EMOTION AND BREATHING

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It is well known that breathing pattern is generated in the respiratory center located in the lower brainstem. This is the center for autonomic metabolic control system. However, breathing pattern, especially breathing rhythm is affected by various inner or outer environmental changes. This is called the behavioral breathing system. Within this system breathing that is related to emotion is called emotional breathing. We used two experimental techniques, one in human and the other in animal, to establish emotional breathing.

1. Human brain and emotional breathing

We have developed the dipole tracing method by which we can estimate the source localization in the human brain from EEG(BS-navi, BRAD NY and Tokyo). First, we examined the relationship between anxiety and breathing. Subject's EEG, airflow, and $ETCO_2$ were monitored and the subject's anxiety was assessed by State Trait Anxiety Inventory (STAI).The respiratory rate increased during anticipatory anxiety and the increased rate was correlated with trait anxiety scores. We recorded respiratory related anxiety potential (RAP) in EEG, 300 to 400msec after the onset of inspiration. During this period, we found the dipole location in the amygdala and temporal pole. Second, we examined the relationship between olfaction and emotion. The respiratory rate increased when the subjects inhaled unpleasant odor. Alpha waves were phase locked with inspiration (inspiratory phase-locked alpha wave : I-) during odor stimulation. Dipoles were estimated in the limbic area: the entorhinal cortex, hippocampus, amygdala, and orbitofrontal cortex.

2. Limbic-brainstem-spinal cord preparation

The limbic-brainstem-spinal cord preparations of 0 to 1 day old rats were isolated under deep anesthesia. The preparation was transected rostrally to visualize the amygdala and piriform cortex on the surface of rostral cut end. Neural activities were detected as changes in fluorescence of the voltage sensitive dye by means of optical recording apparatus. Spontaneous rhythmic activities were recorded from the piriform cortex around the onset of inspiration and the activities propagated to the amygdala.

We conclude that the amygdala is the center for emotional breathing and the rhythm generated prior to this center may be generated in the piriform cortex.