CHAPTER 5

The Neurorelational Framework in Infant and Early Childhood Mental Health

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Everyone lives in a very busy world. Infant, child, adolescent, and family practitioners are increasingly pressured with paper trails, the application of evidence-based treatments, and higher productivity levels. Infant and child psychiatrists are typically asked to quickly assess and then prescribe. In this context of whirlwind diagnoses and treatments lie problems all practitioners have inherited due to issues arising from *fragmentation, isolation, hierarchy,* and *specialization.*

The purpose of the Neurorelational Framework (NRF; Lillas and Turnbull 2009) is to provide a conceptual framework that addresses these four common problems. Turning to principles of brain development and functioning for guidance and organization, the NRF uses brain functioning as a template for 1) understanding the meaning of behavior by holding multiple dimensions at the "micro" individual level in mind at the same time, 2) neutralizing disciplinary competition, and 3) providing a common language for team collaboration at the "macro" community level where a part-to-whole perspective underscores all assessment, diagnostic, and intervention processes. Using this template, the NRF offers an integrated core curriculum of cross-sector knowledge that is germane to all pediatric disciplines and supplies a part-to-whole clinical view that helps clinicians find distinctions from as well as intersections with other disciplines within this complex, multidisciplinary workforce.

In the current age of evidence-based treatments, the NRF aligns itself with evidence-based *practice* (as distinct from *treatment*) as a decision-making process that holds the tension between the best available research, the best of clinical expertise, and the family's cultural values (see Chapter 18, "Evidence-Based Treatments and Evidence-Based Practices in the Infant-Parent Mental Health Field," for a thorough exploration of this topic). The NRF

is not meant to supplant what practitioners already know; rather, it is intended to enhance and highlight the biopsychosocial components of cases. By following the sequence and structure of the NRF, one gains neurodevelopmental organization of a case that can save time and money and can help allocate resources with more precision. In this sense, the NRF holds potential for being its own evidence-based treatment.

A Brief Overview of the NRF

The two overarching goals in the NRF are to assess the infant's or child's and the parent's *individual neurodevelopmental differences* and to assess the *quality of engagement* between parent and child: 1) individual differences are assessed according to the constructs included within the four brain systems (regulation, sensory, relevance, and executive; described in later sections of this chapter), each of which reflects a set of related brain functions (referred to as "functional capacities") that are associated with various brain regions, and 2) the quality of engagement is assessed using the social-emotional milestones (Chapter 3 in Lillas and Turnbull 2009; see also Greenspan 1985; Greenspan and Wieder 1998; Zero to Three 2005). The baseline evaluation of both the individual and the parent-child dyad is considered in terms of stress and stress recovery patterns. Identifying these patterns provides an initial "hit" as to the degree of health and/or toxicity. *Toxicity* is defined in terms of four allostatic load, or stress, patterns, which are discussed in the next section, "The NRF Assessment Process." A basic assumption of the NRF is that one or more allostatic load patterns underlie medical and mental health diagnoses (McEwen 2002). Once a load pattern is identified, the clinician then evaluates each brain system's functional capacities in terms of the degree of strengths and preferences versus the degree of triggers and concerns to gain a precise overview of which system or systems are contributing to the load pattern(s) and what factors facilitate stress recovery.

The development of the NRF was influenced primarily by four complementary neuroscience theories that reflect the global and dynamic functions of the brain and its intimate connectedness to the body and the environment (Chapter 2 in Lillas and Turnbull 2009). With the emphasis on function, the NRF has identified each of the four brain systems as having certain functional capacities that serve as markers for assessment and intervention decisions.

The NRF Assessment Process

Step 1: Document Baseline Health Benchmarks (Allostasis)

The first step of the NRF assessment process is to document baseline health benchmarks, which are organized around a broad, dynamic construct of health known as *allostasis* (Berntson and Cacioppo 2007; Sterling and Eyer 1988). Allostasis holds the tension between flexibility (*allo*) with stability (*stasis*). The *flexible* side of allostasis, and one of the baseline health bench-

marks, is represented by a nervous system's ability to adapt to stress, to shift into a variety of stress responses that are contextually warranted, and to recover from them. An analogy that holds the balance between flexibility and stability, which allostasis represents, is a healthy rubber band. When stressed, the rubber band stretches and can get tight, yet it can always bounce back to its stable state of elasticity. The three normative responses to stress, documented from infant research on states of arousal, are *flooded* (a continuum from agitated to screaming behavior), *hypoalert* (a continuum from dampened/depressed to dissociative behavior), and *hyperalert* (a continuum from anxious to vigilant behavior) (Als 1984, 2002; Barnard 1999; Brazelton 1973, 1984; Sander 1988; Tronick 2007). The *stable* side of allostasis is represented by two predominant states of arousal that characterize self-regulation, one during the sleep cycle and one during the awake cycle. During the *sleep* cycle, stability is shown by cycling into deep sleep, along with adequate sleep cycles—a critical benchmark for baseline health that provides background support to smooth daytime state-of-arousal functions. Deep sleep is restorative; it resets one's thresholds for optimal arousal regulation the next day. During the *awake* cycle, stability is shown via stress recovery back to a stable awake state, with the ability to get into, and stay in, what is referred to as an *alert processing state* (Als 2002). This baseline health benchmark means that when awake, an individual can be calm, alert, present, and engaged with learning and relationships.

The coordination of flexible expressions of all three stress responses (the rubber band gets tight), along with stress recovery (the rubber band bounces back), supported by a stable alert processing state and deep sleep cycling, is one way to operationalize allostasis into parameters that are clinically relevant and observable.

Step 2: Assess for Individual or Dyadic Allostatic Load

When any of the baseline health benchmarks are missing, assessment for individual or dyadic allostatic load, or stress patterns, is indicated. When the *duration* of any of the three primary stress responses is too long, or the *intensity* goes too high, or the *rhythm* is too fast, stress shifts from adaptive to maladaptive parameters—from allostasis to allostatic load. The term *allostatic load* means that there is long-term wear and tear occurring on bodily organs (for elaboration of these associated disease processes, see Lillas and Turnbull 2009, pp. 121–122; see also McEwen 2002). The following are the four *toxic* load patterns:

1. *Over Reactivity to Stress:* Too quick and too frequent stress responses to real or perceived stressors (e.g., poverty, child abuse, caregiver for someone with a chronic illness)
2. *Repeated Reactivity to Stress:* Inability to adjust (habituate) to initial challenges that, over time, should no longer be threatening (e.g., *for child:* transitions to preschool, transitions to divorced parents' home; *for adult:* daily commute, job performance reviews)
3. *Extended Reactivity to Stress:* Prolonged stress response after stressor is removed (e.g., remaining agitated long after an argument, elevated blood pressure hours following a test, staying depressed after losing a game)

4. *Chronic Reactivity:* Chronic stress response, with inadequate stress recovery back to baseline health (e.g., chronic conditions of agitation/hostility, depression, hypervigilance, and/or disrupted sleep cycling)

In summary, *over reactive stress responses* to life experiences that do not adjust, but *repeat* and/or become *long and drawn out,* result in a condition of *chronic reactivity to stress.*

Step 3: Assess Each Brain System's Functional Capacities

With any toxic stress pattern, the process is to assess each brain system's functional capacities for both sources of resilience and triggers that can then guide treatment implications and recommendations. The case study in the following section illustrates each brain system and its pertinent functional capacities, as well as the assessment of stress, or load, patterns and the corresponding development of treatment interventions. Individualized risk factors associated within each brain system are also described: medical issues are referenced in the regulation system; sensory concerns include developmental delays and disabilities; relevance issues encompass mental health concerns; and motor, attentional, and learning weaknesses are considered in the executive system.

Case Study Illustrating Application of the NRF

Adam's parents came to me when he was 3 years old due to baffling behaviors that had stretched their parenting skills beyond their perceived capacities and had them spinning in professional circles, with no one able to identify what ailed him. In the early phase of assessment, before meeting Adam, I "mapped" him and his parents, using the four brain systems.

It quickly became apparent that Adam was suffering from the first three stress (load) patterns. Adam quickly and frequently went into a flooded state of arousal, manifesting in very loud, high-pitched screaming. Later, when he came to my office, which was in a quiet neighborhood, his intensity and volume were so high that one could hear his screaming nearly a block away.

Adam was not habituating (adjusting) to normal transitions, which is the second load pattern. Even when the transitions were to familiar places, such as to the grocery store or to a therapy office he frequented two or three times a week, Adam could not acclimate. Furthermore, Adam's flooded reactions lasted after the provocative event was over. For example, if a toy train that fell off the track was quickly put back on the track, Adam nonetheless remained in a flooded stress response for 10 minutes or more.

The abruptness and frequency of these screaming episodes would likely tax anyone's nervous system, creating a hypervigilant state in defense against the next spontaneous outbreak. Sadly, James, Adam's father, was doubly stretched due to his own traumatic history of having had a father who would quickly and suddenly go into loud rages. James would

react to Adam's sudden flooded state with a startle response that amounted to a flashback of his own father's rages. As a consequence, James was in the fourth load pattern: his sleep cycle was disrupted with disturbing dreams at night, and James was chronically hypervigilant during the day. This made James vulnerable to his chronic reactivity to Adam's screaming (Kaltsas and Chrousos 2007).

Evaluating the Brain Systems

More of this story unfolded as I looked at salient risk factors that pertain to Adam's regulation system, strengths that support the balanced functioning of the regulation system, and any triggers that might be contributing to load conditions.

Regulation System

The *regulation system* influences all developmental domains, providing the basis for all learning and engagement in relationships. *Regulation* refers to the use of energy across the 24-hour sleep-awake cycle, which was introduced as baseline health in Step 1. A *state of arousal* is defined as a cluster of physiological and behavioral signals that regularly occur together (Barnard 1999), with the focus on assessing the flexibility of stress responses (flooded, hypoalert, and hyperalert) in the context of stress recovery (deep sleep and alert processing state).

As described in Table 5–1, both mother and child had a rough start: mother (Eliza) with preeclampsia (gestational maternal high blood pressure), and Adam with a traumatic birth. Adam's nervous system showed signs of vulnerability when his heart rate dropped in response to his umbilical cord being wrapped around his neck. The fact that there was thick meconium (the first stool of the fetus) in Adam's amniotic fluid is evidence of Adam's intense stress over time in utero. Meconium, when inhaled at birth, causes respiratory distress. The degree of distress depends on the amount of inhalation, and Adam had a mild version of respiratory distress.

Although Adam's vulnerability continued to be expressed via frequent respiratory illnesses, his overall development was reported as "normal" until he turned 2. This was another stressful time for this family. His father's work, in construction, became slim to none. Eliza was forced to return to her career in the banking industry, requiring a move. With transitions like these, stress responses in young children are typical. However, Adam's intensity level, frequency, and duration of screaming were not typical, and the behavior continued beyond the 3–6 months that would account for an adjustment disorder. The parents began a rigorous search for answers. As shown in Table 5–1, Adam's strength was his robust sleep cycle. In addition, he was a healthy eater. However, already established through the load patterns, his awake arousal pattern had too little alert processing with inefficient stress recovery. Because of Adam's traumatic birth and the inherent vulnerability in his autonomic nervous system, likely with poor vagal tone (Porges 2001), the other brain systems needed to be assessed for more information. (Table 5–1 is an example of mapping out an individual's risk factors, functional capacities, and subsequent treatment im-

TABLE 5–1. Regulation system risk factors, functional capacities, and treatment implications

Child: Adam, male, age 3 Parents: Eliza and James

Regulation system history and risk factors

- Maternal preeclampsia
- Full-term pregnancy with severe fetal distress during labor
- Cord wrapped around neck three times during delivery
- Heavy meconium-stained fluid at birth; Apgar scores of 6 and 8; to the neonatal intensive care unit for 3–4 days with oxygen for mild respiratory distress
- Frequent respiratory illnesses as young child
- When age 2 years, father's work stopped; mother was able to find work out of town; family moved, and father is now primary caretaker
- At age 2 years, Adam began expressing himself through a flooded state of arousal, primarily screaming; this triggered father's traumatic history and dysregulation

Functional capacities	Preferences and strengths	Triggers and concerns
Capacity for deep sleep cycling	• Sleeps well; goes to sleep easily and stays asleep for 12 hours	• Some days he stays awake during afternoon naptime; he is more irritable on these days
Capacity for alert processing	• Limited, but does have periods of stability, especially in very safe environments, such as home	• Very narrow window and vulnerable to staying in this window
Capacity for adaptive use of and efficient recovery from all stress responses		• Primary stress response is flooded, lasting 10–30 minutes • Hypervigilance is also dominant; Adam seems very anxious to please others • No sign of hypoalert state

Treatment implications

- Due to a vulnerable immune system, protect from too much exposure to other children who are ill at preschool.
- Because Adam is beginning to "lose" his afternoon naptime, be aware that on days he does not sleep, he is more vulnerable to stress.
- Anticipate the need for food and snacks; bring snacks and drink in the car.
- Keep regular sleep routine to support his sleep cycle.
- Begin to anticipate the context for his hypervigilance, providing gentle support for transitions and experiences that cause his stress levels to rise (e.g., fine motor activities such as art, gross motor activities during recess, preschool teacher's somber face and firm tone of voice in dealing with a disruptive classroom).

plications emanating from the regulation system. This can be used as a template for mapping out each brain system.)

Sensory System

The *sensory system* translates various forms of energy into sensory information. Receptor sites in the body (e.g., skin, ears, tongue, eyes) are specialized to pick up specific types of energy (thermal, mechanical, chemical, and electromagnetic). The progression of sensory messages from their elemental features (e.g., perception of motion, contrast, phonemes, volume) to the level where multiple senses cohere as a whole (e.g., a football game, music) is achieved via *sensory processing* capacities, which are the first functional capacity of this brain system. For the sensory system to represent sensory information fully, it must also translate the more dynamic dimensions of the sensory message, such as intensity, rhythm, and volume, across all sensory modalities. This second functional capacity of this brain system is called *sensory modulation*. This is the capacity to balance the flow of sensory signals in a way that is appropriate to the situation: how long or short the duration, how high or low the intensity, and how fast or slow the rhythm of the sensations.

Examination of Adam's sensory system shed light on what triggered many of Adam's toxic load patterns. Although he was a fast sensory processer of visual and auditory information, he was overly reactive to stimuli as well. The NRF emphasizes the relational aspects of sensory information. Muscle output in the form of eye contact, facial expressions, tone of voice, and body posture or gestures (all signals for arousal states) is a source of sensory stimulation for an infant, child, or adult. It became clear that Adam was quickly stressed, becoming hypervigilant or flooded by others whose "output" included fast rhythms, high intensity, and long durations. As a clinician gains information on a child's preferences within each brain system, treatment strategies can be devised. In Adam's case, slowing down all transitions, reworking his schedule so that it was calm and relaxed, and using low-intensity vocal, facial, and gestural rhythms were beginning intervention strategies that matched his sensory preferences. Eliza's calmer, slower rhythm was a natural fit for Adam. This helped James see that if he could become calmer as well, Adam might be able to get better, faster. This possibility became an incentive for James's personal growth.

As described in a later section on the executive system, Adam's fast sensory processing speed was in a serious mismatch with his very slow and poor motor output. These disparities made it difficult to understand him. At first glance, a serious speech delay, sensory modulation difficulties, and poor motor control began to suggest pervasive developmental delays. Adding his intellectual brightness might lead one to conclude that he has high-functioning autism. This was indeed the first assumption as to what was driving Adam's difficulties, and it was revisited many times by many professionals.

The relevance and executive systems are important to understanding the quality of Adam's engagement. Does he avoid eye contact? Can he read others' emotional cues?

Relevance System

The *relevance system* is concerned with what is relevant and meaningful to each individual. What holds personal significance is guided by what strikes a person in a positive or negative

manner. The first functional capacity of this brain system is to flexibly experience, express, and modulate a full range of positively *and* negatively experienced, or *appraised,* emotions in ways that are contextually appropriate. Furthermore, memories shape what becomes relevant to an individual. The second functional capacity of the relevance system is to learn from experience by having access to a full range of positive and negative memories that are appropriate to the context. As emotions and memories combine, meanings emerge. Based on the appropriate balance of positively and negatively valenced emotions and memories, the third functional capacity is to create meanings and appraisals that accurately reflect self and others.

Adam's social-emotional milestones and range of emotions were contingent on his state of arousal. When in an alert processing state, Adam was able to make full eye contact, share joy, have a back-and-forth flow of communication, and use his gestures and words to express what he wanted. He could be funny and had a sense of humor. With enough self-regulation in a familiar environment, when it was not overly stimulating, Adam played with his friends, had play dates with them, and, recently, could be found hugging and kissing his friends good-bye. These were all signs that he was not autistic. In fact, Adam's hypervigilance toward reading others' cues and his own intense desire to please others moved him away from autism and shifted him toward an anxiety disorder. Adam's hypervigilance was fueled by feedback from adults in his environment, including his parents, who now quickly labeled his behavior as "bad."

James's own trauma history left him with negative *appraisals* of his own, so it was all too easy for him to transfer those appraisals to a son whom he could not quite understand, and about whom professionals disagreed as to the origins of his difficulties. Working individually with parents whose appraisal systems are too negatively experienced is critical. In private sessions with James, it was decided that the best route toward providing him with the immediate help he needed was to find proper medical support for his chronic sleep and awake regulation instability. A judicious medication regimen began to help James calm down so that he could better care for Adam. At the same time, neither parent was open to medicating Adam at age 3 years, even though the professional team was suggesting it as an option. Given the resources available through the regional center, the school district, and private insurance, Adam was able to have a full-scope team. Other children in poverty are often not as fortunate. A sad reality is that often such children are quickly medicated but are not paired with intervention services.

Executive System

The *executive system* relies on all the other brain systems to provide information in real time. Ultimately, the executive system is about *movement*—whether initiating or inhibiting behavior is the best choice to promote the accomplishment of one's goals in light of the context. For infants and toddlers, the qualities of motor stability, control, and output are the central aspects of the executive system. For young children on up, the first functional capacity is to express spontaneous, automatic, and consciously controlled behaviors in a flexible and purposeful manner; the second functional capacity is to integrate bottom-up

influences of emotion with top-down control of thoughts; and the third functional capacity allows the individual to integrate his or her own needs in relation to another's needs according to the context—in essence, to be consciously considerate of others.

Adam's motor system was delayed on multiple levels, including fine motor, gross motor, and speech delays. These delays were huge contributing triggers to Adam's load patterns. A crisis ensued when the school district's psychologist diagnosed Adam with autism and offered a placement in the special education classroom. However, because Adam was already reading and doing math at age 3, placing him with young children with serious intellectual disabilities would have created a serious mismatch. Adam did not fit any of the school district's categories of attention-deficit/hyperactivity disorder, autism, or even socioemotional disturbance. A neuropsychologist and I helped the parents to successfully advocate for Adam to be recognized as a "twice-exceptional child" (i.e., a gifted child with learning disabilities, behavior disorders, and/or communication disorders; Nielsen 1994), allowing Adam to remain at his academic preschool (the most natural environment for him) with the help of an aide for coregulation. With special training, his aide and his teachers now understood Adam's profile and knew how to help him with transitions, guide him through his anxiety during art, and calmly yet firmly redirect him to other activities if the current ones were overly stimulating.

Current Status

As time has passed, Adam has made great gains and is thriving. At age 4 years, he functions academically at first- and second-grade levels. Adam still receives occupational therapy, physical therapy, speech and language therapy, and parent-child dyadic treatments. Due to fiscal constraints, Adam's parent-child sessions alternate with parent and/or individual sessions for James on an every-other-week basis. Adam's top-down gains with his use of words for regulatory modulation ("I'm hungry, Dad"; "I'm tired and want to go to bed") as well as emotional regulation ("I'm scared, I want to leave now") are helping him regulate himself. He no longer has to scream out his words all the time; he can speak in a modulated tone. Visual and verbal prompts avert many an outbreak on the front end. When Adam does scream, he can recover within a few short minutes, albeit still too long for James. Adam is still at risk for respiratory illnesses, and Adam's parents feel very alone in this journey. In all of their circles, from family to professionals to friendships, no one has heard of "twice-exceptional children." Although they sometimes slip, they usually can catch themselves when labeling his behavior as "bad." Adam remains a very anxious child. On a recent field trip to a fire station, even with many executive prompts to prepare, Adam was hypervigilant in anticipation of sudden movement or a loud sound. His hands were sweating as he held his dad's hand; when James picked Adam up to hold him for more support, James could feel Adam's heart pounding and racing. Even though Adam has primarily recovered from his first and third load patterns, he still has trouble adjusting to what others would consider "normal" transitions and experiences (load pattern 2). His parents have a written medication prescription for anxiety ready to go, and they talk about filling it al-

most every week. (Although medication was considered a last resort for Adam, it might need to be tried first for other families.) With all of his supports in place, will Adam continue to mature developmentally to the degree that he will not need medication? Only time will tell.

The NRF's construct of the four brain systems has been useful in mapping the complex case of Adam and in serving as a template to clarify what services Adam needed, why he needed them, and how his parents could advocate for receiving the services in a much more timely and efficient manner than is often the norm. Following identification of both his strengths and triggers, Adam could be "seen" and begin to thrive, rather than being left to languish. At the same time, his parents could get help for themselves. As James became an advocate for Adam with the school district, he could reflect, with sadness, on how he had not previously understood his son. Learning to understand Adam and to speak up for him was a turning point in James's journey of healing as well. By first mapping the load pattern and then systematically mapping the strengths and triggers of the functional capacities in each brain system, treatment could be organized with clarity.

Conclusion

The case example presented in this chapter illustrates the comprehensiveness of the NRF for assessing the presenting problems of children and their families across multiple domains—regulatory, sensory, emotional, and executive systems—and for identifying multiple interventions across many different disciplines in a cohesive manner. If stress (load) patterns become a common language for assessment across disciplines, are understood as drivers of multiple disease processes, and are addressed via intervention through multiple sources of triggers and resilience, at an early level, public health prevention could occur on a larger scale than is presently practiced. This is both the challenge and the promise of the NRF approach.

KEY POINTS

- The multiple layers of fragmentation across disciplines include breakdowns on a "macro" community level where funding resources are tied to isolated, and often competing, diagnostic categories. The breakdowns on a "micro" individual level are where individual differences across multiple dimensions for both the child and the parent are not integrated into a comprehensive whole.
- The Neurorelational Framework (NRF) is a comprehensive and wholistic approach to assessment, diagnosis, and intervention for any age, from infancy throughout the life cycle.
- Stress response patterns include over reactivity, repeated reactivity, prolonged reactivity, and chronic reactivity from early life stress and, over time, become toxic, supporting long-term wear and tear on the body and brain, often leading to both medical and mental health disorders at later stages of life.

- The three primary steps elucidated in this chapter can be followed by any practitioner from any discipline to assess and therapeutically address stress and toxic stress. Once a stress response becomes part of a toxic stress pattern, four brain systems are used to map out both neurodevelopmental triggers and sources of resilience for each individual.
- The four NRF brain systems—regulation, sensory, relevance, and executive—mirror the complexity of families' presenting problems, as well as the multiplicity of approaches across disciplines, and provide the comprehensive map for providing wholistic assessment and intervention for children and families.

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