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ABSTRACTS OF CURRENT AEROMEDICAL LITERATURE

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I ACCELERATION PHYSIOLOGY

1. Physical training and +Gz tolerance re-evaluated

The effect of physical training on +Gz tolerance is of vital interest in the aerospace community. The data on the effect of physical training on orthostatic tolerance or simulated air combat manoeuvres are equivocal. The effects of aerobic and strength training programme are briefly reviewed. The data suggest a need for careful reinterpretation of results in the light of conflicting reports and methodological shortcomings. Aerobic training cannot be assumed to always be detrimental nor can strength training be assumed to be universally effective in improving +Gz tolerance. In selecting appropriate screening criteria and training regimens for aircraft personnel, it seems prudent to reinvestigate strength and endurance training effects on +Gz tolerance using multivariate research paradigms. Special attention should be directed to commonly accepted physiological principles which may vary under conditions of altered gravity.

Bulbulian R: Aviat Space Environ Med 57(7):709, 1986.

2. Women's G Tolerance

G tolerance of 102 women and 139 men subjected to standard medical evaluation (Medeval) G profiles were compared. Unpaired test revealed no significant difference between the women and men in either relaxed or straining G tolerance. Covariance analysis controlling for differences in tolerances due to age, height, weight and activity status revealed the women to have marginally low tolerance; the analysis also identified height as a factor having a strong negative influence on G tolerance, and weight as having a positive influence. When the women were matched only by height to men in the comparison group, the women's mean G tolerances were significantly lower than the men's. On standard training G profiles, 88% of 24 women and 80% of 213 men completed the runs, but this difference was not significant. G tolerances of 47 women were measured on the medeval profiles both during and between menses, but no significant differences between women and men in the signs or symptoms of G stress were observed, except for two instances of urinary stress incontinence in women, during the training profiles. Women need not categorically be excluded from aircrew duties due to G intolerance.

Gillingham K, Schude C, Jackson W and Giltrap L: Aviat Space Environ Med 57(8):745, 1986.

3. Acceleration tolerance of asymptomatic aircrew with mitral valve prolapse

Using the USAF School of Aerospace Medicine human centrifuge, 78 asymptomatic USAF aircrewmembers with auscultatory and/or echocardiographic evidence of mitral valve prolapse (MVP) were evaluated for tolerance to +Gz stress. Both rapid (1 G/s) and gradual (1 G/15s) onset acceleration profiles were used to determine +Gz tolerance. There were no unusual characteristics, among the clinical parameters measured, which allowed separation of individuals with MVP into subgroups with altered +Gz tolerance. The MVP group was found to have a normal response to gradual onset +Gz stress, both while relaxed and when performing a protective straining manoeuvre. A small but statistically significant decrease in tolerance to rapid onset +Gz stress was found. There was no indication that asymptomatic individuals with MVP who have undergone complete aeromedical evaluation have any operationally significant intolerance to +Gz stress.

Whinnery JE: Aviat Space Environ Med 57 (10): 986, 1986.

II AVIATION OPHTHALMOLOGY

4. Mild hypoxia and visual performance with night vision goggles

Military night vision goggles

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(NVGs) are image intensifiers normally used when the human operators' visual capabilities are unimpaired by oxygen deprivation. However, mountain search team members and aviators sometimes operate with NVG augmentation at altitudes where hypoxic visual decrement is documented. The objective of this research was to investigate the effects of mild hypoxia on monocular visual performance with NVGs. It was found that mild oxygen deprivation significantly affects unaided square-wave grating visual acuity but does not significantly affect NVG augmented performance. Large differences between visual sensitivities at different spatial frequencies were not differentially affected by mild hypoxia. Supplemental oxygen did significantly improve naked eye but not NVG-augmented night resolution acuity upto a simulated altitude of 13,000 ft (3,962 m) above sea level (ASL).

Lober LL, Roscoe SN, Southward GM: Aviat Space Environ Med 57:318, 1986.

5. The colors of things

Stating that current theories of colour vision do not sufficiently explain the many "illusions" one perceives, the authors argue that this fact reveals the unconventional design of colour vision, rather than any fallibility of the senses or "defects" in visual processing. The authors champion the notion that perceived colours of things do not depend on light from each object sensed independently of all other things in the world but on a comparison of light reflected from an object and its surroundings. They detail some experiments to substantiate the

hypothesis. Colour like beauty is after all, in the eye of the beholder.

Bron P, Sciascia TR, Linders L and Lettun JY: Scientific American 255(3): 80, 1986.

6. The perception of apparent motion

Apparent motion (cf real motion) is defined as the illusion of motion created when a series of still images are rapidly presented to the human visual system. The authors describe experiments to show that perception of apparent motion is a visual function, with the brain matching the successive images for changes in spot/area brightness patterns. This matching is also "limited" by real world expectancies and/or experiences. The authors describe a set of perception rules that are closely allied to the laws of motion. Their experiments/investigations suggest that lower level visual processes can on their own control perception of apparent motion during the early stages of visual processing. They conclude that cellular events leading to visual processing will need further elucidation.

Ramachandran VS and Antis SM: Scientific American 254(6):80, 1986.

III BEHAVIOURAL SCIENCES

7. The effect of skill on performance under an environmental stressor

This paper examines the effect of individual skill level upon task perfor-

mance in transient extreme heat. A summary of published data suggests that individual who are skilful at the task are better able to withstand the detrimental effect of the stress exposure than their unskilled counterparts. Three theoretical explanations of such performance superiority are reviewed - behavioural arousal, attentional capacity and automatic and controlled processing. It is concluded that the automatic and controlled information processing approach holds the greatest potential to account for this effect at the present time. It is suggested that the ability of skilled subjects who are able to resist the effect of heat stress may be a more general attribute of personnel who operate under a variety of nonoptimal environmental conditions.

8. Nocturnal sleep and daytime alertness of aircrew after transmeridian flights

The nocturnal sleep and daytime alertness of aircrew were studied by electroencephalography and the multiple sleep latency test. After a transmeridian flight from London to San Francisco, sleep onset was faster and although there was increased wakefulness during the second half of the night, sleep duration and efficiency over the whole night were not changed. The progressive decrease in sleep latencies observed normally in the multiple sleep latency during the morning continued throughout the day after arrival of the 13 subjects, 12 took a nap of around 1-h duration in the afternoon preceding the return flight. These naps would have been encouraged by the drowsiness at this time and facilitated by

the departure of the aircraft being scheduled during the early evening. An early evening departure had the further advantage that the circadian increase in vigilance expected during the early part of the day would occur during the latter part of the return flight.

Nicholson AN, Pascoe PA, Spencer MB, Stone BM and Green RI: *Aviat Space Environ Med* 57:B42, 1986.

9. Hangover effects on aircraft pilots 14 hours after alcohol ingestion - a preliminary report

The authors had 10 Navy pilots fly two simulated flights under control and hangover conditions. For the former, pilots drank no alcohol within 48 h before the simulated flight. For the latter condition, they flew 14 h after drinking enough ethanol mixed with diet soft drinks to attain a blood alcohol concentration of 100 mg/dl. Pilot performance was worse in the hangover condition on virtually all measures but significantly worse on three of six variance measures and one of six performance measures. The results indicate that caution should be exercised when piloting an aircraft 14 h or less after ingesting similar quantities of alcohol.

Yesavage JA and Vleirer VO: *Am J Psych* 143:1546, 1986.

IV. BIODYNAMICS

10. Contribution of aeromedical research to flight and biomedical science

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Pilot and plane capabilities to withstand high-Gz combat manoeuvres are tactically important. Sustained 10-15 Gz capabilities of current and future planes outstrip safe physiologic limits in spite of the combined use of World War II-vintage straining manoeuvres and relatively ineffective anti-G suits to prevent losses of vision and consciousness. However, the extreme arterial pressure increases needed to maintain cerebral blood flow (e.g., 400 mm Hg at heart level during exposures to 13.5 G when sitting upright) carry risks of anatomic damage to the circulatory system and rupture of air-containing, essentially unprotectable, lungs. These could be minimised, and incapacitating losses of consciousness avoided, by use of horizontal positions designed to eliminate heart-to-head hydrostatic gradients. Development of a prone-position cockpit with a counterweighted, forward-looking head support plus optical-electronically aided all-directional visibility is the most physiologic, safest, and surest way to achieve this goal.

Wood EH: *Aviat Space Environ Med* 57(10, Suppl): A 13, 1986.

11. Biodynamics - the key to flight

Biodynamics measures the effects of mechanical force on living tissues. The quantitative relations of mechanical stress factors and biological strain responses of the living body provide criteria for limits of injury threshold, reversible injury, permanently disabling injury, and fatal injury. These criteria are guidelines for aerospace design and performance standards involving human survival in the

environment of flight. Below these limits, the effects of mechanical force factors on human performance while acutely or chronically exposed to them in aerial or space flight are crucial. Some can be accumulatively disabling; others can be adapted to over a period of time.

Extremes of low-frequency vibration cannot be long endured, while sustained zero gravity in space flight produces mild, transient malaise followed by adaptation in several hours. Aerospace flight biodynamics deals with human reaction to (1) absence of gravity; (2) sustained curvilinear acceleration; (3) sustained acceleration and deceleration (launch and reentry in space flight); (4) single impact force (collisions); (5) low frequency vibration in the whole human body resonance response range; (6) whole-body tumbling and spinning, as in high-altitude free-fall; (7) acoustical range vibrations; (8) explosive blast in air or water; (9) abrupt decompression, as in cabin pressure failure; (10) static forces in tension, compression, torsion and shear. Biodynamic stress analysis takes into account whole-body responses, particular responses of rigid bone, viscous elastic soft tissues, pneumatic and hydraulic effects of gas and fluids in hollow organs, and displacements of solid organs suspended in body cavities. Accurate and comprehensive results require physical measurements, clinical and laboratory studies before and after exposure, subjective reports of trained volunteer subjects, and objective medical and bioengineering evaluation of results. From these results come standards for tolerance and exposure limits, inventions and procedures to overcome limits, enhance performance, or

provide protection from the hazards of flight. Biodynamic research projects are justified by new military requirements, coping with unanticipated problems of flight, development, and man-rating of devices and systems in advanced designs and prototype stage of development of aircraft. This serves both military and civil aviation, where new models derive from military prototypes.

Stapp JP: Aviat Space Environ Med 57(10, Suppl):A 32, 1986.

12. Flight simulation

The author details the use of state of art simulators for fighter training. Stating that simulators can prove a cost effective answer to spiralling costs of training, he feels that they should attain an improved degree of resolution/realism. Describing the mechanisms behind the creation of a simulated moving image, Board models or Computer Generated Imagery (CGI), he states their respective strengths and weaknesses. The use of simulators as a very useful human factors research tool is highlighted.

Haber RN: Scientific American 255(1): 90, July 1986.

V CLINICAL AEROSPACE MEDICINE

13. Frequency of extrasystoles in healthy male employees

147 actively employed men between

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the ages of 15 years and 65 years form the subjects of this study. They were screened thoroughly to exclude IHD and only risk factor for coronary artery disease permitted was the age. All the subjects were evaluated with 24 hr continuous electrocardiographic recordings by Holter technique. They were followed up for a period of six years. Two subjects expired during this period of follow up; though both of them had high frequency of ventricular ectopics, death was not due to cardiovascular disease. Analysis of recorded electrocardiograms showed 95% of men between the ages of 15 and 39 years had less than 2.9 ventricular ectopics per hour. A similar percentage of men aged 40 years or above showed presence of significantly higher frequency (<36 ventricular ectopics) per hour. The authors feel that ventricular ectopics occurring more frequently than 10 per hour in men aged 40 years or above may be considered the cut off point from "normalcy".

Orth-Gomer K, Hogstedt C, Bodin L and Soderholm B: Brit Heart J 55:259, 1986.

14. Radiation of anginal pain to the legs

Radiation of retrosternal angina to arms, neck and back has long been recognised as diagnostic feature of coronary artery disease and myocardial infarction in clinical medicine. Angina due to CAD also radiate to the epigastrium and rarely to hypogastrium especially in cases of diaphragmatic wall and true posterior wall infarctions. Radiation of this pain to the legs is certainly an uncommon entity. The authors report 19 cases of chest pain

due to coronary artery disease who had complaints of pain in the legs. None of them had any local neurovascular disorder to account for the pain in the legs. The mechanism of this radiation of angina to legs is postulated to be due to presence of sensory ganglia. The site of this referred pain was limited to the front of the leg and four inner toes which have innervation from the lumbar sympathetic ganglia.

Kolletis MT, Kalageropoulos CK, Tzannetis GC, Vitakis SK, Xaplantheris PP and Novas IO: Brit Heart J 55:211, 1986.

15. Cardiovascular epidemiology, exercise and health : 40 year follow up of the U.S. Navy's "1000 Aviators"

The interrelationship of ageing, performance, and stress modification has been the subject of investigations in the US Navy. Beginning in 1940, a study of 1056 student and instructor pilots lowered previously high attrition rates in training by emphasising both physical and psychological screening. After World War II, when 208 pilots in the group died, follow up studies of the survivors were conducted in 1951, 1957, 1963, 1969-71, 1977 and 1980-81. In February 1981, 715 questionnaires were mailed to known survivors, with 500 replies subsequently analysed. Additionally, 114 of the respondents who had previously been examined during 1969, were again examined in 1980-81; those individuals were markedly different in their lifestyle, particularly in exercising regularly, abstaining from cigarette smoking and drinking alcoholic beverages moderately, as contrasted to 28 aviators also examined in

1969 who died in the interim. Healthy lifestyle may alter cardiovascular risk preventing premature death.

York E, Mitchell RE and Graybiel A: *Aviat Space Environ Med* 57:597, 1986.

16. Low back pain in pilots

A questionnaire on low back pain (LBP) was administered to 373 fighter pilots, 165 transport pilots, and 264 helicopter pilots. Helicopter pilots had more back pain during flight than did fighter or transport pilots (34.5%, 12.9% and 5.1% respectively). A history of LBP temporarily unassociated with flight was found in 26.5% of helicopter pilots, 31.5% of transport pilots and 25.2% of fighter pilots. We conclude that, despite the pain experienced by helicopter pilots in flight, they are not at increased risk for LBP unassociated with flight.

Froom P, Barzilay J, Caine Y, Margalio S, Forecast D and Gross M: *Aviat Space Environ Med* 57(7):694, 1986.

VI ENVIRONMENTAL PHYSIOLOGY

17. Influence of profuse sweating on systolic time intervals

Systolic time interval (STI) estimation is an useful bedside method of cardiac function evaluation. The procedure is simple, repetitive and being non invasive is easily acceptable to the patients. However several extracardiac factors often influence the result and produce false evidence of cardiac dysfunction. The authors have studied

21 subjects with STI estimation before and after sauna bath and found out that excessive sweating associated with sauna bath had resulted in significant increase in PEPC, Q-I time and PEP:ET ratio and a significant decrease in (I-II) time and ETc. Thus STI is influenced by an extracardiac factor like profuse sweating. This fact should be borne in mind when systolic time intervals are measured at high temperature and high humidity, in febrile patients and in subjects who have been exercising vigorously.

Ishikawa M and Ishikawa K: *Brit Heart J* 56:176, 1986.

18. Changes in left ventricular ejection time based cardiac output in pilots and non-pilots during orthostatic stress

Heart rate, blood pressure, cardiac output and stroke volume calculated from left ventricular ejection time were studied in 9 pilots and 11 non-pilots during 20 min of 70 deg head up tilt. Stroke volume and cardiac output indices fell by about 38% and 17% respectively during tilt in spite of normal reflex response of heart rate and blood pressure.

The reflex heart rate and blood pressure response to orthostatic stress given by 70 deg head up tilt is not significantly different in pilots and non-pilots.

The subjects responded to head up tilt with a rise in heart rate and diastolic blood pressure. There was no change in systolic BP. This was the normal response expected of head up

tilt. There was no difference in the two groups of subjects. So the special environment of flight to which fighter pilots are routinely exposed to does not alter their cardiac output response to orthostatic stress. Other factors must be responsible for their better tolerance of orthostatic stresses of flight.

Dikshit MB, Banerjee PK, Rao PLN and Iyer EM: *Ind J Med Res* 83:301, March 1986.

ERGONOMICS

19. Human performance issues in the design of future Air Force Systems

For future Air Force systems, the question is not whether to introduce automation, but rather what to automate and how to implement it to optimise the use of human and system resources. There is a continuum of levels of automation ranging from the straightforward use of integrative displays of existing information to replacing human operators with robots. This paper is concerned not with automation decisions per se, but with the design and analysis questions relating to human performance that are raised by these various levels of automation. At the simplest levels one is concerned with the design of integrative displays for direct interpretation by the crew. At intermediate levels one is concerned with the design of interfaces to the expert systems that are providing recommendations to the crew. At the level of robotics there are issues concerning scope and depth of supervisory control that the

crew should provide. Although AMRL has been addressing such issues for many of the last 50 years, the need for analytic approaches, for integrative theories, and for cost-effective empirical evaluation tools has never been greater.

Pew RW: *Aviat Space Environ Med* 57(10, Suppl):A78, 1986.

20. Light stress and the cardiovascular system: the glare pressor test

The effects of an impulsive glare of 4100 lx intensity upon the cardiovascular system are investigated in 22 normal males aged 25-40 years. This was part of a battery of reactive tests which included exposure to 90 dB noise and the cold pressor test. The blood pressure responses to glare were normally distributed. The maximum rise and mean change in both systolic and diastolic blood pressure differed very significantly from the immediately preceding baseline values. The maximal blood pressure response during glare did not differ significantly from that during exposure to noise or cold. Glare, however, elicited a significantly greater mean change in both systolic and diastolic blood pressure compared with noise. It is concluded that exposure to an impulsive glare of car headlight intensity is stressful and can evoke a hypertensive response in normal subjects. The prognostic significance of this glare pressor test should be prospectively studied. This test may be particularly useful as a screening procedure for identifying cardiovascular hypersensitivity to light stress among exposed groups, notably drivers, who are reported to be

overrepresented among victims of cardiovascular disorders.

Belkic K: *Ergonomics* 29(4):563, 1986.

21. The effects of lunch on cognitive vigilance tasks

An experiment was carried out to investigate the effects of lunch on cognitive vigilance tasks. Subjects who ate lunch prior to testing detected fewer targets in a paced, successive comparison task, but did not show impaired performance on a proportion perception task. The experiment also demonstrated some differences between morning and afternoon performance in subjects who abstained from eating lunch. This shows that performance changes observed in the early afternoon may be attributed to at least two components. The first of these is meal-dependent, whereas the second is endogenous, and occurs even if lunch is not consumed.

Smith AP and Miles C: *Ergonomics* 29(10):1251, 1986.

SPACE MEDICINE

22. Immunological analyses of US Space Shuttle crew members

We have previously reported changes in the immunoresponsiveness of T-lymphocytes following space flight. Additional data collected before and after 11 shuttle space flights show that absolute lymphocyte numbers, lymphocyte blastogenic capability, and eosinophil

count in the peripheral blood of crewmembers are generally depressed post-flight. These responses resemble those associated with physical and emotional stress and may not be related to flight per se. Additional data from Space Shuttle flights 41B and 41D, involving 11 crewmembers, indicate a postflight fall in cells reacting with B-lymphocyte and monocyte monoclonal antibody tags. Further, the loss of T-lymphocyte blast capability interacts with the decreased monocyte count. This finding implies that the previously reported loss of blastogenic capability may be a function of decreased monocyte control, as noted in several non spaceflight related studies.

Taylor GR, Neale LS and Dardano Jr: *Aviat Space Environ Med* 57:213, 1986.

23. Sudden emesis following parabolic flight maneuvers: implications for space motion sickness

Episodes of emesis unaccompanied by the usual prodromal signs of motion sickness have been reported by Space Shuttle crewmembers. These suggest that space motion sickness has different characteristics from terrestrial motion sickness. This study presents evidence from parabolic flight experiments that sudden vomiting can occur in response to a provocative vestibular stimulus even when no premonitory symptoms are being experienced. Accordingly, in chronic exposure conditions, the absence of prominent signs or symptoms of motion sickness does not necessarily mean an absence of sensitization.

Lackner JR and Graybiel A: *Aviat Space Environ Med* 57:343, 1986.