SYMPATHETIC RELATION TO
ATTENTION, AROUSAL, STRESS, AND MOOD.

A. From its production site in the caudal region of the Pons, norepinephrine (NE) neurons innervate each of the brain cortices, plus the hypothalamus, the cerebellum, and the spinal cord. This widely distributed network of fibers has been traditionally studied behaviorally in terms of attention, arousal, and mood. As regards creative thinking, moderate levels of effective states such as positive feelings achieved after exercise do enhance creative thinking skills. Moderate (compared to extremely high or low) levels of vigilance and attention either improve creative production or are associated with better performance in creative vs. noncreative thinking.

    1. The noradrenergic system has been extensively studied for its effects on emotion, behavior, cognition, and physiological states. The system's most general role is in addressing vigilance and arousal, and regulating attention resources, especially needs arising from novel environmental stimuli.

    2. But noradrenergic neurons respond differently to general motivational and exploratory states compared to more specific demands that require goal attainment and specific attention.

B. Horrobin has suggested that evolutionary brain changes occurring 2 million years ago coincided with the appearance of both psychoses and creativity, and that creativity and psychoses-proneness have made us truly human. He hypothesizes that those brain changes are related to changes in dietary fat intake, with an increased dietary intake of highly unsaturated fatty acids (HUFA).

    1. Alterations in FA metabolism are demonstrated in both psychotic individuals and extremely creative individuals. Those fatty acid metabolic pathways are also intimately related to catecholamine neurotransmitter function, particularly NE activity.

C. Variations in endogenous NE levels with exercise and sleep can help assess noradrenergic effects on creative thought.

    1. Increases in alpha-amylase are found after rigorous exercise and correlate with elevations in plasma NE. Anaerobic exercise in particular will elevate NE and salivary amylase.

a. Exercise has also been shown to enhance creative thought, and anaerobic exercise is more effective than aerobic exercise.

b. Looking at sleep/wake cycles, NE activation is low just before falling asleep, a time when subjects are more likely to have a moment of insight. Such holistic problem solving as opposed to a stepwise process are more likely to be resolved while the NE system is less activated, and general cortical arousal is low.

c. During REM sleep, any neurons in the locus coeruleus (LC) (the site of NE synthesis in the brain) become silent, as REM sleep cannot occur in the presence of NE arousal and activity. Instead, acetylcholinergic neurons in the PONS become active during REM sleep. Waking subjects after periods of sustained REM sleep in order to assess creativity or behavior assures that the NE system has been constrained. Results of testing patients under such conditions show that decreased NE functioning contributes to enhancing creativity that requires divergent rather than convergent thinking.

d. (Convergent tasks, however in contrast, are extremely resistant to sleep loss, while divergent creative thinking ability suffers as a result of sustained sleep loss.)

D. As stress increases, so does NE activity, and performance on cognitive tasks declines. Giving propranolol improves the performance on cognitive tasks.

E. Since the NE system arising from projections in the LC is associated with mediating changes in arousal and vigilance as a consequence of novelty in the environment, a substantial link to creative cognition from NE systems may be through neural mechanisms of arousal.

1. EEG evidence shows that creative thinkers are less aroused than non-creative thinkers when determining creative solutions to problems. EEG alpha activity from the thalamus increases in creative subjects compared to subjects exhibiting low to medium levels of creative ability.

2. Interestingly, EEG alpha wave activity is associated with decreased arousal, as it is an inverse measure of the general cortical arousal response.

3. It has also been shown that EEG alpha relative activity is directly correlated with changes in CSF levels of NE. As NE increase, alpha relative activity decreases.

F. Subjects who exhibit fewer creative traits do focus their attention more narrowly, supporting the idea that creative people have a broader focus of attention and greater attentive capacity related to specific mechanisms of cortical activation.

1. In addition to levels of arousal being decreased in divergent thinking, EEG complexity increases during the same type of thinking. This complexity indicates that although general cortical arousal is lower, more neuronal elements are activated. (--- Noncreative people think narrowly but deeply, while creative people think more broadly.)

2. Direct manipulation of the noradrenergic system produces changes in brain EEG waves. NE tends to vary directly with arousal levels, but inversely with EEG alpha and beta activity.