
<tr>
<td>3</td>
<td>10.3%</td>
<td>8.6%</td>
<td>9.5%</td>
</tr>
<tr>
<td>4 or more</td>
<td>15.2%</td>
<td>9.2%</td>
<td>12.5%</td>
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- Adverse Childhood Experiences are common
- Almost 2/3 at least one
- 64% participants had experienced one or more ACE’s
- More than 1 in 5 report 3 or more ACE’s
- 1 in 4 exposed to at least two categories of abuse
- 1 in 16 experienced 4 or more
Findings

- ACE’s are common
- Almost 2/3 at least one
- 64% participants had experienced one or more ACE’s
- More than 1 in 5 report 3 or more ACE’s
- 1 in 4 exposed to at least two categories of abuse
- 1 in 16 experienced 4 or more

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60% of American Children were exposed to violence, crime, or abuse in their homes, schools, and communities.

Almost 40% of American children were direct victims of TWO or more violent acts, and one in 10 were victims of violence five or more times.

Almost 1 in 10 American children saw one family member assault another family member, and more than 25% had been exposed to family violence during their lifetime.

Exposure to one type of violence increased the likelihood that a child would be exposed to other types of violence and exposed multiple times.

ACEs & High School 10th & 12th graders

Washington School Classroom (30 Students)
Adverse Childhood Experiences (ACEs)

- 6 students with no ACE
- 5 students with 1 ACE
- 6 students with 2 ACEs
- 3 students with 3 ACEs
- 7 students with 4 or 5 ACEs
- 3 students with 6 or more ACEs
ACEs – Significant Adversity Impairs Development in the First Three Years

Center on the Developing Child
HARVARD UNIVERSITY

Source: Barth et al. (2008)
ACEs – Adverse Childhood Experiences And Chronic Depression as an Adult
ACEs – Score and Intravenous Drug Use

N = 8,022  p<0.001
ACE - Risk Factors for Adult Heart Disease are Embedded in Adverse Childhood Experiences

Source: Dong et al, 2004
ACE Score and Indicators of Impaired Worker Performance

Prevalence of Impaired Performance (%)

ACE Score

0 1 2 3 4 or more

Absenteeism (>2 days/month)

Serious Financial Problems

Serious Job Problems
ACEs AND ADULT DISEASE:

54% of depression  
58% of suicide attempts  
39% of ever smoking  
26% of current smoking  
65% of alcoholism  
50% of drug abuse  
78% of IV drug abuse  
48% of promiscuity (>50 partners)  
are attributable to ACE’s.

Dr. V. Felitti. 2011
ADVERSE CHILDHOOD EXPERIENCES are the most basic and long lasting cause of:

- health risk behaviors,
- mental illness,
- social malfunction,
- disease, disability, death, and healthcare costs

Dr. V. Felitti. 2011
Life Course Trajectory: A Balance of Risk and Protective Factors

0–3 ACE’s
More likely:
- Good mental health
- Normal growth and development
- Less chronic disease
- Less tobacco use
- Less drug abuse
- School readiness & success
- Employment

4 ACE’s
High risk
- Tobacco use
- Drug abuse
- Obesity
- Promiscuity, teen pregnancy
- Pathologic Gambling
- Risk taking behaviors
- Lack of social networks
- High risk for school failure
- Gang membership
- Unemployment
- Incarceration
Adverse Childhood Experiences Rarely Occur in Isolation…

They come in groups.

Given an exposure in one category, there is an 80% likelihood of exposure to another.
YOUR WORDS HAVE POWER
USE THEM WISELY.
EARLY LIFE STRESSORS

- Can produce long-term changes in numerous key neuro-endocrine systems that modulate behavior
- In the first 2 weeks of life, separations from the mother produce elevations of cortisol that are proportional to the duration of the separation
- Mammal studies—permanent change may occur that increase the animal’s reactivity to future stressors
Cortisol – the “Stress Hormone”

- Cortisol is called the “stress hormone.”
- Cortisol is released when threat is imminent or perceived.
- Cortisol is “toxic” to the brain, interrupting development by preventing synaptogenesis and myelination.
- Cortisol kicks in the “fight/flight/freeze” stress response system.
- Cortisol stimulates the survival instinct.

Bruce Perry M.D., Ph.D.
HPA Axis Stress Response

Hypothalamus → Releasing factor → Anterior pituitary

ACTH (through blood) → Adrenal cortex → Cortisol
Cortisol and Brain Development

• Frequent and prolonged exposure to elevated cortisol may affect the development of brain areas involved in memory, negative emotions, and attention regulation.

• High cortisol levels in preschool children coincide with poor “effort control” and self-regulatory competencies.
Fight, Flight, Freeze

- Active “fight-or-flight” or hyper-arousal response
- Passive response, known as the surrender response, which involves varying degrees of dissociation — “disengaging from stimuli in the external world and attending to an ‘internal’ world” (Perry et al, 1995).
- Each of these are of adaptive benefit to the organism and promote human survival.
**Autonomic Nervous System**

- Comprised of Sympathetic and Parasympathetic

  - Sympathetic acts as the “accelerator of a car” (fight or flight)
  
  - Parasympathetic “acts like brakes” (withdrawn) (often expressed as “shame”)

- Balance = window of tolerance
Freezing

• Assault Survivors
• Trauma Survivors
• When both the sympathetic and parasympathetic systems are overly activated, “jamming the accelerator and the brakes to the floor at the same time” we “freeze”.
• Now able to utilize this information in judicial hearings and court proceedings.

Bonnie Badenoch, 2008
Effects of Media Violence

- Causes an increase in aggressive behavior.
- Causes an increased levels of fearfulness, mistrust, and self-protective behavior.
- Contributes to the desensitization and callousness to the effects of violence and the suffering of others.
- Provides violent heroes children try to emulate.
- Provides justification for resorting to violence when children think they are right.
- Creates an increasing appetite for viewing more violence and more extreme violence.
- Fosters a culture in which disrespectful behavior becomes a legitimate way for people to treat each other.
Exposure to violence increases cortisol production and secondarily decreases the number of synapses between the cortex and the limbic system.

Bessel Vanderkolk, M.D.
http://developingchild.harvard.edu/resources/multimedia/videos/three_concept/toxic_stress/
Three Levels of Stress

Positive
Brief increases in heart rate,
mild elevations in stress hormone levels.

Tolerable
Serious, temporary stress responses,
buffered by supportive relationships.

Toxic
Prolonged activation of stress response systems
in the absence of protective relationships.
Toxic stress during pregnancy may change the temperament of your child. Infants become more irritable, less consolable, when mom is continually stressed.
Physical effects of trauma on children

- Headaches
- Stomachaches
- Tightening of chest
- Shortness of breath
- Amygdala alarm
- Fatigue
- Excess energy
- Loss of appetite
- Excessive hunger
- Bedwetting
- Increased sensitivity to touch
- Decreased reactivity to physical injury
- Unconscious flinch reaction

Paris Goodyear-Brown, LCSW, RPT-S
Behavioral effects of trauma

- Nightmares
- Flashbacks
- Recurrent images
- Sleep disturbances
- Tantrums/aggression
- Hypervigilance
- Heightened startle response
- Hyperactivity
- Withdrawal/isolation
- Clinging to parents
- Avoidance
- Repetitive play
- Panic attacks
- “Zoning”
- Regression
- Risk-taking behavior

Paris Goodyear-Brown, LCSW, RPT-S
Cognitive effects of Trauma

- Inattention
- Lack of concentration
- Excessive worries or fears
- Repetitive thoughts
- Dwelling on trauma
- Skewed memory
- Dissociation
- Preoccupation with destiny and afterlife
- Increase in irrational beliefs
- Blaming
- Changes in values and beliefs
- Escape through fantasy

Paris Goodyear-Brown, LCSW, RPT-S
Experience Matters

- Babies can suffer
  - Traumatic Stress Responses and Depression have been identified in babies as young as 4–6 months
- Disruptions to Relationships Matter
  - Young children grieve when their attachment relationships are disrupted—regardless of whether we as adults would consider it a positive, less than adequate, or even abusive relationship
Healthy Brain
This PET scan of the brain of a normal child shows regions of high (red) and low (blue and black) activity. At birth, only primitive structures such as the brain stem (center) are fully functional; in regions like the temporal lobes (top), early childhood experiences wire the circuits.

An Abused Brain
This PET scan of the brain of a Romanian orphan, who was institutionalized shortly after birth, shows the effect of extreme deprivation in infancy. The temporal lobes (top), which regulate emotions and receive input from the senses, are nearly quiescent. Such children suffer emotional and cognitive problems.
**Traumatic Experience**

- Floods us w/ physical fear/helplessness
- Colors the world as dangerous/unpredictable
- Creates overwhelming emotional chaos
- Threatens cohesive sense of self
- Assaults self-efficacy and sense of control
- Scrambles ability to engage fully in present/adapt to new situations

**Secure Attachment**

- Soothes and comforts
- Offers safe haven
- Promotes affect regulation
- Promotes personality integration
- Promotes confidence/trust in self and others
- Promotes openness to experience, and new learning

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**Importance of Attachment**
Regulation of Affect

- Affect regulation develops in the right hemisphere of the brain and is assisted by relational co-regulation.
- The sensitive period for affect regulation in the first three years of life.
- Affect regulation is a core skill for social and emotional well-being and is a fundamental building block for learning.
How Does Shaking Injure a Baby?

- Bridging veins stretch, rupture, and bleed, leading to subdural bleeding.

- Brain tissue is distorted/stretched during the event, causing damage to nerve cells and brain tissue (either temporary or permanent damage).
<table>
<thead>
<tr>
<th>Substance</th>
<th>What can occur to Brain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>#1 Cause of MR, abnormal brain formation, thus affecting all brain functioning</td>
</tr>
<tr>
<td>Tobacco</td>
<td>SIDS</td>
</tr>
<tr>
<td>Cannabis</td>
<td>altered responses to visual stimuli, increased tremulousness = neurological development, more likely to show gaps in problem solving skills, memory, and the ability to remain attentive</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>Breathing problems, poor suck reflex, poor body temperature control, poor muscle tone</td>
</tr>
<tr>
<td>Opioids</td>
<td>Neonatal Abstinence Syndrome</td>
</tr>
<tr>
<td>Methamphetamine</td>
<td>Possible developmental disorders, blood flow to placenta is constricted and lessens oxygen flow to fetus, potential for birth defects due to toxic substances used</td>
</tr>
</tbody>
</table>
Treatment Options

- Available at local Community Mental Health Centers
- Private Practice Offices
- Early Childhood Mental Health Specialists
Parent–Child Interaction Therapy

• Developed by Dr. Sheila Eyeberg
• P.R.I.D.E. Skills
  • P. Labeled Praises
  • R. Reflections
  • I. Imitation
  • D. Behavioral Descriptions
  • E. Enthusiasm
Basic Behavior Modification

- Positive Reinforcement
  - Rewarding appropriate Bx will increase that Bx
    - Attention, praise, privileges, tangible items
- Shaping and Chaining
  - Rewarding successive approximations
- Negative Reinforcement
  - Removal of negative stimuli will increase Bx
1–2–3 Magic

- Developed by Dr. Thomas W. Phelan
- Behavior modification for “Stop” Behavior
- Avoid two common traps of parenthood:
  - Too much talking (little adult assumption)
  - Too much emotion
- Time out on the third count
- Verbal and visual cues when counting
- No lectures after time out is complete
- Be consistent!
Cognitive Behavioral Therapy

• Separation of emotions from cognitions

• Coping Skills developed to assist in Socratic Questioning of Thoughts and Behaviors

• Replace cognitions that are harmful with positive thoughts

• Decrease unwanted behaviors by increasing desirable behaviors

• Designed for 16 years of age and older
Interpersonal Neurobiology

- Every act of recall is also potentially an act of modification

- The feeling of comfort a therapist creates will initiate new neural firings that will now become associated with, and ameliorate, the suffering contained in the neural nets of frightening and repeated childhood traumas/events

- Based on “Mindfulness” (1–Mediation, 2–Mindful awareness in relation to self & others, 3–Mindful care of an empathic other

- Changes the way we process information in our six-layered neo-cortex

Bonnie Badenoch, 2008
Benefits of Brain–Wise Therapy

• Decrease shame and increase self-compassion, deepening and speeding up of therapeutic process

• Wisdom by embracing the intergenerational tragedy (same forces that shaped parents/grandparents)

• Decrease the dysregulating intensity of memories (abusers are merely neural net patterns in searching of healing empathy)

• Daniel Siegel’s (2007) FACES (flexible, adaptable, coherent, energized, and stable) increase

Bonnie Badenoch, 2008
Techniques Utilized in Brain-wise Therapy

- Sandplay (awaken and regulate right-brain limbic processes), extremely beneficial to trauma survivors

- Art therapy (drawing with nondominant hand—takes pressure of aesthetically pleasing). Left hand will most often connect to right hemisphere (hurt and fear stored)

Bonnie Badenoch, 2008
“To whom much is given, much is required”~
John F. Kennedy
Resources and Acknowledgments

- Adapted from Dr. H. Otto Kaak and Kristal Hankinson, LMFT presentation
- Adapted from Dr. Ruth Ann Shepherd Toxic Stress presentation
- Trauma Informed Care TOT from DBHDID
- Center for the Developing Child
- ACE Study – Kaiser Permanente
- KY Strengthening Families
Kristal N. Hankinson, LMFT
HANDS Moving Beyond Depression Program Coordinator
Kristal.Hankinson@ky.gov
502-564-3756, ex 4358