# 7

# Human Biological Development and Peace

## Genes, Brains, Safety, and Justice

Barak Morgan, Diane Sunar, C. Sue Carter,
James F. Leckman, Douglas P. Fry, Eric B. Keverne,
Iris-Tatjana Kolassa, Robert Kumsta, and David Olds

### Abstract

This chapter examines the concept of peace from a biopsychosocial perspective. It reviews available knowledge concerning gene-environment regulatory interactions and their consequences for neurodevelopment, particularly during sensitive periods early in life. The hypothesis is explored that efforts on the part of parents to protect, nurture, and stimulate their children can lead to physically, psychologically, and socially healthier developmental trajectories and support the emergence of more peaceful families and communities. It is clear, however, that adverse environments, as in the context of structural violence, may result in lower parental investment in child rearing and negative outcomes for social harmony and health over the course of life. More research is thus needed to understand more fully the potential positive impact that interventions aimed at encouraging families to increase their investment in early child development will have on societal peace. The role of groups in shaping human behavior toward conflict or conflict resolution and peace is examined. Further research is needed to increase current understanding on the neurobiology of groups. In addition, steps need to be taken across multiple sectors of society to reduce all forms of direct and structural violence, as this will surely lead to "better" parenting behaviors, "better" childhood trajectories, and a model of fairness to guide interactions between groups.

## Introduction

Peace can be defined as a positive, dynamic participatory process or a condition in which every person has the opportunity to develop to his or her fullest potential (Kagitcibasi and Britto, this volume). It can also be defined as a

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

condition of *safety* for individuals or groups. Its opposite may be conceived as *threat*, which can take the form of direct conflict and violence or of structural violence (i.e., deprivation or social inequality and injustice), which can interfere with equal opportunities for human development.

In this chapter, we refer to the process of reducing direct violence as peacemaking and the process of reducing structural violence as peacebuilding. Peacemaking most frequently occurs at, and refers to, the individual and family levels, whereas peacebuilding generally refers to activities taken at broader levels (e.g., the community or nation).

When we use the term peace, we are generally referring to an emotional sense of safety. Threat and fear are also emotional constructs. The mammalian nervous system is exquisitely sensitive to states of threat and danger as well as to a sense of safety. Experiences of safety or danger are transduced into changes in gene expression, which can influence neural development, including structures and functions mediated by neurotransmitters and neurohormones (e.g., steroid hormones such as cortisol and neuropeptides such as oxytocin). The primate nervous system is a social organ that not only requires close attunement with other members of their species for normal development, it also produces behavior which constitutes relationships of various kinds. These relationships, in turn, are potentially peaceful or nonpeaceful. This is all the more so for humans who are ultrasocial primates.

Neurodevelopment comprises the unfolding and interweaving of a complex array of processes, all of which require genetic templates. However, the ways in which these genetic templates are used during neurodevelopment—both pre- and postnatally—are entirely dependent upon the environment as mediated[1] by epigenetic mechanisms. Epigenetics is where genes and environment ultimately (and physically) meet.

## Violence

At first glance, "structural violence" may seem like a misnomer, for inequality and injustice may characterize very stable social structures in which there is little if any open conflict or physical violence (see Christie et al., this volume). In terms of their effects on genes, brains, development of potential, relationships and capacity for peaceful and productive living, direct and structural violence are nearly identical, differing mainly in their time frames. Direct violence can inflict trauma in a short space of time, whereas structural violence is persistent and insidious in wreaking its damage.

---

[1] When discussing neural structures and functions, the term "mediate" is preferred to other terms like "regulate" or "based upon," which often imply a sense of causal origin or causal direction. "Mediated" is causally neutral, thus emphasizing the "circular causality" of organism-environment interactions.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

In today's world, structural violence most often takes the form of poverty, the causes of which generate socioeconomic and health inequality. In recent years, interest in the impact of environmental adversity—especially low socioeconomic status (SES)—on the development of biological substrates of cognitive, behavioral, motivational, and social functions in humans has surged (Boyce et al. 2012b), driven in large part by momentous advances in understanding its impact on early biological development in animals (Cameron et al. 2005; Champagne and Meaney 2006; Hackman et al. 2010; Plotsky et al. 2005). The import of these advances lies in the ways whereby environmental conditions during early development become embedded in biology in largely irreversible ways, for better or worse (Gruenewald and Karlamangla 2012; Johnson et al. 2013; McEwen 2012; Shonkoff 2010).

However, both peace and violence are *relational*: they are conditions which are obtained between and among individuals or groups. This requires us to understand types of relationships and their implications for peace and violence. Both peace and violence are also *functional* in specifiable environments. Finally, violence is often regarded by the actor (person or group) as morally justified. Each of these points encompasses biological elements and has developmental implications.

## Environment Becomes Epigenetically Embedded in Biology, Regulating Gene Expression

### Environment Regulates Built-In Intelligence

Throughout the life cycle, organisms and environment work together as an inseparable whole. Even DNA functions only as part of a loop that always includes the environment. A particular trait, for example, may manifest under certain environmental conditions, but under other conditions it may not. Knowing under which genetic and environmental conditions a given trait will manifest is especially relevant vis-à-vis the developmental biology of formative childhoods.

Living systems possess built-in intelligence that "works the environment" for adaptive ends. Built-in intelligence means intelligence that is learned, where "learned" refers to inborn intelligence acquired through natural selection encoded in DNA as well as intelligence acquired through life experience encoded in epigenetics. Working the environment means that organisms use the environment to regulate this built-in intelligence in adaptive ways so as to promote survival and reproduction.[2]

Alone, built-in intelligence is entirely useless. Organisms absolutely depend on environmental information to "close a regulatory loop." Only the

---

[2] Evolutionists use the term "reproductive survival" to denote what organisms must ultimately do to avoid extinction: it is not enough simply to survive; one must survive *and* reproduce.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

environment can tell the organism when, where, and how to use its built-in intelligence in useful ways. Discussions of nature versus nurture turn out to be nature *and* nurture.

This also applies internally to an organism. Something in the internal environment must signal what DNA should do, when, and how much to do it. For example, all cells in the body contain identical genetic material, but some genes are active, for example, in white blood cells whereas others are active in liver cells. Liver and white blood cells occupy different chemical environments within the developing embryo, and these chemical differences in interaction with genes are solely what make these cells different.

The nature-nurture debate has not been fiercely fought over differences between liver and white blood cells but rather over intelligence, emotions, and behavior. It has only recently become clear that the same gene-environment regulatory interactions also apply to these controversial topics, and this has profound social policy implications. This is simply because genes within brain cells (i.e., neurons) are, like all genes, environmentally regulated. What has recently become so compelling is the enduring way in which neuronal genes are regulated by the social environment during early childhood, with dramatic consequences for intelligence, emotions, behavior, and health throughout the life span.

## Embedding of Environment: Epigenetic Changes, Sensitive Periods, and Canalization

Many mammalian genes are toggled on and off reversibly according to changes in the local chemical environment of the cell (e.g., a change in the level of blood glucose or a particular hormone). Some genes, however, are not set fully on or fully off but are somewhere in between in a *once-off* manner according to the environment that prevails during a brief *sensitive period* early in life. Critically, this setting may remain unchanged for life (Szyf 2013a; Zhang and Meaney 2010) and may even be passed on to subsequent generations (Heard and Martienssen 2014; Morgan and Whitelaw 2008; Dias and Ressler 2014; Gapp et al. 2014).

This is achieved because signals from the environment permanently add methyl molecules, called *epigenetic marks*, onto the DNA. Epigenetic marks partially block gene expression. Specifically, the number of epigenetic marks added to a gene determines the setting for that gene: the more marks, the greater the blocking of gene expression. In sum, the permanent nature of methyl epigenetic marks means that gene expression is set at a particular level for life and this setting is under environmental control in a once-off fashion early in life. Once-off, therefore, has a double meaning: epigenetic marks are made once-and-for-all *and* at a sensitive period early in life.

Once a sensitive period has passed, a gene is highly resistant to environmental influence. This combination of early sensitivity followed by later resistance is called “canalization.” It is as if development, after being steered one way or another during a sensitive period, becomes forever confined to a narrow steep-sided canyon or canal. After branching one way or another, it is extremely difficult or even impossible for environmental factors to shift development from one trajectory to another.

It should be noted that loss of DNA methylation, or DNA demethylation, has been observed in different biological contexts, and this alteration can take place actively or passively. Although the involved cellular mechanism has been mapped, the extent to which these processes are sensitive to environmental variation remains unclear (Kohli and Zhang 2013). Even if methylation patterns laid down early in life were somewhat reversible, this does not mean that brain architecture and brain function can be readily reconfigured. During neurodevelopment, earlier lower-level processes (e.g., epigenetic marks) form the foundations upon which later higher-order structures and functions are built. Development is thus a contingent *historical* process; changing something at a lower level does not necessarily turn back the clock on higher-level organization (e.g., neural circuits) that is already present (Hammock and Levitt 2006). For this reason, the notion of once-off irreversible canalization is also applicable to the developmental unfolding of higher-order structural and functional organization (Blair and Raver 2012a). Indeed, neuroplasticity (i.e., the brain’s capacity to change) is very high at birth but diminishes very rapidly, virtually reaching adult levels around the age of six to seven years (Knudsen et al. 2006). Consonant with this, we will continue to use the terms “once-off,” “canalized,” “irreversible,” and “for life” to denote the profound influence of early development on lifelong developmental trajectories.

The significance of once-off canalization can be appreciated by looking at the exception which proves the rule. Posttraumatic stress disorder (PTSD) is an example of how a traumatizing environment can forcefully regulate a strongly canalized developmental trajectory from one deep canal to another late in life. Trauma sufficient to cause PTSD requires a massive environmental push, or many cumulative pushes, powerful enough to force the nervous system into an entirely new and clearly pathological trajectory. That this new trajectory is also deeply canalized is evident in the stubborn resistance of PTSD to treatment.

In the brain, thousands of genes are once-off differentially regulated after birth in response to early adversity. This reflects the fact that the brain, more than any other organ, is not fully developed at birth but undergoes significant development during early childhood, with effects lasting into adulthood (Provençal et al. 2012). Consequently, a child’s postnatal environment has a profound canalizing impact on the structure and function of its brain. This is why childhoods are formative.

In this light, it should be clear that the question of whether peace or violence is in our genes is simply the wrong question. Given the human genome, the question should instead be: *Which environment regulates for violent conduct and which for peaceful conduct?*

From “Pathways to Peace: The Transformative Power of Children and Families,”
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

This is not synonymous with the old "blank slate" version of environmental determinism (cf. Pinker 2003). Rather, it recognizes that each of these types of behavior reflects built-in intelligence which has been selected over the course of evolution as adaptive in particular environmental settings and will therefore manifest (i.e., be regulated for) whenever these settings prevail.

## Threat and Stress in Brain Development

### The Stress Response

The profound relevance of developmental neuroscience to the great social questions of peace and violence lies in newly discovered epigenetic details that address exactly how environment and genes interact. The stress response denotes physiological and psychological changes that occur in response to a stressor and is comprised of two systems: (a) the sympathetic nervous system (SNS) and (b) the hypothalamic-pituitary-adrenal (HPA) axis (Figure 7.1). Both systems are activated by stress via corticotrophin release factor neurons in the amygdala and hypothalamus, respectively (Cameron et al. 2005; Gunnar and Quevedo 2007). The SNS responds rapidly, causing the release of epinephrine and norepinephrine from chromafin cells in the adrenal glands; this prepares the body (increased heart rate, blood pressure, respiration) and focuses the mind to respond appropriately to the stressor. If the stressor poses an imminent threat, the SNS will trigger a fight, flight, or freeze response accompanied by feelings and sensations of rage or panic. If the stressor does not pose an imminent threat, the SNS will keep the body and cerebral cortex in a state of anxious readiness, which orients cognition toward an assessment of the overall situation (what might happen next and what will be the best response).

If the stressor passes, the SNS response will die down, bodily functions will return to normal, and the mind will relax. If the stressor persists, the HPA axis begins to activate and releases glucocorticoids (CORT), also from the adrenal glands. The HPA stress response serves to provide the SNS response with energy (i.e., it increases blood glucose levels) needed to sustain increased heart rate, blood pressure, respiration as well as any strenuous physical activity associated with a potential fight or flight response. As is the case for the SNS, once a stressor passes, the HPA axis will be switched off and blood glucose levels will return to normal.

So what does the stress response have to do with gene-environment interactions, epigenetic marks, and *once-off* canalization in early childhood? To answer this question, we turn to the proverbial lab rat, where it was discovered that rat pups raised by mothers who lick and groom (LG) them more (the high LG group) become more resilient to stress (show normal HPA stress responses), whereas pups raised by low LG mothers exhibit exaggerated HPA stress responses and are susceptible to the toxic effects of stress. This is true

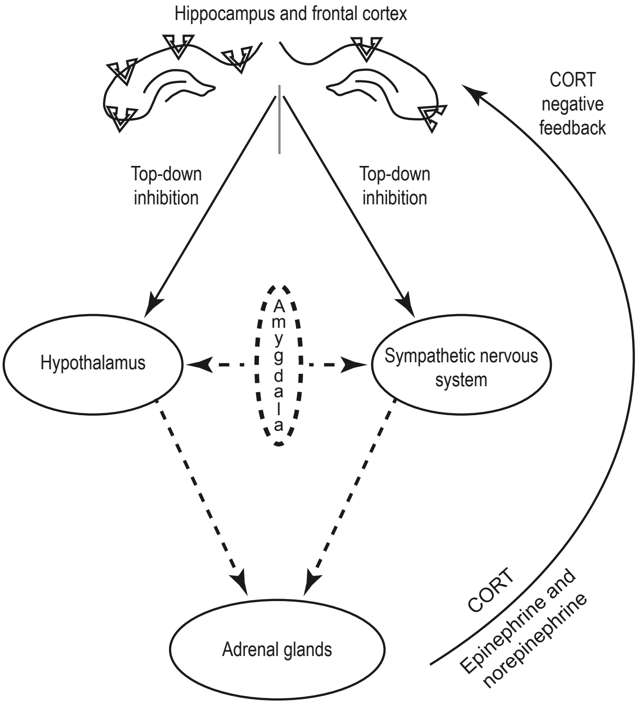

**Figure 7.1** Overview of the neuroendocrine response to stress involving the cortex (hippocampus and frontal), subcortex (hypothalamus, amygdala, and sympathetic nervous system), and adrenal glands. In the absence of stress (solid arrows), the hippocampus inhibits the hypothalamic-pituitary-adrenal (HPA) axis stress response, while the frontal cortex inhibits the sympathetic nervous system (SNS) stress response. When significant stress is present (dashed arrows), the amygdala overrides top-down frontal cortex inhibitory control and activates the SNS to release epinephrine and norepinephrine. If stress passes, the SNS response subsides and the system returns to normal. If stress persists, hippocampal top-down inhibition is overcome and the HPA axis is activated causing glucocorticoids (CORT) to be released to provide the SNS response with energy. When CORT reaches the hippocampus via the bloodstream, it binds to CORT receptors (vee shapes, top of figure) like a key fitting into a lock. Opening this lock boosts top-down inhibition to the hypothalamus, thereby switching the HPA axis stress response off once again (negative feedback). If the number of CORT receptor locks in the hippocampus is low, as depicted on the top right-hand side of the hippocampus, there will be more CORT keys than there are CORT receptor locks to open and the hippocampus will be less able to switch off the HPA axis in a top-down fashion. As a result, the CORT stress response will be abnormally exaggerated. Crucially, the number of CORT receptor locks on hippocampal cells is epigenetically set for life in a once-off manner very early in life. After Meaney and Szyf (2005).

irrespective of the biological mother: pups born to a high LG mother but raised by a low LG mother will develop an exaggerated HPA stress response and vice versa (Claessens et al. 2011). Thus maternal environment (high or low LG) rather than genetic differences influence how the HPA system is "set up."

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

As shown in Figure 7.1, in the presence of stress, as CORT does its work around the body to increase blood glucose levels, CORT also reaches the hippocampus where it binds to CORT receptors like a key fitting into a lock. Opening this lock boosts the top-down inhibitory powers of the hippocampus on the hypothalamus, thereby switching the HPA axis off again (negative feedback).

If the number of CORT receptor locks in the hippocampus is low (Figure 7.1, top right-hand side of the hippocampus), the efficacy of negative feedback will be low; that is, there will be more keys than there are locks to open and the hippocampus will be less able to switch off the HPA axis. As a result, the CORT stress response will be abnormally high and prolonged. Importantly, *during the first few days after birth, the number of CORT receptor locks is under environmental control.*

For a newborn mammal, environment means mother.[3] For rats, the intensity of maternal licking and grooming behavior during the first six days of life regulates the level of gene expression of the CORT receptor gene in a *once-off* fashion *for life*. Pups raised by high LG mothers have fewer marks on this gene, resulting in greater gene expression; this, in turn, results in more hippocampal locks, more effective CORT key negative feedback, more inhibition of the hypothalamus, and hence more effective termination of the HPA stress response. Conversely, pups raised by low LG mothers have more epigenetic marks on this gene, resulting in less gene expression; this, in turn, results in less hippocampal locks, less negative feedback, and an exaggerated and prolonged HPA stress response. *Differences in maternal licking and grooming behavior disappear after the sixth day of postnatal life, whereafter the number of epigenetic marks that have been affixed in the hippocampus does not change. In other words, the HPA stress response is once-off epigenetically set (canalized) for life during a very brief and well-defined sensitive period (0 to 6 days of life)* (Meaney and Szyf 2005).

The same mechanism seems to apply to humans (Suderman et al. 2012). For example, one study found that early childhood adversity (i.e., parental loss, childhood maltreatment, and/or inadequate parental care) was associated with increased epigenetic marking of the CORT receptor gene, which in turn was associated with weakened negative feedback of the HPA axis (Tyrka et al. 2012). Others have found significantly more epigenetic marks on the CORT receptor gene and, as would be expected, significantly lower levels of CORT receptor numbers in the hippocampus, in brains of individuals with a history of early childhood abuse (McGowan et al. 2009), as well as in peripheral tissues such as blood cells in children exposed to (a) maltreatment and reduced nurturing (Perroud et al. 2011), (b) maternal anxiety and depression in pregnancy

---

[3] "Mother" refers to primary caregiver (i.e., the person who takes primary responsibility for the care of another individual who cannot fully care for themselves) and may not be biologically related to the child.

(Oberlander et al. 2008), and (c) in 10- to 19-year-olds whose mothers experienced intimate partner violence during pregnancy (Radtke et al. 2011). All of these studies connect early adversity associated with impaired parenting, both prenatally and postnatally, with once-off hypermethylation of the CORT receptor gene and, in some cases, with hippocampal-HPA changes consistent with impaired negative feedback. In addition, epidemiological studies have found differences in epigenetic marks on hundreds of genes in individuals whose childhood was spent in the lowest socioeconomic strata, irrespective of adulthood SES (Labonté 2012; McGuinness et al. 2012).

In sum, early-life experience has a profound and enduring once-off canalizing impact on gene expression patterns throughout life. This is true for the CORT receptor gene, which codes for hippocampal CORT receptor locks, as well as for the genome as a whole.

## "Top-Down" and "Bottom-Up" Brain Processes: Self-Regulation

Mammal brains, especially human brains, are characterized by a large cortex that overlies subcortical structures. Very roughly, psychological functions of the frontal cortex include conscious thought, attention, working memory, planning, and self-processes (e.g., self-control, judgment, and physical movement). Processes governed by the subcortical structures include emotional arousal, physical urges, vigilance, relaxation, and control of the autonomic nervous system. Infants are born with a well-developed subcortical system, but the cortex undergoes major development after birth, particularly in the first two years. Top-down regulation means that cortical structures inhibit bottom-up physiological and emotional responses so as to integrate instead a wide range of information needed to make more sophisticated assessments than the subcortex can. Bottom-up regulation means that the subcortex overrides top-down cortical control in situations where there is no time to ponder different options and one or more of a limited number of automatic built-in stereotyped fight, flight, or freeze stress or appetitive action responses are urgently needed.[4]

In general, top-down (cortical) regulation of the subcortex is voluntary, effortful, and relatively slow. In contrast, bottom-up (subcortical) activity is involuntary, effortless, and nearly instantaneous. Because top-down regulation is generally voluntary and often mentally challenging, it is also called self-regulation or "effortful control"; a healthy balance between top-down and bottom-up activity is important for personal and social well-being. Healthy balance means knowing when to remain calm and when to react. Not surprisingly, self-regulation has a profound influence on lifetime achievement and physical and

---

[4] Bottom-up activity encompasses much more than just the fight, flight, or freeze stress response and also includes appetitive reward-seeking motivations and other emotionally positive and negative states of mind.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

mental health. In two large longstanding longitudinal studies conducted in the United Kingdom and New Zealand, Moffitt et al. (2011) found that children with poor self-regulation capacities at 3, 5, 7, 9, and 11 years of age had, at 32 years of age, significantly higher rates of substance dependence, criminality, financial problems, and single parenthood; they also had significantly lower income, less financial planning skills, lower SES and reduced physical health.

## Self-Regulation and Socioeconomic Status

Diminished top-down self-regulation is strongly related to low SES, especially during the earliest postnatal years; thereafter, with each year spent in poverty, SES diminishes even further (Blair and Raver 2012b). Several studies in older subjects report similar relations between top-down self-regulatory capacities and SES. Parental SES predicted cognitive function (performance on a learning task) and prefrontal cortex fMRI activation in 8- to 12-year-old children, and this relationship was mediated by CORT stress response (Sheridan et al. 2012a). In a sample of nearly 1,300 children studied at 2 and 48 months of age, CORT levels were higher and decreased more slowly in children with greater cumulative years in poverty and with greater cumulative household poverty (Blair et al. 2013). Similarly, in a sample of sixty children (mean age 11.4 years), lower SES correlated with smaller hippocampal and larger amygdala volumes, suggestive of weaker top-down control and stronger bottom-up reactivity, respectively (Noble et al. 2012). Another study found that lower childhood SES predicted smaller hippocampal volumes 50 years later (Staff et al. 2012). Finally, the prefrontal cortex of 24-year-olds from lower childhood SES backgrounds was less able to inhibit amygdala activity during an effortful negative emotion regulation experiment independent of adult SES and chronic childhood stressor levels mediated this effect (Kim et al. 2013). All of this evidence suggests that socioeconomic adversity may steer brain development in early childhood toward brains characterized by diminished powers of top-down regulation. How does this occur?

## From Maternal Regulation to Self-Regulation: The Maternal Mediation Hypothesis

Moffitt et al. (2011) found that although lower SES in childhood correlated with poorer self-regulation, their main findings (see above) that poor self-regulation predicted a wide range of normatively negative adult outcomes still held after controlling for childhood SES. In many cases, poor childhood self-regulation was a stronger predictor of poor outcomes in adulthood than SES (Moffitt et al. 2011). This suggests that socioeconomic adversity per se does not canalize brain development along a trajectory biased toward greater bottom-up versus top-down modes of brain function. Something else must be

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

mediating the links between early socioeconomic adversity and compromised top-down neuroanatomical, neurofunctional, neurocognitive powers, and HPA axis hyper-responsiveness—all evidence of diminished top-down self-regulation. What could this be?

Part of the answer is that SES *impacts on early self-regulation via the filter of parental care*. This is clearly illustrated in a study of working memory in a sample of youth from a low SES community. Doan and Evans (2011) found that working memory ability (a measure of top-down cortical self-regulation) varied with increasing allostatic load (a composite score of bottom-up physiological measures reflecting of HPA and SNS stress reactivity), according to maternal care. That is, youth with mothers high in maternal responsiveness showed no change in working memory as allostatic load increased. On the other hand, youth with mothers low in maternal responsiveness showed sharply diminishing working memory capacities as allostatic load increased. The influence of maternal care is not, however, limited to socioeconomic adversity. A prospective study of children between 6 and 12 years of age from nondeprived backgrounds found a significant correlation between maternal support and hippocampal volumes (Luby et al. 2012), highlighting the mediating role of early parental care in all SES circumstances.

These results indicate how maternal care serves to *buffer* or *not buffer* an adverse environment. In short, parental care mediates the effect of the environment on early brain development. This is what is called the maternal mediation hypothesis. Starting from birth, an infant has very limited powers of self-regulation because the immature cortex cannot integrate complex information or assert top-down inhibition. As described above for the HPA axis in rats and humans, the acquisition of top-down control is highly sensitive to parental investment in early life. In both species the quality of early parental care literally sculpts and canalizes the self-regulatory powers of the maturing cortex via once-off lifelong epigenetic marks that determine the density of CORT receptors on hippocampal cells. The same applies to the expression of many other genes in the brain (Blair et al. 2013; Blair and Raver 2012b; Cameron 2011; Gudsnuk and Champagne 2012; Monk et al. 2012; Provençal et al. 2012).

During development, CORT, epinephrine, and norepinephrine act on the brain as part of the bottom-up stress response. At moderate levels these hormones enhance synaptic activity in prefrontal cortex areas that subserve attention, working memory, and top-down emotion regulation. However at high levels, prefrontal cortex is shut down and subcortical systems dominate (Arnsten and Li 2005; Blair and Raver 2012a). Since attention, working memory, and emotion regulation are critical components of self-regulation as well as for processing and learning complex information, over time these hormones sculpt the firing and wiring pathways of the brain in ways that canalize brain development along either strong top-down, “reflective” or strong bottom-up, “reactive” stress response trajectories, according to the amount of environmental

From “Pathways to Peace: The Transformative Power of Children and Families,”
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

stress and the nature of maternal/parental care (Blair et al. 2013; Blair and Raver 2012b; Rinaman et al. 2011; Wiggins and Monk 2013).

Several studies (Knudsen et al. 2006; Moffitt et al. 2011; Raver et al. 2012) show that the differences in self-regulation which make a difference later in life are already forged during the first five years of life. Exactly how devastatingly once-off and irreversible early canalization of childhood development can be is tragically evident in studies of Romanian orphans adopted into Canadian and British families. At eight years of age, the social skills of Romanian children who were initially placed in severely deprived institutional conditions soon after birth differed dramatically according to age of adoption into nurturing foster families in Canada. Social skills in orphans adopted prior to 20 months of age closely approximated Canadian children raised in their own families, whereas orphans adopted after 20 months of age closely approximated their orphan peers who remained institutionalized in Romania (Almas et al. 2012). Identical findings were observed for self-regulation abilities in Romanian orphans adopted into British families (O'Connor et al. 2000).

In sum, because a baby is born with a well-developed subcortex but relatively undeveloped cortex, any distress it experiences triggers a powerful stress response which it has no means to curtail; there are no, or very few, CORT receptors in the hippocampus as yet and the child has no cognitive powers to self-regulate. Instead, the child must rely on maternal comfort to regulate its feelings. Even if maternal comfort is not entirely or immediately successful, the mother's mere presence and deeply caring attention results (similarly to high LG rat mothers) in fewer epigenetic marks on the CORT receptor gene and other genes important for top-down control. Strong top-down self-regulation is acquired from the environment, which for infants is predominantly the mother or caregiver.[5]

A further, crucially important dimension to the maternal mediation hypothesis is that while maternal behavior/investment (e.g., maternal responsiveness) mediates the impact of environment on offspring development, the environment also regulates maternal behavior/investment itself. Evidence that maternal investment style is sensitive to environmental adversity is available in both rats and humans. In rats, gestational stress decreases licking and grooming behavior in high but not low LG mothers. Under stressful conditions, once pups were born, LG behavior in the previously high LG mothers was no different from the low LG mothers and the offspring of both groups developed stress response profiles and maternal licking and grooming styles in accordance with having experienced low LG maternal care (Cameron 2011). Although LG behavior exhibits plasticity during gestation (change from high to low LG),

---

[5] Importantly, strong top-down self-regulation does not mean suppression of all emotional responses. Nonjudgmental tolerant and empathic parenting allows an infant to first safely express and later verbalize, and thereby self-regulate subcortically generated distress or excitement such as hurt, anxiety, fear, anger, and desires.

this plasticity does not persist. Initially high (as observed in their first pregnancy) LG rats, who switched to low LG when stressed during their second pregnancy, continued to exhibit low LG behavior toward the progeny of their third pregnancy even though they were not subjected to any further gestational stress. In other words, stress experienced during their second pregnancy served to embed and canalize maternal behavior along a low LG trajectory.

An extensive literature documents the disruptive impact of poverty on normatively positive maternal care in humans (Cameron et al. 2005 and references therein), particularly when mediated by maternal anxiety and depression (Murray et al. 2010). Maternal anxiety undermines maternal buffering capacity and is the biggest factor contributing to a mother's feelings toward her newborn (Cameron et al. 2011). Depressed and anxious mothers are less able to feel positive toward their baby (Cameron et al. 2005). Furthermore, poor maternal-infant bonding correlates with increased SNS and HPA stress responses; adult victims of child abuse also show increased HPA and SNS responses to stress (Cameron et al. 2005). Lower maternal SES also correlates with elevated maternal cortisol in pregnancy and elevated infant cortisol response to vaccination stress at six weeks of age (Thayer and Kuzawa 2014). Lastly, human maternal investment styles transmit across generations, with child abuse being more common in families where parents were themselves abused as children (Cameron 2011).

These findings suggest that the maternal mediation hypothesis is applicable to humans as well. Indeed, in humans as in rats, lower parental investment (including abusive parenting) is associated with greater epigenetic marking of not only the CORT receptor gene but of many genes across the entire genome. Some of these other genes are known to be involved in top-down and bottom-up regulation of the stress response as well as other relevant behaviors, including sexual and caregiving reproductive styles (Cameron 2011; Champagne et al. 2001; Feldman et al. 2012; Kumsta et al. 2013; Wang et al. 2014). Gonzalez et al. (2012) found that early-life adversity predicted decreased maternal sensitivity and that this relationship was mediated by increased HPA axis activity and decreased working memory abilities (i.e., diminished top-down control). Consequently, by regulating for decreased maternal investment, environmental adversity biases early brain development toward less efficient top-down inhibitory control, making spontaneous bottom-up activity more likely. The maternal mediation hypothesis is also supported by studies which show that controlling for parenting behaviors nullifies the association between SES and developmental outcomes (Cameron et al. 2005) as well as studies which show that parental investment in children as well as in resources for children, positive parenting, and decreased material hardship and stress are the major mediators of positive correlations between family income and child outcomes (Yoshikawa et al. 2012).

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

## Strategic Life Histories

Why should low LG mothering in rats and its low parental investment human equivalent result in an overly sensitive stress response and poor top-down self-regulation to predispose an individual to normatively poor physical, psychological, and social outcomes later in life? How does this make evolutionary sense?

There is mounting evidence to support the idea that once-off canalization of the stress response, according to the quality of parental care early in life, serves to prepare offspring for the adult environment (Blair and Raver 2012b; Bugental 2012; Ellis et al. 2011; Ellis and Del Giudice 2014). In a relatively safe, bountiful environment where there is less maternal stress, mothers invest more resources in caring for their offspring. These offspring consequently develop strong top-down regulation of the stress response. Conversely, mothers who inhabit a relatively unsafe, impoverished environment invest fewer resources in maternal care, resulting in offspring that have a more readily activated and exaggerated stress response. This is understandable from an evolutionary perspective because impoverished environments are associated with nutritional deprivation, violence, and infection; weaker top-down control of the stress response provides enhanced protection against all three conditions. For example, weaker top-down control promotes greater anxiety, fear, caution, avoidance, defensive hostility, inflammation, immune reactivity, and mobilization of stored energy: all adaptive responses to a high-risk, resource-scarce environment (Blair and Raver 2012b; Cameron et al. 2005; Matthews and Phillips 2012).

This evolutionary perspective on early development constitutes a fundamental shift from a "rational top-down vs. irrational bottom-up," "healthy vs. pathological," "adaptive vs. maladaptive," or "well-regulated vs. dysregulated" normative framework (where rational, healthy, adaptive, and well-regulated are good and their opposites are bad) to an evolutionary framework in which environmental conditions steer development along canalized trajectories that make strategic sense under those conditions. In this light, irrational, pathological, maladaptive and dysregulated may indeed entail undesirable elements, but this negative aspect is understood as the cost of an early adverse environment regulating, in a once-off canalized fashion, for a strategic developmental trajectory that makes the best of a bad situation (Ellis and Bjorklund 2012). "The best" may still constitute a high-risk strategy that jeopardizes the person's health and survival (Ellis et al. 2012).

This view coheres with a wide range of evidence drawn from organisms as diverse as microorganisms, plants, insects, fishes, amphibians, reptiles, and mammals pertaining to the general notion of life history strategies (Bruton 1989) and, in particular, to the notion of psychosocial acceleration (Belsky et al. 1991; Ellis and Bjorklund 2012; Ellis et al. 2009). Psychosocial acceleration entails early maturation and a suite of behaviors that are diametrically opposed to development under benign conditions: early sexual debut, sexual promiscuity, early first birth, unstable pair bonds, and limited parental investment in many closely spaced offspring (Ellis and Del Giudice 2014; Ellis et al. 2009). The strategic sense in such a trajectory is described as follows (Belsky and Pluess 2013:1246):

> [F]rom the standpoint of reproductive fitness, it is better to "live fast and die young," having offspring along the way, than to die (or become disabled) before getting the chance to reproduce. Thus, adolescents who, for example, respond to dangerous environments by developing insecure attachments, adopting opportunistic, advantage-taking interpersonal orientations, engaging in externalizing behavior, discounting the future, and experiencing early sexual debut are no less functional or even less regulated than are those responding to a well-resourced and supportive social environment by developing the opposing characteristics and orientations.

Animal evidence in support of psychosocial acceleration is found in the offspring of low LG rat mothers who demonstrate accelerated sexual maturation, increased sexual behavior, and reduced parental investment (low LG behavior) (Cameron et al. 2005). In this light, limited parental investment serves as a regulatory signal whereby parents forecast the prevailing environmental conditions their newly born offspring are likely to encounter (for details of the mechanisms undergirding fast versus slow life history strategies in rats, see Cameron et al. 2011; Cameron 2011).

There is considerable evidence consistent with the idea that environmental conditions regulate parental behavior to shape stress responsiveness, reproductive strategy, and other behaviors in human offspring. For example, adverse socioeconomic conditions are stressful and engender parental anxiety and depression. These, in turn, undermine maternal buffering capacity and reduce responsiveness toward newborns, infants, and children (Cameron et al. 2005; Cameron et al. 2011; Murray et al. 2010). Similarly, environmental adversity (e.g., low SES, father absence, maternal depression) disturbs parent-child interactions and is associated with developmental trajectory differences in life history styles (e.g., early menarche, early sexual debut, greater promiscuity) in human females (Belsky et al. 1991). For example, in a study of 958 American youth, household unpredictability and economic harshness—mediated by maternal depression (all measured from 0–5 years old) and maternal sensitivity (measured at ±6–8 years)—all predicted psychosocial acceleration as indexed by sexual behavior at the age of 15 years (Belsky et al. 2012). Similarly, Simpson et al. (2012) studied a sample of 162 males and females born into low SES characterized by varying levels of instability and stress. Individuals who experienced greater unpredictability (measured by changes in maternal employment, residence, and cohabiting male partners) and more rapid environmental change during the first five years of life demonstrated features of a faster life history strategy at 23 years of age. These features (more sexual partners, more aggressive and delinquent behaviors) are consistent with

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

diminished top-down self-regulation. Notably, these features were unrelated to environmental adversity experienced between 6 and 16 years of age, again evidence of once-off canalization during a sensitive period early in life.

The potential costs of psychosocial acceleration characterized by features such as exaggerated stress responses, precocious sexual debut, sexual promiscuity, early menarche, unstable pair bonds, early reproduction, decreased parental investment, impulsivity, aggressive social attitudes, etc. are significant. Nevertheless, while the increased personal risks associated with the prevalence of these traits under conditions of socioeconomic adversity are normatively undesirable, they should not be seen primarily as pathology, dysregulation, dysfunction, or maladaptative. From the evolutionary perspective of life history theory, these social maladies are being regulated for as unavoidable costs of strategies evolved to make the best of adverse conditions. In other words, these traits are no less functional than their normatively positive opposites (Belsky and Pluess 2013; Ellis and Bjorklund 2012; Ellis and Del Giudice 2014; Ellis et al. 2011; Ellis et al. 2012), and trying to cure these social "maladies" without addressing the environmental context that regulates for them will be of limited value (Cameron et al. 2005).

## For Better or For Worse: Individual Differences in Sensitivity to the Environment

A powerful, unifying biopsychosocial understanding of childhood development centered on relations between environmental adversity, caregiving behaviors, stress-response systems, genetics/epigenetics, neurodevelopmental canalization, and self-regulation is currently emerging (Blair and Raver 2012a; Garner and Shonkoff 2012). A comprehensive account of many other important dimensions flowing from and into this core biopsychosocial framework is, however, beyond the present scope. Here we wish to highlight some dimensions that are pertinent to the issue of peacebuilding.

First, not all offspring follow the same developmental trajectory in response to the same environmental conditions. In some individuals, adverse conditions may yield normatively negative, below average outcomes, whereas enriched conditions may yield normatively positive, above average outcomes for the same individuals. This is known as the "for better or for worse" model, where "better" and "worse" are relative to the case where yet other individuals follow average (or "middle of the road") trajectories *irrespective of whether they experience adverse or enriched rearing conditions*. The former type of individual is known as an "orchid" (i.e., a spectacular plant which either flourishes or withers according to the right or wrong conditions), whereas the latter are known as "dandelions" (a nondescript plant which grows equally well under a wide range of conditions) (Ellis et al. 2011). Thus, adverse conditions associated with structural violence not only blight communities with normatively negative human capital ("for worse" orchid outcomes), they also simultaneously rob such communities of their brightest prospects ("for worse" orchids hold the highest "for better" potential, including the potential for peacebuilding) (Ellis et al. 2011).

Second, transgenerational inheritance of canalized developmental trajectories can occur in various ways. As for the HPA axis, maternal licking and grooming behavior also determines epigenetic marking of the estrogen receptor alpha gene in the hypothalamus of female rodent pups. When they become pregnant themselves, estrogen receptor alpha influences the sensitivity of these hypothalamic cells to estrogen. This sensitivity, in turn, predicts the quality of maternal care that these second generation mothers render to their offspring, who later pass the same traits onto female offspring of the third generation (Gudsnuk and Champagne 2012). Thus gene expression profiles of both the CORT receptor gene and the estrogen receptor alpha gene (which determine the HPA stress response and maternal LG behavior, respectively) can be inherited over at least three generations, not via genetic information but via successive parental behavior to epigenetic marks cycles. Maternal style in humans is also passed from one generation to the next; similar neuroendocrine (Gonzalez et al. 2012) and epigenetic mechanisms are also likely involved (Cameron 2011).

Parental *experience* can also be transmitted *without* the mediation of parental *behavior*. To illustrate, we cite two possibilities: one via fathers, the other via mothers. In male mice conditioned to associate a fearful event (electric shock to the feet) with a specific odor, Dias and Ressler (2014) report that this fear-odor association was transferred to male offspring (who had never experienced the electric shock themselves) by means of epigenetic methylation differences in sperm DNA, involving the gene for the olfactory protein responsible for detecting the odor in question. This epigenetic information was also coded into the sperm of the second generation. Similarly, Gapp et al. (2014) found that early trauma resulted in changes to sperm RNA, which were inherited by the next generation.

Increasing numbers of studies are relating prenatal maternal mental health to neurobehavioral outcomes of offspring (Graignic-Philippe et al. 2014), and epigenetic mechanisms have been found to play a role (Keverne 2014) as does the placenta. The placenta serves as an interface between the developing fetal brain and the adult maternal brain as well as a conduit whereby external conditions can influence fetal development (Broad and Keverne 2011). The fetus controls its own destiny, but only if the mother can respond optimally. Thus the placenta produces hormones which suppress maternal fertility, reduce maternal anxiety, and increase maternal food intake in advance of fetal demands. Placental hormones also ensure production and postpartum delivery of milk, time of parturition, and priming of the maternal brain for maternal care.

These intergenerational adaptive events require coadaptation across fetal and maternal genomes. This is facilitated by co-expression of genes in both the developing hypothalamus and developing placenta; at the same time, the placenta is instructing the maternal hypothalamus. Critical periods for regulation of the developing fetal brain and developing placenta are co-adaptively coregulated by the same epigenetically regulated genes (Keverne 2014). Under beneficent environmental conditions, therefore, offspring which receive normatively "optimal" gestational nourishment and maternal care will themselves develop a brain that is epigenetically predisposed to gestation, mothering, and general health trajectories that are normatively "optimal" and adaptive (for these conditions). Equally, however, environmental sources of stress and trauma to the mother transmit to the next generation predispositions toward gestational, maternal care, and general health trajectory consequences that are normatively "suboptimal" (but nevertheless adaptive for these adverse conditions), as described above. In other words, environmental regulation for different strategic life history trajectories begins in the womb, and the maternal stress response to adverse environmental conditions mediates the regulatory impact of the greater environment on fetal development.

To the extent that such mechanisms of transgenerational transmission of developmental trajectories occurs in humans, their significance lies in just how deeply structural violence and structural peace become embedded in a population across multiple generations. This, again, underlines the limitations of transient peacemaking in the absence of peacebuilding that endures for multiple generations.

## Environmental Regulation of Threat-Related Built-In Intelligence

Here we examine in greater detail top-down and bottom-up modes of built-in intelligence for dealing with threat and their regulation. Humans, like most mammals, are highly dependent on others. Individual and close interpersonal relationships including parent-infant dyads and adult pair bonds are critical to both survival and reproduction. In this context, neuropeptide hormones synthesized in the brain, including oxytocin and vasopressin, have emerged as critical players in the body's management of both social behavior and reactions to both threat and safety. Other essential elements, largely outside the current focus, include sensory inputs, salience, reward, and threat detection pathways, the hypothalamic-pituitary-gonadal axis, and the hypothalamic-pituitary-adrenal stress response axis.

### The Neurobiology of Responses to Threat, Stressors, and Trauma

The mammalian body thrives and reproduces most successfully under conditions of safety. However, evolved features of the human nervous system also exist to support survival and reproduction in the face of danger or threat. The physiological and behavioral management of threats depends on neural and endocrine systems that evolved from reptilian ancestors with modifications that are specifically mammalian and which over the course of evolution were adaptive (Porges 2011). In humans, the most complex defense strategies rely on cognitive strategies. These strategies may include elaborate physical or ritualized systems which, although primarily cognitive in implementation, may be motivated by more ancient physiological processes. Many of the apparently irrational behaviors shown by humans may be best understood in the context of attempts to provide physical and emotional safety for ourselves or for those to whom we feel attached.

Examples in humans of cognitive responses to a potential danger might range from simple avoidance of threatening situations to the development of weapons of mass destruction. However, more primitive strategies, based on older brain structures, also provide substrates for our responses to environmental and social demands or threats. Understanding the nature of ancient coping strategies and physical and emotional mechanisms associated with these strategies helps to demystify the human response to stress and trauma.

The sequence of physiological and behavioral responses that follow a stressful or traumatic experience may be considered to be adaptive coping and can follow several patterns, including cognitive planning as well as active or passive coping patterns that are dependent on this more primitive survival-based system. Complicating our understanding of the most ancient coping mechanisms is the fact that this system evolved before the modern neocortex and operates largely below the level of cognitive control. Moreover, when emotional feelings can be detected, they are often diffuse and difficult for the cortex to interpret.

In general, active coping is associated with physical mobilization (e.g., fight or flight) and in some cases emotional anxiety (mental mobilization). Passive coping is characterized by immobility (freeze) and behavioral and psychological depression. Individuals may show consistent and chronic coping responses or may shift from one state to another, in some cases due to changes in the external environment or in response to mental states. Oxytocin and vasopressin are powerful hormones/neuromodulators that have the capacity to modulate emotional states and traits and may help in the understanding of the developmental consequences of stressful or traumatizing experiences (Carter 2005; Carter et al. 2009; Carter and Porges, this volume). For example, the presence of high levels of oxytocin may be capable of creating a sense of safety, allowing both social engagement and refined forms of top-down cognition. Oxytocin may also have the capacity to regulate its own receptor, especially in early life. Vasopressin, in contrast, is a hypothalamic component of the HPA axis, often working in conjunction with corticotropin-releasing hormone. Vasopressin contributes to bottom-up self-regulatory biological states associated with vigilance, hyperarousal, and reactive aggression (Carter and Porges 2013). The actions of vasopressin on the central and autonomic nervous systems may help to explain several of the consequences of early adversity. At present, however, the nature of the dynamic interaction between oxytocin and vasopressin is poorly understood.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

In mammals, including humans, the response to severe threat or traumatic experiences depends on the intensity and chronicity of the experience, as well as the history, age, gender, and health status of the individual. Clues to the body's response to traumatic experiences can be extracted from awareness of the evolution of the nervous system and the hierarchical nature of responses to stress or challenge. According to the polyvagal theory (Porges 2011), in the face of an acute mild stress and in the relative absence of a history of trauma, top-down self-regulatory cognitive responses and social engagement may be sufficient to allow adaptation and coping. More severe stressors may trigger active coping responses, such as increases in heart rate (sympathetic nervous system activation) and a relative reduction in vagal (parasympathetic) activity. These responses would facilitate bottom-up self-regulatory mobilization and if necessary defensive attack or escape. In response to an extreme stressor, and especially after repeated or chronic stress, the body may show even more primitive bottom-up parasympathetic (vagal) mental and physical shut-down responses. Shut-down responses, and other forms of passive bottom-up self-regulatory coping, are marked by reductions in heart rate and blood pressure, sometimes including difficulties in accessing cognition, dissociative states, and even loss of consciousness and fainting.

Exposure to chronic stresses, including circumstances that lead to flashbacks and the reliving of traumatic events, may over time create symptoms which are lumped together under the clinical diagnosis of PTSD. Such responses would be adaptive in protecting vital functions, such as breathing and blood flow to the heart or brainstem, but are incompatible with active forms of social engagement behaviors and higher cognitive functions. PTSD is sometimes characterized by mobilization, but may also include vacillations between hyperarousal and shutdown responses. Under these conditions it is possible for individuals to have a reduced capacity for top-down behavioral inhibition, and states of reactive aggression or rage may appear.

The vulnerability to shifting into either hypermobilized states or hypomobilized behavioral and autonomic shutdown appears to depend in part on brainstem and autonomic pathways that are shared among mammals. These pathways may have evolved in the evolutionary transition from reptiles to mammals (Porges 2011). The enlargement of the neocortex which characterizes primates is supported by modifications in the autonomic nervous system, including a more elaborate parasympathetic system, comprising a myelinated vagus nerve which makes for more efficient top-down self-regulatory control. The myelinated vagus originates in brainstem nuclei that are partly regulated by mammalian neuropeptides, including vasopressin and oxytocin.

The presence of the myelinated vagus normally helps to keep the cortex and hence top-down self-regulation online. However, as described above, newer components of this system may be withdrawn under stress, thereby bringing bottom-up self-regulatory systems online, allowing for more primitive fight,

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

flight, or freeze survival functions, including supplying oxygen and nutrients to tissues.

## Safety in the Brain: The Role of Others

Barring immediate physical dangers and privations, "the environment" for young children (and indeed all humans) consists of other people. For a child, this means close associations with others such as parents, other caretakers, and immediate relatives. In other words the environment is a social one, and the infant's brain comes prepared to socialize from the very beginning (Siegel 2012). Thus the neural substrates that subserve responses to both threat (as detailed above) and safety are regulated, with exquisite sensitivity, by social interaction.

At birth, humans as well as some of the simplest mammals demonstrate complex built-in social intelligence. Research in highly social rodents, such as prairie voles, provides evidence of the capacity of comparatively simple nervous systems to develop lasting social bonds and other complex patterns of sociality, and to use social support to modulate reactivity to environmental challenges (Carter 1998). This form of social intelligence depends, at least in part, on primitive components of the nervous system, which have been in existence long before the evolution of human behavior. An understanding of these older systems is shedding new light onto the deeper biology of human social behaviors.

Causal mechanisms of social (sometimes called prosocial) behaviors are often hard to identify and thus have sometimes been assumed to be simply the absence of aggression. Increasing evidence indicates, however, that social stimuli can induce a cascade of endocrine and autonomic events that may facilitate sociality. For example, male prairie voles are highly social, even prior to reproductive experience, and show parental behavior within seconds of first exposure to an unrelated infant (Kenkel et al. 2012b). The high level of male parenting behavior seen in this species is partly mediated by a unique cocktail of hormones, which include social neuropeptides implicated in other forms of social behavior (Carter and Porges, this volume). Even the presence of an unrelated infant induces (regulates) a transient release of oxytocin and vasopressin in male prairie voles, resulting in both nurturant and protective behaviors toward the infant. The physiological state associated with alloparental behavior in prairie voles also includes activation of both the sympathetic and parasympathetic nervous system; this allows males to show high levels of nurture toward offspring while retaining a capacity for defensive behavior, which may be necessary to protect the young from potential threats (Kenkel et al. 2013).

During interactions between a human mother and child, the nervous systems of both engage in a coordinated interplay of neuronal activation as well as production of neurotransmitters, hormones, and neuropeptides. Cues from one partner (e.g., eye gaze, smiling, vocalizing) are met by the other with rhythmic, contingent alternation or reciprocation at the behavioral level, while at the brain level these activities are accompanied by increased levels of oxytocin in both partners. In moments of extreme behavioral synchrony during a face-to-face interaction, physiological synchrony increases between mothers and their infants so that they share virtually identical heart rhythms within lags of less than one second (Feldman et al. 2012).

Based on information reviewed in the preceding sections, it can be hypothesized that the primal experience of safety for an infant is one which combines synchrony with another person, augmented levels of oxytocin, and activation of the myelinated vagus and the parasympathetic nervous system. *Social interactions permit not only adaptive responses critical in the face of threats but also the use of cues associated with safety to allow growth, restoration, and development of critical social skills and social affiliations*.

## Childhood Adversity and Life-Time Trauma Exposure

Adequate nurturance in early life may predispose an individual to deal more effectively, in a top-down fashion, with subsequent experiences of trauma. Conversely, neglect or abuse in early life may sensitize an individual to bottom-up overreacting in later life. The following account of PTSD exemplifies the downsides of bottom-up self-regulation.

Several studies have repeatedly shown that the number of different traumatic event types experienced influences not only risk for PTSD, but also the severity of PTSD symptoms as well as the likelihood of spontaneous remission (Kolassa et al. 2010b; Mollica et al. 1998; Neugebauer et al. 2009; Neuner et al. 2004). It appears that there is no such thing as ultimate resilience for the development of psychopathology in the face of trauma. If traumatic load is extremely high, the risk for PTSD approaches asymptotically to 100% (Kolassa et al. 2010b).

Genetic factors seem to play a role in the individual risk for PTSD, particularly genetic factors which influence processes of memory formation (Wilker et al. 2014), such as fear conditioning, fear extinction, emotional memory formation, and long-term memory formation (Kolassa et al. 2010a, b; de Quervain et al. 2007; de Quervain et al. 2012; Wilker et al. 2013). Thus, something which might be assumed to be evolutionarily adaptive—good fear conditioning, good (emotional) and long-term memory formation—can become maladaptive in the case of trauma, leading to more (built-in, but not so intelligent!) suffering (de Quervain et al. 2012). In other words, PTSD appears to be a case of an adaptive mechanism being pushed by the environment beyond its regulatory limits, from one embedded canal into another, from which it is unable to return even after the environmental threat has gone.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

### Parental Mediation in Traumatic Stress

In war-torn societies such as Sri Lanka and Afghanistan, it has been shown that mass trauma has an impact on children and their families. The domestic violence present in these and other war-plagued countries puts additional traumatic load on these children. In Afghanistan, family size, child labor, and poverty predicted domestic violence, whereas in Sri Lanka, fathers' drug abuse predicted child maltreatment (Catani et al. 2008; Panter-Brick et al. 2009, 2011). It is likely that parental substance abuse increases as a means of coping with trauma in war-torn societies. Children of mothers with PTSD have an increased risk for child maltreatment (De Bellis et al. 2001; Chemtob et al. 2013). Children of substance-abusing parents are more likely to be exposed to family violence (Dube et al. 2001b). Traumatized parents are persistently unable to experience positive emotions (e.g., loving feelings, psychic numbing) and show a marked alteration in arousal and reactivity. As predicted by the hierarchical organization of the nervous system (Porges 2011), traumatized parents are more likely to exhibit hypervigilance, irritability, aggression, reckless, or self-destructive behavior. All of these can severely impact the parent-child relationship and thus the child's mental and physical health via alterations in systems underlying parent-child attachment (such as altered oxytocin and vasopressin levels). Under severe conditions these may alter epigenetic imprinting, with broad consequences for developmental trajectories and adult outcomes, possibly crossing several generations.

## Distinct Relational Models Regulate Built-In Intelligence Differently

### Relational Models in Early Development

Given the relational nature of peace and violence, it is not possible to understand causes or triggers of violence, or the perceived nature of injustice or normative expectations, without reference to the possible types of relationships and the nature of groups. From the earliest dyadic interaction of a newborn infant with the mother, to participation in ever-widening circles of family, friendships, and myriad group affiliations and alienations established over a lifetime, humans engage in relationships, in and through groups.

Fiske (1992, 2004) proposes that humans construct their relations in essentially four models, based on communalism, authority/hierarchy, equality, or equity (proportionality). Each of the models entails a different set of norms, expectations, and responses to deviation. Each entails a different understanding of justice and morality (Sunar 2009; Rai and Fiske 2011). And each holds the potential to contribute to either violence or peace, depending on circumstances. Predispositions to construe relations in these four models appear early in life: first as love and attachment plus sensitivity to helpful versus harmful actors (communal sharing), sensitivity to and understanding of dominance and hierarchy (authority ranking), demands for and proclivities toward equal sharing, turn-taking and reciprocity (equality matching), and somewhat later as demands for proportional fairness (market pricing).

It is a well-established finding that infants show signs of strong attachment to their caretakers before the end of the first year of life, and that security of the attachment predicts positive development into later childhood, with better social skills, self-regulation and resilience found in children with secure attachment histories compared to those with insecure attachment histories. Like other built-in intelligence, attachment is seen to be regulated by environmental factors such as caretaker sensitivity to the infant's needs or through "the dyadic regulation of emotion" (Sroufe 1996). It can also be a canalizing factor that influences adult experiences of romantic love (Hazan and Shaver 1987).

Other early developments which serve to bond baby and caretaker were reviewed above (see discussion on social neuropeptides). Through interactions with the caretaker(s), the infant repeatedly experiences closeness, safety, need satisfaction, and trust in concert with the operation and regulation of these neuropeptides and other brain mechanisms, including the resonance of shared brain states and synchronized behavior. All these experiences set the stage for full participation in the communal sharing relational model, with its defined boundaries, ethic of mutual help, and frequent induction of shared brain states through such modalities as music, rhythm, and food sharing. It is likely that this is the first relational model constructed by the infant mind, and the one in which most people continue to feel most comfortable, even in adult life. As with attachment processes, failure to experience basic trust in infancy can be a canalizing factor that leads to great difficulties in establishing and maintaining satisfactory relationships in later life.

Although infant sensitivity to dominance relations and hierarchy has been little studied, very recent investigations have found that dominance relations can be recognized as early as 10 months of age (Thomsen et al. 2011). Mascaro and Csibra (2014) found further that at 15 months, infants were able to learn linear (hierarchical) dominance structures more easily than circular structures. These findings suggest that very young children are prepared to notice and mentally represent dominance and hierarchies even before they are able to walk, and long before they can engage in the rough-and-tumble play of the preschool years (age three to four years), in which they establish their own dominance relations (Smith and Connolly 1980). According to Boyce et al. (2012a), dominance hierarchies are well-established in kindergarten classrooms (at age five to six years). These findings suggest strongly that children have an early-developing propensity to recognize dominance, to make sense of it (e.g., as linear hierarchies), to participate in dominance contests, and to accept their own place in the hierarchy. Even though dominance hierarchies would appear to be nearly ubiquitous in the modern world, Boyce et al.'s findings suggest that

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

subordination, even at the age of five years in the relatively benign context of a kindergarten classroom, may have negative effects on children's development; this may be a clue to the pernicious effects of structural violence as manifested in status, class, or subjugation in the larger society.

The chief concern of the equality matching model is fairness, defined in terms of equality and reciprocity, supported by at least a rudimentary conception of rules or normativeness governing rights and obligations. Recent studies have begun to show that this concern has also very deep developmental, probably evolutionary roots (for a discussion on on reciprocal altruism, see Trivers 1971). For example, Rakoczy and Schmidt (2013) reviewed evidence for the "early ontogeny of social norms," showing that children as young as two years of age not only understand that social activities are governed by norms but they also enforce norms on third parties. There is considerable evidence that children from early in their second year onward look longer at unequal distributions or otherwise indicate that equal distributions are expected or approved (Geraci and Surian 2011; Schmidt and Sommerville 2011; Sommerville et al. 2013). When making distributions themselves, 3 1/2-year-olds allocated items to figures who had previously shared, showing awareness of the principle of reciprocity (Olson and Spelke 2008). Three-year-olds also shared the rewards from a joint task equally (Warneken et al. 2011). From these findings we can infer that children are prepared, from an early age, to judge the normative appropriateness of distributions, approving of equal distributions and disapproving of unequal distributions, and to require others to follow the norms of equality and reciprocity. These norms can be applied within a group (e.g., among siblings or in a classroom) or they can be applied to relations with new acquaintances or between groups.

It is very likely that the proportionality rule and the concept of common currency are not cognitively accessible to children until somewhat older ages. However, soon after starting school they must master the idea of "marks" or "grades," which is a system based on proportionality and readily incorporated into the general notion of "fairness."

These models are by no means mutually exclusive; they coexist in nested and/or partially overlapping configurations. We can see then that use of various relational models, with their potentials for different forms of peace and order as well as for conflict and violence, begins to manifest itself very early in life. Let us look briefly at some of the implications for peace and violence.

A communal group is characterized by the equivalence of its members, who are defined as members by clear group boundaries. Members are to be helped, when in need, protected, and trusted; however, there is no such obligation to outside individuals or groups. Indeed, when De Dreu et al. (2012) administered oxytocin intranasally to participants in a competitive game, they found that protection and trust of in-group members increased while defensive aggression toward competing groups increased. They concluded that "oxytocin appears pivotal in up-regulating the human response to (arbitrary) in-group/out-group distinctions, shifting the focus from protecting and promoting oneself toward protecting and promoting members of the in-group. This effect of oxytocin may also be seen at the individual level, for example in mothers' protection of their infants from strangers (Mah et al. 2014) and in social selectivity and exclusion in a wide variety of group-living mammals (Anacker and Beery 2013). It may appear paradoxical that the relational model which appears most intrinsically harmonious and peaceable is also intrinsically susceptible to suspicion and aggression toward out-groups, but inclusion *ipso facto* requires exclusion (for a discussion on parochial altruism, see Bernhard et al. 2006).

Communal and authority-based relational models provide members with no tools to deal with other groups other than competition. This can easily lead to hostility (Sherif et al. 1954/1961) or avoidance, neither of which offers a peaceable option in a crowded world.

In contrast, the "equality matching" model can be used both within and between groups. Within a group, equality matching leads to a demand for justice and rights which can be satisfied by equal exchanges and distributions, reciprocity, turn-taking, and other forms of procedural justice. This model can be seen as deriving from the evolutionarily selected tendency to "reciprocal altruism," as conceptualized by Trivers (1971; see also Sunar 2009). These methods of ensuring justice can also be used by groups in their relations with other groups (e.g., in trading relationships, agreements, and treaties).

By "pricing" not only commodities but behaviors (e.g., labor) in a "common currency," it becomes possible to apply an equality principle to proportions rather than to actual quantities: the principle of equity (outcomes should be proportional to inputs). Legal-rational systems of law as well as corporations and markets make use of this model, allocating everything from salaries to jail terms on the principle of equity. Like equality matching, market pricing also provides groups (including companies, governments, and international entities) with reciprocity-based tools for establishing exchange and agreements.

Unlike the communal and authority-based relational models, equality matching and proportional pricing are not defined by closeness, sharing, or care, nor do they require sharply defined boundaries (except for the case of distribution). They represent concerns for justice, rights, and reciprocity, which are conducive to both peacemaking (as violence reduction) and peacebuilding (as violence prevention).

The logic of this analysis of different varieties of human relating suggests that the conditions which regulate for peaceful versus aggressive behaviors may vary widely, depending on the relational model in which people are operating. It is important to keep in mind that changes in relational models themselves are regulated by environmental conditions, including environments the models themselves engender. Similarly, each model may be challenged by different circumstances or behaviors so that normal peaceful relations turn conflictual and possibly violent. Punishment, revenge, and rebellion are common responses to norm violation, harm-doing, failures of reciprocity, and exploitation. The use of the various relational models, with their potentials for different forms of peace and order as well as for conflict and violence, begins to manifest itself very early in life.

## Altruism in Early Childhood and Evolution

The theoretical position outlined at the beginning of this chapter maintains that nature and nurture are inseparable, that what we need to conceptualize and study is how the environment regulates the built-in genetic intelligence potential. This stance, however, does not obviate the need to determine what the range of expression of that genetic potential is.

It is unnecessary to document the obvious propensity of human beings, from earliest infancy, to behave in selfish ways. However, it is important to document the opposite: the motivation for and performance of altruistic acts (acts that benefit another at some cost to the self) in young children. Evolutionary theorists have shown that kin selection (Hamilton 1964) and reciprocal altruism (Trivers 1971) are plausible products of evolution, leading to a large literature supporting these sources of prosocial (albeit ultimately adaptive) behavior. Recent studies have also shown that altruistic behavior is not contingent on kinship and that reciprocity begins to appear in infancy and early childhood. Sensitivity to whether others behave in helpful or harmful ways can be seen in the first year of life (Hamlin et al. 2007; Thompson and Newton 2013), along with approval for helping and disapproval for hindering or harming. Empathetic/sympathetic behaviors are also seen very early (Hoffman 1975, 2000). Sharing (sometimes solicited, sometimes unsolicited) can be observed by at least the third year (Dunfield et al. 2011; Warneken et al. 2011; Sunar et al., under review) and under normal conditions becomes a predominant response by six to seven years of age (Brownell et al. 2009; Fehr et al. 2008).

Helping also appears early, sometime in the second year, consonant with infants' approval of helping agents (De Bellis et al. 2001; Dunfield and Kuhlmeier 2013; Warneken and Tomasello 2009b). Supporting the idea of an evolved tendency to help, human infants as well as young chimpanzees show some degree of spontaneous help toward a human trying to achieve a goal, without expecting any reward. This suggests the presence of built-in intelligence expressed as altruistically motivated help in the context of a fellow primate's goal-oriented efforts (Warneken et al. 2007; Warneken and Tomasello 2006). The important lesson to draw from these studies of the early developmental and evolutionary emergence of altruism is that helping and sharing behaviors are spontaneous in everyday social circumstances in the absence of any expectation of reward or reciprocation. Children possess built-in intelligence which, all else being equal, inclines them to initiate behavior in support of reciprocal exchanges. Indeed, prosocial behaviors appear to be the default response (i.e., a neutral environment regulates for prosocial as opposed to selfish behaviors in human infants) (Warneken and Tomasello 2006).

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

It is imperative not to essentialize, reify, or romaticize spontaneous prosocial behavior. However, it is useful to understand from a social evolutionary perspective that cooperation can pay such huge dividends that humans are ever alert to opportunities for cooperation and for making themselves as appealing as possible to others as potential cooperators. Sometimes cooperation yields a win-win result where both parties enjoy immediate rewards, but often one party (individual or group) helps another party without deriving any immediate benefit, but with the expectation that the favor will be returned at a later time. Dynamics like these probably drove the evolution of prosocial motivations and behaviors such as altruism, loyalty, honesty, fairness, and rule-following. While these are normatively upheld as noble qualities, they may have sprung from evolutionary self-interest and may still function in these ways, manifesting and vanishing according to what is perceived as most advantageous under a given circumstance. Thus, cooperation (especially within a group) or competition (often toward "out-group" members) may be adaptive and may coexist.

Although the signs and early forms of use of relational models as well as altruistic behavior are striking, they are far from mature and may require ingenious experimental designs to allow detection. Development of these capacities and tendencies requires not only maturation of cognitive and affective abilities (such as perspective-taking, empathy, and various aspects of self-regulation), but also exposure to and socialization into the specific ways of the surrounding culture. In other words, their development depends heavily on the social environment; to discover the extent to which canalization may belong to the "one-off" variety will require further work.

## Groups: Environments of Social Development

Whenever the opportunity is there, children enter into relationships with other young children, from earliest toddlerhood, to form rudimentary groups for play (Sheridan et al. 2011; Whiting and Whiting 1975). The brain is exquisitely tuned to information from the group, so much so that reality itself can be defined by group opinion (e.g., Sherif 1936; Festinger 1954). Group acceptance and status within groups are vital matters for each individual.

In turn, individuals accept group identities with an astonishing alacrity (Tajfel 1982), showing in-group favoritism even in minimal groups. Children as young as three years of age show in-group bias, and by age 6 they begin to derogate out-groups (Buttelmann and Böhm 2014). Within groups, norms shape relational models and govern individual action; their internalization by members results in attitudes, stereotypes, and prejudices, which are also detectable by school age (McKown and Weinstein 2003). Thus some of the most basic elements in human conflict and violence—in-group vs. out-group distinctions as well as competition, stereotypes, and prejudice—are part of typically developing minds of children, experienced during the course of becoming

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

members of a group. At the same time, they are acquiring the benefits of group living: cooperation, sharing, empathy, forgiveness, loyalty, and obedience.

## Neurobiology of Groups and Shared States

Key unresolved questions remain concerning the interplay of the central and peripheral components of groups as complex biobehavioral systems that dynamically engage brain and body over the course of development (Gordon et al. 2011). Research is progressively showing that participation in groups involves an animal's genetic makeup, neuroanatomy, and neurophysiology. All group-living species, but especially primates and the large-brained sea mammals, provide remarkable examples (Connor 2010). Complexity of social groups is associated with brain size, leading to the hypothesis that the human cortex evolved to its current size and intelligence emerged, at least partially, in response to the cognitive demands of complex group environments (Dunbar 2008; see also Cummins 2005). Social neuroscience has produced much information about brain activity of individuals in various social situations. Relevant to our discussion is the finding that the brain reacts to rejection by a group with virtually the same pattern of activation seen in physical pain (Eisenberger et al. 2003). Similarly, loss of status frequently leads to depression, especially in males (Tiffin et al. 2005). Tabibnia and Lieberman (2007) found that fair compared to unfair distributions aroused distinctive patterns of brain activation, with fair distributions leading to activation of reward pathways.

Brain imaging studies are also showing that interconnectedness is not only a feature within one brain; it may also exist across brains. When we listen to music, it appears that there are many similarities in brain activation across individuals, even though the personal listening experience is idiosyncratic (Abrams et al. 2013). Humans engage in neurobehavioral synchrony during singing, chanting, dancing, or other rhythmic activities that foster affiliative relationships within groups. Similarly, when focusing on the same stimulus (be it a film, a speaker, or an athletic performance), certain brain networks exhibit a high degree of synchronization between individuals (Hasson et al. 2004). Findings regarding synchrony between infant and mother are also relevant here. Oxytocin, which is fundamental to child-adult interactions, may have evolved to facilitate both intra- and interindividual synchrony (Carter 2014).

Groups define us, but perhaps even more importantly, group discussion and action has the potential to bring about change (Lewin 1951). Because group processes are so powerful and so fundamental to the pressing issues of peace, it is thus imperative to study shared neurobiological processes beyond the individual or dyad. Advances in measuring real-time behavior in concurrence with ambulatory measures of neurophysiological activity (whether autonomic activity or the peripheral concentration of biomarkers, such as oxytocin or vasopressin) opens the way toward more advanced experimental paradigms tailor-made for investigating group processes (Gordon et al. 2014).

## Can Formative Childhoods Be a Path to Peace?

To our knowledge, there is no evidence to suggest that amelioration of environmental stress for individual children or families will automatically reduce structural violence or lead to greater social harmony at the community or national levels. The evidence and theory reviewed herein indicate two extremely serious hurdles in the path between experience in early childhood and peacebuilding. Both can be best understood as paradoxes that make sense in light of the distinction between peacemaking and peacebuilding.

The first paradox, set out in detail in the foregoing sections, stems from the ultimate dependence of development on the environment, which, combined with parental mediation, canalizes and embeds neurodevelopmental trajectories characterized by greater top-down or bottom-up modes of brain function. These opposing modes of brain function are the embodiment of greater or lesser top-down self-regulatory capacities and slower versus faster life history strategies, respectively. In other words, adverse environments regulate for lower parental investment. This, in turn, regulates evolved built-in intelligence in offspring to manifest in deeply embedded, strongly canalized bottom-up accelerated developmental trajectories characterized by impulsiveness, diminished empathy, defensive hostility, short-term thinking, precocious sexuality, and diminished investment in more offspring—traits which favor reproductive survival under adverse conditions (Belsky and Pluess 2013; Ellis and Del Giudice 2014). Taken alone, this suggests that interventions aimed at supporting a high level of maternal investment would be effective in regulating for individuals with the opposite slowed developmental trajectories characterized by strong top-down inhibitory capacities, better capacities for empathy, conflict resolution and long-term thinking, delayed sexuality, and higher investment in fewer offspring. In other words, individuals adapt to make the most of favorable environmental conditions wherein reproductive survival is better served by reasoned peacemaking than by impulsive aggressive violence, which is both counterproductive and entails significant risks. However, in a context of structural violence, harsh environmental conditions can lead to reduced parental investment in offspring (both pre- and postnatally). This, in turn, will regulate bottom-up built-in intelligence for accelerated developmental trajectories. Thus, unless structural violence is also addressed, interventions which aim directly to change parenting behavior so as to steer childhood development along a "better" trajectory will be going against the grain of evolution, which cares nothing for health, morality, or peace. To the extent that structural violence persists in the environment, efforts to improve the capacity for peacemaking may often be overwhelmed by failures in peacebuilding.

The second paradox stems from the relative independence of the relational models from one another, with the result that peacemaking inclinations and abilities that are supported or useful in one model may be irrelevant or even counterproductive in others. The built-in intelligence that directs individuals to care for others in their in-group simultaneously directs them, depending on the circumstances, to ignore, compete with, exploit, or try to destroy the out-group and its members. Interventions designed to support parents in caring for their children and in preventing neglect and maltreatment are certainly beneficial to children and in fact to all family members; benefits can be expected to extend to participation in other in-groups characterized by norms of mutual help and sharing. However, the attitudes, values, and skills that serve peacemaking within the family may have only limited usefulness in intergroup relations. Favorable early experience, including experiences of bonding and trust accompanied by production of neuroactive substances (e.g., oxytocin) cannot alone prevent—and may under some circumstances actually help set the stage for—hostile attitudes and direct violence between groups.

Dealings with larger groups and with out-groups may activate entirely different relational models. Competition and its resultant victory or defeat engage the attitudes and values of authority ranking, while issues of exchange and distribution engage the relational models of equality matching or market pricing, where the basic issue is not care but rather fairness or justice. And it is justice that is the *sine qua non* for both peacemaking and peacebuilding.

Part of the reason for these potential discontinuities is the mutual independence of relational models; another part is that (direct) violence—like life history strategies—is not simply a dysfunctional, expressive response to difficult circumstances. In a very large proportion of cases, whether of individual or group violence, there is a sense in which violence, in the minds of those who engage in it, has a rationale or justification, such as self-defense, punishment, or the restoration of justice. Very rarely is it a matter of striking out blindly or without purpose. Rather, it is most often seen as a response to injustice or to violations of normative expectations in a relationship, or as instrumental in bringing about a desired change (Boehm 2012; Pinker 2011). These subjective justifications may depend strongly on construals of the immediate situation, including the relevant relational model as well as the group norms governing regulation of relationships defined by these models.

For this reason, we cannot assume that amelioration of environmental stress for individual children or families (peacemaking) will automatically reduce structural violence (peacebuilding) or lead to greater social harmony at community or national levels. Conversely, existing evidence and theory described in this chapter support the hypothesis that the reduction of structural violence (peacebuilding) will have far greater positive impact on early childhood development than the protection of early childhood development (peacemaking) can ever have on reducing direct and structural violence. Obviously, portraying these two intervention models as mutually countervailing hypotheses is an oversimplification; they must always be taken in context. Nevertheless, as a starting point, it is fundamentally necessary to separate them first and only then address any "gray" areas whenever and wherever they arise, not least because there are strong biological grounds for doing so (Cameron et al. 2005). Since

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

reality is never black and white, much further research is vitally necessary, at multiple biopsychosocial levels, to delineate, evaluate, contrast, and better comprehend the strengths, weaknesses, and social meanings of peacemaking and peacebuilding interventions across diverse societal contexts as well as across varying time frames.

## Basic Motivations and Capacities That Can Be Mobilized by Interventions

Throughout this chapter, evidence for the thesis that structural violence may overwhelm peacemaking has been advanced. Nevertheless there is evidence that social policies and a wide variety of interventions, short of wide-scale social change, can bring about some degree of real benefit to the individuals and groups. Humans have a basic capacity and motivations which allow them (as individuals and groups) to respond to and utilize these benefits for the improvement of their own and their children's lives. At this level, peacemaking and peacebuilding can be seen as overlapping to a certain extent.

According to anthropologists and primatologists (e.g., Fry, this volume; Fry and Szala 2013; de Waal 1996, 2009), tendencies that contribute to peacemaking potentials (e.g., restrained agonism, reconciliation after disputes, and continuation of social relations after reconciliation) are common throughout the class of mammals but especially among primates. Likewise, skills in negotiation and other nonviolent means of conflict resolution can be taught and learned by humans as well as other primates (Sapolsky 2013) reinforcing the assumption that such capacities can be brought to the fore by relevant social ecologies (another example of environmental regulation).

The extremely wide variation in social organization that can be observed in human societies—from egalitarian, generally peaceful foraging bands with shifting memberships to rigidly stratified caste societies, to highly mobile market economies, to aggressively militarized societies—is testimony to the malleability of *Homo sapiens*. To the extent that national and other entities are able to write their own constitutions, literally or figuratively, the creation and maintenance of more benign environments is within the realm of possibility. Indeed, legal systems, which both provide protection from criminal predation and offer procedural justice, are hypothesized to be a major factor in the reduction of direct violence (Elias 1939/2000; Pinker 2011). Other social mechanisms include a variety of methods to reduce exclusive in-group identifications and stereotyping of other groups: cross-cutting memberships and a focus on superordinate goals with benefits for both/all sides (interdependence); coalition formation, although, being formed implicitly or explicitly as defense against other groups, coalitions carry an inherent danger of conflict.

In keeping with the finding that controlling for parenting behaviors nullifies the association between SES and developmental outcomes, early intervention

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

programs that fail to change parental behavior have been found to be of limited value (Cameron et al. 2005). Conversely, interventions that do change parental behavior can be effective, not least because they harness parents' deep desire to nurture and protect their children, a trait consistently observed across mammalian species. This primal built-in strategic motivation can be counted on across cultures and contexts, as a driving force needed to nurture children over the long periods of development required for them to develop the capacities required for self-sufficiency. Effective programs for parents build a sense of collaboration aligned with up-regulating this instinctual drive. While this is not the only motivational factor required for effective interventions (others include self or community efficacy), conscious alignment of interventions with built-in motivations increase their likelihood of success (Ellis and Bjorklund 2012).

Programs that target parents as well as those that directly target children may produce beneficial effects. Carré et al. (2014) found that young men who had received an intervention in childhood designed to reduce negative attributions in conflict situations had reduced testosterone reactivity and, in turn, lower levels of aggression in a conflict-inducing game compared with men who had not received the intervention. This reinforces the idea that experience canalizes brain processes, in this case including hormone secretion.

Another example comes from programs which target preschool and early school experiences (Killen and Turiel 1991). Since even very young children are attuned to issues of equality and equity, early age interventions that teach constructive responses to conflicts over unfairness and intergroup negotiation skills may have potential for strengthening top-down self-regulation. This, in turn, might enable more peaceful behavior in later life.

Acknowledging the potential power of group processes, one can also ask whether mothers or fathers from diverse backgrounds might form groups that transcend the usual cultural, ethnical, and religious boundaries. In their work with father support groups, this phenomena has been observed by the Mother Child Education Foundation (AÇEV): in father support groups composed of men from diverse backgrounds, united only by their concern for their children's positive development, friendships between men from different backgrounds emerged and continued past completion of the program (Koçak, pers. comm.). Here is another potential entry point for formative childhoods to support the development of more peaceful communities and societies.

## The Way Forward

For many people around the world, structural violence (poverty, adversity, injustice) contributes to an adverse environment. During sensitive periods early in life, such adversity can lead to a loss of children's developmental potential and the diminishment of their mental and physical health. Helping parents invest in their children may well increase the well-being, health, and resilience

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.

of future generations. More research is needed to explore this question in both human populations as well as in animal model systems.

Initial findings in human populations are already shifting social policies at national and international levels toward greater investment in early childhood development (Shonkoff and Fisher 2013; Shonkoff and Levitt 2010; Kagitcibasi and Britto, this volume). Based on persuasive biological and related evidence, policy makers are realizing that to improve developmental outcomes, it is necessary to do more than intervene early, based on the rationale that this is the most sensitive period during which canalization occurs. Also required are long-term social policies that reduce structural violence (peacebuilding) across the life span in order to regulate for higher caregiver investment and hence for "better" developmental trajectories. High-quality, long-term peacemaking efforts at the family level that are applied across whole communities will overcome the above obstacles precisely because, and to the extent that, these efforts reduce structural violence.

More research is also needed to better understand the neurobiology of groups and how best to encourage groups to view the "other" in a more compassionate fashion (Gordon et al. 2014). Here, studies in humans and primates will be instructive, but the development of intersectorial partnerships at every level of society will be crucial if peace is to be achieved.

From "Pathways to Peace: The Transformative Power of Children and Families,"
J. F. Leckman, C. Panter-Brick, and R. Salah, eds. 2014.
Strüngmann Forum Reports, vol. 15, J. Lupp, series ed. Cambridge, MA: MIT Press. 978-0-262-02798-4.