THE NEUROBIOLOGY OF SURVIVAL AND MALIGNANT MEMORIES

The tenacious effects of trauma are rooted in the well-characterized total initial body freeze, fight-or-flight, alarm or stress response to life threat (6, 55, 54, 97, 7). This complex set of interactive processes includes activation of the centrally-controlled peripheral autonomic nervous system tone, the immune system (42), the hypothalamic-pituitary axis with a concomitant peripheral release of adrenocorticotrophic and cortisol, and of other neurochemical systems in the central nervous system (CNS)(81). The locus coeruleus (LC) is a central mediator of the stress response (36). This bilateral grouping of norepinephrine-containing neurons originates in the pons, a more primitive, regulatory part of the brain, and sends diverse axonal projections to virtually all major brain regions, enabling its function as a general regulator of noradrenergic tone and activity. The ventral tegmental nucleus (VTN) also plays a part in regulating the sympathetic nuclei in the pons/medulla. Acute stress results in an increase in LC and VTN activity and release of norepinephrine that influences the brain and the rest of the body. This system plays a critical role in regulating arousal, vigilance, affect, behavioral irritability, locomotion, attention, the response to stress, sleep and the startle response (42, 53, 55, 81, 36).

Evidence is accumulating that the alarm reaction initiates a cascade of cellular and molecular processes that alter brain structure and function to create an adaptive record of survival-related information. Intense danger activates the neurosensory apparatus and alters the pattern and quantity of neurotransmitter release throughout neuronal systems responsible for sensation, perception and processing of survival information. Neurotransmitter receptor/effector activation then alters intracellular chemical constituents, including second (e.g. cAMP, phosphatidyl inositol) and third messengers. Changes in these messengers alter the micro-environmental milieu of the nucleus. Since the portion of the genome expressed in a given neuron is dependent upon the local micro-environment in its nucleus, changes in gene transcription and expression of proteins can result, including sensitization of receptors to similar future neurotransmitter stimulation in all synaptically connected neurons.

Further evidence suggests that newly arrayed patterns of sensitized

interconnected neurons then organize the brain of a survivor into functional neural networks (48). For example, the widely distributed but tightly connected limbic network is critical in making new experiences storable and old experiences retrievable. Enabling association between multimodal sensory information and affective states related to fear and reward, the amygdala elicits the recall of emotionally charged memories. Such networks integrate the sensation, perception, processing, and memory storage and retrieval of threat-related information to enable adaptive responses to future threats.

Yet, while the alarm reaction enables survival, it seems to go awry in certain individuals when the initial stressor is of sufficient duration, intensity, or frequency. Instead of reversibility of the initial response or appropriate evaluation and response to future situations that resemble the original threat, the individual becomes either hyper- or hypo-reactive and suffers a variety of PTSD symptoms. Evidence is accumulating that sensitization of catecholamine receptors in the LC/VTN system leads to hypervigilance, increased startle, affective lability, anxiety, dysphoria, increased autonomic nervous system hyper-reactivity (37, 53). Facilitory or inhibitory alterations in other systems may underlie memory and learning mechanisms related to hypo-reactivity, avoidant and other PTSD symptoms. Therefore, PTSD appears to represent a maladaptive generalized activation of the alarm response, with symptoms representing exaggerations of appropriate functions: hypervigilance instead of appropriate prediction and early detection of future danger; avoidance and re-enactment rather than adaptation and survival.

Malignant memories (74, 77, 54) can be conceptualized as the patterned maladaptive functional contents of network activities integrating survival-related perception, memory, arousal, cognition, affect, somatic and psychological state, and behavior. Triggered by external sensory or internal cognitive, affective, or somatic cues, a malignant memory invades experience with high levels of noxious arousal and can include cognitive distortions, dissociative and somatic states, affective intensities, and behavioral and affective over-activity or opposite tendencies to hypo-reactivity, numbness, amnesia, or avoidance.