INDEX OF PAPERS and POSTERS

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CONFERENCE PROGRAM

WORKSHOP A

1.) IDENTIFICATION OF INDIVIDUAL BREATHING PATTERNS
   INTRODUCTION TO THE RE-EDUCATION OF DYSFUNCTIONAL
   PATTERNS IN HYPERVENTILATION, ASTHMA. AND EMPHYSEMA
   DIANA M. INNOCENTI, Guy's Hospital. London, United Kingdom
   Introduction: Beverley Timons, St. Bartholomew's Hospital. England

WORKSHOP B

2.) RESPIRATORY AND PSYCHOPHYSIOLOGICAL FACTORS IN THE
    DIAGNOSIS AND TREATMENT OF FUNCTIONAL CARDIAC AND PANIC
    DISORDER
   RICHARD N. GEVIRTZ, California School a/Professional Psychology, San Diego, USA
   Introduction: RONALD LEY, University at Albany. SUNY. USA

SYMPOSIUM I

BREATHTHING RETRAINING: ISSUES AND APPLICATIONS

CHAIR, Bernard Landis, Cornell University Medical College, USA
DISCUSSANT, Erik Peper, San Francisco State University, USA
3.) A Survey of Studies Reporting the Outcome of Breathing Retraining  
Ley, R., & Timmons, B., USA & United Kingdom

4.) Treatment Difficulties and Failures  
Lum, L.C., United Kingdom

5.) Clinical Experience with a Visual Biofeedback Method in COPD Rehabilitation  
Hillsman, D., USA

6.) Lateral-Costal Breathing: The Role of Posture in Effortless Breathing  
Pierce, L., Canada

7.) The Use of Conscious Breathing Techniques in Psychotherapy  
Manne, J., Switzerland

INVITED ADDRESS I

8.) Rehabilitation of Patients with Exercise Hypoxemia  
HANS FOLGERING, University of Nijmegen, The Netherlands  
Introduction: PETER G. F. NIXON, Charing Cross, United Kingdom

SYMPOSIUM II

CAPNOGRAPHY AND HYPERVERVENTILATORY HEMODYNAMICS

CHAIR, Francois Ceugniet, Institut de Therapies el d'Education, France  
DISCUSSANT, Cornelius J.E. Wientjes, TNO Human Factors Research Institute, The Netherlands

9.) Applicability of Capnography in Detecting Hypocapnia Within Patients Having Cardiovascular Disease  
Forbes, A., Australia

10.) Capnograph Assessment of Disordered Breathing  
Landis, B., & Romano, P.M., USA

11.) A Study of Anaerobic Threshold in Chronic Fatigue Syndrome  
Nixon, P.G.F., United Kingdom

12.) Effect of Hyperventilation on Skin and Muscular Blood Flow and Transcapillary Transport of Water and Small Solutes  
Steurer, J., Hoffinann, U., Franzcek, U., & Vetter, W., Switzerland

INVITED ADDRESS II

13.) ASSESSING IMPAIRMENT, DISABILITY, AND HANDICAP IN CHRONIC LUNG DISEASE  
DAVID G. STUBBING, McMaster University, Canada  
Introduction: HARRY KOTSES, Ohio University, USA
PANEL SESSION I
RESPIRATORY PSYCHOPHYSIOLOGY OF AIRWAYS OBSTRUCTION

CHAIR, Omer Van den Bergh, University of Leuven, Belgium

14.) Interoception of Airway Resistance in Healthy and Asthmatic Subjects
Dahme, B., Germany

15.) Asthma Self-Management Training for Adults: Second-Generation Studies
Kotses, H., & Creer, TL, USA

16.) Emotionally-Triggered Asthma: Implications for Self-Regulation Therapies
Lehrer, P.M., USA

17.) Chronic Respiratory Illness: The Patients' Perspective
Higgins, J.R., & Neal, D., United Kingdom

POSTER SYMPOSIUM

CO-CHAIRS: ERIK PEPER, San Francisco State University. USA and
PAUL GROSSMAN, Lawn Cardiovascular Center and Harvard School of Public Health, USA

18.) The Relation of Body Composition to the Perception of Added Resistive Loads
Armstrong, C., & Harver, A., USA

19.) 'Air Hunger' Induced by Brief Increases in End-Tidal PC02 Adapts to
Chronic Elevation of End-Tidal PC02 in Hypocapnic, Ventilator-Dependent Subjects
Bloch-Salisbury, E., Shea, S.A., Brown, R., Evans, K., Banzett, R.B., USA

20.) Serial Measurements of PC02 by the Haldane's Rebreathing Technique as an
Aid to Management of Hyperventilating Patients
Davies, A.E., United Kingdom

21.) Effects of Voluntary Changes in Breathing Frequency on Respiratory Comfort
Denot-Ledunois, S., Vardon, G., & Gallego, J., France

22.) The Effects of Increasing Attentional Load on Breathing Frequency in Healthy
Children
Denot-Ledunois, S., Vardon, G., & Gallego, J., France

23.) Changes of the Bioelectric Activity of the Brain and Sensitivity and
Reactivity of the Bronchi
Fedoseev, G.B., Sinicina, T.M., & Lovitsky, S.V., Russia

24.) Psychophysiological Training by the Help of "Brain Music" in
Prophylaxis of Bronchial Asthma Attacks
Fedotov, A.A., Miroshnicov, D.V., & Lovitsky, S., Russia
25.) Effect of Hyperinflation on Lung Volumes, Diffusing Capacity, and Blood Flow in Humans
Gardner, W.N., Belton, D.C., & Wilson, A.F., United Kingdom

26.) Chest vs. Abdominal Breathing: Effect on PetC02 Levels
Gilbert, C., USA

27.) The Physiological Effects of Voluntary Hypoventilation
Gora, E.P., Russia

28.) A Visual Biofeedback Method to Define and Teach Breathing Patterns
Hillsman, D., USA

29.) Forced Expiratory Flow, Dyspnea/Suffocation Fear Theory, Panic Disorder, and the Reciprocal Placebo Effect
Ley, R., & Ley, J., USA

30.) The Biofeedback Electroencephalogram Training in Patients with Asthma Bronchiale
Lovitsky, S., Russia

31.) Hyperventilation and Asthma - The Grey Area
Lum, L.C., United Kingdom

32.) Ambulatory Monitoring of Respiration in Panic Disorder

33.) Body and Soul
Noske-Fabius, J.A., The Netherlands

34.) Classical Conditioning to Hypercapoia in Freely Moving Rats
Nsegbe, E., Vardon, G., Perruchet, P., & Gallego, J., France

35.) Treatment of Repetitive Strain Injuries with Respiratory Sinus Arrhythmia Training
Pierce, L., Canada

36.) Aggressive Rest: An Adjunctive Treatment Therapy in Chronic Pain and Fatigue
Pierce, L., & Oldham, J., Canada

37.) Effect of Tongue Position on Breathing Mechanics
Pierce, L., & Oldham, J., Canada

38.) Visceral Therapy
Pierce, L., & Webber, J., Canada

39.) Mental Images as Conditioned Stimuli for Increased Respiratory Behavior and Reduced End-Tidal pC02
Stegen, K., Van den Bergh, O., & Van de Woestijne, K.P., Belgium
40.) Negative Affect, Respiratory Reactivity, and Somatic Complaints in a CO2-Enriched Air Inhalation Paradigm
Van den Bergh, O., Stegen, K., & Van de Woestijne, K.P., Belgium

41.) Using a Prolonged Exhalation Breathing Sound as a Tool in Stretching of Muscles
Von Scheele, B.H.C., & Frojd, K., Sweden

42.) Breathing Assessment and Treatment in Post-CVA and Neurological Patients
Webber, J., & Pierce, L., Canada

43.) Independent Effect of Ventilation and CO2 on Lung Volumes, Diffusing Capacity, and Blood Flow in Humans
Wilson, A.F., Rafferty, G.F., & Gardner, W.N., United Kingdom

PANEL SESSION II
APPLIED RESPIRATORY PSYCHOPHYSIOLOGY

CHAIR, Paul M. Lehrer, Robert Wood Johnson Medical School, USA

44.) Psychological Adjustment to Mechanical Ventilation in a Long-Term Care Setting
Gleckman, A.D., Phillippi, T., & Rohr, R., USA

45.) Measurement of Transcutaneous PC02 Among Air Traffic Controllers: Differential Responding to Workload and Stress
Wientjes, C.J.E., Gaillard, A.W.K., & ter Maat, R., The Netherlands

46.) Speaking and Activation: Speech Detection by Respiratory Parameters
Wilhelm, F., & Roth, W.T., USA

47.) Breathing and Biomechanical Indices of Stress in Mood Disturbances and Right-Hand Musculoskeletal Discomfort in Repetitive Computer Work
Schleifer, L.M., Ley, R., & Pan, C., USA

48.) Respiratory and Psychophysiological Strategies in the Treatment of Stagefright
Lang, D., USA

INVITED ADDRESS III

49.) HYPERCAPNIA-INDUCED AIR HUNGER
Robert Banzett, Harvard School of Public Health and Harvard Medical School. USA
Introduction: ANDREW HARVER, UNC Charlotte, USA

PANEL SESSION III
HYPERVENTILATION AND PANIC: PSYCHOLOGICAL ASPECTS

CHAIR, Bo von Scheele, Stress Medicine AB, Sweden

50.) Respiratory and Psychophysiological Factors of Panic Disorder
Moynihan, J.E. & Gevirtz, R. N., USA
IDENTIFICATION OF INDIVIDUAL BREATHING PATTERNS
and
INTRODUCTION TO THE RE-EDUCATION OF DYSFUNCTIONAL PATTERNS IN HYPERVENTILATION, ASTHMA. AND EMPHYSEMA

DIANA M. INNOCENTI, Guy's Hospital. London, United Kingdom
Introduction: Beverley Timons, St. Bartholomew's Hospital. England

Diana M. Innocenti, formerly Superintendent Physiotherapist at Guy's Hospital, London, is the author of numerous publications on the treatment of respiratory disorders. Now semi-retired, she pioneered the British method of retraining breathing patterns in hyperventilation. She is not only recognized as a leading authority in this field but is highly regarded as a lecturer and workshop presenter.

This workshop will provide the first demonstration of the British physiotherapy treatment methods to a North American audience.

RESPIRATORY AND PSYCHOPHYSIOLOGICAL FACTORS IN THE DIAGNOSIS AND TREATMENT OF FUNCTIONAL CARDIAC AND PANIC DISORDER

RICHARD N. GEVIRTZ, California School of Professional Psychology, San Diego, USA
Introduction: RONALD LEY, University at Albany. SUNY. USA

Richard N. Gevirtz, Professor of Psychology, has been active in applied psychophysiology for more than 15 years and has published numerous articles and book chapters. He is a member of the Board of the Association for Applied Psychophysiology and Biofeedback. This workshop will focus on the use of psychophysiological and respiratory data in the treatment of a group of disorders often labeled functional cardiac disorders, "out-of-the-blue" panic, and hyperventilation disorder. The assessment of respiration is emphasized as primary, followed by the use of autonomic measures.
A SURVEY OF STUDIES REPORTING THE OUTCOME OF BREATHING RETRAINING.

Ronald Ley and Beverly Timmons. University at Albany, SUNY, USA and St. Bartholomew's Hospital, UNITED KINGDOM.

Studies that provide information relevant to the evaluation of the efficacy of programs designed to modify breathing in the treatment of psychophysiological disorders are relatively small in number and diverse in terms of the procedures employed, types of complaints addressed, degree of competence of therapists, methods of evaluation, and possibilities of confounding factors in the interpretation of results.

Since information concerning the relative efficacy of breathing retraining in relationship to the type and severity of psychophysiological complaints is vitally important in the progress and development of clinical respiratory psychophysiology, the present paper analyzed the results of 20 studies, published during the past 12 years, that reported the outcome of therapeutic attempts to modify breathing.

The results of these studies are classified on the basis of relevant variables (e.g., types of clinical complaints, respiratory measures, breathing patterns, diagnostic procedures, competence of therapist, methods of assessing outcome) and discussed in terms of their qualitative merit.

While shortcomings can be found in almost all the studies reviewed, a situation which points to the need for more carefully controlled studies, the overarching conclusion reached is that current research points to breathing retraining as a promising technique in the treatment of psychophysiological disorders.

TREATMENT DIFFICULTIES AND FAILURES: CAUSES AND CLINICAL MANAGEMENT.

L. Claude Lum. (formerly) Addenbrooke's Hospital, UNITED KINGDOM.

More than one third of patients suffering from chronic hyperventilation have associated conditions which frustrate efforts at breathing correction. Panic attacks or agoraphobia occur in 50% of my patients. The attendant hyperventilation constantly defeats attempts to control breathing.

Treatment may require the judicious use of drugs (e.g., lorazepam), and hypnotherapy, with systematic deconditioning (Wolpe).

Allergies (e.g., hay fever) may keep patients sniffing and coughing for half the year, perpetuating irregular thoracic inspirations. Oral steroids are often the only effective treatment.

Food intolerance, with bloating after meals, splints diaphragm movement. Such cases need an expert in dietary management.

Pseudo-allergy is common; many patients falsely attribute symptoms to an allergy to particular foods. In two-thirds of such cases of pseudo-allergy, the symptoms have been
shown to be due to a conditioned reflex of hyperventilation on exposure. A similar mechanism is common in allergy to perfumes, and industrial gases.

Progesterone is a strong respiratory stimulant. Severe premenstrual symptoms may disable the patient for 10-14 days per month, preventing the learning of new breathing patterns. The pill, by ironing out gross progesterone fluctuations, is often useful.

The blood sugar is clinically the most important of these non-ventilatory factors. When the blood glucose is below the middle of the normal range (i.e., below 4.4 mmol/L) the effects of overbreathing are progressively enhanced at lower levels. This can be the crucial factor in precipitating panic attacks, seizures, and migraine. Diet modification, to keep blood glucose in the upper half of the normal range, is essential to treatment. A high protein, frequent feed regime is necessary for them, and benefits most patients.

CLINICAL EXPERIENCE WITH A VISUAL BIOFEEDBACK METHOD IN COPD REHABILITATION.

Deane Hillsman, M.D., University of California, Davis, USA.

A computer based system displays precisely defined breathing analogs, and with visual biofeedback prompts patients to alter their breathing patterns.

In a private practice setting, patients readily follow these patterns. With twice daily five minute diaphragm practice at home, patients develop and retain new breathing patterns.

Question: what are the proper breathing patterns? The literature seems generally silent, and mostly anecdotal. Pursed-lip breathing experience notes larger tidal volumes and slower respiratory frequency, and occasionally prolonged expiratory time. Unanswered is whether this applies to spontaneous breathing pattern alterations.


Around 1979 the author noted a small number of emphysema patients in his practice, approximately 1 in 40 patients, who appeared generally comfortable, despite having severely impaired pulmonary function. These patients breathed at a lower frequency (11 to 12 breaths per minute), larger tidal volumes (700 to 900 cc), longer expiratory time (I:E Ratio 1:1.7 to 1:1.9) and with a smooth and coordinated breathing pattern, which appeared to fit their general profile for various reasons.

This breathing pattern has been used for patients in distress, and clinically it appears to be of benefit. Patient examples will be demonstrated.

More rigorous pulmonary mechanics studies to understand the process and permit optimal individual patient prescriptions are needed.
LATERAL-COSTAL BREATHING:  
THE ROLE OF POSTURE IN EFFORTLESS BREATHING

Lorie Pierce. Vancouver, B.C., CANADA.

This study was designed to investigate the relationship between posture and rib cage movement.

Seventeen subjects (mean age, 70.1 yrs) were assessed for their ability to straighten their spine while standing. This measure was used to determine flexibility required to maintain the varied postures and positions required for everyday movements and balance.

These same subjects were also assessed for the quality of rib cage movement while supine, the position in which muscular restriction to movement during breathing is minimized. The effort of breathing was assessed using the description of van Dixhoorn (1993) that effort of breathing increases when the chest cannot expand sideways and is relatively immobile due to, for example, stiffness in intercostal muscles, blockage of rib motion, tightness of abdominal muscles and limited movement in the spinal column.

Two sub-groups were found: those with a marked head-forward posture while standing (> 4 cm); and, those with a slight head forward posture (< 4 cm).

In general, those subjects with a reduced head-forward posture were better able to straighten their spine towards ideal alignment and had more components of effortless breathing present in their rib cage movements.

Suggestions for clinicians and researchers are to monitor lateral-costal, as well as abdominal, movement when assessing the effort of breathing, and to connect with therapists who can assist in treating postural alignment in patients who are undertaking breathing retraining.

Lorie Pierce. Vancouver, B.C., CANADA.

THE USE OF CONSCIOUS BREATHING TECHNIQUES IN PSYCHOTHERAPY.

Joy Manné. Pully, SWITZERLAND.

The connection between breathing disorders and emotional states is widely acknowledged (see Ley, Lum, Fensterheim, Boadella, Conway, Proskauer, Timmons; in Timmons and Ley, 1994).

Less well-known is the use of conscious breathing techniques in therapy. Conscious breathing techniques provide a gentle way of expressing and releasing pent-up emotions.

Breath is a language. Therapists who can sensitively read this language and speak it (Holloway, 1994) can help their clients to gently discharge painful emotions.

This paper presents various conscious breathing techniques, including awareness work with the breath and analytical breathwork and their effectiveness as demonstrated by case histories.

Conscious breathing techniques may be able to alleviate serious breathing problems but unfortunately (as far as I am aware) there is no research on this subject.
Rehabilitation of Patients with Exercise Hypoxemia

Hans Folgering, University of Nijmegen, The Netherlands

Abstract Pending

APPLICABILITY OF CAPNOGRAPHY IN DETECTING HYPOCAPNIA WITHIN PATIENTS HAVING CARDIOVASCULAR DISEASE.

Angus Forbes. Flinders University of South Australia, AUSTRALIA.

The hyperventilation syndrome has been described as prevalent amongst patients presenting with cardiac-related symptoms. This study was conducted to assess the utility of capnography to identify hypocapnia in patients with cardiovascular disease.

The sample (n=74, 24 females, 50 males) was comprised of consecutive voluntary patients undergoing coronary angiography at a large public hospital.

Immediately after the angiography procedure subjects were monitored using a sidestream capnograph for two 2 min phases. Expired gases were collected via either single (right nostril) or double pronged nasal sampling lines.

In phase 1 subjects breathed spontaneously, whilst during phase 2 they were asked to breathe with their mouth closed. After each phase arterial blood was gained via a sheath in the femoral artery.

In phase 1 and 2 the end-tidal CO2 (ETCO2) was significantly correlated with the arterial pCO2 (PaCO2): Phase 1 (r = .52, p < .001); Phase 2 (r = .72, p < .001).

However, during both phases the mean ETCO2 (METCO2) was significantly less than the mean PaCO2 (MPaCO2): Phase 1, METCO2 = 32.95 mmHg, MPaCO2 = 40.90 mmHg; Phase 2, METCO2 = 33.91 mmHg, MPaCO2 = 40.98 mmHg.

Under the mouth-closed condition a modest, but significant increase in the ETCO2 occurred. No effect emerged due to sampling via a single or double pronged nasal catheter.

These results indicated that capnography has limited utility in diagnosing hypocapnia in patients being investigated for cardiovascular disease. This limitation was considered due to the high probability of cardio-respiratory abnormalities within this population, hence a likelihood of increased dead-space ventilation, and ventilation-perfusion mismatching.

It was concluded that capnography may be usefully employed in biofeedback, and that the accuracy of ETCO2 gained via nasal sampling can be improved by having patients close their mouths.
CAPNOGRAPHIC ASSESSMENT OF DISORDERED BREATHING.

Bernard Landis and Patricia Romano. The New York Hospital and St. Luke's/Roosevelt Hospital Center, USA.

Given that there is only one normal capnogram form, departures in size and shape from this standard are considered abnormal.

We developed a method of scoring the 15 major abnormal configurations of the capnogram. Dividing the number of irregular capnograms by the total number of configurations in the sample and expressing the result as a percentage, we arrived at a measure of disordered breathing.

We compared the mean capnogram disordered breathing score (CDBS) of a normal comparison group (14%) with an obstructive airways group (64%), an anxiety/panic attack group (64%) and a group of subjects with stress-related somatic symptoms (47%).

Scores of the normal comparison group were differentiated from the three clinical groups (p < .01). Each of the four groups showed different clusters of scoring factors.

A STUDY OF ANAEROBIC THRESHOLD IN CHRONIC FATIGUE SYNDROME.

P. G. F. Nixon, Charing Cross Hospital, UNITED KINGDOM.

The purpose of this study was to determine whether patients diagnosed as having chronic fatigue syndrome have a lower anaerobic threshold than a comparison group, a qualification for the diagnosis of Lewis' effort syndrome.

The respiratory response to the anaerobic threshold was recorded by capnography during incremental exercise.

Thirty-two consecutive patients with a diagnosis of chronic fatigue syndrome served as subjects, 14 men ranging in age from 28-59 yrs (M = 46.5 yrs) and 18 women ranging in age from 19-59 yrs (M = 36.72 yrs). Thirty-nine volunteers recruited from nursing and office workers, 11 men ranging in age from 25-57 yrs (M = 42.54 yrs) and 18 women in ranging age from 22-62 yrs (M = 37.28 yrs), served as control subjects. The volunteers considered themselves to be healthy but untrained for exercise.

For capnography, the air was drawn from the dominant nostril through a capnograph allowing the end-tidal PCO2 (PETCO2) to be registered continuously with a Datex Normocap capnograph and Elcomatic recorder.

For the incremental exercise task, a Tunturi bicycle ergometer was used according to the STEEP protocol. The starting point is determined by body weight and the work intensity, in watts (W), is increased each minute in a logarithmic progression. The time between onset of exercise and the respiratory breakpoint was measured as well as the work intensity at the breakpoint.

Male patients had a significantly lower mean level of work intensity (M = 47.14 W) compared to the males in the control group (M = 125.91 W) and a significantly shorter mean cycling
time (M = 3.3, and 8.63 min, respectively). Thirteen of the 14 males patients had a breakpoint within the limits of 75 watts and 6 min.

Female patients had a significantly lower mean level of work intensity (M = 30 W) compared to female controls (M = 52.5 W), and exhibited a significantly shorter mean cycling time (M = 2.3, and 4.84 min, respectively). Fourteen of the 18 female patients had a respiratory breakpoint within the boundaries of 35 watts and 3.5 min of exercise.

We conclude that a segment of patients with chronic fatigue show severe reductions of the anaerobic threshold and qualify for the diagnosis of effort syndrome. The assessment of anaerobic threshold in these patients may provide a useful outcome measure in rehabilitation.

**EFFECT OF HYPERVENTILATION ON SKIN AND MUSCULAR BLOOD FLOW AND TRANSCAPILLARY TRANSPORT OF WATER AND SMALL SOLUTES.**

J. Steurer, U. Hoffmann, U. Franzeck, and W. Vetter. Zürich University Hospital, SWITZERLAND.

Hyperventilation provokes hemodynamic alterations. In the early phase of hyperventilation peripheral blood vessels dilate and vascular resistance decreases.

To determine blood flow changes in skin and muscle simultaneously we investigated 10 controls and 10 patients with a hyperventilation syndrome, according to the Nijmegen protocol, by laser Doppler fluxmetry. Blood flux was registered in skeletal muscle (M. tibialis anterior) and calf skin before, during and after a 3 min voluntary hyperventilation.

At the end of a 3 min voluntary hyperventilation (p end-tidalCO2< 2.5 kPa) muscle blood flux increased significantly (p < .05) to about 200% compared to the values before hyperventilation. Skin blood flux exhibited no significant changes during the manoeuvre. No significant differences of skin and muscle blood flux alterations between patients and normal controls was found.

As a further consequence of hyperventilation hemocontration of serum proteins increased significantly (p < .05) about 5% due to a loss of fluid low in protein from the intravascular space.

By measuring fluorescent light intensity (FLI) alterations in the skin after intravenous sodium fluorescein (NaF) injection we could demonstrate for the first time a significant increase of FLI during hyperventilation indicating an increase in the transport of water and small solutes through the capillary wall. The exact mechanism of enhanced transcapillary diffusion of NaF is unknown.

The distinct increase of FLI without significant change of microvascular skin blood flux suggests an increase of capillary pressure or an enhancement of capillary permeability for water and small solutes induced by hyperventilation.
ASSESSING IMPAIRMENT, DISABILITY, AND HANDICAP IN CHRONIC LUNG DISEASE

David G. Stubbing, McMaster University, Canada

Abstract Pending

INTEROCEPTION OF AIRWAY RESISTANCE IN HEALTHY AND ASTHMATIC SUBJECTS.

Bernhard Dahme, University of Hamburg, Germany

A series of studies is presented which investigated the interoception of airways obstruction in healthy subjects and asthmatic patients.

In two experiments the psychophysics of the perception of external added flow resistive loads was examined utilizing the signal detection paradigm. Asthmatic patients showed a lower sensitivity in load discrimination.

In a further experimental study with asthmatic subjects, different levels of bronchoconstriction were provoked by allergic agents.

The ability to discriminate various levels of obstruction by dyspnea ratings showed considerable variation among subjects. Perceptual deficits were associated with anxiety and poor self-management of asthmatic attacks.

In a third study the visceral perception hypothesis of Brener was examined in the context of biofeedback training of total respiratory resistance. It was found that training of voluntary control of respiratory resistance did not improve the perception of airways obstruction: the ability to detect external added loads was not affected by biofeedback training.

The relevance of these results to symptom perception in asthmatic patients is discussed. It is proposed that further research should focus on the interoception of real bronchoconstriction.

ASTHMA SELF-MANAGEMENT TRAINING FOR ADULTS: SECOND GENERATION STUDIES.

Harry Kotses and Thomas L. Creer, Ohio University, USA

We developed and evaluated two self-management programs for adults with asthma. The format of the two programs differed: one was designed for a group, and one was designed for individual patients.

Our group program incorporated principles of learning and communication that facilitated both task acquisition and persuasion. We assigned each of seventy-six patients to either a self-management or a delayed training group.
The patients in the self-management group were given a seven session program of asthma self-management and then shifted to a two-month follow-up condition. Throughout the same period, the patients in the delayed training group continued in baseline after which they were trained in self-management.

All patients were evaluated again one year after the end of self-management training.

The patients in the self-management group improved in attack frequency, pulmonary function, frequency of physician visits, and on paper-and-pencil test measures of asthma knowledge, self-efficacy, and depression, while the patients in the delayed treatment group did not.

Our individualized program focussed on events associated with asthma in individual patients. Each patient’s program consisted of training to reduce or avoid variables related to his or her asthma.

We assigned each of forty-five asthma patients to either an individualized program, a group program, or a control group.

As compared to controls, patients in both self-management groups exhibited pulmonary function improvement, but only patients given the individualized program demonstrated improvement in frequency of asthma attacks.

**EMOTIONALLY-TRIGGERED ASTHMA: IMPLICATIONS FOR SELF-REGULATION THERAPY.**

Paul M. Lehrer. Robert Wood Johnson Medical School, USA

Asthma is a very common disease with increasing morbidity and mortality. It is often associated with negative emotion, and asthma attacks can be triggered by stress. Panic disorder is common in asthma. The mechanisms by which panic and other negative emotions may affect asthma may be through increased autonomic lability and/or hyperventilation.

A repressive coping may be a risk factor in asthma, either because of its autonomic correlates or an inability for repressors to perceive symptoms and take appropriate medical action.

Several self-regulation strategies are proposed as adjuncts to asthma treatment. These include biofeedback for improved sensitivity in perceiving respiratory sensations, relaxation, and biofeedback training for increasing respiratory sinus arrhythmia.

It is further hypothesized that relaxation-oriented methods will have their greatest effect among asthmatics who experience panic symptoms. Data from our laboratory will be reviewed showing the effects of laboratory stress on respiratory impedance in asthma and panic disorder, and the relationship between asthma severity (as measured by the methacholine challenge test) and various measures of psychophysiological arousal.

These data suggest that bronchodilation occurs during exposure to active stressors, and that patients with panic disorder have more dilated airways than normal subjects. Relaxation may produce phasic bronchoconstriction, but improved respiratory function over weeks.
Individuals with more severe asthma, as measured by the methacholine challenge test tend to have elevated palmar skin conductance and respiratory sinus arrhythmia, which may indicate elevated cholinergic receptor sensitivity.

Asthmatics with a repressive coping style tend to be less sensitive than others to respiratory sensations, but tend to show greater levels of sympathetic arousal and less bronchoconstriction.

Preliminary data also will be presented on studies of slow paced breathing and respiratory sinus arrhythmia biofeedback as treatments for asthma.

**CHRONIC RESPIRATORY ILLNESS: THE PATIENT'S PERSPECTIVE.**

J. R. Higgins and D. Neal. University of Hertfordshire, UNITED KINGDOM.

In chronic respiratory illness the presence of persisting symptoms does not allow the self limiting cycle associated with acute illness to occur. Lack of conclusion to the illness period means that individuals and those closest to them, have to maintain their perceived roles in society in spite of the presence of persistent and sometimes unsocial symptoms.

This study set out to try and understand the reality that is chronic respiratory illness.

Eleven subjects with the clinical diagnosis of chronic airflow limitation and their nominated supporters were interviewed using a semi-structured format. Content analysis of the interview data revealed three emergent themes: the maintenance of normality; the desire for control; adaptations to lifestyle.

All subjects highlighted the strong desire for the 'affirmation of ordinary life'. The perception of control was needed to maintain normality and was seen in terms of how much power could be exerted over the symptoms, how well could the illness be kept in its place, how far could the limits be pushed and the perception of normality be maintained?

Maintaining normality and developing control were dependant on lifestyle adaptation. Considerable reorganization of time and place had taken place and the need to make extra arrangements had reduced spontaneity of action, impeded social interaction and encouraged reduction in living space, both personal and social.

In conjunction with the temporal and spatial reorganization, many subjects highlighted re-negotiation of roles and the relationship between patient and supporter was seen as a complex interplay of which all subjects were very protective.

**THE RELATION OF BODY COMPOSITION TO THE PERCEPTION OF ADDED RESISTIVE LOADS.**

Cheryl Armstrong and Andrew Harver. University of North Carolina, Charlotte, USA.
Two findings emerge regularly in studies of heartbeat perception: a minority of subjects demonstrate reliable cardiac awareness and male subjects exhibit greater cardiac awareness compared to females. The superior performance by males has been attributed to gender differences in arousal or sympathetic tone and to differences in body composition.

In this study, we examined differences between male (n=35) and female (n=45) subjects for the threshold resistance to breathing.

Subjects breathed either through an open circuit or, on selected breaths, through a resistive load. Resistive loads were constructed of varying dimensions of nylon mesh enclosed in PVC tubing and were linear for flow rates to 1 L/sec. Twelve loads were used in the threshold resistance task (range, 0 to 5.2 cmH20/L/sec). Loads were presented in random order, every 4 to 10 breaths.

The threshold resistance to breathing was obtained by regressing the added resistance of the loads against the proportion of yes responses and predicting the load detected 50% of the time.

Males were reliably taller, heavier, and exhibited greater lung volumes compared to females. Surprisingly, the threshold resistance to breathing was significantly \[ t(80) = 2.30, p < .05 \] smaller in men (1.41 cmH20/L/sec) compared to women (1.98 cmH20/L/sec).

The univariate correlations between sensitivity to added loads and selected variables were largely small and non-significant, but GENDER, BODY SURFACE AREA, and FEV1 were significant and independent predictors of the threshold resistance to breathing accounting for 73% of the variance in perceptual sensitivity.

We conclude that body composition significantly influences the perception of loads added to breathing.

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' AIR HUNGER' INDUCED BY BRIEF INCREASES IN END-TIDAL PCO2 ADAPTS TO CHRONIC ELEVATION OF END-TIDAL PCO2 IN HYPOCAPNIC, VENTILATOR-DEPENDENT SUBJECTS.

Elisabeth Bloch-Salisbury, Steven A. Shea, Robert Brown, Karleyton Evans, and Robert B. Banzett.

Harvard School of Public Health and
West Roxbury Veterans Administration Medical Center, USA.

Brief increases in carbon dioxide in arterial blood (PaCO2) produce an uncomfortable respiratory sensation perceived as an increased urge to breathe (i.e., air hunger).

We wondered whether subjects' sensation of air hunger adapts to chronic increases in PaCO2. Specifically, we investigated whether the level of end-tidal PCO2 (PETCO2) required to evoke air hunger would increase following prolonged exposure to increased PETCO2.

This is relevant to ventilator-dependent patients who typically have very low PETCO2 (i.e., hypocapnia) as well as pulmonary patients who have chronically elevated PETCO2 (i.e., hypercapnia).
We studied four hypocapnic, ventilator-dependent subjects, each for two weeks. During this time, subjects were ventilated with air (placebo) or air rich in carbon dioxide (CO2 exposure).

The CO2 exposure periods lasted between three and seven days; on average, resting PETCO2 was 15 mmHg higher during CO2 exposure than during placebo. Ventilation and arterial oxygen levels were not different in the two conditions.

At approximately two day intervals, subjects participated in air hunger tests during which they rated the intensity of their air hunger induced by brief increases in PETCO2.

We found that subjects’ sensation of air hunger did indeed fully adapt to chronically elevated PETCO2. That is, the increase in PETCO2 required to elicit a specific air hunger rating during the CO2 exposure was increased by the same amount as the resting PETCO2. Arterial pH did not fully return to control values during chronic elevation of PETCO2.

We suggest two possible mechanisms for the adaptation of air hunger:
1) readjustment of brain interstitial pH; and
2) accommodation in the neural pathway which subserves air hunger sensation.

Supported by NIH grants HL46690, HL19170, and the Veterans Administration.

SERIAL MEASUREMENTS OF PCO2 BY THE HALDANE’S REBREATHING TECHNIQUE AS AN AID TO MANAGEMENT OF HYPERVENTILATING PATIENTS.

Anita Elaine Davies. London, England, UNITED KINGDOM.

Three female patients with chronic disease and still being followed up in 1995 were shown to illustrate the impact of life events on their symptomatology. Serial measurements of PCO2 (mmHg) in each patient demonstrated the part that hyperventilation played in the presenting symptoms.

Measurements were made using the Modified Portable Haldane Apparatus (Campbell B.M.J.1960, 457). The use of an anaesthetic bag demonstrated to the patient the volume of air used and the rate of breathing, which were reduced during the re-training sessions.

Patient No 1: a divorced music teacher aged 46 in 1977 presented with chronic blocked ear and vertigo. Her PCO2 was 30.0 and rose to 36.6 four months later after physiotherapy. Relapses occurred during menopause and with respiratory infections. Conventional medical treatment as well as osteopathy and homoeopathic medicines contributed to her recovery.

Patient No 2: a single banker, aged 44 in 1991, presented with the chronic fatigue syndrome after influenza in 1981. Her PCO2 was 33.0 and remained low until her forced retirement because of ill health was finalized in 1995 and she took charge of her own future. Learning autohypnosis contributed to her recovery.

Patient No 3: a married proof reader aged 55, presented in 1990 with polymyalgia and aphonia. Her PCO2 was 30.0, but rose only to 34.8 a year later, when her voice was normal.
Prednisolone treatment was discontinued and manipulation relieved remaining muscular pains.

Treatment of these patients included conventional and homoeopathic medicines, together with osteopathy and training in auto-hypnosis and counseling when indicated. (Davies, Brit. Homoeopathic Journal, April 1995).

EFFECTS OF VOLUNTARY CHANGES IN BREATHING FREQUENCY ON RESPIRATORY COMFORT.

Sonja Denot-Ledunois, Guy Vardon, and Jorge Gallego.
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It has been suggested that dyspnea is optimally adjusted during breathing, and that departures from spontaneous patterns are detrimental to dyspnea (Chonan et al. JAP 69: 1290-95, 1990). This was based on experiments in which the subjects voluntarily changes their breathing pattern. For this reason, self-assessment of dyspnea may have been influenced by the difficulty of this control.

In the present experiment, we studied the difficulty of voluntarily adjusting breathing frequency to target levels, and its possible influence on the self-estimation of respiratory comfort.

Fifteen athletes (mean age, 22 yrs) volunteered for one session. Breathing variables were collected using a respiratory inductive plethysmograph.

After a 5-min period of spontaneous breathing, subjects adjusted their frequencies to prescribed target values for 2 min by using visual feedback. The targets corresponded to 40%, 60%, 80%, 100%, 150%, 200%, and 250% of individual spontaneous values, in a randomized order.

After each target frequency, the subject estimated the respiratory comfort and the difficulty of the adjustment on a 6-point scale, ranging from very comfortable to very uncomfortable, and very easy to very difficult.

Respiratory comfort reached its minimum for the target frequency corresponding to spontaneous rates confirming Chonan et al.'s data.

However, the similar pattern of the estimated difficulty suggested that the comfort index also reflected the subjects' difficulty in performing the task; the more familiar frequency corresponded to the lowest difficulty.

Self-assessment of dyspnea during voluntary control of breathing does not necessarily reflect those processes which normally operate during spontaneous breathing. A longer practice at each target frequency may affect the differences in difficulty between patterns.

If so, the self-assessment of respiratory comfort would no longer be contaminated by the difficulty of ventilatory control, and provide information on the optimality of breathing...
pattern according to respiratory comfort. By now, however, this hypothesis remains unwarranted.

**THE EFFECTS OF INCREASING ATTENTIONAL LOAD ON BREATHING FREQUENCY IN HEALTHY CHILDREN.**

Sonja Denot-Ledunois, Guy Vardon, and Jorge Gallego.
Université de Paris XI, Universite de Picardie, and Faculté de Médecine de Paris-Sud, FRANCE.

Spontaneous breathing is considered automatic, in the sense that it does not require attention for its execution. If so, focusing attention should not have any effect per se on breathing.

However, tasks implying focused attention generally involve other psychophysiological variables such as emotion or stress, which generally increase breathing frequency. In addition, data from experimental psychology suggest that even the most supposedly automatized acts do need some amount of attention for their execution.

To clarify the effects of attentional load, and the underlying issue of whether or not spontaneous breathing requires some amount of attention, we measured breathing variables during a video game.

Ten healthy children (mean age, 9 yrs) performed a video game of increasing difficulty (Tetris). This game consisted of acting upon successively falling objects by translations or rotations to minimize the stack of fallen objects. Difficulty was manipulated by increasing the speed of objects.

Breathing variables were measured using a respitrace inductive plethysmography. Stress was assessed by three measurements of salivary cortisol upon the arrival of the children to the room, and both when the game ended and 15 min later.

TTOT significantly increased as a function of the game difficulty from 2.56 sec to 3.16 sec \([F(8,72)=3.37, p<0.019]\). Changes in Vt were not significant. Neither heart rate nor salivary cortisol displayed significant changes, although cortisol tended to decrease from the pre-game to the game periods.

The video game was familiar to most subjects, and apparently had low emotional impact. For this reason, the effect of attentional load was predominant over the other factors which otherwise had an excitatory effect on breathing.

The observed decrease in breathing frequency during the video game may present some similarities with the interference effects observed in dual-task experiments, suggesting that spontaneous breathing is not fully automatic.
The aim of this investigation was to research the relation between the sensitivity and reactivity of the bronchi and bioelectric activity of the brain.

For this purpose the bioelectric activity of the brain through electroencephalography was examined in 21 patients with asthma. The sensitivity and reactivity of the bronchi were studied with the acetylcholine-test.

Due to the resultant bioelectric activity the patients were divided in two groups.

In the first group we placed patients that had normal bioelectric activity. In the second group, we placed patients that had abnormal bioelectric activity.

We found that in the patients with abnormal EEG activity, the level of sensitivity and reactivity of the bronchi were significantly (p< 0.01) higher than in patients without this kind of abnormality.

Additional analyses showed that the reactivity of the bronchi was reliably related (p< 0.01) to the electroencephalogram.

We succeeded in transforming the oscillatory vibrations of the electroencephalogram (EEG) registered from fronto-occipital bipolar leads into auditory sounds, which, depending on the type of dominant waves, produced a certain signature representation of the EEG (brain music) specific to the individual state of the patient.

In the course of relaxation the patient can listen to his own brain music and exert active influence upon this music. Later on, and with practice at home, variations in the patient's level of arousal can be monitored.

Effects of using such recordings, on immediate and subsequent 1.5 year observations, were carried out in 17 patients with asthma with predominant neurotic co-morbidity.

Recordings were made of the EEG at the moment corresponding to the phase of disease remission and under conditions of relaxation induced by hypnotherapy, by auto-training or reflexotherapy.

Patients can listen to their own “recordings” as required, usually 1-2 times per week, thus contributing to relaxation and even preventing asthmatic episodes. Such training makes the patient more self-reliant.
EFFECT OF HYPERINFLATION ON LUNG VOLUMES, DIFFUSING CAPACITY, AND BLOOD FLOW IN HUMANS.

Kings College and Kings College Hospital, UNITED KINGDOM.

We previously showed that voluntary overbreathing (VHV) produced over 100% increases in residual volume (RV) measured by CH4 dilution, and smaller increases in cardiac output (Q) and in diffusing capacity for carbon monoxide (DLCO), measured by a single-breath constant exhalation method (SensorMedics 2200, Yorba Linda, CA).

These changes persisted after the end of VHV but the time course of recovery was unclear. The increase in Q was due, in part, to hypocapnia but it was uncertain whether the changes of RV and DLCO were due to the increased respiratory excursions associated with VHV, or to opening of alveoli associated with increases in absolute lung volume.

In the present experiments, we performed the same measurements in 12 normal subjects before and after 5 minutes of normal breathing at a voluntarily raised end-expiratory volume with an increase of expiratory reserve volume (ERV) from mean values of 1.9 to 3.2 L.

Tidal volume, respiratory frequency, and end-tidal PCO2 remained constant and at normal levels throughout. RV, Q, and DLCO were significantly raised at a mean time of 0.8 min after return to normal ERV, RV, and DLCO (but not Q) were still significantly raised at 13.6 min and all had returned to control levels by 29 min. Vital capacity did not change.

These results show that hyperinflation increases RV, Q, and DLCO independently of changes in blood gases and tidal breathing. The increase of RV and DLCO persists for 15-30 min after return to normal breathing whereas Q returns to normal more rapidly.

THORACIC VS. ABDOMINAL BREATHING: EFFECT ON PetCO2

Christopher Gilbert, Ridgewood, N.J., USA.

Thoracic breathing is commonly thought to contribute to lowered PCO2 through the mechanism of hyperventilation. The co-occurrence of strong emotion, however, complicates any cause/effect attributions.

EXPERIMENT 1: To investigate the effect of breathing locus alone on end-tidal CO2 level, 7 subjects were monitored under two conditions designed to create thoracic breathing.

In Part 1, subjects used visual feedback of scalene/trapezius EMG to produce either thoracic or abdominal breathing, alternating for 5 90-sec periods.

In Part 2, subjects tensed or relaxed their abdominal muscles, following the same sequence as before.
Thoracic breathing in Part 1 was associated with significantly lower PetCO2 than abdominal breathing (26.8 vs. 29.8 mmHg; p = .0005). In Part 2, PetCO2 was slightly higher in the Abd.-Tense than Abd.-Relaxed conditions (32.6 vs. 31.8; p = .01). EMG activity was comparable in Parts 1 and 2, and confirmed thoracic breathing. All subjects displayed transient hyperventilation.

**EXPERIMENT 2:** Five subjects were bound with a 6"-wide belt to restrict abdominal expansion. Chest circumference via stain gauge was added to the PetCO2 and EMG measures; 2 conditions (bound-unbound) alternated for 4 2-minute periods of ad-lib breathing.

PetCO2 was slightly higher with the abdomen bound (43.4 vs. 42.5; p = .01). Respiratory rate did not change; chest circumference dropped slightly in the bound condition.

**CONCLUSIONS:** Intentional thoracic breathing lowered PetCO2, but inducing thoracic breathing by restricting abdominal expansion, either actively or passively, raised PetCO2 slightly. Explanation probably involves differences in tidal volume.

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**THE PHYSIOLOGICAL EFFECTS OF VOLUNTARY HYPOVENTILATION**

Elena P. Gora, Moscow State Pedagogical University, RUSSIA.

It is known that drug treatment of hyperventilation syndrome is not effective. The possibility of using breathing training (voluntary hyperventilation or voluntary hypoventilation) for this purpose is discussed. Our aim was to study cardio-respiratory and CNS reactions to voluntary hypoventilation.

We examined 19 healthy subjects, 17-21 years old, at rest, during and following severe hypoventilation (two respiratory cycles per minute for 20 minutes). This regime of voluntary hypoventilation required intensive breathing training.

The parameters of external respiration and interchange of gases, arterial pressure, ECG, EEG and EMG of the muscles of right forearm were recorded. The reaction time (RT) to a light stimulus was measured. The cardiovascular and CNS responses to voluntary hypoventilation were compared.

Respiratory sinus heart arrhythmia intensified in 12 subjects probably due to the increase of parasympathetic control of the heart. Dynamics of EEG and RT indicated increased (of a periodic character) neurogenic influences of the respiratory center on CNS, including the higher parts of the brain. The role of humoral factors in the reaction of CNS on the voluntary hypoventilation is discussed.

Voluntary hypoventilation promoted synchronization of rhythmic processes in the organism and may be used for voluntary control of the functional state of organism.

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**A VISUAL BIOFEEDBACK METHOD TO DEFINE AND TEACH BREATHING PATTERNS.**

Deane Hillsman, University of California, Davis, USA.
A computer based system displays precisely defined breathing analogs, and prompts patients to alter breathing patterns with visual biofeedback. The theoretical presumption assumes optimal breathing patterns reduce the work of breathing, and dyspnea.

This system uses an IBM XT computer. The patient display may be blanked to record spontaneous breathing.

Tidal volume is displayed on the y-axis, and respiratory rate, (i.e., cycle time) on the x-axis, calibrated full scale. Therefore, a large, slow breathing pattern appears superficially similar to a small, rapid breathing pattern. These parameters are designated as the **Primary Breathing Pattern**.

**Secondary Breathing Patterns** are variations within the Primary. These are synthesized by selection of I:E Ratio; inspiration and expiration breath hold times; and inspiration and expiration respiratory analogs (linear, curvilinear, and more curvilinear).

Patients interact by observing a cursor along the breathing prescription, with the patient’s breathing displayed in real time. Learning is by visual biofeedback. Plus and minus error detection limits, with alarms, may be optionally activated.

Training sessions begin with the patient CRT blanked and a record of spontaneous breathing. The breathing prescription is then displayed, and the patient practices for approximately ten to fifteen minutes. Preferably the spouse is in attendance. A training breathing performance record is then obtained.

A copy of these records, with annotations as to deficiencies and desired performance is given to the patient. Patients practice at home twice daily for five minutes, attempting to mimic the breathing prescription with diaphragm breathing, and to place the pattern in mental imagery.

Most patients retain the learned patterns within two to three months. Retention displays a variable decay rate, generally requiring reinforcement once or twice yearly.

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**FORCED EXPIRATORY FLOW, DYSPNEA/SUFFOCATION FEAR THEORY AND PANIC DISORDER.**

Ronald Ley, University at Albany, SUNY, USA.

Asmundson and Stein (1994) tested an hypothesis derived from Ley’s dyspnea/suffocation fear theory of panic disorder. A group of panic disorder patients without significant impairment of pulmonary function underwent measurement of forced expiratory flow (a sensitive indicator of obstructive lung disease).

They reasoned that if the classic panic attack (Type I) is a consequence of uncontrollable acute dyspnea, and if severity of dyspnea is a symptom of pulmonary dysfunction, then the severity of panic attacks should be associated with forced expiratory flow scores.

Results reported by Asmundson and Stein lent strong support for dyspnea/suffocation theory but results reported in a subsequent replication by Spinhoven, Onstein, and Sterk (1995) did not.
The present paper analyzes the data of Spinhoven et al. and reveals an unusual pattern of statistically significant insignificant results, i.e., effects whose magnitudes are lower than that expected on the basis of sampling error.

THE BIOFEEDBACK ELECTROENCEPHALOGRAM TRAINING IN PATIENTS WITH ASTHMA.

S. Lovitsky, Pavlov Medical University, RUSSIA.

The role of the central nervous system in the pathogenesis of asthma is well known. Recordings of the EEG in patients with asthma revealed falls in the seizure threshold. Treatment by the antiepileptic medicine Dilantin normalized these changes. But this treatment is accompanied by toxic kidney and liver effects.

We tried to normalize the neurophysiological changes without medicine. We developed a biofeedback-based EEG system.

This equipment made it possible to detect abnormal spike bioelectric activity, and provide auditory information about such activity to the patient through headphones.

Ten sessions of 30 min each resulted in patients’ ability to alter the EEG pattern and improve asthmatic symptoms.

HYPERVENTILATION AND ASTHMA: THE GREY AREA.

L. Claude Lum, (formerly) Addenbrooke's Hospital, UNITED KINGDOM.

Since the CIBA Symposium of 1959 international study groups have failed to reach an agreed definition of asthma. The CIBA study group of 1971 concluded that, On the available information asthma cannot be defined. The same conclusion was repeated in Clarke and Godfrey's text book in 1992.

Thirty percent of cases of asthma are known to be induced by emotion or exercise, and many symptoms are common to hyperventilation and to asthma: intermittent, labored breathing; relief from bronchodilators (transient in hyperventilation); exercise; cough; and fear, anxiety, and panic.

It is thus a matter of individual preference whether the clinician calls such cases asthma or hyperventilation. The distinction is important. Treatment of hyperventilation cures the patient. The asthmatic is condemned to a life of medication.

AMBULATORY MONITORING OF RESPIRATION IN PANIC DISORDER.

Jose M. Martinez, Laszlo A. Papp, Jeremy D. Coplan, David E. Anderson, Donald F. Klein, and Jack M. Gorman.
New York State Psychiatric Institute and Columbia University, and National Institute of Aging, USA

Substantial evidence indicates that the respiratory system in panic disorder patients is abnormally regulated. However, differences in actual ventilatory measures between panic disorder patients and controls outside of the laboratory have not been documented.

The development of an ambulatory respiratory monitor may facilitate ventilatory studies of panic disorder outside the laboratory.

The subjects for this study were seven patients meeting DSM-III-R criteria for panic disorder with or without agoraphobia and 12 normal volunteers. A portable respiratory monitor was modified to record breath by breath means for respiratory rate and tidal volume, computed every two minutes for 24 hours.

Subjects were fitted with a skin tight body suit, so that the movements of the Respitrace bands (Ambulatory Monitoring, Inc., Ardsley, N.Y.) sewn into the suits were minimal. After the subject is fitted with the body suit, a calibration procedure was performed.

Results: Patients with panic disorder in comparison with the normal control group had a significantly greater within subject standard deviation in minute ventilation during sleep [patients= 3.64+/-.1.19, controls= 2.43+/-.95, (t(14) = -2.23, p< .05)].

Three of the seven patients reported periods of anxiety and limited symptom panic attacks during the monitoring period.

Comparison of these symptomatic periods verses non symptomatic periods revealed greater increases in both tidal volume (1.03 liters vs. 0.677 liters, t(2) = 5.33, p< 0.033) and minute ventilation (14.79 liters/min vs. 8.50 liters/min, t(2) = 7.57, p< .017) during the periods of anxiety and symptom-limited attacks.

We conclude that 1) the respiratory ambulatory monitor is an effective instrument for generating reliable ventilatory data outside of the laboratory; and 2) there was a significant difference between patients and controls in their patterns of minute ventilation between patients and controls during sleep. Tidal volume, rather than respiratory rate, increases characterized the periods of anxiety and limited symptom attacks.

BODY AND SOUL: THEIR RECIPROCAL INFLUENCE AND THEIR IMPACT ON RESPIRATION, POSTURE, AND SPACE-EXPERIENCE.

J. A. Noske-Fabius, Bussum, THE NETHERLANDS.

The inspiratory movement has a sensorimotor as well as a psychomotor element, while the expiration is psychomotor, expressing emotions or a state of mind. So motion and posture can be expressions of our feelings.

The reflection of our psyche (Freud's definition) in the body is the following: (1) the 'Es' is situated in the base of the body (pelvis and legs); (2) the 'Ich' is situated in the upperpart of the body with a well borne sternum; and (3) the 'Uber-Ich' is situated in the head.
The respiratory movement is automatically directed to the corporal region where our attention lies, so the psyche modifies the breathing pattern.

Disturbances in the breathing pattern we mostly see include: a highly thoracic inspiration; oral inspiration; during rest a lack of breathing pauses; expiration in a downward motion; no breath control (e.g., during speech); and, a very quick, superficial respiration or a too deep rationally controlled breath.

The role of muscular tensions in posture and respiration is reviewed, and the means and cases in which breathing therapy can be of help are discussed including the supposed corporal (sensorial) reasons for both hyperventilation and agoraphobia.

**CLASSICAL CONDITIONING TO HYPERCAPNIA IN FREELY MOVING RATS.**

Elise Nsegbe, Guy Vardon, Pierre Perruchet, and Jorge Gallego.
Faculté de Médecine de Paris-Sud and Université de Picardie, FRANCE.

Classical ventilatory conditioning refers to the fact that a stimulus (conditioned stimulus, CS) paired with hypercapnia or hypoxia (unconditioned stimulus, UCS) acquires the ability of eliciting a ventilatory response, as a consequence of the pairing.

Conditioning must be assessed by comparing the ventilatory responses to the CS after the same number of paired or unpaired CS and UCS. Most animal studies on ventilatory conditioning lack this experimental control.

We measured breathing variables in two groups of rats (Experimental, n=9, and Controls, n=7) using a whole body plethysmography.

The UCS was an 8%-CO2 stimulus and the CS was a 1-min tone. These stimuli were paired in the experimental group. In the control group, the UCS was delayed for 3 min from the onset of the CS. Each of the six successive phases comprised six paired-unpaired presentations of the UCS and CS, followed by one CS alone.

The ventilatory responses to these latter CS served to test conditioning. The rates in the experimental group exhibited longer TTOT (in about 15%) than controls following the CS at the end of acquisition. This conditioning effect was confirmed by a significant interaction term using phase as a repeated measure factor and group as a between-subject factor (F(5,70)=3.48, p< 0.016).

The fact that the conditioned response was opposite in direction to the hypercapnic response may be due to the mismatching between the anticipatory signal and the absence of hypercapnic stimulation when the CS is not followed by the UCS. The underlying process is not known. Alternatively, the decrease in frequency may be an avoidance response to limit aversive sensation provided by CO2 inhalation.

This experiment confirmed the high sensitivity of breathing to conditioning, but it also suggested that ventilatory conditioning to exogenous CO2 does not provide a suitable model of those processes actually occurring during exercise.
TREATMENT OF REPETITIVE STRAIN INJURY (RSI) WITH RESPIRATORY SINUS ARRHYTHMIA (RSA) TRAINING.

Lorie Pierce. Vancouver, B.C., CANADA.

Repetitive strain injuries of the forearms appear to present at diagnosis in two sub-types: those which are definite overuse injuries to specific (often unilateral) anatomical structures at prime points of overload, compression or tension; and, those which are more generalized conditions of bilateral numbness, tingling, coldness and loss of grip strength.

From clinical experience it was noted that in the majority of cases of the generalized form of RSI, the expected variation of heart rate with the breathing cycle (RSA) is absent.

This paper describes a biofeedback-based therapy that instructs RSI patients in breathing techniques that restores the RSA pattern while maintaining the breathing as a effortless function.

Complementary skills developed by these patients include the ability to increase hand temperature and decrease galvanic skin response readings.

Ongoing physiotherapy during training restores flexibility in the rib cage to ensure that the breathing remains effortless (e.g., visceral manipulation, postural training).

Patients trained in this technique report an ability to decrease or cease the RSI symptoms as they increase circulation to their arms. This breathing technique is then incorporated into a work-hardening regime that includes return to work activity with patient-directed breaks, as symptoms increase, to re-establish the RSA pattern of breathing.

A case study of a 32 year old male computer keyboard operator illustrates this technique.

AGGRESSIVE REST: AN ADJUNCTIVE THERAPY IN THE TREATMENT OF CHRONIC PAIN AND FATIGUE.

Lorie Pierce and John Oldham. Vancouver, B.C., CANADA.

Patients presenting in a physiotherapy clinic with a diagnosis of fibromyalgia or chronic fatigue were monitored at rest, in various postures and during challenges to their breathing.

Psychophysiological signals monitored included EMG (scalenes, intercostal muscles), ETCO2, GSR, TEMP and HR/BVP.

Patients with resting ETCO2 of <30 mmHg and whose ETCO2 levels decreased further after postural challenge or shifts in breathing patterns, were requested to employ aggressive rest at home between visits.

Aggressive rest describes a regime of non-weight-bearing rest throughout the day in addition to time spent sleeping. The amount of aggressive rest time prescribed is determined by the current sleep patterns, activity patterns and severity of symptoms reported by the patient.
During this rest, patients are encouraged to practice breathing techniques, hand warming and nervous system calming.

Aggressive rest is a therapy that complements the SABRES approach (Nixon 1993) to balancing the need for rest and activity, restoring efficient breathing, and decreasing arousal levels.

This poster presents a 10 month case study of a 51 year old female, diagnosed with fibromyalgia, who has found aggressive rest to be the single most effective technique she has employed in treatment of her condition. Pre and post treatment measurements show an increase in resting pCO2 levels that parallel patient self-reports of symptom reduction.

**EFFECT OF TONGUE POSITION ON BREATHING MECHANICS.**

Lorie Pierce and John Oldham, Vancouver, B.C., CANADA.

In chronic pain patients, a relationship between the reduced ability to balance the head on the spine (head forward posture) and the inability to activate the lower rib cage during inspiration has been noted clinically.

Patients with limited lateral rib cage excursion have a tendency to be caught in a pattern of rapid, shallow, apical breathing even at rest. Clinical experience has shown that this is particularly evident in females.

This paper describes an exercise regime to improve head balance and rib cage movement through restoration of tongue strength and function.

Patients are assessed in the clinic by physiotherapists for their quality of rib cage movement and their ability to straighten the spine, while psychophysiological readings monitor respiration rate, ETCO2 and EMG activity of skeletal muscles assisting respiration.

A case study is included demonstrating a particularly dramatic shift in efficiency of breathing with a change in tongue/head position. Implications for therapy are discussed.

**VISCERAL MANIPULATION THERAPY.**

Lorie Pierce and Janice Webber. Vancouver, B.C., CANADA.

A common clinical finding in the physiotherapy assessment of patients diagnosed with fibromyalgia, post-MVA, or other chronic pain condition, is a tendency towards shallow, rapid, apical breathing with a corresponding reduced ability to expand the lower portion of the rib cage during inhalation (i.e., “bucket-handle movement”).

In psychophysiological assessment, these patients often present with low resting pCO2 values and a poor ability to recover to resting values after breathing is stressed.

This poster explains the effect of an abdominal/thoracic technique, visceral manipulation therapy, towards the restoration of lateral-costal movement in the lower ribs.
Visceral manipulation is a treatment involving specific stretching techniques to the connective tissue around restricted organs. Using these techniques, a trained therapist is able to break down the adhesions formed between the connective tissue layers over individual organs.

Studies have shown that adhesions are formed when the serous fluid between connective tissues thickens and becomes more viscous in nature during the inflammatory process. This phenomenon can occur after trauma such as motor vehicle accidents, direct blows to the rib cage, surgery, and some illnesses.

In some fibromyalgia patients, visceral manipulation therapy may offer an important adjunctive therapy towards the restoration of efficient lateral-costal breathing.

The data presented illustrates pre and post-treatment ETCO2 values and a qualitative change in rib cage movement, after visceral manipulation therapy, in a 51 year old female patient with repetitive strain injury.

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**MENTAL IMAGES AS CONDITIONED STIMULI FOR INCREASED RESPIRATORY BEHAVIOR AND REDUCED END-TIDAL CO2.**

Kriss Stegen, Omer Van den Bergh, and Karel P. Van de Woestijne. University of Leuven, BELGIUM.

In a differential respiratory conditioning paradigm with normal Ss two imagery scripts, describing two typical claustrophobic situations, (being alone in a jammed elevator and being locked up in a sauna) were used as conditioned stimuli (CS+ or CS-). 5.5% CO2-enriched air was used as the unconditioned stimulus (US).

Subjects were instructed to imagine themselves in the situation depicted by the scripts, while either breathing CO2-enriched air or regular room air.

Three CS+ and three CS- trials were run during acquisition, followed by two CS+ and two CS- only trials.

Respiratory frequency, minute ventilation, end-tidal fractional concentration of CO2 and subjective complaints were measured throughout the experiment.

All measures were affected by the conditioning manipulation. The conditioning effect on complaints was not confined to complaints of general arousal, but included respiratory and cardiac complaints as well.

For dummy complaints no conditioning effect emerged. Frequency and minute ventilation increased, while lower CO2-levels were recorded with CS+ compared to the CS- imagery. The effects seemed strongest when the elevator-script served as CS+. 
The findings have relevance for understanding the psychosomatic complaints observed in agoraphobic anxiety.

NEGATIVE AFFECT, RESPIRATORY REACTIVITY, AND SOMATIC COMPLAINTS IN A CO2-ENRICHED AIR INHALATION PARADIGM.

Omer Van den Bergh, Kris Stegen, and Karel P. Van de Woestijne.
University of Leuven, BELGIUM.

Subjects scoring high on negative affect (NA) are known to report more psychosomatic complaints than Ss scoring low. Although lower pCO2-levels have been observed in high NA and in Ss reporting more psychosomatic symptoms, hypocapnia explains only a small proportion of the variance in complaints, while hypervigilance and a negativistic bias towards bodily sensations is considered of more importance.

In this study (n=72) we investigated the level of psychosomatic complaints in high and low subjects (1) in a questionnaire study and some weeks later (2) in laboratory conditions while inhaling three different gas mixtures (room air, 5.5 % and 7.5% CO2-enriched air), presented in randomized order.

Respiratory frequency, tidal volume, minute ventilation, end-tidal fractional concentration and subjective complaints were measured in the laboratory.

Strong NA-complaints links were found in daily life but these links seemed to disappear in the laboratory setting.

Further analysis revealed important order-of-presentation effects: significant NA related differences were found during room air breathing, but only when it had not been preceded by 7.5% CO2-enriched. Differences in respiratory activity were minor and did not co-occur with differences in complaints.

The pattern of results is most compatible with an attentional direction hypothesis about NA-effects.

USING A PROLONGED EXHALATION BREATHING SOUND AS A TOOL IN STRETCHING OF MUSCLES.

B. H. C. von Schéele and K. Fröjd. Bollnäs, SWEDEN.

Effective breathing strategies may complement treatment of some muscular disorders. Increased effectivity in stretching of the muscles might be predicted to related to the decrease in sympathetic nervous system (SNS) activity due to inhibition of the SNS during exhalation.

In this study, prolonged exhalation while performing a deep sound (a pranayama technique) during stretching was compared with subjects' normal stretching behavior.

Two males and four females (mean age, 32 yrs) participated in ten training sessions. Subjects performed both normal and prolonged exhalations, in balanced order.
We measured hip joint angles, hamstring EMG, vastus medialis EMG, heart rate, respiration, and expired CO2 levels. Respiratory sinus arrhythmia (RSA) was calculated according to the recommendations of Grossman (1983). Subjects judged pre-stretching and stretching pain levels.

Preliminary analyses indicated a difference between normal and prolonged exhalation conditions favoring the experimental treatment suggesting prolonged exhalation during normal respiration might facilitate muscular stretching.

Prolonged expiration may be an effective breathing strategy to complement muscular rehabilitation.

**BREATHING ASSESSMENT AND TREATMENT IN POST-CVA AND NEUROLOGICAL PATIENTS: A CLINICAL APPROACH.**

Janice Webber and Lorie Pierce. Vancouver, B.C., CANADA.

Physiotherapy directed at the restoration of function in post-CVA and neurological patients typically concentrates on the improvement of skeletal movement to assist patients with their activities of daily living.

Often absent is the clinical assessment and treatment of breathing dysfunction as a separate entity or as it contributes to excessive effort during movement training (i.e., breath holding).

This poster describes a one year study of the effect of incorporating biofeedback including breathing therapy into the standard physiotherapy protocol of 5 post-CVA patients and 3 patients with other neurological diseases.

Pre and post psychophysiological measures of breathing note where gains were possible.

Patient results span a continuum from successfully integrating breathing retraining into everyday life and activities to not learning the basic rudiments of breathing retraining in therapy.

Implications for therapy are discussed.

**INDEPENDENT EFFECT OF VENTILATION AND CO2 ON LUNG VOLUMES, DIFFUSING CAPACITY, AND BLOOD FLOW IN HUMANS.**

A. F. Wilson, G. F. Rafferty, and W. N. Gardner. Kings College and Kings College Hospital, UNITED KINGDOM.

There is conflicting information about the independent effect of ventilation and CO2 on gas exchange, pulmonary blood flow, and lung volumes.

We measured total lung capacity (TLC), residual volume (RV), vital capacity (VC), dead space, single-breath diffusing capacity for carbon monoxide (DLCO), and pulmonary
capillary blood flow or cardiac output (Q) by a single-breath constant exhalation method (SensorMedic 2200, Yorba Linda, CA) in 10 normal subjects before and after 3 experimental conditions at a fixed level of voluntary overbreathing (VHV) on an open circuit to end-tidal PCO2 (PETCO2) of about 15 mmHg:
(1) with no added CO2;
(2) with CO2 added to the inspired air to raise PETCO2 to 26 mmHG; and,
(3) with CO2 added to restore PETCO2 back to baseline (approximately 38 mmHg).

After 2 min of VHV, TLC and RV (but not VC or dead space) increased by more than 100% and did not fall until at least 15 min after the end of VHV.

This increase was associated with a change in ventilation (VE) rather than PETCO2. DLCO increased significantly by about 20% and was associated with the increase in TLC. Q also increased by about 20% due largely to hypocapnic alkalosis but there was also a component which was associated with the increased lung volume. Tidal volume did not correlate with the observed increases in Q and DLCO.

PSYCHOLOGICAL ADJUSTMENT TO MECHANICAL VENTILATION IN A LONG-TERM CARE SETTING.

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Ten individuals admitted to a skilled nursing facility who required mechanical ventilation for some portion of their admission were administered the Mechanical Ventilation and Weaning Questionnaire (MVWQ).

The authors developed this self-reported, multiple choice measure for use in the present study. The MVWQ includes questions in areas identified by prior studies as potential stressors for the mechanically ventilated patient. The literature suggests that mechanical ventilation can diminish quality of life and induce secondary psychiatric disorders, which may prolong the course of ventilator support.

Previous studies have been performed in acute-care hospitals.

The patients in the present study were treated in a ventilator weaning unit located in a skilled nursing facility. Our hypothesis was that treatment in this setting would be less stressful than in a hospital.

The patients in this sample continued to report loneliness, sadness, hopelessness, anergia, anxiety, insomnia, fear, and lack of respect from health care providers. These problems often required psychotherapeutic and psychopharmacologic interventions.

In addition to describing the MVWQ as a means of collecting data from respiratory patients, we include strategies for enhancing the psychophysiological function of patients with breathing problems.
MEASUREMENT OF TRANSCUTANEOUS PCO2 AMONG AIR TRAFFIC CONTROLLERS: 
DIFFERENTIAL RESPONDING TO WORKLOAD AND STRESS.

TNO Human Factors Research Institute, THE NETHERLANDS.

Transcutaneous PCO2 (PTCO2) and heart rate (HR) were measured via an ambulatory technique among 18 male military air traffic controllers during two one-hour working sessions.

For each individual subject, the raw data were transformed into z-scores. The standardized data were averaged across successive five-minute blocks. Workload and stressors were assessed for every five minute block by counting the number of aircraft under control and the number of potential conflicts between aircraft.

The results indicate that there were two distinct patterns of responding: (1) HR increased linearly when the workload increased (i.e., number of aircraft), but PTCO2 did not change in response to variations in number of aircraft, and (2) HR similarly increased when the number of potential conflicts between aircraft increased, but additionally, PTCO2 decreased.

It was concluded that among military air traffic controllers, increased workload is associated with an adaptive increase in physiological activity, but that the introduction of stress in the task may induce maladaptive physiological responses, including an increase in ventilation beyond metabolic demands (i.e., hyperventilation).

SPEAKING AND ACTIVATION: 
SPEECH DETECTION BY RESPIRATORY PARAMETERS.

Frank Wilhelm and Walton T. Roth. 
Stanford University and DVAMC, USA.

Since speaking in itself produces physiological activation or arousal, whether a subject is speaking or not must be controlled for in clinical psychophysiology. Under ambulatory conditions we would like to be able to detect speaking from a respiratory channel alone, since auditory recording picks up sources other than the subject's voice.

In a laboratory experiment we tried to establish the adequacy of the Respitrace system for speech detection and to determine parameters that could best indicate speech.

16 patients with anxiety disorders and 19 nonanxious controls were instructed to speak continuously for 4 min, to relax (10 min), to speak again (4 min), and to fill out questionnaires (4 min). 11 parameters were derived from the calibrated Respitrace signal for the last 3 min of each task.

Variability was indicated by their coefficients of variation (CV%). Additionally, heart rate (HR), skin conductance level (SCL), and non-specific fluctuations (NSF) were analyzed. Inspiratory/expiratory time (IE-ratio) best distinguished the initial speaking from writing with 96.9% correct classifications at a cutoff criterion of 0.54.
This criterion was also successful in distinguishing speaking from relaxing (97.0% correct), although indicators of variability in timing (CV% of IE-ratio, expiratory time, and respiratory rate) yielded higher discriminability.

Discriminant analyses supported this criterion and suggested the inclusion of variability and volume parameters for a better classification, but discriminant functions did not generalize well across conditions. NSF was higher during speaking than writing (p < 0.02); additionally HR, SCL, and ML were higher during speaking than relaxing (p's < 0.001).

These results show the efficacy of a single parameter (IE-ratio) for speech detection, one which does not require volume calibration.

BREATHING AND BIOMECHANICAL INDICES OF MUSCULOSKELETAL STRAIN IN REPETITIVE COMPUTER WORK.

Lawrence M. Schleifer, Ronald Ley, and Christopher Pan. University of Maryland, University at Albany, SUNY, and National Institute for Occupational Safety and Health, USA.

Ergonomic models of musculoskeletal strain in computer work have focused primarily on biomechanical indices (e.g., key force, keystroke repetition, work posture); relatively little attention has been given to psychophysiological indices (e.g., hyperventilatory responses to mood disturbances). This report explores the relationship between psychophysiological and biomechanical factors with right-hand musculoskeletal strain in 47 data-entry computer workers.

Self-ratings of right-hand musculoskeletal strain (i.e., discomfort, pain, stiffness, or soreness), boredom, and fatigue were taken during prolonged periods of data-entry work during each of three consecutive workdays. End-tidal PCO2, key force, and keystroke repetition were monitored on a continuous basis.

An examination of changes in these measures indicates consistent increases in right-hand musculoskeletal strain within each of the three workdays.

In addition, there was a corresponding pattern of psychophysiological strain, as characterized by increases in boredom and fatigue and decreases in end-tidal PCO2 (i.e., hyperventilation) within each of the three workdays. However, there was no consistent pattern of increases in key force or keystroke repetition.

These results suggest that the psychophysiological demands (i.e., chronic mild hyperventilation) of mood disturbances attendant to repetitive computer work are associated with right-hand musculoskeletal strain.

It is proposed that ergonomic models of musculoskeletal strain in repetitive computer work should be expanded to include psychophysiological stress factors in addition to conventional biomechanical stress factors.
RESPIRATORY AND PSYCHOPHYSIOLOGICAL STRATEGIES
IN THE TREATMENT OF STAGE FRIGHT.

Doe Lang. New York, N. Y., USA.

Most people breathe between 12 and 18 breaths a minute; higher frequencies are a sign of stress, predictive in the long term of distress and illness.

Breathing 11 breaths per minute not only reduces anxiety, but produces an alert, highly intuitive state ideal for optimum functioning in normally stressful public, or private, situations.

Surveys show some people are more afraid of public speaking than anything else. Stagefright hits most of us at some point, and can be not only highly upsetting but damage careers and self-esteem.

In addition to cognitive strategies, one of the most effective antidotes and preventives is a 3-stage breathing process based on the yogi Whole Body breath. I liken this to the evolution of the computer: first room-sized, then table model, and finally the micro-chip.

The Whole Body Breath, taught to people lying on the floor, creates a deep sense of relaxation and well-being. Later, seated in a chair, the clients learn to do two contradictory things simultaneously; beginning with the lower abdomen, expanding the rib cage while still inhaling they then maintain the lifted rib cage instead of collapsing while exhaling.

This remarkable breathing pattern enables anyone to be at ease in any situation.

Hypercapnia Induced Air Hunger

Robert Banzett
Harvard School of Public Health and Harvard Medical School

Abstract pending.

TOWARDS IDENTIFYING SUBTYPES OF PANIC USING RESPIRATORY AND PSYCHOPHYSIOLOGIC FACTORS:
A PRELIMINARY INVESTIGATION.

Jayne E. Moynihan and Richard N. Gevirtz.
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Emerging theories of panic disorder are attempting to account for apparently contradictory findings in the literature, moving beyond a unidimensional model of panic and proposing subtypes that are based on discrete panic symptom clusters.

Relying primarily on the work of Ley and of Klein, a study is underway to validate empirically these theories.
Subjects are evaluated on a variety of psychophysiologic measures, including levels of exhaled carbon dioxide.

Subjects are evaluated during periods of calm, psychological stress, and physiologic stress.

Preliminary results were presented, including symptom profiles of several subjects, demonstrating evidence for the proposed subtypes.

In addition, a preliminary analysis of carbon dioxide levels showed a significant difference between the two types being investigated at this time.

**PSYCHOSOMATIC COMPLAINTS, ANXIETY AND HYPERVERVENTILATION: A CRITICAL EVALUATION.**

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TNO Human Factors Research Institute, THE NETHERLANDS.

There is still much controversy about the role of breathing-related factors in the symptomatology of hyperventilation syndrome (HVS) and panic disorder (PD).

Some regard hyperventilation as a necessary condition for the typical symptoms to develop. Others maintain that symptomatic episodes are primarily associated with enhanced tendencies of distressed individuals to focus their attention upon bodily sensations, and to appraise these in a catastrophic manner. Neither position seems completely tenable.

Much of the controversy may be due to a failure to recognize that symptom formation may be associated with multiple (biological and/or psychological) influences, which might play different roles for different subgroups of patients.

This is illustrated by data from a large subject pool (n = 162). Analysis of the individuals within the highest quartile of psychosomatic symptom scores (n = 40) revealed that on the basis of the trait anxiety (TA) scores and end-tidal PCO2 levels, four subgroups could be distinguished: (1) 35% of the symptom reporters had high TA scores as well as subnormal PCO2 levels, (2) 30% had high TA scores but normal PCO2 levels, (3) 22.5% had normal TA scores but subnormal PCO2 levels, and (4) 12.5% had normal TA scores as well as normal PCO2 levels.

Based on these findings, it is argued that current research may be too strongly focussed on investigating cross-sectional differences between diagnostic groups.

This approach may suffer from two weaknesses:
1) it uncritically assumes that DSM-IV diagnostic criteria should correlate with distinct psychophysiological phenomena; and,
2) it impedes the development of useful psychophysiological grouping criteria that are based on patterns of relationships between symptomatology, psychological factors and physiological measures in individual patients.
PLACEBO-CONTROLLED VALIDATION OF THE HYPERVENTILATION-PROVOCATION TEST: IS THERE A HYPERVENTILATION SYNDROME?

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Hyperventilation is considered an important factor in the production of a variety of somatic symptoms, the Hyperventilation Syndrome (HVS). There is uncertainty on the validity of HVS, stemming from doubts on the validity of the hyperventilation provocation test (HVPT) and findings using the novel technique of ambulant transcutaneous PCO2 (PtcCO2) monitoring.

The present study combined both lines of research and aimed to answer the question: is there an HVS?

In a randomized double-blind cross-over design, 115 patients suspected of HVS and 40 healthy controls performed an HVPT and a control test (CT, isocapnic overbreathing).

Positive results on the HVPT (recognition of induced symptoms) were obtained in 74% of the patients. Of these positively diagnosed HVS patients, 66% also recognized symptoms during the CT (false positives) while 34% behaved as could be expected according to the HVS concept, i.e. positive on the HVPT and negative on the CT (possible true positives).

However, possible true positives did not differ from false positives and negatives on type or intensity of spontaneous symptoms, or physiological HVS criteria (low resting PetCO2 and slow recovery after voluntary hyperventilation).

Healthy subjects had much lower symptom scores, and seldom recognized symptoms during the tests. However, they met physiological HVS criteria as often as patients.

Thirty HVPT positive patients were tested further to assess hyperventilation during spontaneously developing symptom attacks (the golden standard). In 7 of 22 registered attacks, PtcCO2 (mildly) decreased, but apparently following the onset of the attack, suggesting that hyperventilation is a consequence rather than a cause of the attack. There were no group differences.

LEARNING TO HAVE PSYCHOSOMATIC COMPLAINTS.

Omer Van den Bergh, Kris Stegen, and Karel P. Van de Woestijne.
University of Leuven, BELGIUM.

Hyperventilation (HV) produces uncomfortable sensations and psychosomatic symptoms, which may be experienced in a certain situation.

Hyperventilation episodes may be construed as a Pavlovian learning situation in which environmental cues can be considered conditioned stimuli (CSs) and the respiratory challenge as a US.
Assuming that CO2-inhalation produces sensations that to some extent mimic the experience of a real HV-episode, we investigated the learning effects in a series of experiments using 7.4% CO2-enriched air inhalation as the unconditioned stimulus (US) and odors as CSs.

Overall, the results showed:
(1) increased respiratory behavior and psychosomatic complaints in CS+ Only trials;
(2) a selective association effect in that conditioning was only apparent with ammonia as a CS+Odor and not with niaouli;
(3) no generalization of respiratory responses and complaints to new odors;
(4) no conditioning effect on dummy complaints that had not reported when inhaling CO2.

In one experiment, the subjects attentional involvement with processing the complaints during acquisition was manipulated without interfering with the contingency awareness.

The results showed that the complaints during testing were based on an activated memory representation of the complaints during the acquisition phase and not on the somatic responses during the test phase.

A NEW APPLICATION OF CAPNOGRAPHY IN THE FIELD OF FATIGUE.

P.G. F. Nixon. Charing Cross Hospital, UNITED KINGDOM.

This demonstration enabled members to watch the respiratory response to the anaerobic threshold recorded in volunteers.

The equipment consisted of a capnograph, with a high-amplitude chart recorder, drawing air from the dominant nostril in order to identify the point where the acidemia of exercise caused the PETCO2 level to fall from its upslope or plateau.

A rapidly-incremental exercise protocol was employed using a standard bicycle ergometer. The first point noted was the ease and simplicity of this low-cost, non-invasive technique as compared with the complexity of the interventions in a conventional sports physiology laboratory. The technical side was managed competently by staff with one morning's training.

The high-amplitude recorder provided the clear-cut identification of the respiratory responses to acidemia: on occasions when transient gasping did cause interference, the end-point was obtained by extrapolating the lines of best fit from the upslope or plateau and the downslope response.

The respiratory response to the anaerobic threshold is higher in athletes than in sedentary, non-exercisers or in exercise-avoiding people.

It is lowest among those with depletion of the body's alkaline buffering reserves, produced by breathing in excess of metabolic needs over long periods of time, most commonly in response to effort and distress linked with failure of adaptation and coping, associated with hypersensitivity of the sympathetic nervous system.

The technique presented here is simple enough to be used widely to identify a valuable marker of widespread homeostatic incompetence and, consequently, disease.
A STUDY OF ANAEROBIC THRESHOLD IN
CHRONIC FATIGUE SYNDROME (CFS).

P. G. F. Nixon and John Andrews.
Charing Cross Hospital, UNITED KINGDOM.

The anaerobic threshold is reduced when the alkaline buffering systems are depleted, most commonly by breathing in excess of metabolic needs over a long period of time.

Vicious circles are established because academic hyperpnoea occurs at low levels of physical activity, and the sleep is disturbed by nocturnal acid-base shifts.

Muscular aching at low levels of effort; restlessness and heightened sympathetic activity; increased neuronal sensitivity; and, constriction of smooth-muscle tubes (e.g., the vascular, respiratory and gastric-intestinal) can accompany the basic symptom of inability to make and sustain normal levels of effort.

Recovery depends upon due attention to the restoration of proper sleep, the modulation of arousal, the recovery of natural breathing, a salutary balance of rest and effort, and the subject’s achievement of self-regulation and autonomy (the SABRES strategy).

The method appears unconventional to the sports physiologist but to the clinician it provides an inexpensive, simple and technically affordable access to a vital assessment for use in clinical diagnosis and the monitoring of rehabilitation.

Unlike the finding in athletes, the onset of the respiratory response is rarely too shallow or noisy for identification: if required it can be found by extrapolating the lines of best fit from the upslope or plateau to the downslope.

Mischievous hyperventilation spoiling the result was not recognized in the earnest individuals with the effort syndrome variety of CFS (ref: An appraisal of Thomas Lewis's effort syndrome, QJ Med. 1995;88:741-747).

These would exhaust themselves before quitting. In their morbid condition they would have been glad to achieve the threshold levels found in either sedentary, non-exercisers and exercise-avoiding people.