Chapter 9
A Neurophysiological Rationale for the Use of the Relaxation Response: Neurological Desensitization

Since the original applications of behavioral technologies to the treatment of disease, it has been observed that the elicitation of what Benson (1975) has called the "relaxation response" has proved useful in the treatment of a wide variety of psychiatric and stress-related somatic diseases (Benson, 1974; Caudill, Schnable, Zuttermeister, Benson, & Friedman, 1991; Chen et al., 2009; Domar, Seidel, & Benson, 1990; Dunford & Thompson, 2010; Forbes, et al., 2008; Hellman, 1990; Kutz, Borysenko, & Benson, 1985; Lavey & Taylor, 1985; Mackereth, Booth, Hillier, & Caress, 2009; Manzoni, Pagnini, Castelnuovo, & Molinari, 2008; Moturi & Avis, 2010; Rausch, Gramilin, & Auerbach, 2006; Shapiro & Giber, 1978). The relaxation response is perhaps best understood as a psychophysiological state of hypoarousal engendered by a multitude of diverse technologies (e.g., meditation, neuromuscular relaxation, hypnosis). Research into the relaxation response as a therapeutic mechanism and its clinical proliferation have been hampered, however, by a lack of conceptual clarity regarding its therapeutic foundations and/or its mechanisms of action. This chapter will explore the physiological and psychological foundations of the relaxation response to set the stage for discussions in subsequent chapters of specific therapeutic technologies (e.g., meditation, neuromuscular relaxation) used to elicit the relaxation response for the treatment of stress-related diseases.

The specific aims of this chapter are: (1) to explore the psychophysiological foundations of the relaxation response as a possible rationale for the use of the relaxation response as a primary therapy as well as an adjunctive therapy in the treatment of pathogenic stress arousal (while remaining aware of the fact that in some cases specific end-organ symptoms may initially require medical stabilization or amelioration); (2) to gain insight into the counterintuitive and antireductionistic observation that a single therapeutic mechanism (i.e., the relaxation response) can be of value in treating a wide and disparate variety of psychiatric and stress-related somatic disorders; and (3) to consider the relaxation response as a natural treatment for anxiety and excessive stress arousal—a treatment intrinsically antithetical to the very nature of pathogenic stress arousal.

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In order to formulate such a view of the relaxation response as a therapeutic mechanism, it first becomes necessary to reformulate the common perspective on psychiatric and stress-related somatic disorders.

Disorders of Arousal

Traditionally, science has classified diseases on the basis of their cause or their end-organ symptoms or signs. The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; American Psychiatric Association, 2000) is replete with examples of both. Regarding classification by "cause," for example, adjustment disorders are "caused" by the inability to adjust to new situations; viral disorders are caused by viruses; and bacteriological disorders are caused by bacteria. Regarding classification by symptoms, on the other hand, mood disorders are characterized by affective symptom complexes, and anxiety disorders are characterized by anxious symptomatology. The posttraumatic stress disorder is classified by both its cause (trauma) *and* its symptoms (stress). Seldom in our nosological quests, however, do we bother to consider other, less obvious, taxonomic criteria, even though these "latent taxa" might be far more utilitarian. Such a taxonomic consideration is derived from the work of Meehl (1973).

Based on an integration of the work of Selye (1976), Gellhorn (1967), Gray (1982), and Post (Post & Ballenger, 1981), it has been proposed that various anxiety and stress-related diseases be viewed in light of a new taxonomic perspective (Everly, 1985b; Everly & Benson, 1989). Evidence indicates that numerous psychiatric and somatic stress-related diseases possess a latent yet common denominator that serves nosologically as a latent taxonomic criterion—"latent taxon" for short. It has been proposed that this latent taxon is pathognomonic arousal. Thus, such disorders may be referred to collectively as "disorders of arousal." Despite a wide variety of etiological stimuli, and an even wider variety of symptom complexes, these disorders are best seen as but variations on a theme of a pathognomonic hypersensitivity for, or an overall characteristic of, arousal.

More specifically, the "disorders of arousal" concept is based on a corpus of evidence indicating that a major homogenizing phenomenological constituent of these disorders is a limbic-system-based neurological hypersensitivity; that is, a lowered threshold for excitation and/or a pathognomonic status of excess arousal within the limbic circuitry or its neurological, neuroendocrine, and/or endocrine efferent limbs. This neurological hypersensitivity is then capable of giving rise to a host of psychiatric and stress-related somatic disorders as noted in Chaps. 3 and 4 (see Fig. 9.1). These disorders are referred to collectively as "disorders of arousal."

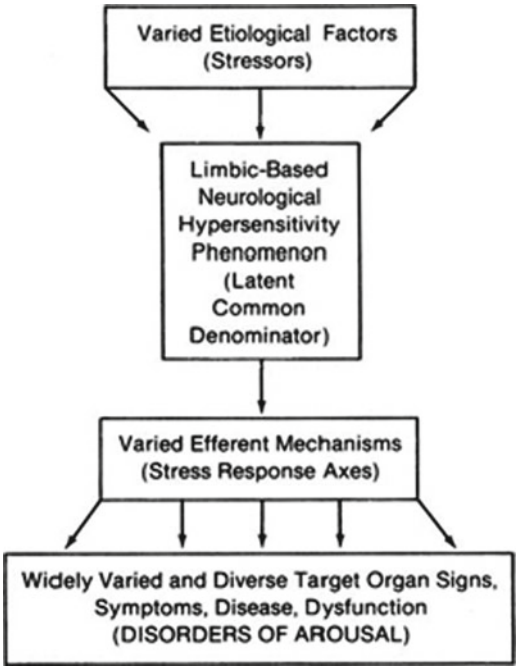

Fig. 9.1 Limbic hypersensitivity phenomenon: The latent taxon in stress-related "disorders of arousal"

Psychiatric Disorders of Arousal

Over the years, clinical psychiatry anecdotes have well documented the notion that anxiety disorders and stress-related syndromes seem to be characterized by what appears to be an increased vulnerability to frustrating, challenging, or sympathomimetic stimuli. This phenomenon is best thought of as a hypersensitivity for stimulation; a sort of neurological sensitization combined with a lowered activation threshold for emotional arousal. Such reports of sensitization or hyperreactivity are consistent with the well-documented activity and function of the limbic system and its major neurological, neuroendocrine, and endocrine efferents (Cannon, 1929; Gray, 1982; MacLean, 1949; Nauta & Domesick, 1982).

In a seminal paper, Papez (1937) boldly discussed the rhinencephalon as the anatomical basis for emotional arousal. He considered the mammillary bodies, fornix, hippocampus, cingulate cortex, and anterior thalamic nuclei as key elements in a then-proposed mechanism of emotion. In a description of Papez's model, Papez notes:

> Neural activity representing the emotional processes originating in the cortex would be passed along into the hippocampus, the fornix, the mammillary bodies, and the anterior nuclei of the thalamus and would finally be projected onto the receptive region of the "emotional cortex" (i.e., the cingulate cortex). From the cingulate cortex, activity representing emotional processes could pass into other regions of the cerebral cortex and add emotional coloring to psychic processes occurring elsewhere. (p. 55)

The "Papez Circuit," as it came to be called, was modified as a contributor to human emotional arousal by MacLean (1949), who developed the notion of a "limbic system" (the term *limbic* is derived from limbus, which means border and refers to the fact that this system serves to undergird the cerebral neocortices). MacLean (1949) hypothesized that in addition to the basic circuitry of Papez, the amygdala, septum, and associated areas were best understood as a "system" of integrated anatomical structures that were implicated not only in emotional expression but also in the aggregation of all sensory stimulation with affect, and that ultimately provide for emotional expression, or "discharge." Such discharge would have profound potential to affect not only mental health but also physical health. According to MacLean, "This region of the brain appears to be so strategically situated as to be able to correlate every form of internal and external perception. And … has many strong connections with the hypothalamus for discharging its impressions." (p. 351). It should be noted that the hypothalamus and hippocampus are still thought to be the prime sites of integration for visceral efferent arousal discharge (LeDoux, 1992; Reiman et al., 1986; Van Hoesen, 1982; for more recent research see, Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012; Feder, Charney, & Collins, 2011).

Finally, the work of Nauta (Nauta, 1979; Nauta & Domesick, 1982) further refined and clarified our understanding of the vital role that the limbic system plays in emotional arousal, the integration of internal and external stimulation, and the process of hypothalamically mediated "psychosomatic" processes. His work supports the conclusion that sensory input is integrated and processed via limbic structures such as the amygdala, the hippocampus, and cingulate gyrus and that such limbic structures have the potential for upward and downward efferent projections. Such projections are likely to exert influence over neocortical as well as hypothalamic, neuroendocrine, and endocrine processes.

It is important to note at this juncture that the limbic system receives efferent impulses from, as well as sending afferent impulses to, brain-stem structures—more specifically the reticular activating system and the locus coeruleus. The reticular activating system (RAS) may be thought of as a system of projections with responsibility for nonspecific arousal of the entire cerebrum. The locus coeruleus (LC) represents an aggregation of 20,000–30,000 cells responsible for 50–70% of the norepinephrine in the human brain (Redmond, 1979). Its activity is highly associated with worry, threat, and flight behavior. The reciprocal connections that the LC has with prefrontal and limbic structures suggest cognitive, affective, and LC activities are intimately interwoven (Gellhorn, 1967; Redmond) and collectively may play key etiologic roles in psychiatric and somatic disorders (Doane, 1986; Gellhorn & Loofbourrow, 1963; Gloor, 1986; Post, 1986; Post & Ballenger, 1981).

The American Psychiatric Association's own DSM-III, DSM-III-R, DSM-IV, and DSM-IV-TR have included references to criteria such as hyper-alertness, hypersensitivity, and autonomic nervous system hyperactivity in the diagnosis of anxiety-related disorders. Considerable evidence that these symptoms arise from the limbic circuitry comes from benzodiazepine and other behavioral pharmacological research (Carr & Sheehan, 1984; Gray, 1982; Pinna, Costa, Guidotti, 2009)

Table 9.1 Psychiatric disorders related to arousal

1. Anxiety disorders (posttraumatic stress disorder, panic disorders, and diffuse generalized anxiety disorders)
2. Adjustment disorders (with anxious mood and with mixed emotional features)
3. Various primary and secondary affective disorders (especially fast-cycling bipolar disorders and secondary reactive depression)
4. Addictive disorders (cocaine, amphetamine, nicotine)
5. Temporal lobe disorders
6. Acute atypical psychotic decompensation
7. Alcohol withdrawal (X>6 years alcoholism)

as well as neurotransmitter research (Mefferd, 1979; Nordquist & Oreland, 2010). Even major reviews of the etiology, diagnosis, and treatment of anxiety disorders implicate subcortically initiated arousal and reactivity as core features of anxiety disorders (Aggleton, 1992; Barlow & Beck, 1984; Carr & Sheehan, 1984; Friedman, Charney, & Deutch, 1995; Gorman, Dillon, Fyer, Liebowitz, & Klein, 1985; Shader, 1984; Shin & Liberson, 2011).

Anxiety disorders are not the only psychiatric disorders wherein arousal plays a significant role. Post and his co-workers (Post, 1985; Post & Ballenger, 1981; Post, Uhde, Putnam, Ballenger, & Berrettini, 1982; more recently, Simon, Kaufman, Musch, Kischkel, & Kathmann, 2010) have cogently argued that limbic hypersensitivity ("sensitization") underlies various primary and secondary affective disorders. They conclude that "sensitization models provide a conceptual approach to previously inexplicable clinical phenomena in the longitudinal course of affective illness" (p. 191). Neurological sensitization is also believed to underlie various functional psychoses, personality disorders, posttraumatic reactions, addictive disorders, and withdrawal syndromes (Aggleton, 1992; Monroe, 1970; 1982; Post, 1985; Post & Ballenger, 1981; Post, Weiss, & Smith, 1995; van der Kolk, Greenberg, Boyd, & Krystal, 1985; more recently Savitz & Drevets, 2009). Similarly, Gellhorn and Loofburrow (1963) implicated propensities for excessive limbic excitation in a host of emotional disorders (see Table 9.1).

The sensitization phenomenon may be based upon one or more of six mechanisms (Cain, 1992; Everly, 1993; Gloor, 1992):

1. Augmentation of excitatory neurotransmitters.
2. Declination of inhibitory neurotransmitters.
3. Augmentation of micromorphological structures (especially amygdaloidal and hippocampal).
4. Changes in the biochemical bases of neuronal activation (e.g., augmentation of phosphoproteins and/or changes on the transduction mechanism *c-fos* so as to change the genetic message within the neuron's nucleus).
5. Increased neuromuscular arousal.
6. Repetitive cognitive excitation.

Somatic Disorders of Arousal

The psychiatric domain is not the only arena within which pathogenic arousal may manifest itself. Many stress-related "medical" syndromes contain a core arousal constituent. A review by Lown et al. (1976) concluded that ventricular fibrillation in the absence of coronary heart disease may be related to increased sympathetic tone or activity. Similarly, evidence indicates that increased sympathetic tone and sympathetic hyperreactivity may be key etiological factors in the development of psychophysiological essential hypertension (Eliot, 1979; Gellhorn, 1964a; Grassi & Esler, 1999; Henry & Stephens, 1977; Steptoe, 1981; Suter, 1986). Other cardiovascular diseases implicated as having pathogenic arousal as a key etiological factor include nonischemic myofibrillar degeneration (Corley, 1985; Eliot), coronary artery disease (Corley; Eliot; Henry & Stephens, 1977; see Manuck & Krantz, 1984, for a more conservative interpretation; more recently, Moulapoulos, 2009), sudden death (Corley; Eliot; Steptoe, 1981), and migraine headaches (Mehlsteibl, Schankin, Herin, Sostak, & Straube, 2011) and Raynaud's disease (Suter, 1986; Cooke & Marshall, 2005). Gellhorn (1967), Weil (1974), and Malmo (1975) have implicated excessive sympathetic tone as a major etiological factor in a host of muscle contraction syndromes and dysfunctions including muscle contraction headaches and fibromyalgia (Sarzi-Puttini, Atzeni, & Cazzola, 2010). Finally, there is some evidence that peptic ulcers (Wolf, 1985), irritable bowel syndrome (Latimer, 1985), and other gastrointestinal disorders may be related to an excessive propensity for arousal (Dotevall, 1985; Henke, 1992; see Table 9.2).

In summary, pathognomonic hypersensitivity within the limbic circuitry as a common denominator within a host of otherwise widely disparate disorders seems to warrant the proposed taxonomic reconsideration, that is, the disorders of arousal taxonomy. It may well be that research will ultimately show that disorders of arousal actually include all stress-related psychosomatic disorders (see Friedman & Schnurr, 1995; Heninger, 1995; Williams, 1995; Chrousos, 2009).

Table 9.2 Somatic disorders related to arousal

1.	Hypertension
2.	Stress-related ventricular fibrillation
3.	Nonischemic myofibrillar degeneration
4.	Stress-related coronary artery disease
5.	Migraine headaches
6.	Raynaud's disease
7.	Muscle contradiction headaches
8.	Non-head-related muscle contraction dysfunctions
9.	Peptic ulcer
10.	Irritable bowel syndrome

The Neurological Foundations of Limbic Hypersensitivity and the Disorders of Arousal

Ergotropic Tuning

Within this chapter, it has been argued that a limbic-system-based neurological hypersensitivity to stimulation and a propensity for sustained arousal undergirds a host of psychiatric and stress-related somatic disorders, herein called "disorders of arousal." The work of Gellhorn not only documented the existence of complex autonomic nervous system–neocortical–limbic–somatic integration (Gellhorn, 1957; 1967) but also later served as one of the most coherent and cogent explanations of the pathognomonic arousal described in this chapter. Over four decades ago, Gellhorn described a hypothalamically based "ergotropic tuning" process as the neurophysiological basis for affective lability, ANS hyperfunction, anxiety, stress arousal, and related emotional disorders (Gellhorn, 1965; 1967; Gellhorn & Loofburrow, 1963). Gellhorn has stated:

> It is a matter of everyday experience that a person's reaction to a given situation depends very much upon his own mental, physical, and emotional state. One might be said to be "set" to respond in a given manner. In the same fashion the autonomic response to a given stimulus may at one time be predominantly sympathetic and may at another time be predominantly parasympathetic. … The sensitization of autonomic centers has been designated "tuning" and we speak of sympathetic tuning and parasympathetic tuning… and refers merely to the "sensitization" or "facilitation" of particular centers of the brain. (Gellhorn & Loofburrow, 1963, pp. 90–91)

Gellhorn chose the term *ergotropic tuning* to describe a preferential pattern of SNS responsiveness. Such a neurological status could then serve as the basis for a host of psychiatric and stress-related somatic disorders.

From an etiological perspective, Gellhorn (1965) states: "In the waking state the ergotropic division of the autonomic is dominant and responds primarily to environmental stimuli. If these stimuli are very strong or follow each other at short intervals, the tone and reactivity of the sympathetic system increases" (pp. 494–495). Thus, either extremely intense, acute (traumatic) sympathetic stimulation or chronically repeated, intermittent lower level sympathetic stimulation, both of which can be environmental in origin, can lead to SNS hyperfunction. Such sympathetic activity, according to Gellhorn, creates a condition of sympathetic neurological hypersensitivity, called ergotropic tuning, which serves as the neurological predisposition, or even etiological factor, associated with the psychophysiological sequelae observed in anxiety, stress, and related disorders of arousal.

Several mechanisms may sustain the ergotropically tuned status. Gellhorn (1964a, b) has provided cogent documentation that discharge from limbic centers sends neural impulses in two simultaneous directions: (1) to neocortical targets and (2) to the skeletal musculature via pyramidal and extrapyramidal projections (see also Gellhorn & Loofburrow, 1963). The neocortical centers then send impulses back to the limbic areas and to the locus coeruleus by way of noradrenergic and

other pathways, thus sustaining limbic activity. Simultaneously, neuromuscular proprioceptive impulses (indicative of neuromuscular status) from afferent muscle spindle projections ascend primarily via the dorsal root and reticular activating system, ultimately projecting not only to cerebellar targets but also to limbic and neocortical targets. Such proprioceptive bombardment further excites target areas and sets into motion a complex mechanism of positive neurological feedback, sustaining and potentially intensifying ergotropic tone (Gellhorn, 1964a, b; 1965; 1967).

Thus, we see that Gellhorn has proposed a model and empirically demonstrated that intimate neocortical–hypothalamic–somatic relationships exist that use the limbic system as a central "hub" for efferent projections to the neocortex and somatic musculature as well as an afferent target for neocortical, proprioceptive, interoceptive, and brain-stem impulses. This configuration creates a functional, potentially self-sustaining mechanism of affective and ergotropic arousal. It certainly seems reasonable that such a mechanism could play a major role in chronic anxiety and stress-related disorders of arousal.

Neurological Reverberation and Charging

Weil (1974) has developed a model somewhat similar to that of Gellhorn. In fact, Weil makes brief reference to the work of Gellhorn in his construction of a neurophysiological model of emotional behavior.

Weil notes, in agreement with Gellhorn, that the activation thresholds of the ANS (particularly hypothalamic nuclei), as well as limbic centers, can be altered. Instead of the concepts of sympathetic and parasympathetic systems, Weil uses a parallel but broader construction, that of arousal and tranquilizing systems, respectively. He calls the facilitation of activation within these systems, "charging." With regard to the concept of neurological hypersensitivity, Weil notes that two major processes can be effective in "charging the arousal system" in the human organism: (1) high-intensity stimulation and/or (2) increased rate of repeated stimulation. The processes that appear to underlie the charging of the arousal system as well as the mechanisms that could serve to sustain such a neurological status seem to be (1) the neuromuscular proprioceptive system, as described earlier, and (2) intrinsic neuronal reverberation. Regarding the latter, Weil (1974) notes:

> The reciprocal association of the hypothalamus with the midbrain and the thalamic reticular formation makes possible the establishment of intrinsic reverberating circuits. Such hypothalamic reticular circuits are in a position to be set into motion by extrinsic impulses reaching the reticular formation. They provide a neuroanatomical basis for the maintenance of a reverberating supply of impulses to reticular nonspecific activation even during a momentary reduction or deficiency of extrinsic input. (p. 37)

Thus, we see that Weil's notion of charging is similar to Gellhorn's notion of tuning. Weil's formulation seems somewhat broader in the neurological mechanisms it encompasses, yet narrower in its implications for emotional and behavioral

disorders. Points of agreement can be found, however, in the recognition of the fact that neurological hypersensitivity (i.e., a lowered threshold for activating limbic, autonomic, and hypothalamic effector systems) can be achieved through environmental stimulation and proprioceptive stimulation when presented in either an acute and intense (trauma-like) manner or in a lower level yet chronically repeated exposure pattern. Once achieved, such a status of lowered activation threshold could serve as a self-sustaining neurological basis for emotional and psychophysiological dysfunction.

Neuromuscular Set-Point Theory

In reviewing Gellhorn's and Weil's notions of tuning and charging theory, respectively, and the neurological mechanisms that support them, one is impressed with the central role that the striated musculature plays in sensitizing and maintaining hypersensitivity (ergotropic status). The work of Malmo seems appropriate to introduce at this juncture, for it deals directly with the role of striated muscles in psychophysiological and anxiety disorders. In a brief but cogent treatise, Malmo (1975) summarizes his classic studies on the prolonged activation of the striated musculature of anxiety patients following stressor presentation, compared with nonanxiety patients exposed to the same stressor. The work of Gellhorn clearly demonstrated that the striated muscles were target organs for limbic arousal. Malmo and his colleagues found that select groups of individuals who possessed arousal disorders, such as anxiety, seemed to demonstrate somewhat higher baseline levels of muscle tension when compared with nonpatients. More important, however, upon the presentation of a stressor stimulus, the muscle tension of the patient population reached higher levels of peak amplitude and subsequently took significantly longer to return to baseline levels once the stressor was removed. This phenomenon was interpreted by Malmo as being indicative of a defect in homeostatic mechanisms following arousal in such patients.

Malmo offered two possible mechanisms that might explain the observed homeostatic dysfunction: one neural, the other biochemical. He cites the research of Jasper (1949), who discovered that direct stimulation of the motor cortex created not only the expected electromyographic activity in the target muscle but also an "after discharge" in that muscle. The after discharge may be thought of as a residual depolarization of the neurons in the absence of direct exogenous stimulation. However, when Jasper simultaneously stimulated the thalamic–reticular system, the after discharge was eliminated. These data suggest that the thalamic–reticular system may play a role in dampening, or inhibiting, excess neuromuscular activation. Malmo then extended Jasper's work to his own and used it as a model to explain the homeostatic dysfunction observed in his own studies. Malmo saw Jasper's discovery as the homeostatic mechanism that was most likely dysfunctional in anxiety patients (i.e., a mechanism protracting neuromuscular excitation in stressful situations). More specifically, he argues that this neural inhibitory system represents a

"set point" similar to that of a thermostat. This neural set point may be designed to dampen excessive muscular activity, thus preventing excessive strain. He notes that in cases where muscles are extremely tense and corresponding proprioceptive activity is sufficiently strong (i.e., exceeding the tolerances of the set point), the inhibitory neurons would be activated, thus reducing lingering peripheral muscular after-charge activity. He further notes:

> Such a system as this would work well in providing for extra muscular exertion to meet emergencies; and by the return of the set point to normal afterwards, the motor system would have a built-in protection against excessive strain. If, however, extremely demanding life situations are prolonged … it seems the setpoint "sticks" at the higher (above normal) level even when the individual is removed to a quiet environment. This then would be a neural mechanism that could account for the "persistence" of anxiety and the accompanying increase in muscular activity. (Malmo, 1975, pp. 152–153)

Malmo places the most emphasis on this neural mechanism in explaining the homeostatic dysfunction seen in anxiety patients, yet he does briefly mention a biochemical–neurological process that has played a central role in the formulation of current thinking on arousal disorders. Malmo notes that muscle tension leads to increased levels of lactic acid (a by-product of anaerobic metabolism). Furthermore, he notes research by Pitts and McClure (1967) clearly demonstrating that lactate infusions had panicogenic properties for panic anxiety patients but had none for nonanxiety patients. It has been postulated that panic patients metabolize lactate normally, thus suggesting a neural receptor hypersensitivity existing somewhere in their CNS as the etiological site for this dysfunction. The lactate infusion data are similar to those obtained by inhalation of 5% CO_2, thus demonstrating panicogenic properties for this agent as well. The specific mechanism by which these agents induce panic attacks is unclear at this time. Interested readers should refer to Carr and Sheehan (1984), Gorman, Dillon, Fyer, Liebowitz, and Klein (1985), and Liebowitz et al. (1984). The major point of clinical interest, however, is that Gellhorn and Weil, as well as Malmo, have shown mechanisms by which anxiety and stress may lead to chronically contracted muscles and that these muscles (while under chronic anaerobic contraction) may produce a by-product (lactic acid) that may have anxiogenic properties of a biochemical nature in addition to the anxiogenic properties of excessive proprioceptive bombardment of the brain stem, limbic system, and neocortex. Thus, there appears to be remarkable agreement from researchers in diverse fields as to the probability that neurological hypersensitivity underlies anxiety and stress-related disorders of a chronic nature.

Models of Neuronal Plasticity

In an attempt to understand the phenomenon of neurological hypersensitivity at the most basic structural levels, this section briefly reviews popular models of neuronal plasticity. It should be noted that the phenomenon of neural plasticity appears to be evolving from the role of explanatory construct to useful clinical phenomenon,

largely as our understanding of this once vague notion has similarly evolved. In this section we briefly follow that evolution.

The concept of *kindling* represents one of the most popular models of plasticity and neurological hypersensitivity in clinical literature. *Kindling* is a term originally conceived of to identify the process by which repeated stimulation of limbic structures leads to a lowered convulsive threshold (limbic ictus) and to a propensity for spontaneous activation of such structures, with resultant affective lability, ANS hyperfunction, and behavioral disturbances (Goddard, McIntyre, & Leech, 1969; Joy, 1985; Post, 1985; Post, Uhde, Putnam, Ballenger, & Berrettini, 1982). Kindling-like processes have been implicated in a host of behavioral and psychopathological conditions (Cain, 1992; Gloor, 1992; Mann, 1992; Monroe, 1970; Post & Ballenger, 1981; Reynolds, 1992; McFarlane, 2010).

Shader (1984) has stated, "With regard to anxiety disorders, one might speculate that kindling processes … could increase attack-like firing from a source such as the locus coeruleus" (p. 14). Redmond and Huang (1979) support such a conclusion by suggesting that panic disorders are predicated on a lowered firing threshold at the locus coeruleus. Such discharge could then arouse limbic and cortical structures on the basis of ventral and dorsal adrenergic efferent projections arising from the locus coeruleus. Monroe (1982) has provided evidence that certain episodic behavioral disorders may be based on a kindling-like limbic ictus. He notes, "As it is known that environmental events can induce synchronized electrical activity within the limbic system, this also provides an explanation of why environmental stress might sensitize patients to acute exacerbations of an ictal illness" (p. 713). Monroe (1970; 1982) implicates explosive behavioral tirades, impulsively destructive behavior, extreme affective lability, and episodic psychotic behavior in such a neurological dysfunction. According to van der Kolk, Greenberg, Boyd, and Krystal (1985), "Long-term augmentation of LC (locus coeruleus) pathways following trauma underlies the repetitive intrusive recollections and nightmares that plague patients with PTSD (posttraumatic stress disorder)" (p. 318).

Post et al. (1982) have taken the kindling model and extrapolated from it, stating, "Kindling and related sensitization models may also be useful conceptual approaches to understanding the development of psychopathology in the absence of seizure discharges" (p. 719). They report data that demonstrate the ability of adrenergic and dopaminergic agonists to sensitize animals and humans to behavioral hyperactivity and especially affective disorders. They refer to this phenomenon as "behavioral sensitization" rather than kindling because no ictal status is obtained as an end point. Rather, the achieved end point represents a lowered depolarization threshold and an increased propensity for spontaneous activation of limbic and related circuitry (Post, Weiss, & Smith, 1995).

According to Racine, Tuff and Zaide (1976), "Except for neural development and learning, the kindling phenomenon may be the most robust example of neural plasticity in the mammalian nervous system" (p. 19). Indeed, models of learning and memory may serve as tools for understanding the biology of kindling-like phenomena. Goddard and Douglas (1976) conducted a series of investigations designed

to see if the "engram" model of memory had applicability in the understanding of the kindling phenomenon. They concluded:

> Thus it would appear that kindling is caused, in part, by a lasting potentiation of excitatory synapses. More work is needed to decide whether the changes are pre-synaptic or in the post-synaptic membrane, whether they are accompanied by alteration in synaptic morphology… Our answer to the question: does the engram of kindling model the engram of normal long term memory? is yes. (pp. 14–15)

Lynch and his colleagues at the University of California have sought to clarify this mechanism and have identified postsynaptic processes as the likely target area. Their research in long-term neuronal potentiation revealed a functional augmentation in the dendritic spines of stimulated neuronal pathways. More specifically, such changes included a 33% increase in synaptic contacts, as well as a decrease in the length and width variation of the dendritic spines (Deadwyler, Gribkoff, Cotman & Lynch, 1976; Lee, Schottler, Oliver & Lynch, 1980). Rosenzweig and Leiman (1982) have suggested that the number of dendritic spines as well as the postsynaptic membrane area may be increased in such neural plasticity. Delanoy, Tucci and Gold (1983) pharmacologically stimulated the dentate granule cells in rats and found a kindling-like neurological hypersensitivity to result. Similar agonists have been shown to enhance state-dependent learning.

Joy's superb review of the nature and effects of kindling (1985) summarizes the potential alterations in biological substrata that may be involved in the kindling phenomenon. He notes that "kindling produces important changes in neuronal function and connectivity" (p. 46) and continues:

> One would expect that these changes would have morphological or neurochemical correlates. Increased connectivity could result from a morphological rearrangement of neuronal circuits, perhaps from collateral sprouting and new synapse formation. Alternatively, it could result from a modification of existing synapses, perhaps by the growth of presynaptic terminals or by an increase in the postsynaptic receptive surface or number of receptors, (p. 49)

Whatever the biological alteration underlying the neuronal plasticity associated with limbic system neurological hypersensitivity, the phenomenon: (1) appears to be inducible on the basis of repeated, intermittent stimulation (Delanoy et al., 1983), with the optimal interval between stimulations to induce kindling being about 24 h (Monroe, 1982); (2) appears to last for hours, days, and even months (Deadwyler et al., 1976; Fifková & van Harreveld, 1977; Goddard & Douglas, 1976; Monroe, 1982); (3) appears to show at least some tendency to decay over a period of days of months in the absence of continued stimulation if the initial stimulation was insufficient to cause permanent alteration (Fifková & van Harreveld, 1977; Joy, 1985); and (4) appears to be inducible on the basis of environmental, psychosocial, pharmacological, and/or electrical stimulation (Black et al., 1987; Doane, 1986; Monroe, 1970; Post, 1986; Post, Weiss & Smith, 1995; Sorg & Kalivas, 1995).

In summary, the preceding sections have argued for the existence of a group of disorders that share a latent yet common denominator of limbic-based neurological hypersensitivity and arousal. The neurology of this "common thread" has been

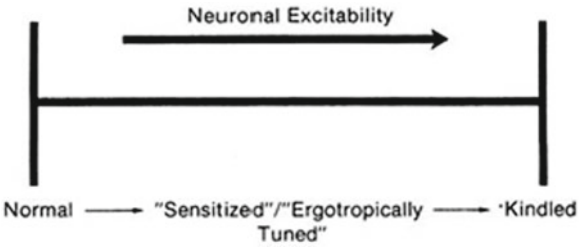

Fig. 9.2 Limbic hypersensitivity phenomenon (LHP)

discussed in some detail. Figure 9.2 graphically depicts the hypersensitivity phenomenon.

The etiological and/or sustaining mechanisms of the limbic-system-based neurological hypersensitivity that serves to undergird the disorders of arousal may be summarized into six basic categories:

1. Increased excitatory neurotransmitter activity within the limbic circuitry (Black et al., 1987; Post, 1985; Post & Ballenger, 1981; Post, Rubinow, & Ballenger, 1986; Post, Weiss & Smith, 1995; Sorg & Kalivas, 1995).
2. Declination of inhibitory neurotransmitters and/or receptors (Cain, 1992; see Everly, 1993).
3. Augmentation of micromorphological structures (especially amygdaloidal and hippocampal) (Cain, 1992; Post, Weiss & Smith, 1995; see Everly, 1993).
4. Changes in the biochemical bases of neuronal activation (e.g., augmentation of phosphoproteins and/or changes on the transduction mechanism *c-fos* so as to change the genetic message within the neuron's nucleus) (Cain, 1992; Sorg & Kalivas, 1995).
5. Increased arousal of neuromuscular efferents, with resultant increased proprioceptive bombardment of the limbic system (especially amygdaloid and hippocampal nuclei) (Gellhorn, 1964a, b; 1968; Malmo, 1975; Weil, 1974).
6. Repetitive cognitive excitation (Gellhorn, 1964a, b; Gellhorn, 1968; Gellhorn & Loofburrow, 1963; Post, Rubinow & Ballenger, 1986).

The important point to keep in mind here is that these mechanisms appear to be inducible and responsive to environmental, psychosocial, pharmacological, and/or electrical stimulation (Castren & Rantamaki, 2010; McEwen, 2011). If, indeed, a group of psychiatric and somatic diseases exist that differ in their end-organ symptoms yet share a common pathogenic thread of neurological hypersensitivity and arousal, a therapy for the etiological and sustaining mechanisms of such disorders of arousal seems almost too obvious. If we look beyond the multitude of varied symptoms and signs that characterize these numerous disorders to the common yet latent taxonomic criterion of limbic-based neural hypersensitivity, it becomes obvious that, at least in theory, antiarousal therapies are "ideal" for achieving a neurological desensitization and amelioration of the core mechanism of pathogenesis in all of these disorders. Any such therapy, therefore, should prove of value in treating not only the *symptoms* of these varied disorders (assuming the symptoms

have not become self-perpetuating) but also the *causal mechanisms* of neurological hypersensitivity and psychophysiological arousal also. Ironically, Gellhorn and Loofburrow (1963) noted nearly 40 years ago, "If it were possible to alter the autonomic reactivity at the hypothalamic level important therapeutic results might be obtained" (p. 90).

McEwen (2011) masterfully summarizes the notion that learning and other environmental exposures affect neural structures. He notes that excessive stress results in reduced neurogenesis and even dendritic shrinkage, especially in the hippocampal regions. Interventions that reduce stress arousal, especially cortisol saturation might prove neuroprotective. Physical exercise, mental exercise, and even selective serotonergic reuptake inhibitors may exert neuroprotective and even neurogenic effects. It is an easy extrapolation to hypothesize that relaxation techniques might have a similar effect.

The Relaxation Response

The preceding sections have argued that there exists a host of psychiatric and stress-related somatic disorders that, although diverse in their end-organ symptomatology, share a latent common thread of limbicogenic hypersensitivity (i.e., a propensity for hyperreactivity and/ or sustained psychophysiological activation). These disorders have been referred to as "disorders of arousal." The available data suggest that these disorders may possess the following key etiological or sustaining constituents: (1) increased excitatory neurotransmitter activity, (2) increased neuromuscular arousal, and (3) repetitive cognitive excitation. It would seem reasonable that in order for a therapeutic intervention to work effectively to ameliorate these disorders, it should work in such a way as to neurologically desensitize and reduce overall activity within the limbic circuitry. This can be achieved by (1) reducing excitatory neurotransmitter responsivity, (2) reducing neuromuscular arousal, and (3) reducing cognitive excitation. Just such an antiarousal therapy has been uniquely captured in Benson's concept of the "relaxation response," a natural antiarousal psychophysiological phenomenon intrinsically antithetical to the mechanisms that undergird the "disorders of arousal" (Benson, 1975; Benson, Beary & Carol, 1974; Hellman, Budd, Borysenko, McClelland, & Benson, 1990).

Current evidence fails to indicate reliably that there is a best way of eliciting the relaxation response; furthermore, there is no reliable evidence that only one or two specific diseases may show superior therapeutic improvement from its application (Lehrer, Woolfolk & Sime, 2007). Indeed, many technologies are available to elicit the relaxation response, such as mantra meditation, progressive relaxation, presuggestion hypnosis, and prayer (Benson, 1983; 1985), and a wide variety of diverse diseases seem amenable to its therapeutic effect (Benson, 1985; Hellman et al., 1990; Lavey & Taylor, 1985; Lehrer, 1995; Lehrer et al., 2007; Murphy & Donovan, 1988; Shapiro & Giber, 1978).

The Physiology of the Relaxation Response

The physiology of the relaxation response is fundamentally a physiology of hypoarousal, and much of its therapeutic effect derives from this quality. According to Gellhorn, relaxation is a result of a "loss in ergotropic tone of the hypothalamus, [and] a diminution of hypothalamic-cortical discharges" (Gellhorn & Kiely, 1972, p. 404). In agreement with Gellhorn, Taylor (1978) has suggested that relaxation involves a decrease in the arousability of the central nervous system. According to Benson (1983), "The relaxation response results in physiological changes which are thought to characterize an integrated hypothalamic function. These physiological changes are consistent with generalized decreased sympathetic nervous system activity" (p. 282). A more current reinterpretation might be that the relaxation response represents a neurological "desensitization" of the limbic system and/or its sympathetic efferents.

Specific empirical investigations have traditionally shown the elicitation of the relaxation response to result in decreases in O_2 consumption and CO_2 elimination, with no change in the respiratory quotient. Other similar changes include a reduction in heart and respiratory rates with a similar reduction in arterial blood lactate (Benson, 1983; 1985). All of these alterations are consistent with a decrease in central and peripheral adrenergic excitation (Benson, 1985; Delmonte, 1984). Yet the actual mechanisms appear more complex. Research has failed to show reductions consistently in circulating adrenergic catecholamines (Michaels, Haber, & McCann, 1976). In fact, it has been observed that plasma norepinephrine may actually increase as a result of the elicitation of the relaxation response (Hoffman et al., 1982; Lang, Dehof, Meurer, & Kaufmann, 1979). Yet more recent investigations into this seeming paradox reveal that although there may be more norepinephrine available, a diminished adrenergic responsivity actually occurs at the end organ itself (Hoffman et al.; Lehmann et al., 1986). In effect, the relaxation response has shown evidence of exerting effects consistent with those of an adrenergic end-organ blocking agent (Benson, 1983; 1985; Lehmann et al. 1986).

Behavioral psychophysiological studies support the notion that the relaxation response is capable of dampening a form of adrenergic responsivity. In one study, Allen (1981) used a 2,700-Hz tone at 90 dB for a duration of 0.7 s to trigger what was assumed to be posterior hypothalamically mediated arousal in 653 subjects. He found that after training in the relaxation response for a period of approximately 10 weeks, participants demonstrated a dampened psychophysiological responsivity to the auditory stressor. The results of Allen's study are basically in concert with those of Goleman and Schwartz (1976), who compared the stress reactivity of 30 experienced meditators with that of 30 control subjects. Results indicated that recovery from a 12-min video stressor was more rapid among the experienced meditators when compared with the control participants. A study by English and Baker (1983) used a cold pressor to induce arousal and then measured blood pressure recovery time among 36 participants. All participants participated in a 4-week progressive relaxation program and then were submitted to a repetition of the cold pressor.

Results indicated that relaxation training did not reduce cardiovascular response during the stressor but did facilitate a more rapid recovery within the domain of measured blood pressure.

Similar results regarding facilitated psychophysiological recovery as described in this section have been found by Praeger-Decker and Decker (1980) and by Michaels, Parra, McCann and Vander (1979). Although not totally concordant, these studies in the aggregate still suggest that the elicitation of the relaxation response serves to reduce forms of excessive arousal (Benson & Friedman, 1985; Delmonte, 1984). Complete agreement among observers remains entangled, however, in methodological and phenomenological complexities. The interested reader is referred to Suler (1985), Delmonte, Shapiro (1985), and Benson and Friedman (1985) for a useful debate of this topic.

Having addressed the notion of arousal responsivity and the relaxation response, we now consider the issue of neuromuscular arousal. Gellhorn (1964b) notes that "states of abnormal emotional tension are alleviated in various 'relaxation' therapies through reducing proprioceptive impulses which impinge on the posterior hypothalamus and maintain the cerebral cortex in an abnormal state of excitation" (p. 457). Gellhorn (1958a; b; 1964a, b) and Weil (1974) have clearly documented the existing interconnections between the neuromuscular system and the limbic circuitry. Similarly, they have argued that reductions of neuromuscular tone achieved by the elicitation of the relaxation response would be of value in reducing abnormal states of limbic sensitivity and excitation. The primary mechanism of mediation used to achieve such a neurological desensitization, Gellhorn and Weil argue, is the reduction of proprioceptive stimulation to the limbic system.

Finally, Averill (1973), Benson (1983; 1985), Gellhorn (1958b; 1967; Gellhorn & Kiely, 1972), and Lazarus and Folkman (1984) all agree that cognitive distortion, rumination, and overall cognitive excitation can give rise to states of ergotropic and generalized psychophysiological arousal. Similarly, evidence shows that a reduction in cognitive arousal via the relaxation response contributes to a reduction in ergotropic tone and a neurological desensitization effect as well as a reduction in dysphoric psychological states (Benson, 1985; Klajner, Hartman & Sobell, 1984; Kutz, Borysenko, & Benson, 1985; Lavey & Taylor, 1985; Shapiro & Giber, 1978).

The "psychotherapeutic effect" of the relaxation response has been hypothesized to be derived from a sense of "mental calmness" (Rachman, 1968), a sense of "control" (Klajner, Hartman & Sobell, 1984; Stoyva & Anderson, 1982), and a reduction of cognitive–affective rumination (Gellhorn, 1964b; Gellhorn & Loofburrow, 1963). In reviewing the evidence for the psychotherapeutic value of the relaxation response, one is struck by the recurrent theme of an increase in "self-efficacy" derived from consistent practice of the relaxation response, as well as the sense of control engendered by the physiological auto-regulatory skills developed (Bandura, 1977; Romano, 1982; Sarnoff, 1982; Shapiro & Giber, 1978).

This point is especially well made by Green and Green (1977), Hamberger and Lohr (1984), and Stoyva and Anderson (1982). Bandura (1982b), however, has done the most to develop this theme. He notes that the most powerful tool for combating

perceptions of low self-efficacy and helplessness appears to be experience. Furthermore, he has shown that perceptions of self-efficacy can actually influence SNS activity, as well as subsequent performance. He concludes, "Treatments that eliminate emotional arousal … heighten perceived efficacy with corresponding improvements in performance" (Bandura, 1982b, p. 28). The relaxation response appears to be just such a treatment.

Selecting a Relaxation Technique

As noted earlier in this chapter, many different techniques/strategies can engender the relaxation response. Such therapeutic technologies include meditation, neuromuscular relaxation, controlled breathing, imagery, and hypnosis. As Lehrer, Woolfolk and Sime (2007) point out, research has shown there to be no single, best relaxation technology; nor has any one stress-related disorder proved to be the most responsive to therapeutic amelioration by any specific relaxation technique. Not all relaxation techniques, however, are equally efficacious. The answer to this seeming paradox resides in the concept of individual differences.

"Inadequate recognition of individual differences is a methodological deficiency that has seriously slowed psychological research" (Tart, 1975, p. 140). Indeed, few outcomes in the behavioral sciences are a result of "main effects"; rather, "interaction effects" usually explain far more clinical variation.

So how does the clinician know what relaxation technology to employ? What treatment will be the most useful? Rather than ascribe main effects to therapies, perhaps the individual patient should be given primary consideration, as discussed in Chap. 6. If, then, the relaxation response can be engendered via numerous techniques, with none showing generic superiority, then the clinician should select the relaxation technique that best meets the interacting needs of patient, therapist, setting, and disorder (Paul, 1967). Unfortunately, there are no algorithmic models to guide the clinician to this end. Nevertheless, a review of Chap. 6, or texts such as that of Millon and Everly (1985) or Millon (2011), will serve to give the clinician insight into personologic differences. For example, compulsive persons may respond well to structured, directive therapy interventions (e.g., biofeedback), whereas avoidant–defensive persons may respond better to less structured technologies.

In the final analysis, it may be that the most powerful stress management/behavioral medicine programs are multicomponent programs with aspects that functionally address (1) neurological hypersensitivity via neural desensitization practices, (2) neuromuscular hypertension, and (3) pathogenic cognitive reiteration. Such a program was established by Herbert Benson (1979; 1996; Kutz et al., 1985) and evolved into a multidimensional "mind–body" behavioral medicine program through the input of Ian Kutz, Joan Borysenko, Margaret Caudill, Alice Domar, and others, and has been found to be effective in the treatment of a wide variety of "disorders of arousal" (Caudill, 1994; Caudill et al., 1991; Domar et al., 1990; 1992; Hellman, 1990; Hellman et al., 1990; more recently, Dusek & Benson, 2009). Benson's

formulations and clinical applications clearly represent "watershed" ideas that have evolved into the "gold standard" of clinical stress management programs.

Clinical Precautions and Undesirable Side Effects

It was assumed that the clinical use of the relaxation response was a totally harmless therapeutic intervention, but data have argued to the contrary.

Luthe (1969) was perhaps the first to point out that the relaxation response should be used with caution. A pioneer in self-regulatory therapies, Luthe has compiled an impressive list of precautions for such therapies. They include psychotic states, dissociative reactions, paranoid ideation, dysfunctional thyroid conditions, and "disagreeable cardiac and vasomotor reactions."

Stroebel (1979), another pioneer in self-regulatory therapies (especially biofeedback), has argued that fragile ego structures serve as precautions for self-regulatory interventions. Heide and Borkovec (1983) observed in 30.8% of their progressive neuromuscular relaxation patients, and in 53.8% of their meditation patients, clinical evidence of anxiety reactions during preliminary training. Edinger (1982), on the other hand, reported that undesirable side effects arose from relaxation training in 3–4% of the clinical cases surveyed.

These disparate reports led Everly, Spollen, Hackman, and Kobran (1987) to conduct a survey analysis of clinical practitioners who use relaxation training as a major component of their practice. Data were obtained from a national survey of 133 clinicians reporting on over 71,000 patients and over 700,000 patient hours. The results indicated that anxiety reactions occurred about 1.0% of the time; muscle tension headaches resulted about 0.8% of the time; a freeing of repressed ideation resulted about 0.7% of the time; and undesirable depersonalization resulted about 0.7% of the time from the elicitation of the relaxation response or some other form of self-regulatory therapy.

Based on the research of Luthe (1969), Stroebel (1979), Emmons (1978), and Everly et al. (1987), there are five major areas of concern in the elicitation of the relaxation response.

Loss of Reality Contact

The loss of reality contact during the elicitation of the relaxation response includes dissociative states, hallucinations, delusions, and perhaps paresthesias. Care should be taken when treating patients who suffer from affective or thought-disturbance psychoses or who use nonpsychotic fantasy excessively. In such conditions, the use of deep relaxation may exacerbate the problem.

Drug Reactions

Clinical evidence has clearly indicated that the induction of the relaxation response may actually intensify the effects of any medication or other chemical substance that the patient may be taking. Of special concern would be patients taking insulin, sedatives/hypnotics, or cardiovascular medications. All such patients should be carefully monitored medically (although in many cases, chronic relaxation may ultimately result in long-term reductions in required use of medications).

Panic States

Panic state reactions are characterized by high levels of anxiety concerning the loss of control, insecurity, and, in some cases, seduction. Diffuse, free-floating worry, and apprehension have also been observed. With such patients it is generally more desirable to provide a more concrete relaxation paradigm (such as neuromuscular techniques or biofeedback) rather than the abstract relaxation paradigms (such as meditation). Similarly, it is important to assure the patient that he or she is really always in control—even in the states of "passive attention," which will be discussed in the following chapter on meditation.

Premature Freeing of Repressed Ideation

It is not uncommon for deeply repressed thoughts and emotions to be released into the patient's consciousness in response to a deeply relaxed state. Although in some psychotherapeutic paradigms such reactions are considered desirable, such reactions could be perceived as destructive by the patient if unexpected and/or too intense to be dealt with constructively at that point in the therapeutic process. Before implementation of relaxation techniques, the clinician may wish to inform the patient of the possibility that such ideation may arise. Similarly, the clinician must be prepared to render support should such thoughts emerge (see Adler & Morrissey-Adler, 1983; Glueck & Stroebel, 1978).

Excessive Trophotropic States

In some instances, relaxation techniques that intended to be therapeutic may induce an excessively lowered state of psychophysiological functioning. If this occurs, several phenomena may result:

1. *Temporary Hypotensive State.* This acute state of lowered blood pressure may cause dizziness, headaches, or momentary fainting, particularly if the patient rushes to stand up following the relaxation session. The clinician should know

the patient's history of resting blood pressure before employing relaxation techniques. Caution should be used if the patient's resting blood pressure is lower than 90 mmHg systolic and 50 mmHg diastolic. Dizziness and fainting can often be aborted if the patient is instructed to open his or her eyes and to stretch and look around the room at the first signs of uncomfortable lightheadedness. Similarly, the patient should be told to wait 1–3 min before standing up following the relaxation session.

2. *Temporary Hypoglycemic State.* This condition of low blood sugar may follow the inducement of the trophotropic state and most likely last until the patient eats. Deep relaxation, like exercise, appears to have an insulin-like action, and may induce such an action if the patient has a tendency for such conditions, or has not eaten properly that day. The acute hypoglycemic state just described may result in symptoms similar to the hypotensive condition.
3. *Fatigue.* Although relaxation techniques are known to create a refreshed feeling of vigor in many patients, a very few have reported feeling tired after relaxation practice. This is a highly unusual result and may be linked to an over-striving to relax on the part of the patient. The clinician should inform the patient that the best outcome in any attempt at relaxation is achieved when the patient *allows* relaxation to occur, rather than making it happen.

Summary

Earlier in this chapter, we suggested that the disorders of arousal described earlier might be treated effectively if limbic hypersensitivity and related factors could be reduced. Operationally, this meant achieving a reduction in (1) adrenergic catecholamine activity and responsiveness, (2) neuromuscular arousal, and (3) pathogenic cognitive processes, such as rumination and perceptions of powerlessness and a lack of control. We have reviewed the concept of the relaxation response as described by Benson and found it to be capable of achieving all three of the aforementioned therapeutic goals necessary for the successful treatment of the stress-related psychiatric and somatic disorders of arousal. Thus, it would appear that a cogent rationale for the use of techniques that engender the relaxation response in the treatment of the human stress response has emerged. To briefly review, this chapter has suggested the following:

1. Neuronal hypersensitivity for excitation residing within the limbic system may be a latent common denominator serving to undergird a host of stress-related psychiatric and somatic disorders.
2. These disorders, in the aggregate, have been referred to as "disorders of arousal" by Everly and Benson (Everly, 1985b; Everly & Benson, 1989).
3. The relaxation response, as described by Benson, represents a broad-spectrum psychophysiological phenomenon antithetical to the stress-related disorders of arousal.

4. As such, the relaxation response may be a valuable tool in the treatment of all of the disorders of arousal, despite their wide varieties of etiological mechanisms and their diverse target organ symptom complexes.
5. There is no best relaxation technology. Clinicians should consider the interaction of the needs of the patient, therapist, setting, and disorder in the selection of the technology for the elicitation of the relaxation response.
6. Contrary to popular opinion, the elicitation of the relaxation response is not without its precautions and undesirable side effects. Precautions include patients with psychotic disorders, major affective disorders, patients on pharmacotherapy, and those with dysfunctional thyroid conditions, fragile ego structure, and delusion conditions. Undesirable side effects appear to occur between 3 and 4% of the time (Edinger, 1982; Everly et al. (1987)) and include depersonalization, excessive trophotropic states, anxiety reactions, freeing of repressed ideation, and headaches.

In summary, this chapter has reviewed in detail the neurophysiology of the limbic system and the relaxation response. The notion of the disorders of arousal has also been introduced. In effect, we see the emergence of a rationale for using the relaxation response in the treatment of a multitude of diseases spanning a wide spectrum of traditional diagnostic boundaries—something counterintuitive to traditional, linear, Pasteurian conceptualization.

Thus, we hope that this chapter has given new credibility and importance to therapeutic technologies such as meditation, controlled respiration, and, especially, progressive neuromuscular relaxation exercises (given the important role of proprioception in the prolongation of stress-related disorders). With these points in mind, let us now move to a discussion of techniques that engender the relaxation response and see how they can be used in the treatment of all stress-related disorders of arousal described in this chapter and in Chap. 4.

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