Allan Schore

Affect Dysregulation and Disorders of the Self

CHAPTER 1

The Experience-Dependent Maturation of a Regulatory System in the Orbital-Prefrontal Cortex and the Origin of Developmental Psychopathology

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THE ONTOGENESIS OF SELF-REGULATION is an essential organizing principle, if not a fundamental mechanism, of the development of dynamic living systems. The concept of regulation is one of the few theoretical constructs utilized by literally every scientific discipline. The robustness and heuristic nature of this construct are reflected in the fact that regulatory processes can be studied simultaneously along several separate but interrelated dimensions, ranging from the molecular level of organization through the social and cultural levels. In fact, the adoption of this multilevel, multidisciplinary perspective is an absolute necessity for a deeper understanding of ontogeny, since development represents a progression of stages in which emergent adaptive self-regulatory structures and functions enable qualitatively new interactions between the individual and his environment. Since this early dialectic between the changing organism and the changing environment involves dynamic alterations in both structure and function, these "self-regulatory structures" need to be identified in terms of what is currently known about biological structure as it exists in nature. The phenomena of self-regulation thus represents a potential convergence point of psychology and neuroscience.

In discussing the development of self-regulatory structures of the mind, Cicchetti and Tucker (1994) asserted that "the best description of development may come from a careful appreciation of the brain's own self-organizing operations" (p. 544). There is now widespread agreement that the brain is a self-organizing system, but there is perhaps less of an appreciation of the fact that the self-organization of the developing brain occurs in the context of a relationship with another self, another brain. This other self, the primary caregiver, acts as an external psychobiological regulator of the "experience-dependent" growth of the infant's nervous system, whose components are rapidly organizing, disorganizing, and reorganizing in the brain growth spurt of the first two years of life. This "experience" is specifically affective, and the system of reciprocal mutual influences that is created by the caregiver-infant dyad accounts for the central role of affect in the formation of an attachment bond between the pair. These experiences are also shaping the maturation of structural connections within the cortical and subcortical limbic areas that come to mediate socioaffective functions. This interactively regulated affective interchange therefore constitutes a mechanism by which the social environment influences the development of psychobiological systems involved in homeostatic regulation. In optimal growth-facilitating socioemotional environments that provide modulated and varied affective experiences, the structural maturation of the brain in infancy and childhood is expressed in the ontogenetic emergence of more complex autoregulatory functional systems. In contrast, misattuned relational environments that generate high levels of negative affect act as growth-inhibiting environments for developing corticolimbic systems.

In *Affect Regulation and the Origin of the Self* (1994), I integrated current ideas about the origins of social functioning from the developmental sciences, recent data on emotional phenomena from the behavioral sciences, and new research on limbic structures from the brain sciences in order to generate models of the adaptive development of self-regulation as well as the origins of dysregulated systems that characterize both internalizing and externalizing forms of developmental psychopathology. Drawing from and expanding upon that multidisciplinary work, in this work I utilize a multilevel approach to characterize the structure-function relationships that underlie the development of affect regulation in the first and then the second year. I describe how different types of age-appropriate transactions of regulated positive and negative affect between the primary caregiver and the infant act as a growth-facilitating environment for the postnatal maturation of a specific corticolimbic system in the prefrontal cortex that mediates regulatory, homeostatic, and attachment functions. Then, I present evidence to show that deprivations of interactive affective experiences and/or failures of various classes of external affect regulation define growth-inhibiting environments for the development of this same system. In this way, different types of unregulated stresses that occur during the critical period of growth of the orbitofrontal cortex act as a source generator for insecure attachments. Finally, I suggest that such events predispose the vulnerable individual to future psychopathology by permanently altering corticolimbic circuits that are implicated in the regulatory failures that underlie the pathophysiology of psychiatric disorders.

This work is presented as a contributution toward the creation of what Hinde (1990) refered to as "an integrated developmental science." I should note that the developmental models that I am presenting are offered not as fixed statements or established principles but as heuristic proposals that can be evaluated by experimental and clinical research. This integrative, multilevel approach does, however, suggest a definite overarching psychoneurobiological perspective with which

to view early development, one quite compatible with and supportive of a developmental psychopathological viewpoint that conceptualizes normal and aberrant development in terms of common underlying mechanisms.

AFFECT REGULATION IN THE FIRST YEAR

From the moment of birth, the primary caregiver plays an essential role in regulating her infant's psychobiological states, especially disruptions of ongoing states and transitions between states. Because the infant's organ systems (especially its central and peripheral nervous systems) continue to mature over the course of infancy, her involvement is critical to processes as basic as the infant's fluid balance regulation and temperature regulation, life-sustaining functions that ultimately become autoregulated. These very earliest "psychosocial contacts" that entrain biological rhythms primarily involve olfactory-gustatory and tactile-thermal sensory modalities, but by the second quarter of the first year, with the increasing myelination of the occipital areas of the cerebral cortex, a particular type of visual information which conveys the mother's affective responses to the infant is now capable of triggering synchronous changes in the both the child's and the mother's internal state.

Affective Transmissions in Mutual Gaze Transactions

Over the first year of life visual experiences play a paramount role in social and emotional development. In particular, the mother's emotionally expressive face is, by far, the most potent visual stimulus in the infant's environment, and the child's intense interest in her face, especially in her eyes, leads him to track it in space, and to engage in periods of intense mutual gaze. The infant's gaze, in turn, reliably evokes the mother's gaze, and this dyadic system forms an efficient interpersonal channel for the transmission of reciprocal mutual influences. These mutual gaze interactions represent the most intense form of interpersonal communication, and in order to enter into this affective communication, the mother must be psychobiologically attuned not so much to the child's overt behavior as to the reflections of his internal state. She initially attunes to and resonates with the infant's resting state, but as this state is dynamically activated (or deactivated or hyperactivated) she contingently fine tunes and corrects the intensity and duration of her affective stimulation in order to maintain the child's positive affect state. As a result of this moment-by-moment matching of affective direction, both partners increase together their degree of engagement and facially expressed positive affect. The more the mother tunes her activity level to the infant during periods of social engagement, and the more she allows him to recover quietly in periods of disengagement, the more synchronized their interaction. In this way, not only the tempo of their engagement but also their disengagement are coordinated. By doing so the caregiver facilitates the infant's information processing by adjusting the mode, amount, variability, and timing of stimulation to the infant's actual integrative capacities. Facial mirroring thus illustrates interactions organized by ongoing regulations, and the development of mutually attuned synchronized interactions is fundamental to the ongoing affective development of the infant.

At another level, this overt, behavorial synchronization reflects a transformation of inner events, namely a powerful state transition. In synchronized gaze, the dyad creates a mutual regulatory system of arousal in which both move together from a state of neutral affect and low arousal to one of heightened positive emotion and high, yet modulated, arousal. According to Beebe and Lachmann (1988a), as the mother and infant match each other's temporal and affective patterns, each recreates an inner psychophysiological state similar to the partner's. Dyadically resonating, mirroring gaze transactions thus induce a psychobiologically attuned, affect-generating merger state in which a match occurs between the expression of accelerating, rewarding, positively hedonic internal states in both partners. The child is motivated to enter into a "reciprocal reward system" because "euphoric states are perhaps the most appetitively compelling experiences available to life forms as so far evolved" (Schwartz, 1990, p. 125). The dyadic nature of this system is seen in the fact that the mother's face, the child's "emotional" or "biological" mirror, reflects back her baby's "aliveness" in a "positively amplifying circuit mutually affirming both partners" (Wright, 1991, p. 12). The result is a transformation of state and the production of what Stern (1985) called vitality or crescendo affects. The burgeoning capacity of the infant to experience increasing levels of self-maintaining vitality affects is thus at this stage externally regulated by the psychobiologically attuned mother, and depends upon her capacity to engage in an interactive emotion communicating mechanism that generates these in herself and her child. Fogel (1982) underscored the developmental principle that a major task of the first year is the evolution of affective tolerance for increasingly higher levels of arousal, and that this is facilitated by the mother's modulation of the infant's highly stimulated states.

Indeed, regulatory processes are the precursors of psychological attachment and its associated emotions (Hofer, 1994), and psychobiological attunement is now thought to be the mechanism that mediates attachment bond formation (Field, 1985). These dialogues between mother and child increase over the second and third quarter of the first year, and in them the pair creates a symbiotic "merger" experience that acts as a crucible for the forging of preverbal affective ties, that is, for the generation of a bond between the infant and the attachment object. Infant research now suggests that the baby becomes attached to the modulating caregiver who expands opportunities for positive affect and minimizes negative affect (Demos & Kaplan, 1986). The positive emotions of pleasure and interest are the major indicators of affect attunement (Stern, 1985). In other words, the affective state underlies and motivates attachment, and the central adaptive function of dyadic attachment dynamics is to interactively generate and maintain optimal levels of the pleasurable states of "interest-excitement" and "enjoyment-joy" (Tomkins, 1963).

The Neurobiology and Psychobiology of Dyadically Regulated Positive Affect

According to Bowlby (1969), vision is central to the establishment of a primary attachment to the mother, and imprinting is the learning mechanism that underlies attachment bond formation. Furthermore, attachment is more than overt behavior, it is internal, "being built into the nervous system, in the course and as a result of the infant's experience of his transactions with the mother" (Ainsworth, 1967, p. 429). Imprinting involves a state of mutually entrained central nervous system propensities and a synchrony between sequential infant-maternal stimuli and behavior (Petrovich & Gewirtz, 1985). This points to another level of analysis—the neurobiological level. In this "transfer of affect between mother and infant," how is the infant's growing brain influenced by these events?

Trevarthen's work (1993) on maternal-infant protoconversations bears directly on this problem. A traffic of visual and prosodic auditory signals induce instant emotional effects, namely excitement, and pleasure builds within the dyad. The resonance of the dyad ultimately permits the intercoordination of positive affective brain states. His work underscores the fundamental principles that not only is the baby's brain affected by these transactions, but also that its growth literally requires brain-brain interaction and occurs in the context of a positive affective relationship between mother and infant. Trevarthen concluded that "the affective regulations of brain growth" are embedded in the context of an intimate relationship, and that they promote the development of cerebral circuits. This interactive mechanism requires older brains to engage with mental states of awareness, emotion, and interest in younger brains, and involves a coordination between the motivations of the infant and the feelings of adults.

Even more specifically, what is happening here is that the infant's early maturing right hemisphere, which is dominant for the child's processing of visual emotional information, the infant's recognition of the mother's face, and the perception of arousal-inducing maternal facial expressions, is psychobiologically attuned to the output of the mother's right hemisphere, which is involved in the expression and processing of emotional information and in nonverbal communication. The right cortex is known to be specifically impacted by early social experiences, to be activated in intense states of elation, and to contribute to the development of reciprocal interactions within the mother-infant regulatory system. The child uses the output of the mother's emotion- regulating right cortex as a template for the imprinting, the hard wiring of circuits in his own right cortex that will come to mediate his expanding affective capacities. In this way, the parenting environment influences the developing patterns of neuronal connectivity that underlie behavior (Dawson, 1994).

In fact, the mother's face is triggering high levels of endogenous opiates in the child's growing brain. These endorphins are biochemically responsible for the pleasurable qualities of social interaction, social affect, and attachment, as they act directly on subcortical reward centers of the infant's brain (Bozarth & Wise, 1981). As a consequence of this, the catecholamine dopamine, an essential neuromodulator of reward effects, is released from the anterior regions of the reticular formation in the ventral tegmental area, thereby triggering an elevation of dopaminergic-driven, energy-mobilizing, sympathetic-dominant ergotropic arousal and dopamine-mediated elation. There is now agreement that in postnatal life experience-dependent visual processes rely both upon cortical sensory processing of information from the "outer" world, and upon internally generated signals involving catecholamines from the reticular formation (Singer, 1986). Maternally induced increasing amounts of dopamine and endorphins thereby mediate the experience of enjoyment in the infant. Amplified levels of interest in her face are also accompanied by elevated levels of corticotropin releasing factor (CRF), a neuropeptide produced in hypothalamic centers that regulates the production of endorphins by the pituitary and activates the sympathetic division of the autonomic nervous system (Brown et al., 1982). Heightened activity in the sympathetic nervous system (which is in an active stage of growth at this time) is associated with intense elation, increased arousal, and elevated activity level in infants. The caregiver also modulates nonoptimal high levels of stimulation, thereby down-regulating supra-heightened levels of sympathetic arousal. In this manner, the attachment relationship is essentially a regulator of (ergotropic) arousal (van der Kolk & Fisler, 1994). By promoting a symbiotic entrainment between the mother's mature and the infant's immature nervous systems, the child is stimulated into a similar state of heightened sympathetic activity and resultant positive affect, alert activity, and behavioral activation. It is now well established both that it is the affective state that underlies and motivates attachment behavior and that the combination of joy and interest motivates attachment bond formation.

Furthermore, the mother is not only acting as a modulator of the child's current affective state, she is also regulating the infant's production of neurohormones and hormones which influence the activation of gene-action systems that program the structural growth of brain regions that are essential to the future socioemotional development of the child. Dopamine increases the transcription of the gene that encodes the precursor of endorphin in the pituitary, and circulating endorphins act as a controlling mechanism of postnatal development by influencing DNA synthesis and regulating dendritic growth and spine formation (Bartolome, Lerber, Dileo, & Schonberg, 1991; Hauser, McLaughlin, & Zagon, 1989). These biochemical events may explain the principle that stable attachment bonds that transmit high levels of positive affect are vitally important for the infant's continuing neurobiological development

(Trad, 1986). Such findings have significant implications for an overarching conceptualization of the adaptive function of positive affect in early development. Current developmental psychoanalytic research indicates that "It is the emotional availability of the caregiver in intimacy which seems to be the most central growth-promoting feature of the early rearing experience" (Emde, 1988, p. 32).

Interactive transactions that regulate positive affect, in addition to producing neurobiological, structural consequences, are also generating important events in the infant's bodily state, that is, at the psychobiological level. In describing the mother-infant experience of mutuality, Winnicott (1986, p. 258) proposed that "The main thing is a communication between the baby and mother in terms of the anatomy and physiology of live bodies." Hofer's (1990) developmental psychobiological research revealed that in the "symbiotic" state the adult's and infant's individual homeostatic systems are linked together in a superordinate organization which allows for mutual regulation of vital endocrine, autonomic, and central nervous systems of both mother and infant by elements of their interaction with each other. Furthermore, he stated that "in postnatal life, the neural substrates for simple affective states are likely to be present and that the experiences for the building of specific pleasurable states are likewise built into the symbiotic nature of the earliest mother-infant interaction" (1990, p. 62). Hofer emphasized the importance of "hidden" psychobiological regulatory processes—in these, dyadic symbiotic states are physiologically mediated by the regulation of the infant's "open," immature, developing internal homeostatic systems by the caregiver's more mature and differentiated nervous system. Importantly, a primary function of this symbiotic state is the generation of pleasurable states, that is, states marked by high levels of positive affect. These studies support the earlier work of Mahler, who posited a "symbiotic" stage of development in the second and third quarters of the first year (Mahler, Pine, & Bergman, 1975).

The Attainment of an Early Capacity for the Self-Regulation of Affect at the End of the First Year

In observational research, Mahler, a pioneer of developmental psychoanalysis, proposed that the symbiotic phase is followed by a "practicing" subphase that begins at 10 to 12 months and extends through 16 to 18 months. She further divided this critical period into an early phase at the end of the first year and a late phase which extends into the middle of the second year. The onset of the practicing period is defined by rapid changes in motor behavior, that is, the attainment at the end of the first year of upright posture and locomotion that supports the child's first independent steps. This capacity allows the neo-toddler to separate himself from the mother in order to begin to explore the nonmaternal physical environment, a fundamental event in the development of autonomy. The child is often observed to be relatively emotionally independent from the mother and absorbed in his own narcissistic pleasures, but upon the attainment of mastery of some autonomous ego function (or stressful encounters with the environment), he becomes aware of his need for his mother's acceptance and "renewed participation." This need for "emotional refueling" occurs in "reunion" episodes that occur after periods of separation between the practicing age infant and the primary caregiver. Reunion behavior, a central focus of study of attachment theory, is an even more important indicator of the quality of attachment than the child's protest at the point of separation. What interactive mechanism can account for what Brent and Resch (1987) called "reunions that occur across social space"?

It is known that when the infant locomotes more widely in its environment, vision is the primary mode of connection with the mother (Rosenblum, 1987). The child's sorties into the world occur under "the watchful eye of the caregiver," in which he uses the mother as a "beacon of orientation." But at the point when he returns to the secure base the mother's attention to the child's emotionally expressive face intensifies. With these facial cues the psychobiologically attuned mother is now able to appraise the child's internal state, and on the basis of this she reengages in synchronized patterns of visuoaffective communication. The toddler, in turn, attentively responds to the visual (and prosodic auditory) stimulation emanating from the mother's emotionally expressive face. In this dialectic the mother's communications provide the infant with salient maternal appraisals of interactions and events in order to regulate the child's internal state of arousal that supports his affect and behavior. The "renewed participation" at the reunion is thus an affective re-attunement. These episodes of "microregulation," in which each partner responds to the other in latencies ranging from simultaneous to one-half second, are thus critical moments of reciprocal signaling that mediate emotional reconnection after separations. The dyad thus evolves an operative mechanism for processing high intensity affective transmissions that efficiently reestablishes psychobiological attunement without the need for frequent and prolonged physical contact.

This mutual regulatory system is adaptive in that it allows for the arousal level of the child's developing nervous system to be rapidly recalibrated against the reference standard of the mother's. Since arousal levels are associated with changes in metabolic energy, the primary caregiver is thus modulating shifts in the child's energetic state. Indeed, these interactive refueling reunion transactions involving patterned energy transmissions between caregiver and infant may represent the fundamental mechanism of the attachment dynamic. Field (1985) defined psychobiological attunement in terms of the dyad being "on the same wavelength." This may in fact be more than a metaphor; it may refer to similar brain and thereby bodily states. Furthermore, synchronized bioenergetic transmissions not only sustain the toddler's activity level and emotional state, they also supply the modulated stimulation required to supply the enormously increasing bioenergetic demands of the "experience-dependent" growth of the child's developing brain. Reite and Capitanio (1985) suggested that an essential

function of attachment is to promote the synchrony or regulation of biological and behavioral systems on an organismic level.

Bowlby (1988) described how the emotionally responsive mother creates a "secure base" from which the mobile toddler may circle out in order to explore the world and then return. To accomplish this, the child uses the mother's affective expression as a signal, an indicator of her appraisal of safety or danger in a particular environmental circumstance. However, although the phenomenon may be more covert and subtle, the mother's facially expressed affective transmissions also act as an amplifier of positive arousal, a generator of energy required for further physical explorations of the environment by the infant. In social referencing, the infant is guided in exploration by the mother's emotional expression, underscoring the importance for the child to "keep an eye on" what mother is feeling, thereby allowing for rapid mood modification effects via dyadic resonance or contagion of positive affect. Emde (1988) characterized the 12-month-old toddler's "sparkling-eyed pleasure" associated with early mastery experiences, which is amplified under the watchful eye of the approving caregiver. Affect-transmitting, attention-focusing social referencing experiences are mediated by a fast-acting dyadic visuoaffective psychobiological mechanism, and this interactive dynamic that generates and maintains high levels of the positive affects of elation and excitement allows for the appearance of an ontogenetic adaptation, play behavior. Play transforms an environment into one that facilitates the processing of novel information and thereby improves learning capacity. These incipient experiences of separations and reconnections that support play enable the child to be exposed to an "enriched" environment, one that shapes developing brain networks (Tucker, 1992) and increases neural interconnectivity (Fagen, 1977).

THE ONSET OF A CRITICAL PERIOD FOR THE MATURATION OF THE ORBITOFRONTAL CORTEX AT THE END OF THE FIRST YEAR

"Enriched" or "growth-promoting" environments specifically influence the ontogeny of homeostatic self-regulatory and attachment systems (Greenspan, 1981). Bowlby (1969) pointed out that the maturation of control systems involved in attachment functions is open to influence by the particular environment in which development occurs. Cicchetti (1994) asserted that the capacity for attachment originates during early affect regulation experiences near the end of the first year of life. He also contended that caregiving plays a role in the ontogenesis of neuroregulatory processes during experience-dependent sensitive periods (Cicchetti & Toth, 1991). This leads to the next question: What specific areas of the brain are beginning a critical period of growth at 10 to 12 months, the time when attachment patterns are first reliably measured?

I suggest that dyadic communications that generate intense positive affective states and high levels of dopamine and endogenous opiates represent a growth-promoting environment for the prefrontal cortex, an area critically involved in Bowlby's imprinting processes (G. Horn, personal communication, August 9, 1994) that undergoes a major maturational change at 10 to 12 months (Diamond & Doar, 1989). An impressive body of neurobiological research indicates that increasingly complex self-regulatory structural systems are located in the frontal, especially orbital prefrontal, cortex (Damasio, 1994; Pribram, 1987). These systems are not ready-made at birth, and do not arise spontaneously in development, but are formed postnatally in the process of "social contact" and objective activity by the child (Luria, 1980). Indeed, the maturation of the prefrontal cortex, the largest area in the human cerebral cortex, is essentially postnatal, and the limbic orbital prefrontal areas are known to mature before the nonlimbic dorsolateral prefrontal areas (Pandya & Barnes, 1987). Neurons in the deep layers of the frontal polar regions of the human cortex mature at one year of age (Rabinowicz, 1979), and synaptic excess, an indicator of a critical period, has been observed to onset in the human prefrontal cortex at the end of the first year of life (Huttenlocher, 1979). Most importantly, there is now convincing evidence to show that orbitofrontal areas are critically involved in attachment processes (Steklis & Kling, 1985) and homeostatic regulation (Kolb, 1984).

In line with the principle that the postnatal growth of the brain is essentially influenced by events at the interpersonal and intrapersonal levels, attachment experiences, face-to-face transactions between caregiver and infant, directly influence the imprinting, the circuit wiring of this system. The onset of critical periods reflects the activation and expression of specific genes at particular times in development (Bateson & Hinde, 1987), and the expression of hereditary influences requires transactions with the environment (Plomin, 1983). In developing corticolimbic areas these transactions are specifically affective, and in them the mother regulates the neurochemistry of the infant's maturing brain and the neural substrates for infant emotion (Hofer, 1984, 1994). In the latest neurochemical models of critical period events, monoamine neurotransmitters and neurohormones are thought to regulate the temporal framework of developmental brain growth as well as mediate the effects of external influences on this process (Lauder & Krebs, 1986). Dopamine and endogenous opiates, neurochemicals that are increased in attachment experiences, are known to regulate neural growth and development (Le Moal & Simon, 1991; Hauser et al., 1989). Indeed, studies have shown that dopaminergic neurons innervate the orbital cortex (Levitt, Rakic, & Goldman-Rakic, 1984) and provide a trophic function in prefrontal development (Kalsbeek et al., 1987). (For a detailed discussion of the neurochemistry and neuroendocrinolgy of imprinting, see Schore [1994].) .

The orbital area of the prefrontal cortex (so called because of its relation to the orbit of the eye) is "hidden" in the ventral and medial surfaces of the prefrontal lobe. This area of the cerebral cortex is so intimately interconnected into limbic areas that it has been conceived of as an "association cortex" for

the limbic forebrain. It is functionally involved in the pleasurable qualities of social interaction, and contains the highest levels of opioids and dopamine in the cerebral cortex (Steklis & Kling, 1985). It also contains extremely high numbers of serotonin receptors (Raleigh & Brammer, 1993). In addition to receiving convergent multimodal input from all sensory areas of the posterior cortex, this frontolimbic structure uniquely projects extensive pathways to limbic areas in the temporal pole and the amygdala, to subcortical drive centers in the hypothalamus, and to dopamine neurons in reward centers in the ventral tegmental area (Nauta, 1964). In such an anatomical position, it hierarchically dominates the ventral tegmental limbic forebrain-midbrain circuit (Nauta & Domesick, 1982). Descending projections from the prefrontal cortex to subcortical structures mature during infancy, and the neural connections between the cortex and hypothalamus are established during the sensitive period for the development of social responses. This cortex also sends projections into motor areas, as its activity is associated with eye and head movements and motor responses of the face. In line with the proposal of orbitofrontal maturation at 10 to 12 months, distinct patterns of infant facial expressions, indicators of motor responses to emotion, are first reliably coded at the end of the first year (Malatesta, Culver, Tesmaa, & Shepard, 1989).

The orbitofrontal cortical area is especially expanded in the right cortex (Falk et al., 1990), the hemisphere which more so than the left, shows extensive reciprocal interconnections with limbic and subcortical regions. The right cortex is dominant for the processing, expression, and regulation of emotional information, is centrally involved in the memorial storage of emotional faces, and contains a representational system based on self-and-object images. In view of the fact that attachment experiences induce high levels of activity in neurons that selectively respond to faces (Horn & McCabe, 1984), it is important to note that this frontolimbic structure (like the amygdala and temporal cortex) contains neurons that specifically respond to the emotional expressions of faces. Furthermore, this prefrontal region is functionally implicated in appraisal processes, directed attention, and in the tracking of emotionally relevant objects in extrapersonal space, and is activated during the mental generation of images of faces. It also is known to play an important role in the processing of social signals necessary for the initiation of social interactions and affiliative behaviors. Activation of the mature orbitofrontal cortex elicits subcortical hormonal changes, such as an increase in pituitary endorphin and ACTH activity, as well as sympathetic nervous system adrenomedullary plasma noradrenaline and adrenaline release. Most significantly, in the cerebral cortex, the orbitofrontal region is uniquely involved in social and emotional behaviors and in the self-regulation of body and motivational states.

As the first year draws to a close, the initial phases of the anatomical maturation of the orbitofrontal cortex, a structural system that also subserves cognitive and memory functions (Stuss et al., 1982), allows for the developmental advances in cognition and attention that are observed at this time.

cognitive functional output of the orbital cortex, the delayed response function, enables the individual to react to situations on the basis of stored representations, rather than on information immediately present in the environment. This also applies to socioemotional information—at 10 months infants are first able to construct abstract prototypes of human visual facial patterns (Strauss, 1979). As a result of attachment experiences the infant develops a schema, a mental image of the mother, especially her face. With the imprinting of a representational model of the primary attachment figure's emotionally expressive face, affective responses to an object can be maintained even in its absence. This emergent function results from the experience-dependent structural development of a corticolimbic system that can generate and store abstract templates of prototypical facial emotional expressions. Developmental neuroscience studies characterize the internalized regulatory capacities of the infant that develop in relation to the mother as a "mother icon" that acts as a "neurobiological guidance system" (Kraemer, Ebert, Schmidt, & McKinney, 1991).

Due to the organization of its dense connections with sites in both the cortex and subcortex, this corticolimbic system can begin to play an essential adaptive regulatory role. At the orbitofrontal level, cortically processed exteroceptive information concerning the external environment (such as visual and prosodic information emanating from an emotional face) is integrated with subcortically processed interoceptive information regarding the internal visceral environment (such as concurrent changes in the emotional or bodily state). As a result, this prefrontal system can now generate interactive representations—nonverbal internal working models of the infant's transactions with the primary attachment figure that dyadically maximize positive and minimize negative affect. Indeed, at the end of the first year internal working models of attachment are first encoded. These internal models are now viewed as mental representations that enable the individual to form expectations and evaluate the interactions that regulate his attachment system. Such "presymbolic" representations encode the infant's physiological-affective responses to the emotionally expressive face of the attachment figure. These interactive representations appear at the end of the first year, and in them the infant represents the expectation of being matched by, and being able to match the partner, as well as "participating in the state of the other" (Beebe & Lachmann, 1988b). By the end of the first year, the end of early infancy, they can now be accessed in the absence of the mother to appraise upcoming relational encounters, thereby allowing for the adaptive capacity of affect regulation.

AFFECT REGULATION IN THE SECOND YEAR

In optimal growth-promoting environments, the interactive mechanism for generating positive affect becomes so efficient that by the time the infant begins to toddle he is experiencing very high levels of elation and excitement. Developmental neuropsychological studies reveal a significant increase in positive

emotion from 10 to 13.5 months (Rothbart, Taylor, & Tucker, 1989). As the practicing stage proceeds from early to late infancy, however, the socioemotional environment of the caregiver-infant dyad changes dramatically, and the nature of their object relations is significantly altered. At 10 months, 90% of maternal behavior consists of affection, play, and caregiving. In sharp contrast, the mother of the 13- to-17-month-old toddler expresses a prohibition on the average of every 9 minutes. In the second year the mother's role now changes from a caregiver to a socialization agent, as she must now persuade the child to inhibit unrestricted exploration, tantrums, bladder and bowel function (i.e., activities that he enjoys).

Socialization Experiences and the Emergence of the Attachment Emotion of Shame

In other words, in order to socialize the child, she must now engage in affect regulation to reduce the heightened levels of positive affect associated with the pleasure of these activities. How does she do this? In fact there is one very specific inhibitor of accelerating pleasurable emotional states, one negative emotion that is more closely associated, both psychologically and neurologically with positive affects. Shame, a specific inhibitor of the activated ongoing affects of interest-excitement and enjoyment-joy, uniquely reduces self exposure or exploration powered by these positive affects (Tomkins, 1963). Indeed, shame, which has been described as "the primary social emotion" makes its initial appearance at 14 to 16 months (Schore, 1991).

In the second year the toddler continues to bring the things he/she is exploring and attempting to master to the mother's vicinity. However, at this point of social development the nature of the reunion exchanges is altered in that they now more than any time previously also engender intense stress. Face-to-face encounters that at one time elicited only joy become the principal context for shame experiences. As in the early practicing period, the late practicing senior toddler, in an activated state of stage-typical ascendant excitement and elation, exhibits itself during a reunion with the caregiver. Recall that the child now has access to presymbolic representations that encode the expectation of being matched by, and being able to match the partner, as well as "participating in the state of the other." Despite an excited expectation of a psychobiologically attuned shared positive affect state with the mother and a dyadic amplification of the positive affects of excitement and joy, the infant unexpectedly encounters a facially expressed affective misattunement. The ensuing break in an anticipated visual-affective communication triggers a sudden shock-induced deflation of positive affect. Shame represents this rapid state transition from a preexisting positive state to a negative state.

Psychobiological attunement drives the attachment process by acting as a mechanism that maximizes and expands positive affect and minimizes and diminishes negative affect. The negative affect of shame is thus the infant's immediate physiological-emotional response to an interruption in the flow of an anticipated maternal regulatory function, psychobiological attunement which generates positive affect, and to the maternal utilization of misattunement as a mediator of the socialization process. In other words, shame, which has been called an "attachment emotion" (Lewis, 1980), is the reaction to an important other's unexpected refusal to enter into a dyadic system that can recreate an attachment bond. It is well established that attachment bond disruptions precipitate an imbalance in the regulation of affect (Reite & Capitanio, 1985). Thus in the prototypical object relation of shame a separation response is triggered in the presence of and by the mother who spontaneously and unconsciously blockades the child's initial attempt to emotionally reconnect with her in a positive affective state. The impediment to anticipated positive affect is specifically a perception of a facial display which signals not joy and interest but disgust, and which precedes a sudden unanticipated break in social referencing, the process by which the toddler's affect and behavior are regulated by maternal facial expression. The misattunement in shame, as in other negative affects, represents a regulatory failure, and is phenomenologically experienced as a discontinuity in what Winnicott (1958) called the child's need for "going-on-being." How long and how frequently the child remains in this state is an important factor in her ongoing emotional development.

This intense psychophysiological distress state, phenomenologically experienced as a "spiraling downward," is proposed to reflect a sudden shift from energy-mobilizing sympathetic- to energy-conserving parasympathetic-dominant autonomic nervous system activity, a rapid transition from a hyperaroused to a hypoaroused state, a sudden switch from ergotropic high arousal to trophotropic low arousal (Scherer, 1986). In such a psychobiological state transition, sympathetically powered elation, heightened arousal, and elevated activity level instantly evaporate. This represents a shift into a low-keyed inhibitory state of parasympathetic conservation-withdrawal (Powles, 1992) that occurs in helpless and hopeless stressful situations in which the individual becomes inhibited and strives to avoid attention in order to become "unseen." This state is mediated by a different psychobiological pattern than positive states—corticosteroids are produced in a stress response, and these reduce opioid (endorphin) and corticotropin releasing factor in the brain. Physiologically there is an influx of autonomic proprioceptive and kinesthetic feedback into awareness, reflecting activation of medullary reticular formation activity in the brain stem. As opposed to the attuned state, shame elicits a painful infant distress state, manifest in a sudden decrement in mounting pleasure, a rapid inhibition of excitement, and cardiac deceleration by means of vagal impulses in the medulla oblongata. This shift reflects the reduced activation of the excitatory dopaminergic ventral tegmental limbic forebrain-midbrain circuit and increased activation of the inhibitory noradrenergic lateral tegmental (Robbins & Everitt, 1982) limbic forebrain-midbrain circuit.

Interactive Repair and the Origin of Internal Shame Regulation

As a result of the interactive misattunement of socialization experiences the toddler is suddenly and unexpectedly propelled from an ongoing, accelerating positive affective state into a decelerating negative affective state, a stressful state transition that he cannot autoregulate. Prolonged states of shame are too toxic for older infants to sustain for very long, and although infants possess some capacity to modulate low-intensity negative affect states, these states continue to escalate in intensity and duration. Thus parental active participation in regulating the child's shame state is critical to enabling the child to shift from the negative affective state of deflation and distress to a reestablished state of positive affect. In early development, parents provide much of the necessary modulation of states, especially after a state disruption and across a transition between states, and this allows for the development of self-regulation. This transition involves and highlights the central role of stress recovery mechanisms in affect regulation. Stress has been defined as the occurrence of an asynchrony in an interactional sequence; further, a period of synchrony, following the period of stress, provides a "recovery" period (Chapple, 1970). The child's facial display, postural collapse, gaze aversion, and blushing act as nonverbal signals of his internal distress state. If the caregiver is sensitive, responsive, and emotionally approachable, especially if she reinitiates and reenters into synchronized mutual gaze visual-affect regulating transactions, the dyad is psychobiologically reattuned, shame is metabolized and regulated, and the attachment bond is reconnected. This repair is important to future emotional development. The key to this is the caregiver's capacity to monitor and regulate her own affect. Winnicott (1971a) described the "good enough" mother's "holding" or "containing" function as the capacity to "stay with" the child through its emotional/impulsive expressions, and Tomkins (1963) proposed that negative affect is reduced when the parent continues to maintain affective engagement with the child who is experiencing negative affect, thereby communicating tolerance of negative affect in both.

In this essential pattern of "disruption and repair," the "good-enough" caregiver who induces a stress response in her infant through a misattunement, reinvokes in a timely fashion her psychobiologically attuned regulation of the infant's negative affect state that she has triggered. This reattunement is mediated by the mother's reengagement in dyadic visuoaffective transactions that regenerate positive affect in the child. Her shame stress-regulating interventions allow for a state transition in the infant—the parasympathetic-dominant arousal of the shame state is supplanted by the reignition of sympathetic-dominant arousal that supports increased activity and positive affect. The latter effect is neurochemically mediated by a resumption of CRF-inducing endorphin production and a reactivation of the ventral tegmental dopaminergic limbic cir-