

**Stress, Neurodevelopment, and Programs that Promote the Well-Being of Children  
and Families: Early Childhood**

**March 13-14, 2012**

**Washington, DC**

**Meeting Summary**

## **Attendee List**

George Askew, Office of the Dep. Asst. Secretary for Early Childhood Development / ACF  
Lisa Badanes, Metropolitan State College of Denver<sup>1</sup>  
Katie Beckmann, Office of the Dep. Asst. Secretary for Early Childhood Development / ACF  
Marco Beltran, Office of Head Start / ACF  
Anne Bergan, Office of Planning, Research and Evaluation / ACF  
Lisa Berlin, University of Maryland  
Caryn Blitz, Office of the Commissioner, Admin. on Children, Youth and Families / ACF  
Jennifer Boss, Zero to Three  
Cheryl Boyce, National Institute on Drug Abuse / NIH  
Misty Boyd, Cherokee Nation Behavioral Services  
Melissa Brodowski, Children's Bureau / ACF  
Laurie Brotman, NYU Child Study Center  
Jacqueline Bruce, Oregon Social Learning Center  
Cecilia Casanueva, RTI International  
John Constantino, Washington University School of Medicine  
Wendy DeCoursey, Office of Planning, Research and Evaluation / ACF  
Janet DiPietro, Johns Hopkins University  
Mary Dozier, University of Delaware  
Stacy Drury, Tulane University  
Kathleen Dwyer, Office of Planning, Research and Evaluation / ACF  
Kelly Fisher, Office of Planning, Research and Evaluation / ACF  
Nathan Fox, University of Maryland  
Mark Greenberg, Pennsylvania State University  
Elena Grigorenko, Yale University  
Megan Gunnar, Institute of Child Development, University of Minnesota  
Brenda Jones Harden, University of Maryland  
Lauren Hashiguchi, Office of Planning, Research and Evaluation / ACF  
Laura Hoard, Office of Planning, Research and Evaluation / ACF  
Jason Hustedt, University of Delaware  
Sarah Hutcheon, Society for Research in Child Development  
Susan Jekielek, Office of Planning, Research and Evaluation / ACF  
Charisse Johnson, Children's Bureau / ACF  
Sara Johnson, Johns Hopkins Schools of Medicine & Public Health  
Lauren Kass, Children's Bureau / ACF  
Ginger Knox, MDRC  
Valerie Maholmes, National Institute of Child Health and Human Development / NIH  
Nancy Margie, Office of Planning, Research and Evaluation / ACF  
Ivelisse Martinez-Beck, Office of Planning, Research and Evaluation / ACF  
Aleta Meyer, Office of Planning, Research and Evaluation / ACF  
David Murphey, Child Trends  
Charles Nelson, Harvard Medical School  
Kieran O'Donnell, McGill University  
Joyce Pfenning, Children's Bureau / ACF

---

<sup>1</sup> Primary note taker and preparer of meeting summary

Ned Presnall, Washington University, St. Louis  
Brian Richmond, Office of Child Care / ACF  
Ann Rivera, Office of Planning, Research and Evaluation / ACF  
Michelle Sarche, University of Colorado  
Mariela Shirley, National Institute of Alcohol Abuse and Alcoholism / NIH  
Elaine Stedt, Children's Bureau / ACF  
Lauren Supplee, Office of Planning, Research and Evaluation / ACF  
Carolyn Swaney, ICF International<sup>2</sup>  
Louisa Tarullo, Mathematica Policy Research  
Jennifer Vu, University of Delaware  
Sarah Watamura, University of Denver  
Mary Bruce Webb, Office of Planning, Research and Evaluation / ACF  
T'Pring Westbrook, Office of Planning, Research and Evaluation / ACF  
Rebecca Wong, ICF International<sup>3</sup>  
Maria Woolverton, Office of Planning, Research and Evaluation / ACF  
Keri Young, Youth in Need  
Marty Zaslow, Society for Research in Child Development  
Charles Zeanah, Tulane University

---

<sup>2</sup> Logistical coordinator

<sup>3</sup> Secondary note taker

### ***Meeting Background and Goals***

Chronic and severe activation of the body's physiologic stress response systems without the support of a primary caregiver, also known as "toxic stress" (Shonkoff, 20120), is a significant contributing factor to the development of negative outcomes in both physical and psychological health. Although much of this research has been documented in animal models, research with humans has also demonstrated these associations. Of particular interest to researchers, policy makers and practitioners are the findings that point to the critical importance of early caregiving. Specifically, this work suggests that the effects of early adverse life experiences on development may be particularly harmful if these experiences occur repeatedly in the absence of the buffering support of a sensitive and consistent caregiver. Although significant gains have been made in understanding the biological mechanisms underlying the links between early experiences and later development, more research is needed to increase our understanding of exactly how stress leads to psychological and physical health problems so that we might provide better support to children who are experiencing early toxic stress.

The overall goal of this roundtable meeting was for participants to explore the added value of biological constructs in our efforts to better understand both the theories and intervention strategies behind early toxic stress and development. Specifically, this meeting sought to address three key questions: 1.) What do we already know about toxic stress from the relevant research in the field? 2.) Can we identify the specific gaps in our knowledge that would be vitally useful for promoting healthy development in child care, Head Start, home visiting, and child welfare populations? 3.) Which of these findings and recommendations for future directions are ready for dissemination for programs and policy makers?

## **I. Welcome and Introductions**

Kathleen Dwyer began the meeting by summarizing both the background and purpose of the meeting. She also acknowledged key personnel who helped in its organization and explained the meeting agenda. Participants at the meeting (about 50% of whom were federal staff, with the remaining consisting of a mix of professionals with expertise in stress, neurodevelopment, and intervention) introduced themselves. Finally, Mary Bruce Webb gave a brief introduction about the Administration for Children and Families (ACF), including their mission and services that they provide.

## **II. The Effects of Early Adverse Experiences on Development**

*Moderator: Sarah Watamura, University of Denver*

The purpose of this session was to examine the state of the research regarding the effects of early adverse experiences on development. The following questions guided the session:

a) To what extent does stress reactivity mediate the link between risk factors and developmental outcomes? b) How do factors that increase vulnerability (or promote resilience) to the effects of chronic or overwhelming adversity interact with one another to affect stress reactivity and, ultimately, child development? c) To what degree have these questions been explored in animal models, clinical human populations, “at-risk” populations, and normative populations?

*Neural Development and Brain Plasticity: A Précis to Understanding the Effects of Early Adversity – Charles Nelson*

This presentation focused on how the brain benefits from early experiences in life and on the concept of plasticity. That is, while genes are important for providing the blueprint for development, it is experience that shapes the actual architecture. Even as early as prenatally we can see the role that both genetics and experience play as evidenced in the vast differences we see between a 25 week old brain and a 27 week old brain. Through the different stages of brain development (such as neural tube formation, neurogenesis, and differentiation), the foundation of the brain, along with its circuitry, are

formed and are uniquely ready for the experiences it will receive postnatally. The circuitry of the brain relies on these experiences to customize the connections to serve the needs of the individual (but always within the constraints imposed by genetics). This openness to experiences is also known as plasticity. Importantly, different areas of the nervous system mature at different rates (e.g. low level processing areas mature earlier than those that support higher level processing), so the impact that experience has on the brain is not constant throughout development. In addition, there may be periods in development when neural connections are particularly sensitive to inputs from the environment. Examples of these critical or sensitive periods include speech and language development as well as face processing (Pascalis et al., 2002) during the first year of life.

#### Conclusions and Clarification Points:

- Must consider several factors when modeling developmental plasticity including timing, dose, duration and type of experiences
- Different experiences will affect different systems differently at different times in development.
  - The locus of a particular intervention therefore should focus on the timing of the particular exposure
- Early development is analogous to building the foundations of a house by providing support for all subsequent development. If the initial building blocks are even slightly misaligned, subsequent blocks may also be misaligned.
  - It is best to intervene before the blocks become misaligned, but this does not mean that later interventions are not possible. Instead, it may be harder to implement change or take more effort to bring the child back to even keel (and even then it might not be possible to fully remediate all of the effects).

#### *Does Maternal Psychological Stress Harm the Developing Fetus – Janet DiPietro*

This presentation focused on understanding the interface between the mother and her developing fetus. It is often assumed that when something goes wrong with a child's development that it can be traced back all the way to prenatal development. In fact, Dr. DiPietro argues it is very hard to make this developmental link.

The effects of maternal stress on the developing fetus, in particular, are difficult to understand. All of the connections between maternal stress and prenatal development occur in the placenta, and the placenta has multiple functions that we know relatively little about. We do know that the placenta directs production of cortisol during pregnancy, and that pregnancy is a state of natural hypercortisolism (cortisol naturally increases across gestation). Over time pregnant women become less responsive to stress. In addition, the placenta takes on a more pronounced role in terms of cortisol production as the pregnancy progresses, thereby reducing the influence of maternal psychological factors on cortisol production. Importantly, the language used to discuss the effects of cortisol during pregnancy is often incorrectly interchanged with words like stress, anxiety and depression. In fact, maternal cortisol output is often unrelated to how anxious, depressed or stressed pregnant women report feeling.

In addition, most studies on maternal stress and child outcomes are based on self-report measures where we ask women how stressed or anxious they are and then ask them how their child behaves. This presents an inherent confound as women who are stressed or depressed tend to perceive their children more negatively regardless of their actual behaviors. Also, because studies on prenatal stress cannot randomly assign to condition, they are observational in nature. Because women who are prenatally stressed are often postnatally stressed, it is difficult to distinguish prenatal from postnatal effects. Animal models, while helpful, do not perfectly mimic the types of stressors that humans typically experience or the cognitive interpretations that co-occur. In her ongoing work since 1991, Dr. DiPietro and her colleagues have sought to document ontogeny in the human fetus, as well as to evaluate antenatal stability, predict child outcomes from fetal measurements, and to examine the maternal factors that influence the fetus as well as the fetal factors that influence the mother. They have reported that the more anxious a mother was prenatally, the higher their child's mental and psychomotor development index was at age 2 (DiPietro et al., 2006). In addition, women with higher stress during pregnancy had newborns with more mature neural impulse transmission (DiPietro et al., 2010). Other work highlights the prenatal synchrony of the fetus and their mother. Using a variety of physiologic measurement techniques (e.g. heart rate, uterine blood flow, salivary cortisol), they found

that when pregnant women are challenged during a laboratory task, the fetus is likely to show reduced motor activity (DiPietro et al., 2003). Similarly, when pregnant mothers are relaxed, the fetus slows its movement and shows a reduced heart rate response (DiPietro et al., 2008). We also see fetal factors influencing the mother. For example, if you blindfold the mother and put on headphones so that she is unaware of any stimulations of the fetus, the mother's heart rate and skin conductance will slow down when their fetus is stimulated by a loud sound even though they are unaware that this stimulation even occurred.

#### Conclusions and Clarification Points:

- It is important to separate perceived psychological stress from physiologic stress in our research; they should not be used interchangeably.
- Stress should be conceptualized using the U shaped model of stress (Yerkes-Dodson, 1908). Too much stress can be over-arousing, and too little stress can be under-arousing. Instead, maximum performance (or healthier outcomes) would be expected at moderate levels. This model should be applied when we are examining the effects of stress during pregnancy.
- Importantly, most of the research to date on prenatal stress and developmental outcomes has been with relatively low-risk, middle-class women. These women are more likely to be within the optimal level of stress in U shaped model. We know less about women who are above the threshold in the stress model and much more work is needed with this population.
- Prenatal psychological distress predicts postnatal psychological distress so the prenatal period presents a key opportunity for mental health intervention, particularly since women have so many contacts with health professionals during routine prenatal care.
- There is a synchronous relationship between the mother and her fetus during pregnancy, with bidirectional influences, similar to the interaction that takes place between mothers and children after birth.



*The Effects of Early Adverse Experiences on Development: Lessons Learned from the Bucharest Early Intervention Study – Nathan Fox*

The purpose of this presentation was to present recent data suggesting a relationship between early severe psychosocial deprivation and negative cognitive developmental outcomes. The sample of interest was the subset of children from Romania who were institutionalized during Ceausescu's regime and subsequently raised in government sponsored orphanages. Within these institutions, care was routinized with a regimented daily schedule and no individualized care was provided. In addition, these children had low levels of social interaction with caregivers, and little opportunity to bond with a specific individual as there was high caregiver turnover and high caregiver to child ratios.

Data were presented on the Bucharest Early Intervention Project, which is a randomized intervention trial with three assigned groups: 1.) Children who were taken out of the institution and placed with foster care families who had received training to become attachment figures for these children; 2.) Children who remained in the orphanage and received care-as-usual and; 3.) A community control group of children living in their birth homes in Romania. Children in the study were assessed at baseline, and then again at 30, 42, and 54 months, and at 8 years of age. At baseline, the institutionalized children (Groups 1 & 2) demonstrated significantly lower IQ scores than the never institutionalized children (Group 3). However, at 30, 42 and 54 months of age, the children who were in the foster care intervention group (Group 1) demonstrated significant advantages in IQ scores compared to the care-as-usual group (Group 2) (Nelson et al., 2008). At age 8, if the child remained in the foster care intervention group the entire length of the study (Group 1), IQ scores were significantly better than the care-as-usual group (Group 2) or children that were originally in Group 1 but left, demonstrating the persistence of the effect of the intervention (Fox et al, 2011). In addition to changes in IQ scores, the data also show improvements in brain development for the intervention group (Group 1). At baseline, the community controls showed better EEG brain activity than the institutionalized children (Marshall et al., 2004). At age 8, there were significant effects of the intervention. Brain activity in the foster care group care children (Group 1) was indistinguishable from brain

activity in the community control group (Group 3) (Vanderwert et al., 2010). This was especially true for children in the foster care group who left the institution before the age of 24 months (Group 1). For children in Group 1 who left after 2 years of age or children in Group 2 (those randomized to remain in the institution, brain activity was similar and depressed. Conclusions and Clarification Points:

- Early severe neglect has a profound effect on brain development and cognition.
- Placement in foster care before 24 months of age leads to better outcomes.
- Institutional care should be considered a last resort if children are young when they are placed there and efforts should be made to move them to permanent families as early in life as possible.

*Severe Deprivation: Effects on Attachment and Socioemotional Development – Charles Zeanah*

The purpose of this presentation was to present recent data from the Bucharest Early Intervention Project (see study description above) suggesting a relationship between early severe psychosocial deprivation and negative socioemotional developmental outcomes.

At baseline using the Strange Situation procedure, the institutionalized children (Groups 1 & 2) were less likely to be classified as securely attached than the community control group (Group 3), and more likely to be classified as either disorganized or unclassifiable. In addition, the vast majority of the institutionalized children did not have fully developed attachments, suggesting that secure attachment means something different for institutionalized children. At 42 months of age, 50% of the foster care intervention children (Group 1) had developed a secure attachment as compared to less than 20% of the care-as-usual institutionalized children (Group 2). However, if these children were placed in the foster care group after 22 to 24 months of age (late entry to Group 1), they were less likely to form secure attachments. Foster children who were securely attached at 54 months were less likely to demonstrate internalizing disorders. In addition, the caregivers of the foster children were less likely to rate these children as having either a reactive or indiscriminate attachment style. There were no timing effects for these changes in

caregiver attachment style ratings. The foster children (Group 1) were also less likely to leave indiscriminately with a stranger who came to their front door at 54 months and age 8 as compared to the care-as-usual (Group 2)- children.

Data were also presented on the impact that early neglect has on the expression of positive affect. At baseline, using the Lab-TAB puppet and peekaboo procedure, community children expressed much more positive affect and attention to the task than did the institutionalized children. At 30 and 42 months, the children in the foster care group were more likely to show positive affect in response to these tasks compared to the care-as-usual group. Other data suggest that the intervention also had positive effects on the children's social behaviors, with foster children showing decreases in inappropriate, awkward and negative behaviors with peers and exhibiting higher parent-reported social skills at age 8 compared to the care-as-usual children.

#### Conclusions and Clarification Points:

- Socio-emotional development is powerfully and adversely affected by institutionalized care.
- Children who grow up in an institution may not necessarily view it as stressful per se; rather, the experience may be a violation of what is evolutionarily expected for normal development. Without an adequate caregiver, normal development may not occur.
- However, recovery is possible if intervention is provided.

### **III. Workgroup Discussion- 1**

Participants were divided into six workgroups and asked to discuss two questions each. All groups addressed the question, what is the take-way message from this session? The second question varied across groups: Two groups addressed priorities for research activities; two groups addressed messages that should be prioritized for practitioners; and two groups addressed messages that should be prioritized for policymakers. After the small-group discussions and interactions among the groups, participants then reconvened

for a large-group discussion related to these issues. Following is a summary of the themes that emerged:

### Take Home Messages:

#### **Stress**

- Messages about stress need to be contextualized within the U shaped model (not all stress is necessarily bad for development).
- In order to understand the potential impact that the stressor will have on development, we need to understand the type of stressor and the outcome measures we are interested in.
- The child is part of a whole unit, and our interventions need to include all of these component parts, as stress affects multiple systems.
- The caregiver plays a vitally important role in the impact that stress has on children, and children do best in a parent/ child environment because that is what they expect biologically and psychologically.

#### **Plasticity**

- Early experiences of stress can be toxic to development, and it is important to recognize both the developmental timing of the adversity and who the population is that is affected.
- We also need to recognize the type of stressors involved.
- However, plasticity is reason for hope, particularly if the intervention occurs before 2 years of age.

### What information is ready for dissemination?

#### **Stress**

- Biological markers can provide compelling evidence for policy makers.

## **Plasticity**

- Developmental timing is a critical component for us to address in our models, and we need to capitalize on natural plasticity and sensitive periods in our interventions.
- The impact of early experiences on the brain need to be emphasized because this is a very powerful message for policy makers and practitioners.
- There is not a one size fits all model for intervention and interventions should be individualized.
- Interventions that happen earlier may bring about better outcomes, and might be more cost-effective than later interventions where we will need to try harder to get similar outcomes.

## What research activities should we prioritize?

### **Stress**

- Understanding how we can incorporate physiologic indexes in high risk populations, as more research is needed to understand the effects of stress in disadvantaged families (not just middle class families).
- More complex understandings of stress exposure with varying measurements.
- Demonstration projects (using ACF programs and biomarkers to demonstrate the effectiveness of an intervention).

### **Plasticity**

- Prenatal interventions.
- An understanding of both pathways to repair and compensatory pathways.
- Individual differences in developmental trajectories.

#### **IV. Approaches to Studying Stress Neurobiology and Development**

*Moderator: Stacy Drury, Tulane University*

The purpose of this session was to provide an overview of several approaches of interest to studying stress neurobiology and development. Overviews of the approaches would highlight the methodology, utility, limitations, and the range of interpretations.

*Why and How to Measure the HPA axis system – Megan Gunnar*

Early adverse experiences have been shown to increase the risk of poor developmental outcomes. Biologically plausible models for how these adverse experiences affect development are needed, and the HPA-axis (partially indexed by cortisol) may be one such mechanism for understanding how stress gets “under the skin.” Steroid hormones are useful because they are lipid soluble and as such have widespread effects on the body. They enter all cells, and readily pass the blood-brain barrier. Once they enter the cell, they bind to specific receptors in the cell where they interact with DNA to regulate gene expression and act as gene transcription factors. Therefore, through their powerful effects on the body, steroid hormones are able to shape the physical development of the brain and body.

The activity of the hypothalamic pituitary adrenal (HPA) axis (which produces cortisol) plays a role in the development of behavioral and emotional problems, and also impacts physical and mental health. It does not, however, provide an index for how stressed a person is. In fact, this system is extraordinarily complex, with many different regulatory inputs involved (e.g. the immune system, osmotic challenges). It is therefore very difficult to measure direct psychological effects on the HPA axis as we need to be sure that we are controlling all of these other inputs. Stress is a multifaceted phenomenon, with duration, type, context, age, gender and genes all influencing how the organism adapts to a challenging event.

What aspects of the stress system should we measure? Ideally, we would like to measure the acute stress response, where we are able to see individual differences. Chronic occupation of glucocorticoid receptors produces most of the catabolic and potentially destructive effects of cortisol, and is therefore a vitally important aspect of the

stress system. In order for us to measure this response (which peaks at about 20 minutes post-challenge), we first must have a true resting state. These baseline measurements are particularly hard to obtain in high risk populations. With children, we also have the unique task of designing a potent enough stressor that will produce a physiologic response but that is still ethical and practical. However, not all children will respond the same way to a challenge. For example, preschoolers who completed a laboratory temperament assessment were not likely to show a stress response unless they were high in behavioral inhibition and were accompanied by a parent who was low in emotional supportiveness (Kertes et al., 2009). Finding reliable stress reactivity paradigms in young children is a challenge that must be addressed. One method that has been successful is naturalistic separation paradigms, like that which occurs for children who are attending childcare. For example, Ahnert and colleagues (2004) studied toddlers entering their firsts child care experience and found elevations in cortisol that were still apparent on the 9<sup>th</sup> day of child care. Notably, these elevations were unrelated to whether the child was securely attached to their parent; however, during a period of adaption to childcare when they were accompanied by the parent, insecurely attached toddler were already exhibiting elevated cortisol levels, while this was not the case for securely attached toddlers. Thus, natural conditions, such as starting child care, may be useful contexts in which to study stress reactivity and regulation in young children. The second way that we can measure physiologic stress is by assessing basal activity. This is particularly useful for when we want to measure stress during an individual's daily life. This diurnal cortisol rhythm is critical to healthy functioning. A basal pattern includes a cortisol awakening response (CAR) in the morning, and then a decline in production across the day. Measurement of CAR and basal rhythms are difficult as we need to use actigraphy to monitor sleep and wake activity, collect compliance verification, and because they require multiple assessments and multi-level modeling. Infants and toddlers tend to show flatter patterning across the mid-section of the day than adults (Watamura et al., 2004), and these patterns are influenced by age and context (Dettling et al., 2009; Watamura et al., 2003), as well as napping behaviors (Watamura et al., 2002).

A new and intriguing measurement of physiologic stress may be through hair cortisol. This technique should provide a cumulative measure of cortisol production and may give us insight into chronic stress over time. For example, in a population of non-human primates, researchers showed differences in hair cortisol levels in primates who were being maltreated at 6-months of age, but not at birth (before the maltreatment had begun) or at 18-months (when the maltreated monkeys no longer needed their mothers) (Sanchez et al., unpublished data). However, it is still unclear how this measurement might work in children and in diverse ethnic populations, and therefore it would be best to also provide concurrent salivary assessments as a backup.

#### Conclusions and Clarification Points:

- Cortisol has good potential for contributing to our understanding of how early adversity gets under the skin as long as it is measured and interpreted properly.
- Respect the assumptions of the biological model that is being used
- Different types of cortisol measures reveal different things about human functioning.
- The word dysregulation should be used with caution, as a proper understanding of whether or not the system is truly altered or simply different between groups is necessary.

#### *Studying Stress, Neurobiology and Development; Genetics and Epigenetics – Stacy Drury*

The goal of this presentation was to provide a careful and thoughtful analysis about genetics, with a particular emphasis on what it can and cannot offer. In particular, that genetic assessment has something valuable to offer, as long as you measure and interpret the findings accurately.

When we are thinking about genetics, we also have to think about the environment. Genes may act as scaffolding for subsequent development, but this scaffolding is quite rubbery and changeable depending on our experiences. Genes interact uniquely with the environment, so it is very important that we specifically define what we mean when we are designing our studies. Are we talking about a single gene or single nucleotide



polymorphisms? Are we measuring how multiple genes interact cumulatively over time or are we studying genome-wide associations? The environment can be very tricky to define. A life event needs to be specified. When did it start? How long did it last? What was its severity? And there may be cumulative exposure whereby multiple measures of the environment are necessary. It is not until you understand all this that you can actually think about treatment.

One must also consider developmental issues that are involved in genetic research as we are likely to see changes in gene expression over the course of maturation. Different parts of the brain will be differentially impacted at different developmental time points, with varying influence of the environment over time. Genes are differentially expressed in different cells and tissue types at different points in time; therefore the effect of a gene is literally dependent on its immediate environment. Some of the genes linked to early adversity include 5HTT, CRHR1, GR, BDNF, MAOA, GABA, AVP, Oxytocin, DAT, DRD2, DRD4 and COMT. But there are complicated models of both the direction and strength of the influences of genes and the environment. For example, there are certain individuals who may be differentially susceptible to the effects of “plasticity” genes (5httlpr, MAOA, DAT, DRD4, DRD2, and BDNF) depending on their environment. Genes are considered plastic when a particular allelic variant results in negative outcomes in an unsupportive environment but particularly good outcomes in a nurturing environment (Bakermans-Kranenburg & Van IJzendoorn, 2006). Examples of this include research on maltreatment and antisocial behavior (Caspi et al., 2002), depression and negative emotionality (Hayden et al., in press), and depression and early life events (Taylor et al., 2006). While these “plasticity” genes create differential susceptibility to our environmental contexts, they also mean that humans can thrive in varied and complex environments, with some individuals doing relatively well in a range of environment (dandelions) and others thriving in particularly enriched environments but suffering in impoverished ones (orchids).

We also must move beyond a single gene model of influence. Instead, it may be fruitful to think in terms of cumulative genetic plasticity. From this perspective, the likelihood of a positive or negative outcome depends on the environment and the accumulation of plasticity genes, thereby creating a plasticity gradient. Evidence for this

theoretical model comes from research on adolescent self-control/ regulation demonstrating differential outcomes depending on the level of parenting the adolescent received and the number of plasticity alleles they had (Belsky & Beaver, 2011).

One other area of increased interest is epigenetics which involves investigating how early experiences influence processes such as methylation, histone acetylation, chromatin structure, and miRNA. While much of this work has come from obesity studies, recent evidence suggest that there are genes associated with altered epigenetic markers and psychiatric outcomes including AVP, COMT, RELN, GR, GABA-A, PPIEL, POMC, ER $\alpha$ , BDNF, and GAD1. However, there are inherent challenges associated with epigenetic studies such as tissue specificity, the consideration of developmental timing, having sufficient power to detect your associations, and methodological considerations (e.g., Are you getting your sources from blood or saliva or buccal cells?).

#### Conclusions and Clarification Points:

- Genetic and epigenetic methods are useful techniques for explaining individual differences for outcomes and for interventions.
- They are also useful for understanding neurobiology (where to look and when).
- Epigenetic factors are an additional level of individual variability.
- Combining biophysiology, genetics, and neuroscience could advance personalized treatments and help us to develop novel interventions.

#### **V. Workgroup Discussion - 2**

Participants went into their workgroups for discussion. Workgroups addressed two questions each. As with the previous discussion, all groups addressed the question, what is the take-way message from this session? Again, the second question varied across groups: Two groups addressed priorities for research activities; two groups addressed messages that should be prioritized for practitioners; and two groups addressed messages that should be prioritized for policymakers. Each group was assigned a different question from the question it had addressed in the previous discussion. After the small-group discussions

and interactions among the groups, participants then reconvened for a large-group discussion related to these issues. Following is a summary of the themes that emerged:

### Take Home Messages:

#### **Biomarkers**

- Biomarkers are very complex.
- Understand the basic research in the fields of physiologic stress and genetics or work with someone who does (you have to be well trained).
- Be hypothesis driven.
- Take into account the age of the participants you are interested in.
- Be thoughtful about your research designs and the limitations associated with each.
- Common measurement would be useful across different studies.

#### **Cortisol**

- Physiologic stress = activation of a set of complex systems NOT necessarily whether or not someone reports feeling stressed.
- Make sure to use a stressor that actually elevates cortisol (and is ethical). Naturally occurring stressors like a doctor's visit or starting a new child care, are sometimes useful.

#### **Genetics**

- Genetics is a radically changing field.
- Genes are not deterministic.
- It is not necessarily about whether you have the genetic risk or not, but whether you have the risks and whether there is also a poor fit with your environment that enhances your genes in a positive or negative way.

### What information is ready for dissemination?

#### **Biomarkers**

- We know that early adversity has a profound impact on development and biomarkers can help us to understand the pathways through which these effects might occur.
- These are not simple processes to understand.

## **Cortisol**

- Physiologic measures can detect important differences that otherwise won't be observed behaviorally. They can help with more subtle (and early) detections of risk.

## **Genetics**

- The expression of genes can be changed by the environment.

What research activities should we prioritize?

## **Biomarkers**

- Population specific data collection utilizing cortisol and genetic techniques.
- How can we provide maximally protective contexts for optimal expression of biology?
- Understanding how receptive ACF populations will be to genetic and physiologic methods.

## **Cortisol**

- Understanding the usefulness of hair cortisol.

## **Genetics**

- Gene and environment interaction studies.
- Differential susceptibility studies.
- Using genotypes to identify individual differences that predict what services will work.

## **VI. Early Childhood Interventions to Optimize Stress Reactivity**

*Moderator: Michelle Sarche, University of Colorado, Denver*

The purpose of this session was to explore early childhood interventions aimed at buffering the effects of chronic or overwhelming adversity on children's stress reactivity. The following questions guided the session: a) Which theoretically and empirically-based

intervention approaches, targeting which mechanisms of change, have the most potential for buffering the effects of chronic or overwhelming adversity on children's stress reactivity? What are their theoretical and empirical bases? b) What particular considerations need to be given for implementing and sustaining these types of interventions within existing Early Head Start, Head Start, Child Care, and home visiting programming?

*Attachment and Biobehavioral Catch-Up – Mary Dozier*

Children who have experienced early adversity are at risk for problems related to attachment organization, neuroendocrine function, and the regulation of emotions and behavior. The purpose of this presentation was to present data on an attachment and biobehavioral intervention designed to address these specific problems.

The intervention was targeted to help parents to provide nurturing care to their children when they are distressed, even when the child does not explicitly elicit distressed behavior and even if nurturing does not come naturally to the parent. The study included 120 children, half who were randomly assigned to the Attachment and Biobehavioral Catch-up (ABC) intervention and the other half randomly assigned to an alternate intervention. The ABC intervention involved 10-sessions with the parent at home when the child was present. These sessions were designed to help change behaviors in the context where the parents provide care and included video-feedback and in-the-moment comments to assist in the development of synchronous behaviors, nurturance when the child was distressed, and to decrease the occurrence of frightening behaviors. Children in both groups were assessed using Ainsworth's Strange Situation (Ainsworth et al., 1978), on cortisol values at wake-up and bedtime, and on behavior problems and emotion regulation tasks.

Results suggested overall evidence for the effectiveness of the ABC intervention. There was a reduction in the percentage of children who were classified with a disorganized attachment in the ABC group (30%) as compared to the children in the other intervention (50%) (Bernard et al., in press). In addition, children in the ABC intervention group showed a steeper daytime cortisol slope compared to the other intervention group,

as well as better affect regulation (less anger toward mother and better frustration regulation) and fewer parent-reported problem behaviors. Dissemination of this intervention is on-going at several sites around the country and around the world.

Conclusions and Clarification Points:

- The ABC intervention results presented indicated enhanced attachment-related, physiologic, emotional and behavioral outcomes.
- Future interventions need to ensure that parent trainers are carefully screened and that they have the resources needed to succeed.
- Fidelity must be carefully monitored or the effects of the intervention will be lost.

*Intervening With Young Children in the Welfare System: Multidimensional Treatment Foster Care for Preschoolers (MTFC-P) – Jacqueline Bruce*

The purpose of this presentation was to provide results from a randomized controlled trial for Multidimensional Treatment Foster Care for Preschoolers, a family-based preventive intervention for preschool-aged foster children and their caregivers. There are over 400,000 children in foster care in the United States. These children are exposed to a range of early adverse care experiences and are an exceptionally high risk group for cognitive, physical and social delays, as well as psychopathology. The HPA axis might play a meditational role in these effects, and therefore is potentially a good target for intervention.

The goal of the Multidimensional Treatment Foster Care for Preschoolers (MTFC-P) is to decrease foster children's difficulties by promoting a consistent, responsive, and contingent environment. The intervention includes intensive training, support and supervision for the foster caregivers, as well as targeted services to address each child's developmental, behavioral and emotional needs. The MTFC-P study was conducted with 117 preschool-aged foster children who were randomly assigned to two groups (MTFC-P and services-as-usual foster care) and 60 non-maltreated preschoolers. Outcomes were assessed at 3 month intervals for 2 years and at 6 month intervals in middle childhood.

Morning cortisol values were collected on two consecutive mornings, and the children's cortisol levels were classified as low, average or high. A higher percentage of foster children had low morning cortisol than the control children at time one (Bruce et al., 2009). Within the foster children, severe physical neglect predicted low cortisol and severe emotional maltreatment predicted higher morning cortisol (Bruce et al., 2009), suggesting different effects on the HPA axis depending on type of adversity experienced. The data on morning cortisol levels over time suggest that over the course of 12 months, the services-as-usual foster care children were more likely to show blunted cortisol (Fisher et al., 2007). Caregivers in the MTFC-P group showed decreases in stress over this 12-month period, and the higher caregiver stress shown in the services-as-usual foster care group predicted their blunted cortisol (Fisher & Stoolmiller, 2008).

The executive function data also demonstrate intervention effects. Foster children were more likely to perform worse on a Day/Night Stroop task. This poor inhibitory control was particularly bad for children with multiple foster care placements (Pears et al., 2010). Electroencephalogram data also document differences in the services-as-usual foster children and the MTFC-P children. MTFC-P children processed negative and positive feedback as normal adults would, as compared to the services-as-usual foster care children who showed deficits in processing (Bruce et al., 2009).

#### Conclusions and Clarification Points:

- The MTFC-P intervention demonstrated the potential to reverse the negative neurobiological effects of early adverse care.
- The MTFC-P intervention demonstrated cost effectiveness compared to services-as-usual foster care, perhaps because it is likely to reduce the number of multiple foster care placements.

*ParentCorps: Helping Children to Succeed – Laurie Miller Brotman*

The purpose of this presentation was to present data on a randomized controlled trial with children who were at risk for behavior problems and academic underachievement. Prevention and intervention within the context of low socioeconomic

status (SES) is a complex problem as it is likely to result in a cascade of dysregulation, problem behaviors and environmental disadvantages. From this perspective, timing is critical as small changes early in the cascade can create large impacts. Understanding the early steps of the developmental cascade is critical as it provides an avenue for intervention. Potential domains of change include parenting practices (e.g. decreasing harsh parenting and increasing responsiveness), as well as child development (e.g. social competence, peers relations, behavior problems).

The goal of ParentCorps is to support schools to allow for high quality family engagement policies and practice. This support will help to motivate and equip parents so that they can successfully implement positive practices at home and communicate with teachers as effective partners in their child's learning. In addition, school support will help to improve teacher effectiveness and classroom quality and provide children with the foundations needed to succeed. ParentCorps strategies include a 13-session group intervention for families of Pre-Kindergarten students professional development and consultation for early childhood teachers.

1050 Black and Latino 4-year-olds (87% of the Pre-K population in 10 schools) living in in disadvantaged urban communities participated in a school randomized controlled trial of ParentCorps. Findings to date indicate that ParentCorps in Pre-K results in improved parenting practices and teaching practices, reduced behavior problems and greater academic achievement test scores by the end of Kindergarten. Children with poor self-regulation are at increased risk for obesity. Among high-risk children, ParentCorps also results in lower body mass index, increased physical activity and lower rates of sedentary activity in second grade. .

#### Conclusions and Clarification Points:

ParentCorps in early childhood holds promise for improved behavioral health, physical health and academic achievement for children living in disadvantaged, urban neighborhoods.



*Nurturing Mindfulness in Caregivers and Children: A Promising Approach for Stress Reduction*  
– Mark Greenberg

Mindfulness is a promising intervention approach in the reduction of negative effects of stress. Mindfulness involves paying attention, whether to your breath, your heart rate or something else. It also involves being aware of one's own conduct and the quality of their relationships, with kind and clear insight. Research on the effects of mindfulness have shown decreases in depression, anxiety and chronic pain symptoms, as well as increases in working memory and inhibitory control, and increases in immune function. This is a very young field that is demonstrating dramatic growth in published research.

Dr. Greenberg argued that mindfulness has been used to improve interpersonal relationships and could be contextualized to parenting. In a NIDA funded intervention with 65 adolescents and their parents, researchers sought to change the dynamics and negativity within these dyads. The intervention lasted 7 nights with the goal of becoming more aware. Behaviors included things like listening with full attention, emotional awareness, nonjudgmental acceptance, self-regulation, and compassion. They found significant changes in anger management, and positive and negative affect in both the adolescents and mothers pre and post testing. They also found increases in maternal well-being (Duncan et al., 2009).

Yoga is another useful tool for decreasing stress and improving coping skills and attention, and it may be particularly effective in low income youth. Four schools were recruited from inner city Baltimore to participate in 2 randomized interventions. Forty 4<sup>th</sup> and 5<sup>th</sup> graders were recruited for the intervention and forty students for the control group. The intervention group participated in a series of yoga and mindfulness exercises four days a week for 45 minutes for a period of 16 weeks. Results showed significant changes in self-reported rumination, emotional arousal, and intrusive thoughts.

Mindfulness training has also been used for teachers. The Cultivating Awareness and Resilience in Education (CARE) project aimed to increase teachers' well-being by increasing mindfulness, positive affect, and efficacy while decreasing burnout and negative affect. The intervention included two retreat days and two days of phone coaching, online

support, and a sustainability plan. After the intervention, teachers reported higher efficacy and emotion regulation, and lower daily symptoms and sense of urgency.

#### Conclusions and Clarification Points:

- Mindfulness and yoga are useful tools for reducing stress and improving attention, cognition and social-emotional and behavioral competencies, but this work is still in its preliminary stage and more research is needed to understand its effectiveness.
- Outcomes may differ depending on the practices used (breathing, yoga, compassion focus, attention focus).
- Outcomes may also depend on the population.
- Having a clear theory of change is critical and this needs to be contextualized.

### **VII. Workgroup Discussion - 3**

Participants went into their workgroups for discussion. Workgroups addressed two questions each. As with the previous discussions, all groups addressed the question, what is the take-way message from this session? Again, the second question varied across groups: Two groups addressed priorities for research activities; two groups addressed messages that should be prioritized for practitioners; and two groups addressed messages that should be prioritized for policymakers. Each group was assigned a different question from the questions it had addressed in the previous discussions. After the small-group discussions and interactions among the groups, participants then reconvened for a large-group discussion related to these issues. Following is a summary of the themes that emerged:

#### Take Home Messages:

##### **Interventions**

- Interventions can change biology!
- Developmental issues and appropriateness of age in our intervention efforts are vitally important.

- Parent engagement is hugely important and we need to make sure that we fit the intervention to their needs and culture.
- Helpful to calculate the cost/ benefits associated with our interventions.
- Mindfulness as an interesting avenue for intervention.

#### What information is ready for dissemination?

##### **Interventions**

- Intervening early will be more cost effective.
- Need high quality training of the people who are doing the intervention.
- We need better parent training programs.
- There is no silver bullet or inoculation.

#### What research activities should we prioritize?

##### **Interventions**

- What are the core features of the interventions that are working? Need a clearer understanding of the mechanisms.
- How intense does an intervention need to be to get the same effects?
- Need research on developmental continuity of our intervention programs (don't just end them). Effectiveness research.
- Scalability of interventions.
- Understanding the mechanism behind yoga and mindfulness.

#### **VIII. Goodbye Remarks**