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THE EFFECT OF 70% EXHALATION AND THORACIC BREATHING UPON END-TIDAL CO2

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Observation of and control over respiration patterns are important tools in the psychophysiology of stress-related disorders. These disorders, such as anxiety, panic, asthma, angina pectoralis (Fried, 1987; Ley, 1985; Lum, 1981; Nixon, 1989) are affected by and related to dysfunctional breathing. This process appears to be reversible. When subjects change their dysfunctional breathing patterns their symptoms of anxiety, panic, asthma, coronary heart disease may be reduced (de Ruiter el al., 1980; Peper and Tibbetts, in press; van Dixhoorn, 1990). This dysfunctional breathing pattern often consists of shallow rapid breathing punctuated with sighs, a process which may lead to hyperventilation and hypocapnia. This process can be rapidly simulated by subjects when they exhale sequentially only 70% of their previous inhaled breath (Peper and MacHose, 1990). Within one to two minutes, most subjects reported a significant increase in discomfort. This study explores the effects of different breathing patterns upon end-tidal CO2.

METHOD

Subjects: 23 college students, ranging from 20-38 years of age (X=31), who volunteered to participate in this study.

Equipment: A J&J I-330 Physiological Monitoring system was used to record surface EMG activity (M-501 module), thoracic and abdominal displacement (RS-301) and End-tidal CO2 was recorded with an Instrumentation Laboratory End-tidIL 200 calibrated against 5% CO2 and Nitrogen mixture.

Procedure: Subjects were seated on a comfortable chair in a quiet room and instructed to relax while the experimenter attached the recording equipment. Two EMG recordings were taken from the upper thorax and abdominal region. The upper thoracic EMG electrodes were placed over the left trapezius and the right scalene; ground was placed equidistant between the two active electrodes. Abdominal electrodes were placed over the rectus abdominis, one inch below the navel and 1 inch laterally from the midline. Respiration strain gauges were placed midway across the sternum encircling the thorax and encircling the abdomen one inch above the umbilicus. End-tidal CO2 was recorded from the patent nostril, as identified by the subject, by inserting the collecting tube slightly inside the nostril and taping it to the upper lip.

Then subjects were instructed in the proper sequential 70% exhalation process (Peper and MacHose, 1990). They were instructed to the specifics of each breathing condition and

asked to continue breathing in each condition until instructed to change to the next breath condition. Each condition lasted one minute in duration unless the subjects felt uncomfortable. They were asked to breath in the following sequence: effortless breathing, 70% exhalation, effortless breathing, abdominal breathing, thoracic breathing, abdominal breathing, and effortless breathing.

After the subject's sensors were removed they filled out the Nijmegen questionnaire (van Dixhoorn & Duivenvoorden, 1985), general history form, and subjective questionnaire.

RESULTS

During the 70% exhalation condition, a consistent decrease of end-tidal CO2 was observed in 65% of the subjects with concurrent increase in thoracic EMG and thoracic diameter. There appears to be a strong correlation between the inability to perform the 70% exhalation and the presence of asthma and allergy in subjects who have not previously received breath training. A significant increase occurred in subjective level of anxiety and tension during the 70% exhalation condition ($P<.01$) and the thoracic breathing condition ($P<.02$) as compared to the previous breathing conditions as shown in Figure 1.

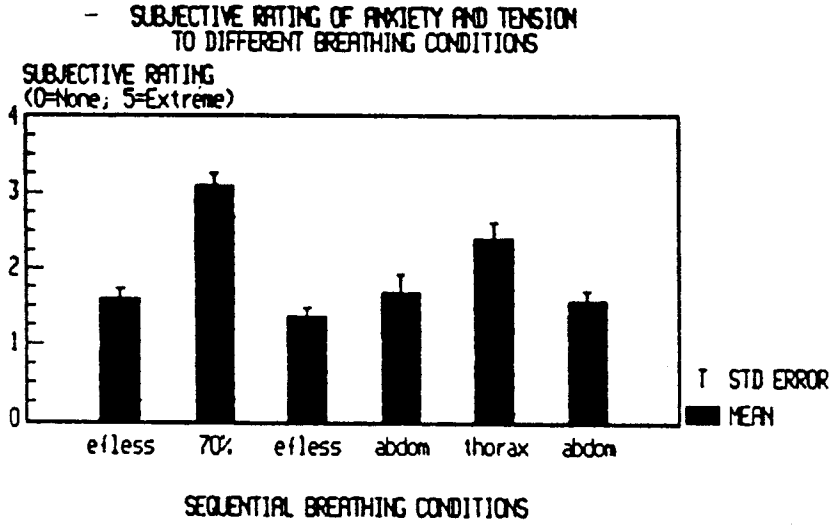

Figure 1. Subjective rating of anxiety and tension

Significant correlations of 0.43 ($P<.05$) were observed between a history of anxiety and 70% exhalation and 0.62 ($P<.01$) between a history of depression and thoracic breathing. In addition, end-tidal CO2 decreased slightly during

thoracic breathing for 65% of the subjects as illustrated in Figure 2.

Physiological Recording of Sequential Breathing Conditions (K.G.)

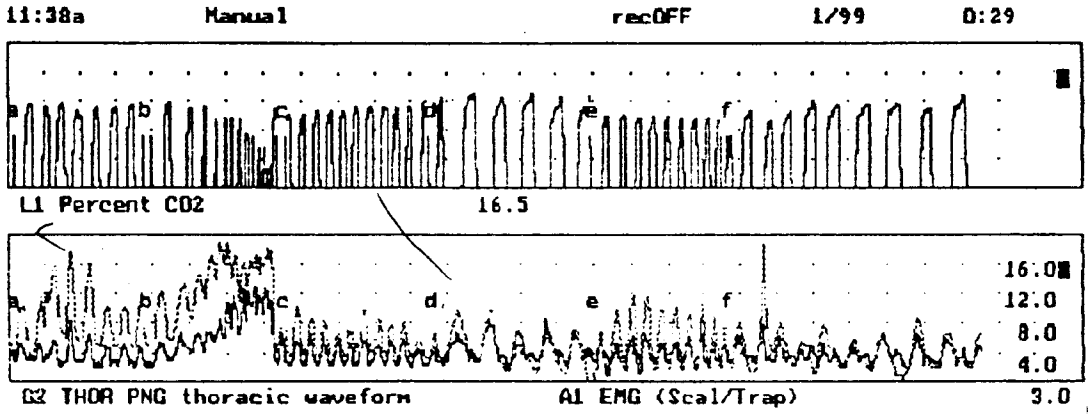

Figure 2. B=70% Exhalation and E=Thoracic conditions.

DISCUSSION

Difficulty in the subject's flexibility to change breathing patterns upon command appears to be related to a previous history of asthma and allergies. Possibly this procedure (measured by end-tidal CO2, EMG, and respiration strain gauge) could be developed as a diagnostic tool to identify people at risk. To our surprise a history of anxiety and depression were correlated to their breathing response on the 70% exhalation and thoracic condition respectively. Both these findings suggest that more attention needs to be paid to the subtlety of breathing patterns.

Those subjects that appear the most healthy appear to have the capability to change breathing styles easily under all conditions. In most cases the decrease in end-tidal CO2 occurred during the sequential 70% exhalation condition. This pattern appears very similar to that observed by Nixon and Freedman (1988) when their cardiac patients were instructed to think about a relevant personal stressor. Interestingly our subjects did not overtly hyperventilate, they just shifted to a more rapid thoracic hyperinflating pattern. Most likely the powerful effect observed by the end-tidal CO2 is due to the remixing of the inhaled air in the dead air space.

A long term effect upon end-tidal CO2 is more likely the result of chronic thoracic breathing. In at least 65% of our subjects thoracic breathing reduced end-tidal CO2. And, even when they shifted back towards abdominal breathing the

end-tidal CO2 slowly returned. This suggests that if subjects chronically breathe in a thoracic manner they may be at risk for subclinical hypocapnia and thereby aggravate existing pathologies.

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