Humanity's Evolved Developmental Niche and its Relation to Cardiac Vagal Regulation in The First Years of Life

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Abstract

Background: The Evolved Developmental Niche (EDN) is a millions-year-old developmental system that matches the maturational schedule of the offspring, optimizing health. Every animal has a developmental niche.

Aims: Humanity has fallen away from providing its EDN. Does it matter?

Study design: Several components of humanity's EDN were reviewed (breastfeeding, positive touch, allomothers, responsive care, free play) in relation to cardiac vagal nerve regulation, a signal of healthy development.

Focal **subjects** were young children.

Outcome measures: A review of research on the selected EDN components in relation to vagal nerve function was performed. Data were available for all but the allomother component, which is typically not measured by western researchers, although allomothers provide EDN components alongside parents.

Results: Apart from the lack of research on allomother effects, all these EDN components have been shown to influence cardiac vagal regulation in young children.

Conclusions: Converging evidence suggests that providing the EDN in early life may not only support aspects of the child's primal health system, but bolster capacities for social health and wellness, the cornerstone of a positive life trajectory.

Keywords: Evolved Developmental Niche, cardiac vagal regulation, breastfeeding, touch, play, responsivity

Humanity's Evolved Developmental Niche: Cardiac Vagal Regulation in The First Years of Life

The trajectory for an individual's health begins early. During infancy, the primal adaptive system—comprised minimally of the brain, immune system, and hormonal system—are holistically interactive, shaping the integral development of the individual's physiology (Odent, 2002). A well supported primal adaptive system establishes a positive trajectory for health thereafter. Indeed, researchers recently have been noting that early life stress undermines health over the long term, for example, by seeding inflammation (McEwen, 2008, 2017, 2019).

Despite the concern for early life stress, few understandings of evolved expected care (our species' baseline for optimal care) are provided to those who are in contact with babies—from medical personnel to parents and other carers—not only for avoiding early stress but for facilitating the development of primal adaptive health. There exist limited sets of guidelines. For example, the World Health Organization's guidelines for "baby-friendly" hospitals identify practices that should be followed after birth to promote breastfeeding. But on the other hand, despite the multidisciplinary evidence for the importance of breastfeeding for child health, studies are still published suggesting that artificial formulas can do just as well or better for some particular ingredient (Cheung et al., 2023). Further, despite studies demonstrating the importance of maternal presence for healthy infant development (Moriceau & Sullivan, 2006), studies of sleep training continue to be published suggesting that distressing the infant through forced solo sleeping is not harmful in the short-term with regard to assessment of a limited variables in comparison to a poorly controlled comparison group (Price et al., 2012). In fact, the impression given by too many scientists is that we do not know how babies should be treated until we have done adequate empirical experiments.

The view here is that research experiments are not the first place to consult for guidance on how to support a healthy primal adaptive system. Humanity already developed the appropriate support system for human infants over the course of evolution: the evolved nest or evolved developmental niche. It is here that we can find a set of baselines for supporting lifelong health, baselines that apply to all young children, typical and atypical.

Humanity's Evolved Developmental Niche

Like every animal's nest, the Evolved Developmental Niche (EDN; Narvaez, Gleason et al., 2013; a.k.a. evolved nest; Narvaez & Bradshaw, 2023) is a developmental system that aligns with the maturational schedule of the offspring (Gottlieb, 2002), optimizing health. The EDN is the ecological system of care that evolved to meet basic needs, representing the way humans cared for their young for 99% of human genus existence. The EDN is still provided in nomadic forager and traditional communities around the world (Hewlett & Lamb, 2005; Konner, 2005). Provisioned by a community and not simply by mothers, the EDN includes: (1) infant-directed breastfeeding; (2) positive touch, being held or kept near others constantly; (3) caregiver prompt and appropriate responses to keep baby optimally aroused; (4) multiple allomothers (frequent care by responsive individuals other than mothers such as fathers and grandmothers); and (5) multiage self-directed free play in nature (Hewlett & Lamb, 2005; Tarsha & Narvaez, 2019). (The EDN also includes soothing perinatal experiences, social embeddedness, nature immersion and connection, and routine healing practices [Narvaez, 2024]. We do not discuss these here for space reasons.)

With the EDN, we have a set of baselines for child treatment. Each component is associated with physiological, psychological, and social health (e.g., Narvaez, Panksepp et al., 2013). The focus here is on cardiac vagal regulation, a capacity associated with the primal adaptive system, a physiological indicator of self-regulation (Laborde et al., 2018). We examine what we know of the relation between EDN experience and cardiac vagal regulation.

Cardiac Vagal Regulation

The autonomic nervous system (ANS) consists of two branches, the sympathetic (SNS) and the parasympathetic nervous system (PNS). The parasympathetic system slows the heart, influences anti-inflammatory effects, and opposes the sympathetic (fight-or-flight) system (Thayer & Lane, 2000). It contains the tenth cranial nerve (termed the vagus nerve, vagal tone, or heart rate variability) that operates to soothe and calm the heart, lungs, liver, digestive track, and immune system (Mazzone & Undem, 2016). The vagus nerve functions through a bidirectional system (sensory and motor components) that together play an integral role in the expression and experience of emotional states (Carter, Bartal & Porges, 2017).

The vagus nerve also functions to conserve energy, increasing calming and restorative properties in both physiological and cognitive systems after exposure to stress (Xu, Raine, Yu, & Krieg, 2014). According to Polyvagal theory (Porges, 2011), which is buttressed by numerous empirical studies (Field & Diego, 2008; Kolacz, Kovacic & Porges, 2019), the vagus nerve is a critical neurological component of the social engagement system that controls attention, emotion, self-regulation, communication, social behavior, and relational attachment. When developed well, the vagus nerve facilitates executive functioning skills (Bridgett et al., 2015) and healthy sociality, including emotional and self-regulatory capacities (Balzarotti et al., 2017; Côté et al., 2011). Vagal function is also an online biomarker for resilience (Smeets, 2010).

In short, well-developed parasympathetic functioning is related to numerous positive health outcomes and when dysregulated, is predictive of a wide range of social and physical pathologies. When dysregulated it is a transdiagnostic biomarker (Beauchaine, 2015) in post-traumatic stress disorder (PTSD), attachment disorders, obesity, eating disorders, neurological disorders, migraines, depression, neuropsychiatric conditions, attention hyperactivity deficit disorder (ADHD) and autism (Beauchaine, Gatzke-Kopp, & Mead, 2007; Ming et al., 2005; Schore, 2003). Further, it is a critical variable in predicting children's aggressive behavior (Xu et al., 2014).

As part of the primal adaptive system in the brain, the parasympathetic system is shaped by dynamic interactions in early life (Lomanowska et al., 2017). These include birth experience, unmitigated stress, and caregiver responsivity, with a growing need to understand the mechanisms by which different early life experiences shape child cardiac vagal regulation and sociomoral development (Calkins, 2011).

Converging evidence from developmental psychology, neuroscience, evolutionary biology, and epigenetics suggests that the EDN may be a critical ecological context in shaping child cardiac vagal regulation, a major component of physiological regulation (e.g., Kim et al., 2011; Schore, 2003; Tarsha & Narvaez, 2019). For example, a recent investigation examining childhood history in women found that EDN experience buffered the effects of childhood adversity on adult cardiac vagal regulation years later (Tarsha & Narvaez, 2022). Greater experiences of the EDN in childhood predicted enhanced adult cardiac vagal flexibility even in the presence of childhood trauma, suggesting that the EDN may mitigate the long-term effects of child trauma on parasympathetic regulation.

The Evolved Developmental Niche and Parasympathetic Regulation

To understand the impact of the EDN on physiological development, each component of the EDN (breastfeeding, positive touch, responsive care, alloparents, and free play) is first outlined according to our ancestral context, small-band hunter gatherer communities. Then, the component's relation to parasympathetic functioning is examined, highlighting evidence, when possible, from longitudinal studies and meta-analyses.

Breastfeeding

In our ancestral context, breastfeeding takes place on demand and lasts 2-5 years or longer with the average age of weaning around 4 years of age (Hrdy, 2009a). Unfortunately, in the United States, approximately only a quarter of women exclusively breastfeed their infants at six months of age and only 34% breastfeed through the first year (Louis-Jacques & Stuebe, 2018).

Successful and repeated breastfeeding requires dyadic coordination that involves activation of both the mother's and the infant's parasympathetic nervous system. To understand the role of the maternal and infant vagus nerve during breastfeeding, it is important to recall that the vagus nerve has two branches, the ventral efferent (outgoing) vagal and the dorsal vagal motor (DVM) process (Porges, 2009). The DVM is an evolutionary ancient vagal circuit that controls autonomic states below the diaphragm and immobilization responses in reaction to dangerous stimuli. The ventral vagal, on the other hand, is the phylogenetically newer branch and is known as the myelinated vagus. It contains a neuroanatomical and neurophysiological link between the regulation of the striated muscles of the face (via the brain stem), the larynx and the regulation of the ANS. Due to this neurophysiological link, the muscles of the face and larynx are connected to the heart and social engagement system by means of the vagus nerve (Porges, 2011). This facilitates the connection between heart, voice, emotion and face, making it possible to eat, drink, suckle, breathe and express emotional states on the face and through the voice.

During breastfeeding, the myelinated vagus of both the mother and the infant are activated, but in different ways. For infants, the process of feeding is complex and requires the activation of the ingestion-vagal reflex (Porges & Furman, 2011). The process of properly ingesting food, even for newborns, requires the sequential integration of sucking, swallowing, and breathing. This complex, repeated series of events requires the integration of the striated muscles of the face, head and neck coupled with the regulation of the lungs (bronchi), heart, the pharynx, larynx, esophagus, and soft palate. The striated muscles of the face, head and neck are unlike the striated muscles of the limbs because they are controlled by the myelinated vagus through different neuronal pathways, traveling through several cranial nerves. The activation of the infant's vagus nerve during breastfeeding means that the social engagement system, the face-heart connection, is also activated through the branchiomeric pathways which are special visceral efferent pathways. Simply stated, as the newborn feeds, the vagus nerve is stimulated by the ingestion-vagal reflex (muscles of the face, head, and neck), activating the social engagement system, facilitating engagement with the mother's (or caregiver's) face, providing the infant with parasympathetic experiences of relaxation. Such physiological regulation calms, soothes and homeostatically keeps the infant in a growth state.

Porges and Lipsitt (1993) suggest that the ingestion-vagal reflex is an important part of the infant-caregiver bonding process and paramount for development of infant regulation generally. The increase in vagal activity during feeding and the activation of the social engagement system (face-heart connection) allow for warm reciprocal interactions between the infant and the mother (or caregiver), training the vagus (and the child generally) for future social interactions. Consequently, breastfeeding may uniquely exercise the vagus nerve, providing a type of training beyond feeding for efficient reactivity that is integral to social interactions (Brown, 2007; Jacob, Byrne, & Keenan, 2009). Indeed, several studies show that breastfed babies have a more relaxed resting vagal function (vagal tone) (e.g., Di Pietro et al., 1987)

The connection between breastfeeding and increased infant vagal regulation, compared to bottle-feeding, may be because breastfeeding requires different movements. The breastfeeding infant's tongue must be very active, evoking effortful peristaltic (wave-like) motions to draw milk from the mother's breast, constantly pressing itself against her breast (Brown, 2007). In addition, when breastfeeding, the infant establishes a specific sequential pattern of sucking, swallowing and then breathing, all actions that actively stimulate the vagus nerve. The bottle-fed infant, on the other hand, experiences something similar to drinking from a straw and is not required to move his/her tongue in the peristaltic motion. In fact, during bottle-feeding, the infant's movements are the opposite; the tongue is relaxed and not moving and the infant does not establish the sequential breastfeeding pattern of suck-swallow-breathe (Goldfield et al., 2006). Breastfeeding requires infants to suck more frequently utilizing different neuromuscular actions (Moral et al., 2010).

Positive Touch

The next EDN component is touch which can generally be assessed as present or absent, positive or negative. Positive touch experiences refer to welcomed affectionate touch. Negative touch refers to the presence of harsh touch. Within nomadic forager communities, Schiefenhövel and Trevathan (2019) noted how touch is abundant and provided from the first moments after birth. A short initial cry immediately after birth is an expected phenomenon in these societies but excessive crying is costly in terms of metabolic expenditures. Any distress signal is mitigated by cradling and soothing in order to facilitate infant survival both in terms of energy preservation and the possible alerting of predators to the vulnerable mother and infant. Babies and young children remain in physical contact with their mothers and others at all times, including nighttime, and there is no negative touch (Hewlett & Lamb, 2005).

As social mammals, infants and children need extensive positive (affectionate) touch for proper development and are more likely to suffer adverse outcomes if they are deprived of touch, or receive harsh physical touch (e.g., corporal punishment) (Field & Diego, 2008; Gershoff, 2002; Montagu, 1986; Narvaez, Wang et al., 2019). Left-side cradling touch is commonplace across the world and its absence in early life is associated with autism (Malatesta et al., 2020). Decades of empirical evidence from both animal (Harlow, Dodsworth, & Harlow, 1965) and human studies (Maitre et al., 2017; Meaney, 2001; Spitz, 1945), demonstrate that affectionate touch is the cornerstone of sensory-cognitive development, facilitating growth (Schanberg et al., 2003), social and emotional development (Feldman & Eidelman, 2004), and neurobehavioral and cognitive development (Feldman & Eidelman, 2003). Frequency of maternal affectionate touch is also associated with developing the social brain (Reece et al., 2016) and broad psychological constructs such as body awareness (Crucianelli, & Filippetti, 2020).

Sharp and colleagues extended this line of animal research with observational human studies, examining the longitudinal effects of maternal stroking in the first year of life through a series of investigations. Frequency of maternal stroking during the early postnatal period (2 and 5 months) was associated with lower levels of child internalizing scores at 9 months of age, at 2.5 years of age and 3.5 years of age (Sharp et al., 2012; Sharp et al., 2015; Pickles et al., 2017). The researchers concluded that, similar to epigenetic research with animals, affectionate touch in the first year of life was a critical moderator of child internalizing behavior, carrying longitudinal effects. Together, the animal and human research underscores the importance of maternal touch in facilitating both healthy stress response systems and deceasing internalizing problems. However, when examining vagal tone specifically—which is part of the stress response system—few studies in either animal or human research have been conducted.

Responsive Care

In addition to breastfeeding and positive touch, the EDN includes responsive care. Providing responsive care means meeting the needs of the infant or child in the present moment, keeping infants in an optimal state of arousal—not stressed and not under aroused (Schore, 2019). Within the EDN framework, children receive consistently warm, responsive care by mothers and others, starting from their earliest moments of life throughout childhood (Hewlett & Lamb, 2005). Babies have priority and are not put down (Sorenson, 1998).

Responsive care requires the implementation of consistent and accurate detection and recognition of children's signals, most especially in times when the infant or child may become stressed or is distressed (Szymanska et al., 2017). According to Schore (2009c), responsivity involves affective communication between the mother (or caregiver) and infant or child includes mutual gaze transactions that are psychobiologically attuned whereby the caregiver synchronizes his or her behaviors to the child, co-regulating the child's changing bodily based emotions and behaviors.

Regarding parasympathetic functioning, responsive or sensitive caregiving may be the most well studied of the EDN components, spanning both infancy and early childhood. For example, in infancy, differences in vagal regulation during both the Still Face Paradigm and normal mother-child play interactions are visible as early as three months of age and have been associated with differences in mother-infant synchrony (Moore & Calkins, 2004). During normal play episodes, infants whose mothers were less sensitive and responsive showed less adaptive patterns of cardiac vagal regulation (higher cardiac vagal withdrawal). They also showed less cardiac vagal withdrawal during stressful situations and had more difficulty recovering from stress.

Maternal sensitivity in the first months of life is also predictive of more long-term infant cardiac vagal regulation. Maternal sensitivity predicted greater cardiac vagal withdrawal (physiological regulation) at five months and greater orientation toward the mothers at ten months of age (Perry, Calkins & Bell, 2016). In addition, the interaction between child cardiac vagal tone and maternal sensitivity was predictive of transactional dynamics between the child and caregiver. Children whose mothers were more responsive and sensitive at age 2.5 had greater cardiac vagal withdrawal at age 4.5 and this in turn, predicted great maternal responsiveness at 5.5 years (Perry et al., 2014). Other studies have confirmed these findings (Kennedy et al., 2004). Not only does maternal responsivity influence child cardiac vagal development early on with long-term effects, greater child cardiac vagal regulation predicts greater maternal responsivity.

Differences in attachment style and cardiac vagal regulation, for both mothers and infants, are well documented. Infants classified as insecure avoidant demonstrate higher cardiac vagal withdrawal during stress (strange situation paradigm) compared to secure infants (Hill-Soderland et al., 2008). Their mothers also showed differences in cardiac vagal regulation compared to mothers of securely attached infants. Mothers of less secure infants showed less cardiac vagal withdrawal during the reunion period, which is typically the most stressful episode, suggesting that the mothers of the securely attached infants were making greater attempts (physiologically more engaged) to repair the interaction. Other studies confirm the association between increased maternal responsivity and increased maternal cardiac vagal activation (Mills-Koonce et al., 2007). Mothers who provide responsive care demonstrate increased cardiac vagal activation or are less stressed with providing responsive care. Conversely, mothers of avoidant infants demonstrate the opposite association, suggesting that they may be physiologically challenged by the affective demands of their infants.

Alloparents

Providing responsive care requires help from multiple caregivers, referred to as allomothers or alloparents. These are caring individuals, other than mother, who provide responsive care. During human evolution, alloparents increased the likelihood that children would receive consistent, responsive care (Hrdy, 2009). In our ancestral context, mothers are assisted by others (e.g., father, grandmother) in caring for infants and children (Hewlett & Lamb, 2005) which facilitates longer breastfeeding duration (Quinlan & Quinlan, 2008). In assessments of carers, around half the time alloparents are holding babies, not the mother (e.g., Röttger-Rössler, 2014). When parents are surrounded by a supportive community of alloparents, their knowledge and expectations about parenting also increase and their stress surrounding parenting decreases, allowing for more positive rather than negative parenting interactions (Serrano-Villar et al., 2017). Because alloparents increase wellbeing, they are understood to be a protective factor for both parents and the developing child (Hrdy, 2009). In this way, alloparenting intersects several of the other EDN components (e.g., breastfeeding, touch, play) because it involves support for both the mother and father as well as the developing child. Regarding its involvement in parasympathetic regulation, few studies have examined the role of alloparents.

Free Play

The final EDN component discussed is free play which is an important part of mammalian childhoods and is shown to promote numerous positive outcomes in children. In nomadic forager communities, play is the foundation of all social interactions including hunting, gathering, and religious practices and ceremonies (Gray, 2009). Humor and playful attitudes inundate all activities and social experiences as community members creatively generate riddles, songs, and teasing as they conduct daily affairs. Children are given the freedom to explore and play at will throughout their childhoods. The community focus on play is thought to also counteract tendencies towards dominance with other members, deliberately using playful teasing to quell aggressive and egotistical inclinations (Gray, 2009; Lee, 1979).

Within the EDN framework, the type of play investigated here is physical social play known as self-directed free play or rough-and-tumble play. It is unstructured, with multiple-aged playmates, and ideally takes place in nature. Free play promotes brain development in multiple ways, including advancing affectively beneficial gene expression profiles, emotion regulation, and resilience to stress; it is an effective treatment for attention deficit hyperactivity disorder (ADHD) and promotes prosocial behavior (e.g., Panksepp, 2007). The changing dynamics of self-directed free play provides opportunities for learning how to shift and adapt to unexpected actions of playmates, affording opportunities to build emotional and relational flexibility (Spinka, Newberry & Bekoff, 2001). There is also evidence that lack of self-directed free play in childhood may contribute to altered or impaired social, sexual, and conflict interactions with peers (van den Berg et al., 1999).

Considering that opportunities for free play may be on the decline within the United States (Gray, 2011), understanding the possible impact of play on parasympathetic regulation is paramount. Most studies that incorporate cardiac vagal assessments and play measure vagal functioning *during* play experiences (social play or in parent-child dyadic relationships) rather than investigating play as a *predictor* of vagal functioning. During mother-infant play, cardiac vagal tone has been associated with coregulated communication interactions. For example, Porter (2003) utilized a complex coding measure to assess communication patterns between mothers and their six-month-old infants during play. The communication patterns were categorized as symmetrical, asymmetrical, unilateral, or disruptive (a dimension of nonregulation). Infants showed higher cardiac vagal regulation values when the communication was coregulated and had lower cardiac vagal regulation when there was unilateral communication. Other studies of mother-infant play indicate that cardiac vagal regulation is a predictor of affect during mother-infant synchrony (Moore & Calkins, 2004), is associated with language development (with differences between genders; Suess & Bornstein, 2000) and with moderating hostile-withdrawn parenting behavior (Leary & Katz, 2004). These findings suggest that not only is play important for child cardiac vagal development but for the language and communication patterns between the mother-infant dyad.

More recently, Gleason and colleagues (2021) examined frequency of free play in the last weeks as a predictor of children's cardiac vagal functioning in a sample of six-year-olds. Vagal functioning was assessed at baseline as well as during stress and recovery, providing information regarding how child cardiac vagal functioning changes. The group found that free play related to vagal regulation during both the baseline and stress conditions but did not account for how vagal functioning changed between the conditions.

Conclusions

We reviewed research regarding the relation of one feature of the primal health system, cardiac vagal tone, to the provision of our species evolved system of care, the evolved developmental niche. Although direct research on EDN effects is limited, the findings mentioned here support its usefulness as a baseline for promoting infant primal health and subsequent wellbeing.

Physiological health is not the only aspect of development influenced by the EDN. In fact, adults in nomadic forager communities demonstrate enhanced sociomoral capacities and orientations: ethnographic scholars report that they are highly prosocial, compassionate, generous, caring, and egalitarian (Fry & Souillac, 2013; Ingold, 2005; Narvaez, 2013; Wolff, 2001). Our other work has examined the relation of EDN provision to child mental health, sociality, and morality (e.g., Narvaez, Wang et al., 2013; Narvaez, Woodbury et al., 2019; Tarsha & Narvaez, 2023). Converging evidence suggests that providing the EDN in early life may not only support aspects of the child's primal health system, but bolsters capacities for social health and wellness, the cornerstone of a positive life trajectory. Its absence may be a significant contributing factor to the continuing decline in wellbeing among virtually every age in the USA (e.g., National Research Council, 2013).

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