11 From Neuron to Social Context: Restoring Resilience as a Capacity for Good Survival

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The qualities of good survival in extreme situations have inspired the search for the neurobiological mechanisms supporting adaptation in extreme environments. The goal of this chapter is to provide a brief selective historical review of basic brain, endocrine, and behavioral mechanisms that constitute resilience at a biobehavioral level. The processes to be reviewed include concepts of homeostasis, affiliation as an antistress system, brain circuits that respond to features of context, mirror neurons and social neural networks, and the nature of agency in resilient adaptation.

Resilience does not occur in isolation. It is an interactive process that requires someone or something to interact with. It is dependent upon context or environment, including our most important relationships. How are individuals and their brains resilient in their social environment? The short answer is that our neurophysiological constitutions find viable ways of being in our worlds. Understanding the neurobiological mechanisms supporting resilience is a recent development, indeed is emerging as technology advances.

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Localization of Brain Functions: The Disease and Accident Model

The brain as a socially responsive organ of the human anatomy did not appear as a concept until 1990 when Leslie Brothers (1990) coined the expression “social brain” to refer to primate cognitive processes that detect the intentions of others. These “social cognitions” were related to neural activity that could be investigated. Brothers arrived at this position after an extensive review of the literature on primate social signals, the discovery of primate “social” neurons, and a review of human impaired social cognition in autism, recognition of faces, frontal lobe surgeries, and temporal lobe stimulation. Human brain disorders and experimental animal models provided the decisive clues to Brothers’ recognition of the brain’s role in social processes.

An interval of 130 years separates Brothers’ social brain hypothesis and the first scientific demonstrations locating higher human functions in the brain, notably Paul Broca’s work of the 1860s that localized speech in the left frontal cortical area. This period represents a time of unparalleled growth in scientific methods and models of observation that expanded the scope and depth of inquiry into brain functions.

The nineteenth century opened with Franz Joseph Gall’s model of the brain in which he hypothesized that the convolutions of the head

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corresponded to organs beneath the skull that controlled particular mental functions. Each of the 27 organs represented a particular function such as affection, vanity, and others. Phrenology spread widely, placing its books in many homes, and applying its methods to the evaluation of many prominent leaders. In 1822, the Académie Français commissioned Pierre Flourens to test Gall's theory. Flourens proceeded by destroying varying amounts of cortex in chickens, frogs, and other animals. He found that the destruction of one part of the cerebrum affected all functions. All parts of the cortex were responsible for each of the faculties, thus appearing to falsify Gall's mosaic of cortical organs and associated faculties.

However flawed, phrenology did point to the brain as the place to look for human faculties. The idea of cortical localization gained particular ascendancy through discoveries concerning impaired speech. Passionate discussions and dramatic demonstrations on speech and the brain took place in Paris in mid-nineteenth century. Jean-Baptiste Bouillaud had collected hundreds of cases where loss of speech was associated with anterior lobe injury. He offered a price to anyone who could contradict this finding. Bouillard lost the wager. Simon Aubertin described a case of a man who had shot himself in the head. The injury had exposed his brain, allowing Aubertin to apply degrees of pressure to the anterior cortex, thereby stopping or reinstating the patient's speech. A few days after Aubertin's presentation in 1861, Paul Broca presented the case of "Tan," the only word his patient had uttered. On autopsy, Tan's brain showed a prominent left anterior cortical lesion, a finding immortalized as Broca's area and Broca's aphasia. Two years later, using many cases, Gustav Dax demonstrated left hemisphere dominance for speech. Thus began the intense activity over localizing the functions of the brain, present to this day, and cast in its modern version in the varieties of imaging studies (for a detailed historical review see Finger, 2000).

To this localization tradition based on disorders and injury belongs the case of Phineas Gage, the foreman of a crew building the Burlington Northern Railroad. While tamping the explosive, premature ignition of the powder shot the tamping iron through the left side of Gage's jaw and through the top of his skull. Gage survived but was much changed: used profanity, acted impulsively and childlike, and was irresponsible. Gage was no longer Gage; an astonishing discovery showing that damage to his frontal lobes had changed his personality (Harlow, 1848).

How Hormones, Neurotransmitters, and the Internal Milieu Relate to the Environment

Stress Hormones and Neurotransmitters

While the brain-focused approaches increasingly uncovered cortical faculties, the body demonstrated the necessity of adapting to and taking the environment into account in ways that sustained life. Thus, the importance of the environment or context entered through the back door of the body with the *milieu intérieur* of Claude Bernard (Gross, 1998). Bernard noted that extracellular fluid constituted the immediate internal environment. The stability of this cellular milieu protected warm-blooded mammals in their ability to survive freely and independently in many different environments. The "external variations" of the environment were compensated for by "the conditions of life in the internal environment" (Gross, p. 383). Bernard's concept had little impact for over 50 years until it came to influence the work of Walter Cannon.

The study of how the body coordinated physiological processes in order to maintain steady states under conditions of challenge and rest became Cannon's life work. He called this process of mobilization of resources during challenge and restoring resources during rest *homeostasis* (Cannon, 1929). How the body automatically corrected physiological parameters under these conditions was controlled by the autonomic nervous system (ANS). The sympathetic nervous system (SNS) maintained homeostasis and was engaged quickly during challenges, as it mobilized the energies of the body through the secretion of epinephrine and norepinephrine (adrenaline and noradrenaline), which in turn released glucose and fatty acids, increased the heart rate and blood pressure, and rushed energy to muscles for fight–flight action, and away from organs and activities not needed for emergency response, such as digestion. The parasympathetic nervous system (PNS) preserved body energies and functioned in a restorative manner by promoting digestion, growth, reproduction, and immune responses. It was engaged when threats had subsided. In major ways the two branches of the ANS, the sympathetic and parasympathetic, are said to act in opposition to each other. When one is engaged, the other is reduced in its activation.

In his early studies, Cannon examined, with the use of X-rays, the influence of SNS on the movements of the stomach and intestines in cats. The movements stopped with strong emotional stimuli and returned when the animal was relaxed or asleep, thus demonstrating the decreased activation of the SNS during digestion. He examined the role of the SNS in maintaining homeostasis during various bodily disturbances, as in hemorrhages, hypoglycemia, low and high body temperature, muscle exercise, and others. He found that the SNS acted promptly, mobilized energies quickly, and had a widespread effect that acted in a coordinated response in one direction, such as fight–flight.

Cannon viewed behavior itself as a homeostatic mechanism. Homeostatic mechanisms of temperature regulation were evident in shivering, seeking shelter, and putting on a coat. He even suggested that some "social homeostatic" mechanism was needed "to support bodily homeostasis" and thereby expanded Bernard's idea of self-regulation of bodily fluids in the wider social environment. Cannon summarized his positive view of the body's adaptive abilities in his book, *The Wisdom of the Body* (1932).

While Cannon was the first to recognize the role of the SNS and the role of epinephrine and norepinephrine in the acute stress response, Hans Selye (1956) pioneered its glucocorticoid component and the role of glucocorticoids in chronic stress, the best known of these being cortisol. In his search for the next new hormone, Selye injected rats with a variety of hormones and found that they all had the same effect on the organism. Even other toxins and challenges of heat, cold, or pain had the same effect. He called this pattern of responses *general adaptation syndrome* (GAS). When chronically stressed by crowding, noise, or fighting, the animals died. On autopsy they had enlarged adrenal glands, enlarged pituitary glands, shrunken thymuses, and stomach ulcers. Selye attributed these findings to an excess of adrenal hormones. He thought these hormones formed a signaling system that involved the pituitary, the adrenal cortex, and the release of glucocorticoids, parts of a system known today as the hypothalamic–pituitary–adrenal (HPA) axis.

McEwen writes of Selye's work: "Most conspicuously absent was a demonstrable link connecting the emotions, the stress response, and the brain…the scientists of Selye's day did not accept the brain as the master coordinator of the stress response" (McEwen, 2002, p. 40). McEwen aptly observes that the emotions were not considered to be a function of the brain either. Indeed the brain was not considered an "emotional organ" until Paul McLean's identification of the limbic system in the 1950s. The 1980s changed this state of affairs, first with the conceptualization of *allostasis* (Sterling & Eyer, 1988) and McEwen's formulation of *allostatic load* (McEwen & Stellar, 1993), and second, with the studies of oxytocin as a social/affiliative antistress hormone and neuropeptide.

Sterling and Eyer proposed the concept of *allostasis* for maintaining stability through finely tuned changes that matched resources and needs, such as the cardiovascular system at rest and active states. McEwen (McEwen & Stellar, 1993) extended the concept of allostasis to other physiological mediators, notably cortisol, catecholamines (epinephrine and norepinephrine), age as a mediator, and others. McEwen also proposed that inefficiencies in allostasis over a longer period of time could result in accumulated negative effects, or *allostatic load*. This process resulting in allostatic load is more comprehensive than chronic stress in that it covers more facets that affect adaptation: genes, early development, life style, diet, exercise, smoking, alcohol, and other inefficiencies (McEwen & Seeman, 1999). Cannon's relatively simple concept of homeostasis has become a much more nuanced and complex process connecting organism and environment in richly textured ways.

The Affiliative Hormone and Neuropeptide

At last we arrive at an endocrine and neuropeptide system that is social and affiliative and is said to function as an antistress system. If there is an entity such as Cannon's "social homeostasis," a possible candidate might be the oxytocin affiliation system. This work began with the study of the monogamous prairie vole *Microtus orchogaster* during the early 1980s (Getz & Carter, 1980), 50 years after Cannon's seminal work on *homeostasis* and 100 years after Bernard's formulation of the *milieu intérieur*. The starting point for Getz and Carter was not the brain or physiological mechanisms that were in need of explanation, but the particular social arrangement of monogamy in these voles. The question as to the possible brain mechanisms that could differentiate between the monogamous voles and polygamous montane voles, or *Microtus montanus*, emerged from questions about a social arrangement. Getz and Carter identified the difference between monogamous and polygamous voles in the number and distribution of oxytocin receptors in the brain. These two strains of voles quickly became a powerful animal model for the study of the role of oxytocin in social behavior through methods of injecting oxytocin directly into the animal's brain. Since oxytocin did not cross the blood–brain barrier, peripheral oxytocin could not be taken to reflect comparable levels of central oxytocin. Injection of oxytocin directly into the brains of voles resulted in increased social behavior, pair bonding, attachment, sexual behavior, exploration or approach to novelty, and decreases in stress and pain. Oxytocin could also be released by social interaction, touch, warm water, massage, sexual behavior, and lactation (Carter & DeVries, 1999).

Uvnaes-Moberg and colleagues (Uvnaes-Moberg & Roberta, 2005; Uvnaes-Moberg, 1998) call the oxytocin affiliative response pattern the "calm and connection" pattern, which is physiologically supported by the vagal PNS and compliments the fight–flight stress response. When the vagal PNS is activated, sympathetic system activities are reduced. Characteristic parasympathetic activities emerge, such as increased digestion, relaxed muscles, lower cardiovascular activity, and lower cortisol that are accompanied by feelings of calm, well-being, and positive social interaction. In this parasympathetic mode, energy is used for the purposes of growth and restoration rather than for muscular activity. The calm and connection pattern can be evoked by calming sensory stimulation of touch and warmth and by environmental and psychological positive interaction. Feelings of calm and connection are slower to emerge in contrast to the immediate reactions of fight–flight.

Oxytocin thus functions as a multifaceted endogenous system for buffering stress.

Circuits in the Brain Respond to the Environment: The Fear Circuit

As the study of the brain deepened from gross cortical structures to neurotransmitters, it simultaneously expanded to questions about how brain circuits responded to the threats and rewards posed by the environment. Animal models could manipulate context, lesion areas of the brain, and empirically measure the responses of the lesioned organism. Joseph LeDoux did exactly that: he manipulate context and lesioned the brains of rats in his hunt for the brain's fear circuit.

To elicit fear reliably, LeDoux turned to fear conditioning, a well-established experimental model in which foot shock elicited fear in rats while sound alone did not elicit fear. By pairing the neutral sound with mild foot shock, the neutral sound came to elicit fear when the sound was presented alone. The sound was no longer neutral but became a cue for foot shock and impending danger. At a physiological level the sympathetic response releases stress hormones and mobilizes energy in preparation for fight–flight.

To find the fear network, LeDoux (1996; LeDoux & Phelps, 2000) followed "the natural flow of information through the brain" (1996, p. 151). He started at the highest part of the brain, or the cortex, and moved to interior and lower areas.

He lesioned the relevant auditory cortex. This had no effect on the fear response. He lesioned the next lower level, the auditory part of the thalamus. This did prevent fear conditioning. The sound stimulus did have to enter the thalamus, the station for all sensory input. LeDoux then disconnected the auditory thalamus from the amygdala. This also prevented conditioning. The essential fear circuit consisted of the thalamus and the amygdala, a circuit that could transmit fear signals without going through the cortex. LeDoux called this path the "low road" as compared to the "high road" in which the fear circuit took the longer route through the auditory cortex. The thalamus–amygdala, or low road, was faster but less accurate in that the thalamus provided rough details of a potential threat. The thalamo-cortico-amygdala path, or high road, was slower but more accurate and detailed in identifying danger. LeDoux thus demonstrated that emotional learning about danger in the environment could bypass the neocortex and higher processing activities of the brain and take the quicker short route through the thalamic-amygdala path, a route with distinct survival advantage. Better to be wrong and alive than right and dead.

Brain-Environment Dimensions

We have encountered one biobehavioral dimension in the form of the ANS and its sympathetic branch responsive to threat with fight–flight capacities and the parasympathetic branch engaged during digestion and restorative functions. Since Cannon, investigators have proposed a number of broad brain–behavior–environment dimensions. In an interesting paper Schneirla proposed that biphasic processes supported "how animals generally manage to reach beneficial conditions and stay away from the harmful, that is, how *survivors* do this" (1959, p. 1). Approach was defined as coming nearer to a stimulus source and withdrawal as increasing the distance to a stimulus source.

The main principle supporting this biphasic approach–withdrawal was intensity of stimulation. Schneirla argued that in all organisms low intensities of stimulation evoked approach reactions while high intensities of stimulation evoked withdrawal reactions. Low-energy stimulation led to food or other benefits, including no harm, while high-energy stimulation led to harm or death: "stimulative energy fundamentally dominates the approach and withdrawal responses of all animals" (p. 7). Low-intensity stimulation brought about vegetative changes through the parasympathetic system while high-intensity stimulation produced interruptive changes through activation of the sympathetic system and adrenalin secretion. Schneirla believed that his approach–withdrawal concepts summarized a broad biobehavioral evolutionary adaptive mechanism grounded in the works of Darwin, Cannon, Sherrington, and others.

An entirely different conception of approach–withdrawal evolved from the study of emotional concepts, one common method being the study of words representing emotions. Here investigators asked for judgments about emotional states and emotional objects. The goal was to identify the basic features of emotions. Results uncovered fundamental conceptual dimensions, the most common being two-dimensional ones of pleasant vs. unpleasant and activated vs. deactivated (e.g., Russell, 1979, 1980; Russell & Feldman Barrett, 1999). Russell proposed a "circumplex" model in which mood words could be arranged around the perimeter of a circle, segmented by two basic dimensions.

Subsequent investigations confirmed the two-dimensional structure (Watson & Tellege, 1985). However, more recently, Watson and colleagues (Watson, Wise, Vaidya, & Tellegen, 1999) concluded that the model did not fit the data closely. They identified two unipolar constructs of Negative Activation and Positive Activation that functioned independently as two basic biobehavioral systems of activation evolved for key adaptive tasks.

Taking a more psychobiological approach, Gray (1981, 1982) proposed two general motivational systems as the basis of behavior and affect, namely the behavioral inhibition system (BIS) that inhibits behavior leading to aversive outcomes and the behavioral activation system (BAS) that leads to reward. According to Gray (1987), the BIS focuses maximal attention on the environment, to analyzing it and its novel and dangerous stimuli through "stop, look, listen" activities. BIS promotes vigilant scanning for threat. BAS is seen as an appetitive system of approach to pleasant and rewarded results. It is based on incentive motivation rather than pain avoidance. These concepts were further elaborated by the BIS/BAS Scales of Carver and White (1994).

Additional support for the neurobiological basis of the BIS and BAS systems came from the work of Richard Davidson. He and his colleagues had applied electroencephalographic (EEG) measures to demonstrate prefrontal hemispheric asymmetry in a number of studies (Davidson, 1992; Davidson & Tomarken, 1989) In subsequent work they related hemispheric asymmetry to the BIS and BAS systems, showing greater left prefrontal activation associated with higher levels of BAS and greater right prefrontal activation associated with reported higher levels of BIS strength. (Sutton & Davidson, 1997).

A related dimension is proposed by Panksepp in his seeking and rage or aggression circuits. Panksepp proposes that these two neural circuits express mutually inhibitory interactions (1998). The mechanism that turns seeking into rage/aggression resides in the expectancy of the seeking system, where frustration of expectancy triggers rage/aggression. Panksepp locates the seeking behavioral system in the brain dopamine circuit, or reward circuit of the brain. Electrical stimulation of the ascending dopamine circuit evokes vigorous exploration and search, feelings of engagement, being able to do things, and feelings of excitement, a circuit that corresponds to the seeking behavioral system. According to Panksepp, the seeking system investigates and explores the environment with intense interest, engaged curiosity, eager anticipation, and invigorated feelings. It is not surprising that the seeking system interacts with higher brain mechanisms of the prefrontal cortex that generate plans and with higher-order information processing.

Mirror Neurons and Shared Action Representation

We arrive at the latest discovery that is revolutionizing our understanding of the brain and its deep social nature, namely the discovery of mirror neurons at a time that overlapped with Leslie Brothers' "social brain" proposal. Since then, research into the social brain and social neuroscience as well as affective neuroscience has exploded. This is reflected in the increasing number of major publications: the edited volume *Foundations of Social Neuroscience* (Cacioppo et al., 2002); *Social Neuroscience*: *A New Journal* (2006); the *Wisconsin Symposium on Emotions* dedicating its 12th annual symposium to "Order and Disorder in the Social Brain;" Panksepp's *Affective Neuroscience* (1998); and Davidson, Scherer, and Goldsmith's *Handbook of Affective Sciences* (2003). A review is beyond the scope of this chapter. Instead, we will focus on studies of mirror neurons that have lent significant energy and enthusiasm to these developments.

In a series of detailed neuroanatomical studies, Giacomo Rizzolatti and colleagues (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti & Craighero, 2004) reported their findings on mirror neurons in macaque monkeys. These investigators had implanted electrodes into individual neurons of area F5 of the premotor cortex, in humans the homologous area of the left prefrontal speech area (identified earlier in this chapter as Broca's area). In macaques, this area was known to be involved in actions of the hand in grasping, holding, tearing, and bringing to the mouth. The investigators discovered that these neurons were not only activated by the grasping actions of the monkey's hand but also by the monkey simply observing an experimenter picking up an object. Thus, performing the action and observing someone else perform the same action produced the same activation in the neurons of area F5 in the monkey. Perception of action and performing an action were identical. Seeing and doing were the same, a surprising finding since action and vision were thought of as different abilities and as located in separate brain areas.

Early findings by the Rizzolatti group established that mirror neurons were activated by particular kinds of grasps the monkey made: a precision grip made for grasping a small object (raisin) with two fingers, a whole-hand grip for large objects (apple), or actions that achieved a similar goal but the grasping was for a broader range of objects. Of note is that these mirror neurons were not activated when the actions involved the same muscles or when actions did not have an object, such as in scratching an arm. Mirror neurons were thus involved in *object-oriented* action. Other neurons were called *canonical* neurons, since they responded to the sight of objects graspable with a precision grip or whole-hand grip. The type of object did not matter, only size did.

Of note is also that mirror neurons were activated when monkeys recognized the actions of others but were unable to see the action sequence fully, such as when the experimenter reached for an object behind a screen which the monkey had previously seen the experimenter place there (Umilta et al., 2001). These neurons were multimodal in that they were also activated by sounds of action (Kohler et al., 2002). Mirror neurons were even sensitive to experience, being more activated in experienced pianists listening to piano music as compared to inexperienced ones (Seung, Kyong, Woo, Lee, & Lee, 2005).

Investigators set out to explore the functions of mirror neurons. The main findings affirm that mirroring the actions of others helps to understand the actions of others by extracting the goal and meaning of those actions (Rizzolatti, Fogassi, & Gallese, 2001). Resonance reveals the outcome of the action and, thus, the goal of action (Gallese, Keysers, & Rizzolatti, 2004). The mirroring of action becomes a mechanism for simulation in order to know goals, intentions, and the minds of others.

In identifying a similar mirroring system in humans, a number of studies have used imaging approaches: including functional magnetic resonance imaging (fMRI; Buccino et al., 2004), positorn emission tomography (PET; Rizzolatti et al., 1996), transcranial magnetic stimulation (TMS; Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995), and magnetoencephalography (MEG; Hari & Salmelin, 1997). Studies have identified three brain areas particularly activated when observing the actions of others: (1) inferior frontal area corresponding in part to Broca's area (monkey ventral premotor area F5), (2) inferior parietal lobule, (3) middle temporal gyrus in humans (in the monkey, the superior temporal sulcus, STS).

Keysers and Gazzola (2006; Keysers et al., 2004) propose that shared activation is also evident in sensations such as pain and in perceiving emotions such as disgust and fear. They propose that the shared circuits for action, sensations, and emotions are established through Hebbian learning and through anatomical connections between the frontal, parietal, and temporal mirror neuron nodes, summarized in the well-known expression "neurons that fire together, are wired together."

The work on mirror neurons has become important to our understanding of resilience and trauma and to the development of a Resilience Building Model (BRiM), to be discussed in the concluding part of this chapter. From this vantage point, we would like to propose an additional function for mirror neurons, namely that they represent the structure of action as a unitary entity comprised of the actor, the action performed by the actor, and the object at which the action is directed, a structure or unit designated here as Actor-action-Object (AaO). The process by which this takes place may be through encoding this structure in a modular way as a single unit. It is unclear whether this unity is achieved through an inherent property of mirror neurons, through a network resulting from Hebbian learning, as Keysers and Gazzola suggest, through mirror neurons reflecting a small segment of such a network, or through some as yet unidentified mechanism. Several factors point to the existence of such an action structure:

1. In the case of macaques, mirror neurons require that the action be directed at an object. Otherwise the neurons will not fire. Also of note is that mirror neurons are not activated by pantomime in macaques, such as opening and closing the hand in a dumb-show performance (Umilta et al., 2001). In humans, mirror neurons are activated by transitive actions directed at objects and intransitive actions without objects, demonstrating a capacity to distinguish between whether an action has an object or not.

2. In real life the unity of Actor-action-Object is ubiquitous. In our everyday activities action is not disembodied. Take the example of "kicking." At a minimum, "kicking" requires effectors of legs that do the kicking. The legs, too, are not disembodied but require to be attached to a body. The body, too, cannot be disembodied but must enact the action. Thus, there is no "kicking" happening on the sidewalk without legs, without the legs attached to a body, without the body enacting the kicking, and without the actor. Nor is "kicking" happening on the sidewalk without an object being kicked. Kicking the air would appear strange, abnormal, raising concerns about something being wrong with the person doing the kicking. Thus, actions DO NOT require us to search for the Actor performing that action among myriad actors or to grope for the Object at which the action is directed among the countless objects surrounding us. However, these elements can be thus disorganized in various abnormal conditions, such as psychoses, deliriums, or identity confusion in schizophrenia. By contrast, our social world has remarkable coherence and is orderly, well organized, and remarkably smooth in the countless interactions taking place every moment around the globe. Our narratives relate stories about protagonists acting and interacting with objects and others in countless intricate ways, across many centuries, in different cultures, and in different languages.
3. Another area supporting the AaO unity is language. The AaO structure is captured in the structure of most languages, be it in syntax or through grammar. The subject and object of a sentence can be identified through the order in which subject and object occur in a sentence (e.g., English), or through grammatical endings added to nouns identifying them as subject or object (e.g., German). No matter how different the languages are, they have ways of identifying the actor and what the actor is doing with what or to whom or whether the doing is transitive or intransitive. In linguistics and in robotic simulations of language this is the universality of the predicate or predicate-argument of who does what to whom or what (Steels, 2007).
4. Another aspect of language supporting the AaO structure comes from a class of words, namely emotion terms, such as fear or anger. These words often represent the three elements of AaO in a unitary way: (a) the agent, (b) a particular action readiness state of the agent, and (c) a target or object outside of the agent. Emotion words are actually good examples that treat AaO as a unitary entity, such as the single word "fear" or "afraid" where such an action tendency implies an agent and an object outside of the agent.
5. The structure AaO stands in sharp contrast to experiences of trauma. Here the traumatized individual is actually the Object of someone else's AaO enactment. For the traumatized person the order of the action unit or structure is inverted into OaA, such that he is the Object and not the Actor/Agent/Initiator of the action. He re-experiences the traumatic event in intrusive thoughts, stimulus reminders, and nightmares; is hypervigilant; and avoids social contacts and other situations.

What happens to the mirroring of perceived action when the person is an Object? Is the action of the Object the result of a mirror neuron simulation mechanism that re-enacts the abuse perpetually and unstoppably? Or is there some other process driven by emotional mechanisms, such as the amygdala and sympathetic arousal and related actions? Grezes and de Gelder (2008) state the issue pointedly, "It is, however, an open question whether the critical factor for understanding actions with an emotional component is the activity within motor-related areas as such (the mirror system) or the interaction between the emotion-processing areas and an action-related network" (p. 72). They offer one explanation. Emotions prepare the organism for a response to the environment. Perception of fear, for example, would trigger a fear reaction that was based on a fear motor program in subcortical and cortical circuitry. This fear circuitry does not involve the mirror neurons. Mirror mechanisms and emotional processing are coactivated in motor resonance or detecting intentions. However, mirror mechanisms may be dissociated from socio-affective capabilities, such as in autism.

Grezes and de Gelder's position is important in that they distinguish mirror mechanisms from emotional processes. The OaA unit in trauma may incorporate both mirroring or resonance in cases where the Object is inflicting self-abuse and mirroring the actions of the perpetrator, while the unit also represents the emotional fear reaction or a relevant sympathetic response to the perpetrator's treatment. The fear response may dissociate the fear circuit amygdala hyperactivity from the prefrontal cortical areas involving mirror neuron mechanisms that are not resonating with the perpetrator's actions. Thus, both mirroring/resonance of perpetrator's actions and fear of those actions and of the perpetrator may be involved, thus holding the victim doubly captive. At the same time, experiencing himself as an Agent in these situations is simply not in his brain, is not represented in his brain circuitry or neuroendocrine response. What is doubly represented is that of the object status and the emotional reaction of stress.

Agency and Adaptation

Our own work on brain functions and social context began several years ago with a review of good survival in extreme situations. Not all experiences of extreme situations lead to extreme stress and trauma. Indeed, the more prevalent response is one of resilience (McFarlane, 1996). Our study began with a view of resilience as a naturally occurring response to threat, one that naturally ameliorates or terminates distress. This endogenous resilience capacity would appear to be an excellent candidate for treating post-traumatic stress disorder (PTSD), as it is aimed at what Yehuda and Davidson (2000) target for treatment, "PTSD develops from an inadequate termination of a stress response…reducing the distress would be of paramount importance in the treatment of PTSD" (p. 1).

Treating distress and the reminders associated with PTSD have been the core object of mainstream psychological therapies for PTSD over the past 30 years. The main therapeutic approaches evolved out of contemporaneous psychological theories of classical and operant conditioning and of cognitive psychology, leading to empirically efficacious treatments for PTSD (Foa, Keane, Friedman, & Cohen, 2009) represented by exposure therapy (ET) and cognitive behavior therapy (CBT). New directions in therapeutic approaches have increasingly turned to the development of capacities and skills stunted in patients suffering from anxiety and mood disorders. Linehan (1993) incorporated Zen practices of acceptance and toleration of dysphoric affect in her treatment of borderline personality disorder. Recognizing the lack of effective treatment for complex PTSD associated with childhood abuse, Cloitre, Koenen, Cohen, and Han (2002) developed a skills training model. The emerging interest in capacity-building and resilience models (Kent & Davis, 2010) reflect the growing trend in "new wave therapies" (Hayes, 2004). Our own interests in resilience grew out of the recognition that the main qualities of resilience were lost or compromised in traumatic responses to threat. Over the past 6 years, we have sought to identify core resilience qualities, to develop well-articulated treatment approaches that would restore resilience in individuals suffering from PTSD, and to test their efficacy in clinical trials.

To identify resilience characteristics, this study began with naturalistic examples of good survival in extreme situations, as described in printed autobiographies by survivors themselves, in biographies, and in histories. In this informal literature, two features repeatedly characterized good survival: an attitude of approach and engagement and of social relatedness. The examples extended from Eugenia Ginzburg (1967) chanting poetry while in solitary confinement in the Gulag; a boy playing his violin whenever his city was bombed (Leet, 1984. Personal communication); a boy in Chauchilla, California, helping his schoolmates escape from a collapsing cave and kidnapping (Terr, 1979); and an inmate in a Nazi concentration camp who survived 6 years in that camp by resolving not to hate but to love and be helpful (Ritchie, 1978). In the large developmental research literature on resilience of

Approach/Engagement --	Withdrawal/Defense
Social Relatedness	
Exemplary Behaviors of Approach/Engagement	Exemplary Behaviors Withdrawal/Defense
interest	flight – fight
curiosity	fear – anger
appreciation	avoid – attach
noticing beauty	hide – confront
Social Relatedness	
empathy	
friendship	
helping	
love	

Fig. 11.1 Behavioral response tendencies of approach/engagement and withdrawal/defense

Approach/Engagement --	Withdrawal/Defense
Social Relatedness	
parasympathetic (Cannon)	sympathetic (Cannon)
seeking (Panksepp)	rage/anger (Panksepp)
left hemisphere (R. Davidson)	right hemisphere (R. Davidson)
ventral vagus (Porges)	HPA axis (McEwen)
oxytocin (Carter)	cortison, (Selye, McEwen)
prefrontal cortex (Luria, Fuster)	amygdala (LeDoux)
mirror neurons (Rizzolatti)	stress loop (Sousa, Dias-Ferreira)
(Broca's area)	(amygdala vs. prefrontal cortex)

Fig. 11.2 Psychobiological dimension supporting action tendencies of approach/engagement and withdrawal/defense

children growing up in adversity, two characteristics emerge when describing resilience and positive adaptation. These are a close relationship with one or more adults and self-efficacy or being effective in their environments. These particular two qualities are replicated in numerous studies with remarkable consistency (Masten, Best, & Garmezy, 1990; Luthar, 2006).

Our wide-ranging review pointed to two prominent characteristics of good survival in the survivor literature and the resilient positive adaptation in the developmental research: (1) approach and engagement in the person's circumstances in ways that kept him or her well, and (2) social relatedness and maintaining connections with others. Figure 11.1 summarizes the main behaviors associated with approach/engagement and the response tendencies of withdrawal/defense. These two response tendencies are frequently found concurrently in low stress situations. They can become dichotomous in extreme situations of threat and challenge in which one or the other tendency prevails.

A third characteristic of good survival is an efficient stress response. The neurobiological literature on stress has long recognized an efficient stress response as essential for good adaptation, as first articulated by Cannon's (1938) fight–flight response, by Selye's (1956) GAS, and reflected in the conceptions of allostasis (Sterling & Eyer, 1988) and allostatic load (McEwen & Seeman, 1999). It is the biological literature that has long postulated a dimension of contrasting and opposing functions of approach/engagement and withdrawal/defense, as represented by the work of Panksepp (1998), Davidson (2000), Carter (1998) and Uvnaes-Moberg (1998), Porges (2001), Luria (1980), Fuster (2008), Sousa and colleagues (Sousa et al., 2000), Dias-Ferreira and colleagues (Dias-Ferreira et al., 2009), and others. Figure 11.2 summarizes this physiologically supported action dimension.

We are endowed with these major physiological mechanisms and related behaviors to interact with the environment and to do so with sensitivity to environmental contingencies. Adaptation is smooth when the environment is mainly a contingent one and what we do has an effect on it. Resilience and traumatic stress come to the fore in noncontingent environments, where what we do

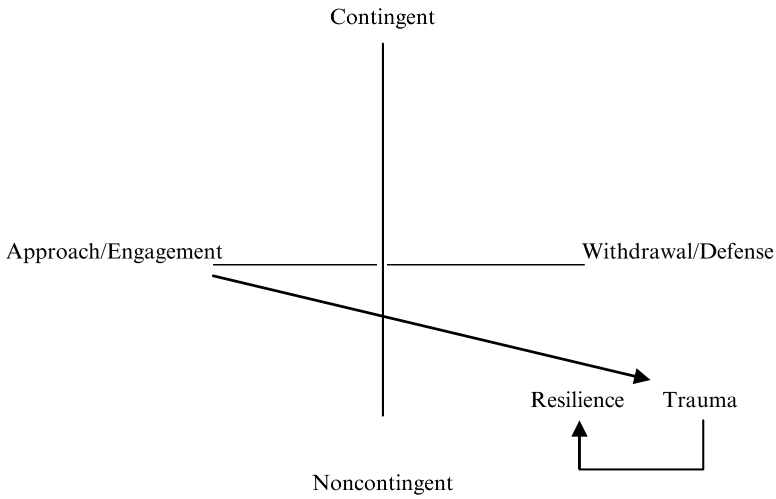

Fig. 11.3 Model for building resilience through resilient action change

has little effect and where resilience and traumatic stress exhibit quite contrasting qualities, with resilience showing approach/engagement, social relatedness, and an efficient stress response while traumatic stress appearing to be characterized by a dysregulated stress response and the symptom triad of PTSD that includes re-experiencing, avoidance, and hyper-reactivity.

Our goal was to restore the three resilient qualities of approach/engagement, social relatedness, and an efficient stress response in conditions in which these were lost or compromised, such as PTSD, depression, and chronic illnesses. We did this by basically simulating and recreating experiences of resilience qualities (approach/engagement and social relatedness) and then taking these into past stressful or traumatic experiences in ways that dissipated the distress and transformed stress/trauma into resilience. With this method we simulated resilience in stressful/traumatic experiences that had lacked resilient responses. At the same time, we fundamentally changed agency. Participants did not return to past stress/trauma as objects and victims of those past experiences but as agents and initiators of resilient responses that were already part of their experiences. Changes in affect, in symptoms, and in cognition happened concurrently with the change in action. Figure 11.3 summarizes the BRiM model.

We developed a manualized program that covers the restoration of resilience strengths. It has evolved into four modules and is adapted to treat outpatient PTSD, depression, mixed Axis I groups, inpatient and outpatient addiction, sexual assault, chronic illnesses including chronic pain, fibromyalgia, and cancer. Depending on the type and severity of the disorder, the manualized program is adapted to extend from 4 to 12 weeks and is conducted in a small-group format. The sessions cover key components of resilience. Beginning modules cover the restoration of individuals' resilience strengths that include approach/engagement and social relatedness. These capabilities are subsequently drawn on as patients revisit the life episodes associated with distress. In a subsequent resolution module, participants practice the use of restored strengths by returning to challenging experiences in ways that disarmed the stress. The final module encourages individuals to consider the question "What is a good life?" as a means of helping them reweave their life narratives into ones that bring their strengths forward and that help to consolidate treatment gains.

The program begins with components of resilience experiences instead of traumatic ones. Participants are asked to place stressful/traumatic episodes "on hold" or to set them aside until the

Table 11.1 Modules for the building resilience model (BRiM)

Introduction. The body sense. The brain registers states of stress and calm in body states. This introduction serves to improve awareness of bodily states of calm energy and strength in body map exercises. Trauma is first experienced in the body, is physiologically maintained, and needs to leave bodily states.
Module I. Approach/engagement proactive orientation. It covers experiences of interest, appreciation, noticing beauty. It is regained by reexperiencing past episodes of childhood and early adulthood times that are formative. Participants are asked to describe each episode, indicate where in the body the respective qualities (of interest curiosity etc.) are, and to make a visual representation (method and materials of their choosing such as collages sculptures etc.). Approach is a basic vital response of all living organisms to approach what sustains them.
Module II. Social relatedness. It covers experiences of empathy, affiliation, friendship, bonds, love. Participants are asked to reexperience and reinstate past affiliative episodes by describing them, making the body connection, and making a visual representation. Affiliation is vital for reproduction and rearing of all mammals.
Module III. Trauma/stress resolution. It integrates the reestablished approach and relatedness experiences of Modules II and III with traumatic and stressful life events. Stressful experiences are revisited in a graded manner with practiced resilience strength experiences. Again participants are asked to describe this resilience-based return to trauma, make dividing underline the body connection, and make a visual representation.
Module IV. The future with resilience. It asks the question, what is a good life. It explores a view of the future that participants can look forward to rather than one they dread.

integration phase of Module III. They are asked to find an episode from formative years of childhood and early adult years in which they are cherished and loved or they cherished and loved someone or something else. They are asked to turn to this episode when stressed during the course of the study, rather than remain in their stressful state. The emphasis throughout the program is on the rebuilding of resilience-related strengths that are richly interconnected to neuroendocrine, neurophysiological, psychological, and cognitive functions of the individual. Each module is described in Table 11.1.

Didactic materials for each module include sample readings, photographs, and brief film excerpts. Modules also include brief and simple descriptions and illustrations of relevant brain, neurophysiological, and neuroendocrine functions, such as the fear circuitry and executive functions, the fight–flight response, cortisol and oxytocin, with an emphasis on experience-dependent brain plasticity. The brain can be changed, and related biological functions can be changed through a change in experience that is resilience-based.

A current test of this model with PTSD participants shows strong declines in symptoms of PTSD, depression, and anxiety; gains in well-being, social role and vitality; and increased memory and executive functions (Kent, Davis, Stark, & Stewart, in press).

Conclusion

The study of the brain started with Broca's area in 1861 with the discovery of the localization of speech. Today the intense interest in neuroscience has returned full circle to Broca's area in the discovery of mirror neurons and their role in intentional action. An area once considered primarily devoted to language is now treated as fundamental to the joint execution and perception of action in which language is seen as an adaptation or modification of functions carried out by action. Action has become adapted to the purpose of communication in ways that may have started with hand gestures and evolved to communication with sounds, as proposed by Rizzolatti and Arbib in their paper whimsically entitled "Language Within Our Grasp" (1998). Through their mirroring function, mirror neurons in Broca's area and related areas demonstrate that we are profoundly social beings in ways that allow us to experience each other's actions, intentions, and emotions. We are resilient when we maintain agency and approach/engagement in the face of adversity. We can restore agency when it is derailed by overwhelming experiences and hyper-reactivity of the stress response. Agency can be restored through an approach of simulated resilience that restores homeostasis and activates related neurocortical areas of resilience (Pardo, 2010).

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