SECTION 6

Socialization

From birth, human infants show sensitivity to the special status of the caregiver. The relationship is one of reciprocal influence between infant and caregiver. A detailed analysis of the context surrounding this relationship provides a basis for deepening our understanding of early development and its influence on later subjective experience and behavior. The importance of the caregiver in early development also leads to examination of the consequence of the stress induced by violations of this bond. Animal studies have shown long-term consequences of early stress. There are some obvious connections to the human condition, but much needs to be done to draw together the two forms of investigation. This section begins with an examination of animal models of attachment that show the possibility of understanding this process in terms of the transmitters, modulators and genes involved.

In the second part of the section, evidence for synchronicity and reciprocity in early maternal–infant relationships is reviewed. These universals of socialization can be studied through detailed behavioral observation. Nevertheless, behavior alone is probably insufficient to provide a handle on the subjective experience of the individual. Children and adults use narratives to describe their internal feelings and these may provide methods for connecting subjective experience with underlying neural systems.

In the final part of the section we consider how culture influences socialization. Caregivers reflect the training of their own cultures. In understanding socialization it is important both to consider the universal aspects that appear common to members of our species and to use empirical methods to examine efforts to socialize the young within specific cultures.

Animal models of attachment

Attachment theory envisages a motivational system with evolutionary survival value on a par with hunger and sex (Bowlby, 1969). The attachment system is organized to maintain physical proximity to the caretaker soon after birth and psychological proximity, or closeness, later in development. We now have the opportunity to examine some of the underlying processes of attachment in terms that can be related to neural structure and function.

Three major questions have been raised by the basic observations that led to the field of attachment research. First, how does the infant come to know and prefer its own mother, maintain proximity with her and continue to do so even despite abuse and neglect at her hands? Second, why does separation from the mother produce such intense and widespread emotional responses in the infant? Third, how do individual differences arise in the characteristic patterns or qualities of the mother–infant interaction, and how do these early interactions become translated into long-term effects on infant development and ultimately similar maternal behavior in the next generation?

Infants of mammalian species that are born in an immature state face the daunting task of coming to identify, remember and prefer their own mother. They must learn to reorganize their simple motor repertoires, long adapted to the uterine environment, so as to be able to approach, remain close and orient themselves to their mothers for the first nursing bout. It has been assumed until recently that these processes were well beyond the capacities of newborn mammals (except in precocial species such as the sheep) and that the relationship initially depended almost entirely upon maternal behavior until well into the nursing period (Bowlby, 1982; Kraemer, 1992). Attachment has thus been supposed to be built up slowly in the weeks or days after birth in humans or rats. But the last decade has produced a number of studies revealing earlier and earlier evidence of learning, even extending into the prenatal period as will be described below. In addition, coordinated motor acts have been demonstrated in fetuses in response to specific stimuli that will not be encountered until after birth. Thus the solutions for the infant’s cognitive tasks appear to be found much earlier than previously thought and to take place through novel developmental processes that had not been imagined until recently.

Prenatal origins

The first strong evidence for fetal learning came from studies on early voice recognition in humans, in which it was found that babies recognize and prefer their own mother’s voice, even when tested within hours after birth (DeCasper & Fifer, 1980). Newborn infants, in the first hours after birth, prefer human voices to silence, female
voices to males, their native language to another language and their own mother to another mother reading the same Dr Seuss story.

Animal studies reveal some of the mechanisms involved in these early developments. Removal of the dam from rat pups was found to produce a rapid (30 min) fall in the pups’ growth hormone levels, and vigorous tactile stroking of maternally separated pups (mimicking maternal licking) prevented the fall in growth hormone (reviewed by Kuhn & Schanberg, 1991). Brain substrates for this effect were then investigated. Growth hormone levels are normally maintained by maternal licking, acting through serotonin (5HT) 2A and 2C receptor modulation of the individual acts. Parental responses, sensory impressions and associated affects are laid down in memory during and after early parent–infant interactions (Stern, 1985; Gergeley & Watson, 1999). These individual units of experience are integrated into something like a network of attributes in memory, invested with associated affect, and result in the formation of what Bowlby referred to as an ‘internal working model’ of the relationship.

We can speculate that at least some of the early learning and maternal regulatory interactions that we have described for rats occur also in human babies. These experiences are gradually joined together in memory and stored as the mental representations and related affective states that older children are able to describe in words. It seems likely that these mental structures combine the infant’s newly developing capacities to anticipate events and to respond to symbolic cues with the earlier biological functions of the ‘hidden’ regulatory interactions, through processes similar to the functional links involved in the classical conditioning of physiological responses. In this way our concept of the ‘mental representation’ can be thought to link together, into a functional network within the child’s brain, the learned patterns of behavior and the physiological response systems previously regulated by the mother–infant interaction. In this way we can envisage the development of self-regulation of the behavioral and physiological systems underlying motivation and affect, gradually supplanting the sensorimotor, thermal and nutrient regulatory systems found in the interactions of younger infants with their mothers. This would link biological systems with internal object representation and would account for the remarkable upheavals of biological as well as psychological systems that take place in adult humans in response to cues signaling impending separation, or in response to losses established simply upon hearing of a death, e.g. by telephone (Hofer, 1984).

**Long-term effects**

Meany and his colleagues used the maternal behavior observational approach to directly test the long-term implications of the discovery of maternal regulators (Liu et al., 1997). They found that rat dams in their colony who showed high levels of licking, grooming, and of the high-arched-back nursing position (LG/ABN) produced pups later found to be less fearful in a variety of behavioral tests, and to show lower than normal hypothalamic–pituitary–adrenocortical (HPA) axis responsivity to restraint stress as adults, than the offspring of dams that naturally showed the lowest levels of these early interactions.

In order to show that these differences in the offspring in adulthood were not simply reflections of a different genetic constitution in the two groups, Meany and his colleagues handled daily the infants of the low LG/ABN group, an early intervention that is known to increase levels of the mother’s concurrent LG/ABN behaviors. By doing so, he showed that the adult behavior and HPA axis responses of the offspring also changed to closely resemble the patterns that naturally occurred in the previously studied high LG/ABN group.

These results showed that an intervention that alters the mother–infant interaction pattern also changes the adult fear behavior and physiological response characteristics of the offspring. One of the observations that currently occupy researchers in the attachment area is how mothers in one generation can pass on to their adult female offspring the attachment pattern they experienced as infants. The experiment just described provided a chance to find out if this transgenerational effect occurs in non-primate species and to explore how it comes about. By allowing the offspring of the handled litters described above to rear another generation under normal laboratory conditions, Meany and his colleagues went on to find that the mother–infant interaction established by these progeny resembled the one their mothers had been induced to have in their own infancy (high LG/ABN) rather than the one characteristic of their ancestors before the handling intervention (low LG/ABN) (Francis, Diorio, Liu & Meany, 1999). Furthermore, the unmanipulated pups in these litters also went on to show the adult behaviors and hormonal stress patterns typical of offspring of high LG/ABN litters (see Figure 6.1).

The discovery of regulatory interactions and the effects of their withdrawal allow us to understand not only the responses to separation in young organisms of limited cognitive–emotional capacity, but also the familiar experienced emotions and memories that can be verbally described to us by older children and adults.
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**Figure 6.1** Maternal regulations of infant systems in 2-week-old rat pups. The direction is indicated as (+) increase and (–) decrease. Separation produces the opposite response.

Perhaps the most challenging area for future research is to find out how to apply what we have learned in these brain and behavior studies to the human condition. At present, there is widespread use of the concept of regulation as inherent in the mother–infant interaction in humans. This word is generally used in two ways: first, to refer to the graded effects of different patterns of interaction on the emotional responses of the infant, the so-called ‘regulation of affect’ (Schore, 1994); second, to refer to how the behaviors initiated by the infant or mother and/or their responses to each other act to regulate the interaction itself, its tempo or rhythm (hence its ‘quality’) or the distance (both psychological and physical) between the members of the dyad (e.g. Gergeley & Watson, 1999). The word ‘regulation’ is used extensively in the literature on molecular genetic, cellular and electrophysiological brain processes so that it serves as a useful conceptual link across wide differences in the level of organization at which developmental processes are studied.

**Self-regulation in humans**

Children who have experienced abuse show significantly greater behavioral disturbances and fewer socially desirable behaviors than those who have not experienced such treatment (Visser, Strauss, Gelles & Harrop, 1991; Feldman et al., 1995; Kinard, 1995; Spatz-Wisdom, 1997). Impulsive, disruptive and aggressive behaviors are prominent among the undesirable behaviors manifested by children who are victims of abuse.

Differences in cognitive, neurochemical and neuroendocrinological functioning have been identified in children with histories of abuse, compared to children without such histories. For example, Carrey and colleagues (1995) found verbal IQ scores in children to be inversely related to severity of abuse. De Bellis and colleagues (1994a, 1994b) found altered regulation of cortisol secretion and plasma dopamine beta hydroxylase (DBH) activity in adolescent girls with histories of sexual abuse. Galvin and colleagues (1995) noted abnormalities in plasma DBH activity in abused boys as well. Earlier onset abuse was associated with greater dysregulation.

As a result of exposure to extreme stressors such as child abuse, alterations in the regulation of neurochemical and neuroendocrinological systems, if protracted over time, may have profound implications for the development of crucial cognitive functions, including language, memory and executive controls related to attention, conditioning and inhibitory control. These functions in turn are essential underpinnings to the development of well-regulated pro-social behavior.
Beyond extreme stressors such as frank abuse, home environments may exert chronic negative influences on mental and physical development in more subtle and sustained ways (Repetti & Taylor, unpublished manuscript). The actions of stressors such as deficient nurturance and overt conflict may result in neurochemical and neuroendocrinological changes over time similar to those noted for more frankly abusive experiences, leading to comparable adverse developmental impact. It is not yet known how much the culture of poverty, including exposure to violence in the home and surrounding environment, may induce some of the same effects as abuse histories. It is obvious that research in this area may be of great importance in protecting children from the deleterious effects of high levels of stress. The animal models discussed above provide the basis for the neurobiological effects of stress on the brain. The mechanisms of executive attention and self-regulation discussed in Sections 3 and 5 provide a hint as to how these neurobiological effects might relate to temperamental characteristics of individuals in providing a life-long influence on behavior. The possibility of mitigating the effects of stress through psychological and/or sociological interventions suggests that there could be very important practical as well as theoretical results.

Universals of human interaction

The social sensitivity of humans has a basis in cognitive and emotional systems of the brain that are already specialized for this function at birth. Even newborn infants appear to communicate flexibly with the rhythms of interest and feelings of other humans. These early infant interactions can be seen as precursors to the development of the theory of mind. Theory of mind has been widely studied during the second and third year of life in tasks that are largely verbal. As in many cases of ‘core knowledge’ there seems to emerge at birth a protoskill that can be observed in aspects of infant behavior and that becomes elaborated into the much more subtle cognitive skill – in this case, knowledge of the mental state of others.

The psychobiological significance of innate intersubjectivity (Trevathan, 1979, 1980) is demonstrated by the communicative preferences and activities of infants less than 1 week old. It has been possible to show that newborns are sensitive to expressions of emotion in others by recording heart rate during attention, or by eliciting their head rotations, leg movements or sucking to trigger stimuli (see Figure 6.2). Comparison with neonate–parent interactions in other species helps to trace the evolutionary origins and the intergenerational transmission of knowledge and skills in human societies. The intersubjective motives that drive the human infant’s social play may be peculiarly human. In contrast, the state-regulating communicative behaviors and reactions of infants resemble the needs shown by the helpless young of many other species (Hofer, 1990; McKenna & Mosko, 1994; Rosenblatt, 1994; Blass, 1996; Carter, Lederhendler & Kirkpatrick, 1997; Panksepp, Nelson & Bekkedal, 1997; Suomi, 1997).


As discussed in ‘Animal models of attachment’, newborns are affected by the mother’s mood and identify her speech in utero, weeks before birth (DeCasper & Spence, 1986; Fifer & Moon, 1994; Hepper, 1995). Her speech can be identified by her newborn immediately, and visual recognition of her face is acquired within hours of birth (Zeifman, Delaney & Blass, 1996; Blass, 1999). Particularly important is research demonstrating that the imitative responses of the newborn baby need sympathetic expressive and imitative reciprocity in a partner (Heimann, 1989; Kugiumutzakis, 1998; Nagy & Molnár, 1994; Trevathan et al., 1999).

Ethical considerations make it hard to study the paradigms used in animals. However, useful methods have been developed for observing the consequences of interrupting normal infant–caregiver interaction. For example, the blank face test (Tronick, Als, Adamson, Wise & Brazelton, 1978; Murray & Trevathan, 1985) requires a mother who has established a protoconversational interaction with her infant to arrest her movements on a signal from the experimenter, and simply look at the infant without any reaction to what the infant does. This commonly results in the infant showing a succession of ‘appeals’ for communication by smiling, vocalizing and gesturing, punctuated by increasingly sober staring at the mother, and then emission of signs of avoidance of eye contact and distress.

A second video interaction method was designed to deal with the objection that, in the blank face test, the infant was simply affected by the mother’s sober face and inactivity (Murray & Trevathan, 1985). A double video (DTV) or ‘videophone’ link was set up so that
A Regulation of sleep, feeding and breathing. Innate ‘pre-reaching’. Imitation of expressions. Smiles to voice.

B Fixates eyes with smiling. Protoconversations. Mouth and tongue imitations give way to vocal and gestural imitations. Distressed by ‘still face’ test.

C ‘Person–Person’ games, mirror recognition. Smooth visual tracking, strong head support. Reaching and catching.


Figure 6.2 Illustration of various infant–caregiver social interactions as a function of the age of the infant in weeks.

Infant subjects a few weeks old (less than 3 months) and their mothers could see each other and communicate live. Once good, happy communication was obtained, a portion of the recording of the mother from an animated and playful period of the encounter was rewound and replayed to the infant. The projection of the mother’s behavior to the infant was exactly as before, but the physical recording was not, in any reliable way, reacting contingently to what the baby was expressing at any moment.

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Here infants showed occasional accidental interaction with the taped behavior of the mother, confusion when she failed to respond in time and appropriately, and then prolonged distress and avoidance, as in the ‘still face’ experiment. It takes time for the infant to recover from this loss of contact when the mother resumes normal sympathetic communication, or is ‘online’ again, as was the case in the ‘still face’ experiment. Replay of the infant’s behavior to the mother in the DTV apparatus causes her to feel ‘something is wrong’. Different mothers experience different emotions and make different verbal evaluations, more or less uncomfortable, when the infant appears not to ‘connect’. Their responses depend on their emotional health, self-confidence and family security.

The distinctive voice of an affectionate adult talking to an attentive baby has been analyzed in detail. Motherese or infant-directed speech has characteristic rhythmic and melodic features as well as specific vocal qualities of pitch and timbre. It is organized in repeated phrases, and creates slowly changing, cyclic ‘narratives’ of emotion (see Figure 6.3). The dynamic narrative envelopes of a mother’s utterances, their changing pitch contours and other dynamic qualities have been identified as necessary training for the infant’s developing self-awareness and consciousness of agency. On the other hand, the extraordinary precision of the infant’s mirroring, even with restricted vocal repertoire, has been taken as further evidence for an innate capacity for such ‘online’ communication (Beebe, Jaffe, Mays & Alson, 1985; Trevarthen et al., 1999).

Comparison of speech to infants in different languages confirms that there are universal rhythmic and prosodic features (Grieser & Kuhl, 1988). Thus, for example, motherese or infant-directed speech in a tonal language (Mandarin or Thai) and in a non-tonal language (English and German), compared to adult-directed speech in either language, has higher pitch (fundamental frequency, F0), larger F0 range, shorter utterances and longer pauses, fewer syllables per phrase, and less phrase time/sample time. Three different functions have been attributed to the way adults talk to infants: this speech engages attention (Papousek, Papousek & Symmes, 1991), communicates affect, facilitating social interaction (Fernald, 1989, 1992; Kitamura & Burnham, 1998), and helps language acquisition (Fernald & Mazzie, 1991).

**Development of cooperative awareness**

Longitudinal film studies in semi-controlled lab/studio conditions have documented orderly age-related transformation of the infant’s motives through the first year. These events stimulate increasingly precise and selective coordination with the mother’s emotionally inflected, rhythmically patterned and repetitive expressions in play (Fogel, 1977; Beebe, Stern & Jaffe, 1979; Mayer & Tronick, 1985; Beebe et al., 1985; Jasnow & Feldstein, 1986). The baby’s increasing interest in manipulation and in visual inspection and tracking leads the mother to play games with objects. Just before the end of the first year, joint interest of mother and infant in their surroundings is triggered by the infant’s emerging curiosity about what the mother is doing (Trevarthen & Hubley, 1978). This change in infants’ acceptance of the mother’s initiatives has momentous consequences in learning and profound effects on the ways mothers act with and speak to their infants.

The evidence from early infancy suggests that the relational emotions are specifically adapted to real-time regulation. Interactions between the child and others contribute to the building of relationships of affectionate attachment, trust and companionship, and to defense against abuse, mistrust and disregard. These are fundamental to the ecology of human consciousness. States of emotion hitherto deemed ‘complex’, ‘non-basic’ and ‘acquired’ may have to be reinterpreted as primary and necessary to the child’s entry into the social/cultural world, with all the rational, linguistic and pragmatic conventions and rituals it offers.

**Microanalytic techniques**

**Gestures**

The fine-grained analytic techniques to record interactions between caregivers and infants need to be greatly expanded. For example hand gestures play an important but largely uncharted role in emotional expression in infants, as well as in the mimesis and paralinguistic expressions of toddlers (McNeill, 1987). Deaf infants babble with their hands, and they acquire linguistic signs at approximately the same age as hearing infants acquire speech.

Image processing methods available now would permit computer-assisted tracking and analysis of hand movements, which could be carried out in parallel with acoustic analysis of the sounds by which an adult may engage closely with the purposes, interests and feelings of an infant or child (see Figures 6.3 and 6.4). Much excitement has attended the discovery of mirror neurons, which mediate imitation of hand and hand–mouth actions, in an area of the prefrontal cortex of monkeys. This finding should enhance studies of expressive hand gestures in human development that are both descriptive and experimental.

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Figure 6.3  Illustration of recording methods for detailed analysis of infant and caregiver interactions.

Sound

Application of musical acoustic models to mother–infant vocal communication demonstrates the precision and reciprocity of consistent parameters of vocal motor expression between communicating humans that apply to any age. The analysis has been shown to have highly effective application in study of maternal psychiatric illness and its effects on an infant, and there are promising applications in early childhood education as
well, where rhythms of interaction and good vocal ‘attunement’ have been shown to be crucial in the establishment of effective teaching.

Musicality is demonstrated in the common features of speech, gesture, dance and facial mimicry; and in the heightened expressiveness of all modalities of signaling for infants and toddlers, allowing the same motive messages to be transmitted to blind, deaf and deaf-blind children. Improvisatory music therapy is rapidly gaining ground in psychiatric work and special education as clinicians become aware of its effectiveness in assisting recovery or improved development in a great variety of cases from premature newborns in intensive care to children with socio-emotional disorders of all kinds, and adult patients suffering from psychiatric illnesses or dementia.

**Narrative**

With the explosion of techniques and studies in brain imaging and neurophysiological recording, the possibility of understanding the brain correlates of subjective experiences of all kinds is realizable. We may be approaching the point where the limiting factor will no

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**Figure 6.4** Above shows the close orientation of the infant to the adult voice and below is a spectrogram showing the strong inflection in the adult voice when speaking to the infant.
longer be the ability to describe the events in the brain, but rather to understand the relationship between what happened in the brain and the narrative reports of subjective experience told during or immediately after an experience for which the brain activity is captured. The relationship between lived experience, as recorded in the brain, and the narrative account of that experience becomes crucial. Autobiographical narratives constitute the basic (non-biological) data for clinical psychiatry, and for some experiments in psychology. These data are the major source for diagnostic categorization and the almost exclusive medium of treatment for non-pharmacological therapies (cognitive, psychodynamic, behavioral etc.).

Telling narratives is apparently a universal activity of humans, something that all people do with language (Nelson, 1996). Furthermore, there are basic narrative elements that are common across cultures. Perceiving and interpreting the world of human interactions in terms of a ‘narrative format’, i.e. behavior as goal-directed and motivated in a specific context, also appears to be a universal feature of human life. This narrative format provides coherence to multiple discrete acts. This can be considered the receptive aspect of the narrative form, while telling narratives is the productive aspect.

Developmentally, there are three large capacities to be assembled. The first is the receptive aspect of perceiving human actions in terms of a narrative format. Second, once language is well in place, there is the productive aspect, i.e. the linguistic rendering of recalled episodic memories in the very specific form of a plot that unfolds along a line of dramatic tension. And finally, there is the age-related development of the narrative form itself.

The following list consists of the main capacities that must be considered for a full understanding of narration and its development.

Plot The narrative form must have a plot (Bruner, 1990) even in a minimal form (Labov, 1972). The elements that make up a full plot are the essential ordinary questions posed to understand an event between people: Who? What? Why? When? Where? and How? This is what interests us about one another and provides the framework for stories, novels, myths, journalism, gossip etc. In other words, some grasp is needed of the following elements: agents, goal-directed action, motives, means, goal states, and context (time and place). It is also in these terms that we interpret and perceive human behavior – the receptive aspect to make sense out of it. Each of these plot elements requires separate capacities, each having its own developmental history. These separate capacities are researchable from the point of view of brain–behavior correlations.

Coherence These separate plot elements (and their capacities) need to be integrated. The plot is grasped as a single coherent whole. The elements fall into place in the making of this gestalt. The plot, as a superordinate entity, is our unit for parsing important kinds of human activity. Is the plot unit assembled developmentally or is there some kind of primitive gestalt that is progressively elaborated developmentally?

Dramatic tension Plots, besides putting into place the needed elements of a story, have a line of dramatic tension (Labov, 1972). The line of dramatic tension is the contour of rising and falling arousal, activation and excitement along which the plot unfolds. This is usually seen in terms of preparation high point or crisis and resolution. It is a temporal aspect of the narration. It is with this element that we rejoin Trevarthen’s notions of ‘musicality’. The temporal contour of dramatic tension is analogous to a musical phrase which is grasped as a single whole. Much more work is needed on this temporally dynamic aspect of experience. It is discussed in greater detail below.

Intersubjectivity The capacity for intersubjectivity underlies narration and the narrative format. To grasp that another person could be enacting a motivated, goal-directed behavioral sequence, the observers must be able to align their minds with the other’s subjective state. Similarly, to tell a narrative, one must simultaneously align one’s mind, to some extent, with that of the listener as well as the actors of the story.

Self Some sense of self is also implied in narration. The observer of or teller about human action must place themselves relative to the unfolding events. There are different positions in which the self can be placed and experienced: teller, actor, patient etc. These positions may shift during the observing or the telling or the listening to a narration. This issue of the experienced position of the self relative to an unfolding event is fascinating and needs to be studied.

Areas for further exploration Only three of the issues from the above list will be selected for a further examination here, namely the issues of coherence, temporal line of dramatic tension, and intersubjectivity. One final methodological issue will be added concerning the correspondence between online experience as recorded with imaging and electrophysiological techniques and the later narration of the experience that was recorded.

The structure of language serves to some extent as an example of the problem of coherence. What new feature (mental and brain activity) is added when a meaningless
list of words is rearranged into a meaningful sentence? When the elements of a plot (agent, action, goal etc.) are non-verbal, we are faced with a similar problem, but in a form appropriate to a pre-verbal infant. The question boils down to what brain activity corresponds to the emergence of coherence when separate elements of a plot become integrated, and are there commonalities in brain activity, or only domain specificities, depending on whether the cohering elements are movement, or words, or colors etc.?

Approaching such questions experimentally in infants seems possible. For instance, in one condition of an experiment of Gergely, Nadasdy, Csibra and Biro (1995) with pre-verbal infants about 14 months old, the following animated cartoon was shown. Colored balls, no. 1 and no. 2, are separated by a wall. Ball no. 1 ‘wants’ to get close to ball no. 2. It runs back and forth but is stopped by the wall. Ball no. 2 moves in anticipation. Finally, ball no. 1 jumps over the wall and goes right up to ball no. 2 and rubs against it; they move together ‘happily’. With the use of other experimental conditions, Gergely et al. show that infants view this action as a coherent event, and that they have grasped the motive behind the action that ties it all together. A control condition could be presented with the same elements and same actions but repositioned in space so that no plot involving all the elements could be discerned. In moving from the plotless to the plot condition what differences would be found in brain activity? Is there some activity that reflects the emergence of a gestalt that is the equivalent of coherence? There are many different experimental situations, at different ages, that could be devised to test the same question.

It is important to distinguish between recognition (in the sense of matching to a previously established scheme) and the emergence of coherence (where a scheme gets established initially). In general, the emergence of coherence has been insufficiently studied, yet it represents such a key mental event.

In a narration or in perceiving a narrative format, coherence is created not only by all the elements fitting together into a coherent gestalt, but also by the temporal contour of the line of dramatic tension. This temporal contour provides a unifying (affective and arousal) envelope for the unfolding of the plot. ‘Musicality’ describes the temporally dynamic dimensions of human movement, emotion and communication. Thus it includes more than what is formally music (Trevarthen, 1999–2000). Stern (1985) has attempted to capture similar temporal dimensions of experience with the term ‘vitality affects’. Manfred Clynes (1980, 1983) has sought after similar phenomena in describing the temporal characteristics that reveal the personal signature of a musical performer’s or composer’s style in ‘sentic’. Sylvan Tomkins (1962) has categorized contours of the intensity of any stimulus over time that he believes correspond to different discrete emotions. The philosopher Susan Langer has used the term ‘forms of feeling’ to render the abstract feelings that are elicited by art, but disconnected from local realities (Langer & Knauth, 1957).

These authors are trying to grasp the temporal dimension of objective and subjective events. All human behavior, and its experiential aspect, has a duration, even when it is short. This is true, be it a movement, a perception, an emotion or a thought. And during the unfolding of the experience in time, there are almost always shifts in the speed, rhythm, amplitude, effort, form, tension, or several of these together. These shifts are subjectively experienced (and certainly reflected in brain activity) even when they cannot be objectively observed in overt behavior. Sometimes the shifts and modulations during the experience are very small, at other times large. It is these time-based changes that create the temporal dynamics that we will call the ‘temporal contour’.

Infants appear to be extremely precocious with regard to the temporal elements of their environment. From the first weeks and months of life, infants seem to be predesigned to identify and discriminate different durations, different tempos or temporal intervals, and different simple rhythms (Lewkowicz & Turkewitz, 1980).

It has also been suggested that infants are pre-programmed to identify and be differentially responsive to different temporal contours of sound (Tomkins, 1962). For instance, if the intensity of a sound rises very rapidly, like a pistol shot, infants (and adults) will startle. If it accelerates a little less rapidly, but still quickly, like a motorcycle revving up or a vacuum cleaner starting up, it may evoke fear. If it rises even less rapidly it may evoke interest. If the intensity rises and then falls off, one may experience pleasure, and so on. These responses, observable in infants, are thought to be innate, but their presence assumes that the infant is sensible to the form or pattern of the temporal shifts in sound intensity.

What is needed now is to expand what we already know about infants’ capacities for perceiving the temporal dimension and use it to help explain the fundamental problem of grasping coherence in human action. The temporal contour of behavior as seen, heard and felt is a very plausible candidate for units of coherence that operate very early in development. Stern (1999), as well as Trevarthen (Trevarthen & Hubley,
1978, 1979, 1999–2000), have suggested this, but much more work needs to be done in this area.

**Intersubjectivity**

As discussed in the last section, intersubjectivity is a prerequisite for apprehending the narrative format and for telling a narrative. Because the narrative form turns on the element of goal-directed motives, without an intersubjective sense this form would not exist. This subject has become of central interest in current theories of ‘theory of mind’, in part because of their implications for autism and other failures of empathy and ‘altero-centered participation’ (Braten, 1998) as seen in various personality disturbances.

The literature is rich with well-replicated experiments on the capacities to imitate the action of others (e.g. Meltzoff & Moore, 1977; Meltzoff & Borton, 1979) or, later in development, to imitate the motives of others (Meltzoff, 1995). These experimental situations are sufficiently standardized and repeatable to lend themselves to brain activity recording. Further information here would go a long way toward understanding the bases not only of intersubjectivity but also of intermodal transfer.

The essential questions go beyond the findings of mirror neurons and adaptive oscillators, but ask what additional brain activity, if any, is activated when someone places himself or herself in the position of another such that an imitation or empathic event can be enacted. This may be studied via correspondences between lived experience as reflected by online recording of brain activity and the later narrative report of that experience.

The full interpretation of recorded brain activity often rests on the narrative account of the subject/patient given after the fact. This raises the perennial question of how faithful such narrative accounts are, even when given immediately after the online experience. Such a question is inevitable when we know that narratives are construction from reality and not faithful reconstructions of reality. The answer to the question is essential not only for understanding the implications of a recording of brain activity, but also for understanding the nature of narration.

Some experiments, such as those recording the brain activity of hallucinating patients (Silbersweig et al., 1995), indicate that there can be a good correspondence between the sensory modalities later narrated as experienced and the brain activity recorded during the hallucination. The issue of the correspondence between brain activity and narration as it concerns duration, timing and temporal contouring of the experience is equally important but more difficult to examine.

To approach this problem Stern has developed an interview called the ‘micro-analytic interview’, which attempts to capture the temporal parameters of an experience as reconstructed during an assisted narration (Stern, 1999). The procedure, in brief, is as follows. The subject narrates an experience that occurred several hours before. A short piece of the experience, usually 10–30 s duration, with a clear beginning and ending is chosen. The interview concentrates only on that short piece and takes 1–1.5 h. The subjects are asked what they experienced. That is the first pass. Then they are asked what they thought; felt; saw; imagined; remembered; heard; did in action, gesture and postural shifts; etc. Each of these requires a separate pass through the experience. The subjects diagram each separate pass with relative timing indicated. Each pass usually requires that the diagrams of the previous pass be corrected or updated. This process results in a diagram with a (subjective) time line, which often resembles a musical score because so often events occur in parallel or with much overlap.

The final diagram is analyzed in many ways, but one of the most relevant here is that the experience is broken into units. The largest we call a ‘present moment’. This represents a continuous conscious experience surrounded by unconscious gaps. These are usually of 2–5 s duration. This is the generally agreed upon duration of the ‘sensible present’ (James, 1891), the ‘perceived present’ or ‘psychological present’ (Fraisse, 1964) or the ‘actual present’ (Koffka, 1935).

Within the ‘present moments’ there are different ‘takes’, shifts in person, action, place, time or position of the self relative to the action. Some of these ‘takes’ consist of shifts in one or more of these criteria. Usually, if all four change, a new ‘present moment’ will be ushered in. Each of these units is subjectively timed, noting that shifts in the position of the self relative to the action represents a phenomenological event of subjective importance but for which there is generally no behavioral marker. Accordingly, correlations between subjective report and brain activity will have to rely solely on narrative construction.

In short, despite all the methodological problems and epistemological difficulties, the ‘micro-analytic interview’ promises at least an opening to establishing correlations between recorded brain activity and subjective experience.

**Cultural influences**

Virtually all contemporary theories and data in neuroscience, psychology and culture derive from Western
investigators, settings and populations even though approximately 70% of humankind live in non-Western cultures. Thus, at minimum, the generality of this monolithic scientific enterprise has not been adequately tested; indeed, in instance after instance the infusion of a cross-cultural perspective has exposed the limitations of narrow Western and Anglocentric viewpoints and their problematic application to non-Western, non-Anglo cultural groups.

We can define culture to include broadly the social context of life, in other words people, values, ideologies, beliefs and so forth; and we can define environment to include the physical context of life, in other words materials, toys, books and so forth. Culture and environment mutually interact, of course, and together they construct the full ecology of development. Understanding the human beings’ social and physical contexts sets the stage for understanding individual developmental processes and outcomes (see Figure 6.5).

Cultural study submits the roles of experience in development to their most comprehensive test because variation across cultures and environments tends to be greater than variation within cultures and environments. In the sense that all members of the human species traverse the same (or similar) developmental path, genetic, biological or maturational processes are at work. Moreover, structurally similar and shared general experiences of living in the same culture or environment, and being subject to the same forces of nature and learning, manifestly operate to generate similar or identical outcomes in structure and function. However, a look around the world readily reveals that rates of development, final resting levels, and most significantly phenotypic variations of structures and functions in the species are highly modifiable and specialized to particular cultural and environmental experiences.

Cultures contrast in the specific types of competencies caregivers promote in children, in the paths caregivers follow to instill in children the desire for achieving those goals, and even in the developmental timetables caregivers wish their children to meet. Consider how these separate but related goals articulate in Japanese and US cultures. An American mother tries to promote autonomy in her child, and organizes her interactions so as to foster physical and verbal independence in her child, perhaps as a reflection of, or headed toward, the assertiveness and individualism characteristic of the American culture. A Japanese mother tends to see her infant as an extension of herself, and works with her child to consolidate and strengthen a mutual dependence between them, perhaps as a reflection of, or headed toward, collectivity and an emphasis on interpersonal awareness critical in Japan. These interactions take different forms and may have different functions, with different kinds of interactions and responsiveness predicting individualist versus collectivist cultural characteristics. But parents might also engage in different, culturally specific forms to achieve these ultimately similar functions.

Consider maternal responsiveness. American mothers tend to emphasize environment-oriented responsiveness by incorporating the world outside the dyad into their interactions. Figure 6.6 shows that, when an American baby looks at mother, an American mother is likely to orient the baby to the environment. Japanese mothers emphasize responsiveness oriented within the dyad; when a Japanese baby looks at mother, a Japanese mother is likely to try to keep the social dyadic interaction going. Japanese and American mothers are both responsive and at the same overall level, but differ in the forms they emphasize which appear to be consonant with more general values in these two cultures. That is, responsiveness is cross-culturally common, and responsiveness differs in form, but cultural differences in responsiveness nonetheless appear to serve the same overarching function of promoting

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**CULTURAL NEUROSCIENCE**

**EXPERIENCES OF DEVELOPMENT**

ECOLOGY/ENVIRONMENT

CULTURE/IDEOLOGY

PARENTING BELIEFS

CHILD DEVELOPMENT

BRAIN

PARENTING BEHAVIORS

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Figure 6.5 Model of relations between culture and neuroscience.

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children’s social adjustment, albeit adjustment in terms of different cultural values: individualist versus collectivist (Bornstein et al., 1992).

Research has amply documented cultural and environmental variation in parenting behaviors and child development (e.g. Mead, 1935; Benedict, 1938; Ainsworth, 1967; Caudill & Schooler, 1973; LeVine, 1988; Whiting & Edwards, 1988; Bornstein, 1991). For example (Bornstein, in preparation), comparable urban samples of mothers and infants from Argentina, Belgium, Israel, Italy and the USA differ on virtually all domains of parenting. Figure 6.7 shows cross-cultural comparisons for six maternal domains. The physical score is the mean highest level mothers promoted; the remainder of the data are mean standard scores of several different behaviors that constituted each domain. Three results are immediate. First, mothers in different cultures differed in every domain assessed. Second, there is no one consistent country profile. It is not as though mothers in one country outstrip mothers in another in parenting generally. Third, the scales being the same, there is some variation across domains of behaviors.

From an anthropological stance, one could argue that the particular cultures compared here are, in some sense, more similar than different. However, the fact that mother behaviors varied so pervasively among these cultures underscores the significance of potential cultural influence on everyday parenting and family behaviors. The culture also shapes larger structures than the family that influence children. Stigler and Hiebert (1999) examined cultural differences in teaching methods through detailed video observations of eighth-grade mathematics classrooms. American teachers tend to emphasize terms and procedures, thinking of math as a set of tedious skills. They try to interest students with praise and real-life problems. In contrast, Japanese teachers are more likely to emphasize ideas, expecting the concepts alone to stir students’ natural curiosity. They weave together lessons that have a distinct beginning, middle and end. Teachers in other countries are more likely to share lessons on what works in the classroom and receive more sophisticated training.

Stigler and Hiebert have shifted their thinking from fixing teachers to fixing teaching. They ground this view on their belief that teaching is a cultural activity, based on the norms and expectations of the society in which it is found. Their cross-cultural research shows that differences in teaching between cultures are much greater than differences in teaching within a given culture. In the last 50 years, Japanese educators have taken an incremental approach to improving teaching by working together to enrich individual lessons: teachers are given the time and resources to do the action research essential to improving daily lessons for all students. In America, teachers are often told by administrators what and how to teach and most often work in isolation. Cultural assumptions define effective teaching for educators, students, parents, politicians and school board members.

Parental beliefs and behaviors are thought to influence the development of structure and function in the child; however, parental beliefs and behaviors are themselves influenced by culture and environment.
Thus, the family is shaped by ecological (and historical) contexts, but the family shapes ecology (and history) as well, and so the two are mutually influential.

Unfortunately, connecting culture and neuroscience is among the least practicable or feasible and among the most demanding and complex of scientific endeavors and will require concerted effort. Several limitations constrain our understanding of each: a narrow participant database, a biased sampling of world cultures, and a corresponding bias in the audience to which the literature is addressed, as well as certain logistic difficulties in its execution. A cultural developmental neuroscience (Bornstein, in preparation) inherits the multiple disadvantages of its several methodologies.

Historically, different comparisons are impelled by different motives, cultural ones by an assessment of social aggregate phenomena and developmental and neuroscience ones by interest in individual structure and function. The three approach issues and questions at different levels of analysis, at the cultural level and at the individual level. The three also address different psychological states, static culture versus the changing individual. Additional methodological questions — sample representativeness, the quality of experimenter-participant communication, population matching, technical feasibility and logistics, and inference — challenge all research, but are particularly acute in forging an alliance between culture and neuroscience. Historically, cross-cultural studies have been only marginally cross-cultural or developmental in the sense of testing few cultures and few ages. Instead, cross-cultural investigators have typically assessed some structure or function in the West and then tried to test it in at least one non-Western culture. By relying on pairwise comparisons and natural experiments, investigators have run a risk of confounding variables over which they have no control or may even have no knowledge. Furthermore, developmental studies have typically concentrated on a particular age (other than adulthood) in the life cycle and have qualified as ‘developmental’ only because the focus is on infants, children or (least frequently) the aged, and not because multiple points in the life span can be compared. Finally, the technical and logistical challenges of doing good neuroscience in the field are formidable. Recommendations to making a comprehensive cultural developmental neuroscience spring from addressing and righting these shortcomings.

Direction of cultural research

How parents see their own children has its special consequences too: parents who regard their child as being difficult are less likely to pay attention or respond to their child’s overtures, and their inattentiveness and non-responsiveness can then foster temperamental difficulties and cognitive shortcomings. All of these kinds of parental beliefs are developed and/or influenced by culture; as ecologies vary, so do parental beliefs. Beliefs are displayed as everyday customs with regard to children and provide important contexts for understanding the nature of children. Hopkins and Westra (1988, 1989, 1990), for example, surveyed English, Jamaican and Indian mothers living in the same English city and found that Jamaican mothers expected their infants to sit and to walk earlier, whereas the Indian mothers expected their infants to crawl later. In each case, infants’ achievements accorded with their mothers’ predictions. That is, parents in different cultures hold different ideas about the meaning and significance of their own parenting behaviors as well as of the behaviors of their children, and parents appear to act on culturally defined beliefs as much or more than on what their senses tell them. Parents in Samoa think of young children as having an angry and willful character, and, independent of what children might actually say, Samoan parents universally report that Samoan children’s first word is ‘tae’ – Samoan for ‘shit’ (Ochs, 1986). The ways in which parents (choose to) interact with their infants appear to relate to parents’ general belief systems. Mothers in rural Thailand do not believe their infants can see (1.7% believe their babies can see at 1 week, 14.7% at 1 month), and they swaddle infants on their backs in a hanging hammock that allows the baby only a narrow slit view of the ceiling or sky (Kotchabhakdi, Winichagoon, Smitasiri, Dhanamitta & Valyasri, 1987).

Brain and behavior, structure and function, are plastic to cultural and environmental experience. A limit to our understanding associations between brain and behavior is attributable to the fact that much of our knowledge derives from studies of non-human organisms, from which generalization must be cautious, and from human beings, but only those reared in special circumstances. True experiments with humans in this field are rare.

The core to developing a vital association between culture and neuroscience is forging alliances among three heretofore disparate specialties. Cultural developmental neuroscience holds the potential to combine the best that the cultural, developmental and neuroscience research traditions each can offer into a positive synergy (Bornstein, in preparation). Cultural and cross-cultural study is vital to delimiting the true range of human experience and to establishing realistic and valid developmental norms. Cultural study is also valuable for the check it provides against an ethnocentric
worldview and the implications of such a view. Finally, comparison in the context of culture is valuable for increasing our understanding of the contributions of nature and nurture to development (Bornstein, 1980). Studies of development provide a standard for understanding how structures and functions manifest themselves at different ages (and presumably how they relate to one another between ages), and there is no substitute for insights into the development of structure and function through the life cycle. Developmental scientists are interested not only in manifestations and quality of structure and function but also in developmental expressions of individual stability or instability and level of group continuity or discontinuity of structure and function (McCall, 1981; Bornstein & Lamb, 1992). Developmental neuroscientists are concerned, moreover, with the question of how a structure and function manifests itself and why development has occurred. The goal of neuroscience is to forge an understanding of the foundations of structure and function in the brain and physiology of the organism, whether in the general spheres of neurological anatomy, single-cell and intercellular physiology, or gross electrical activity or functional metabolism. Questions asked at this level of investigation concern the structural ontogeny and organization of brain with a view to defining their relation to function.

Closing statement

The ideas and research methods covered in this report represent an early step in formulating an integrative research agenda. Greater synthesis and elaboration of these ideas should take place in the course of laboratory and field research. At the same time, we have covered considerable ground by connecting neurobiological mechanisms to human social experiences under both normative and non-normative situations. What is most important in this report is the fact that behavior is presented in its genuine complexity. In fact, the structure and content of narratives might serve to link the elements of the cultural traditions at the societal level with observable behavior and subjective experience at the individual level and hidden regulators at the level of biological mechanisms.