

# Investigation of the effects of exercise on the changes in arterial oxygen saturation and psychomotor performance seen during moderate hypoxia



*Matthew Greenfield*



# Hypoxia

- Decreased partial pressure of oxygen in the atmosphere
- Inadequate oxygen supply to the tissues
- Slow decompression or Rapid decompression



# Hypoxia

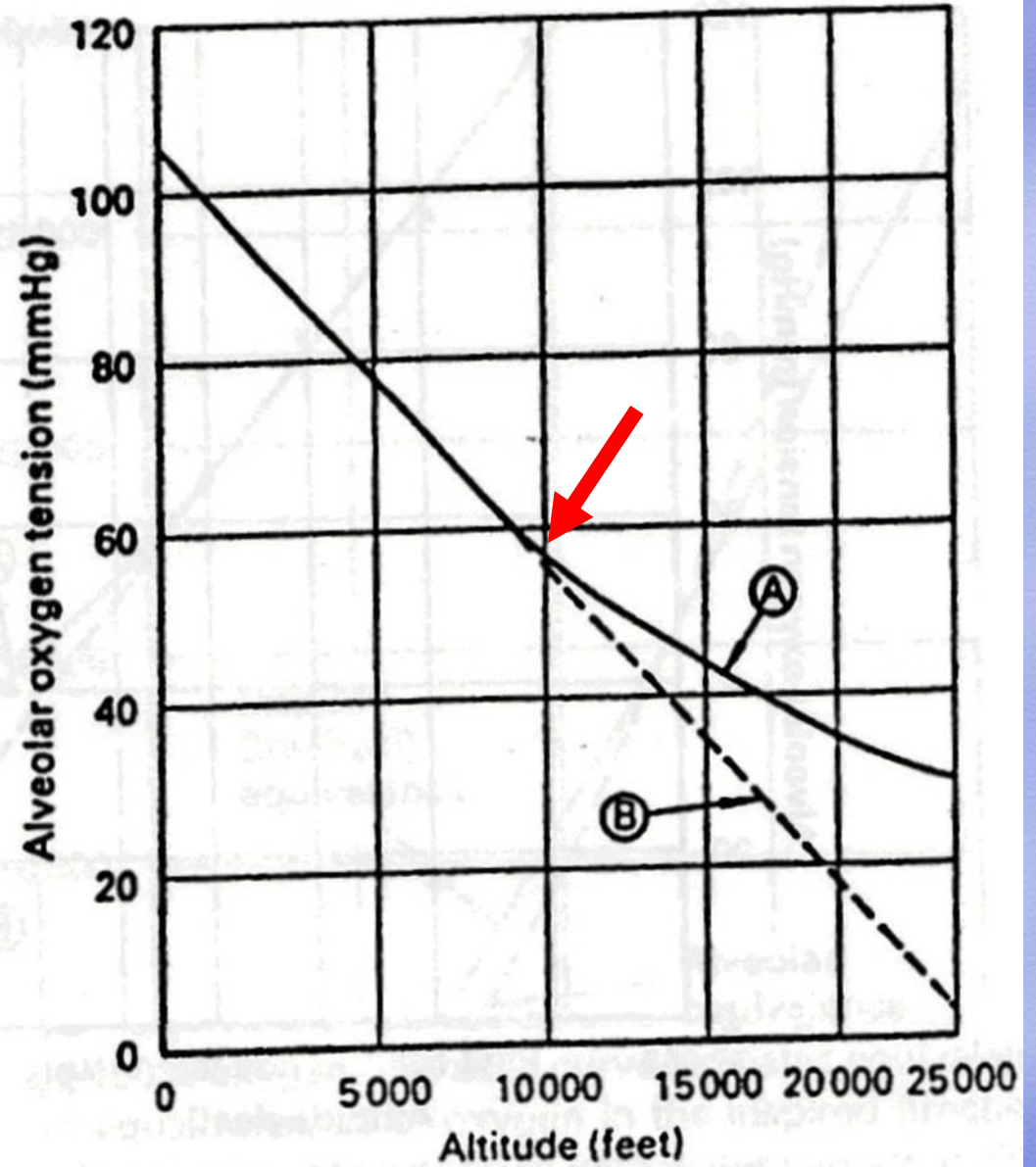
- Impaired novel task performance at and above 5,000ft

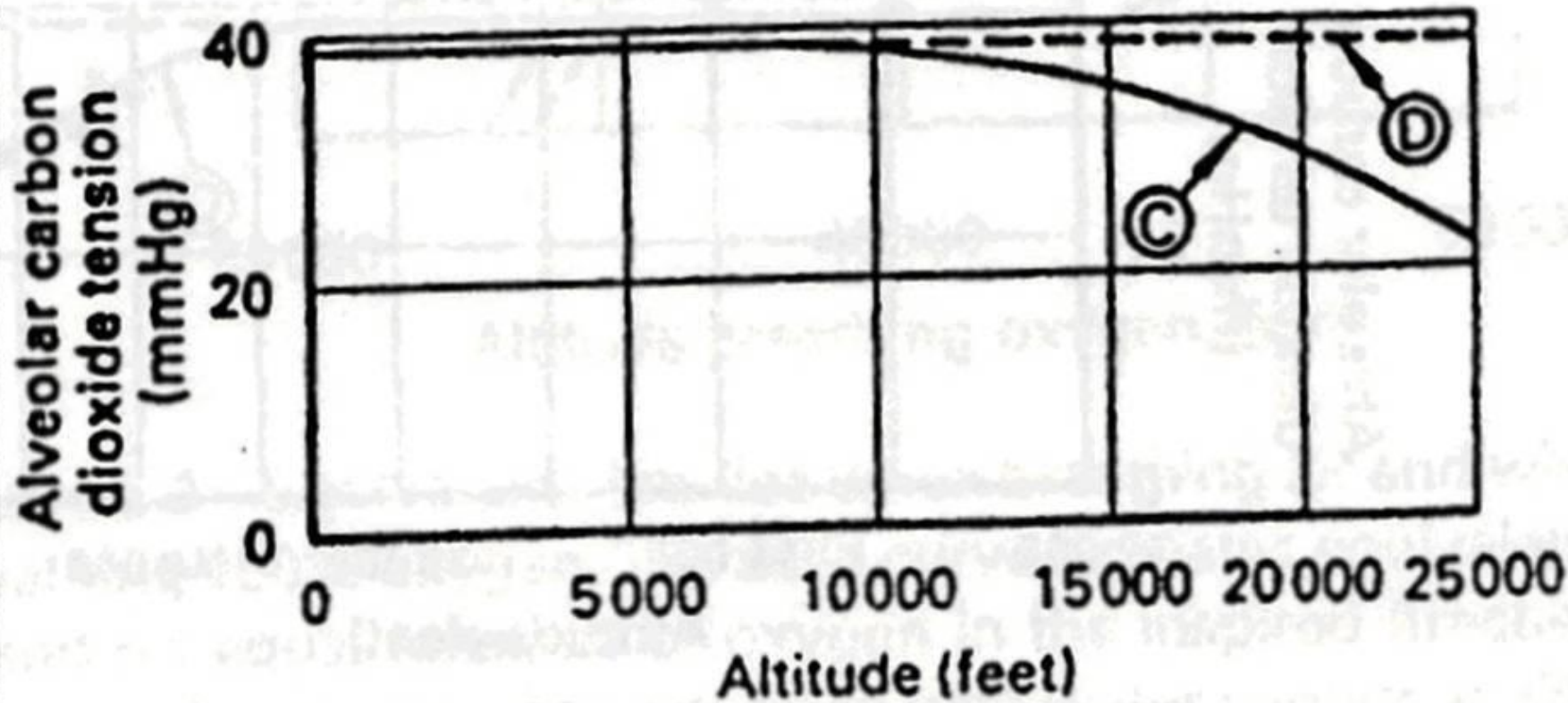
## Above 10,000-15,000 feet:

- Prolonged reaction times
- Impaired performance
- Euphoria
- Decreased self criticism



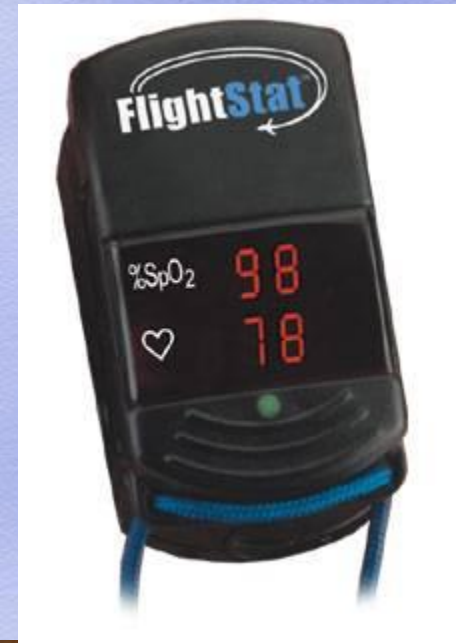
- Hyperventilatory response





# Pulse oximeters

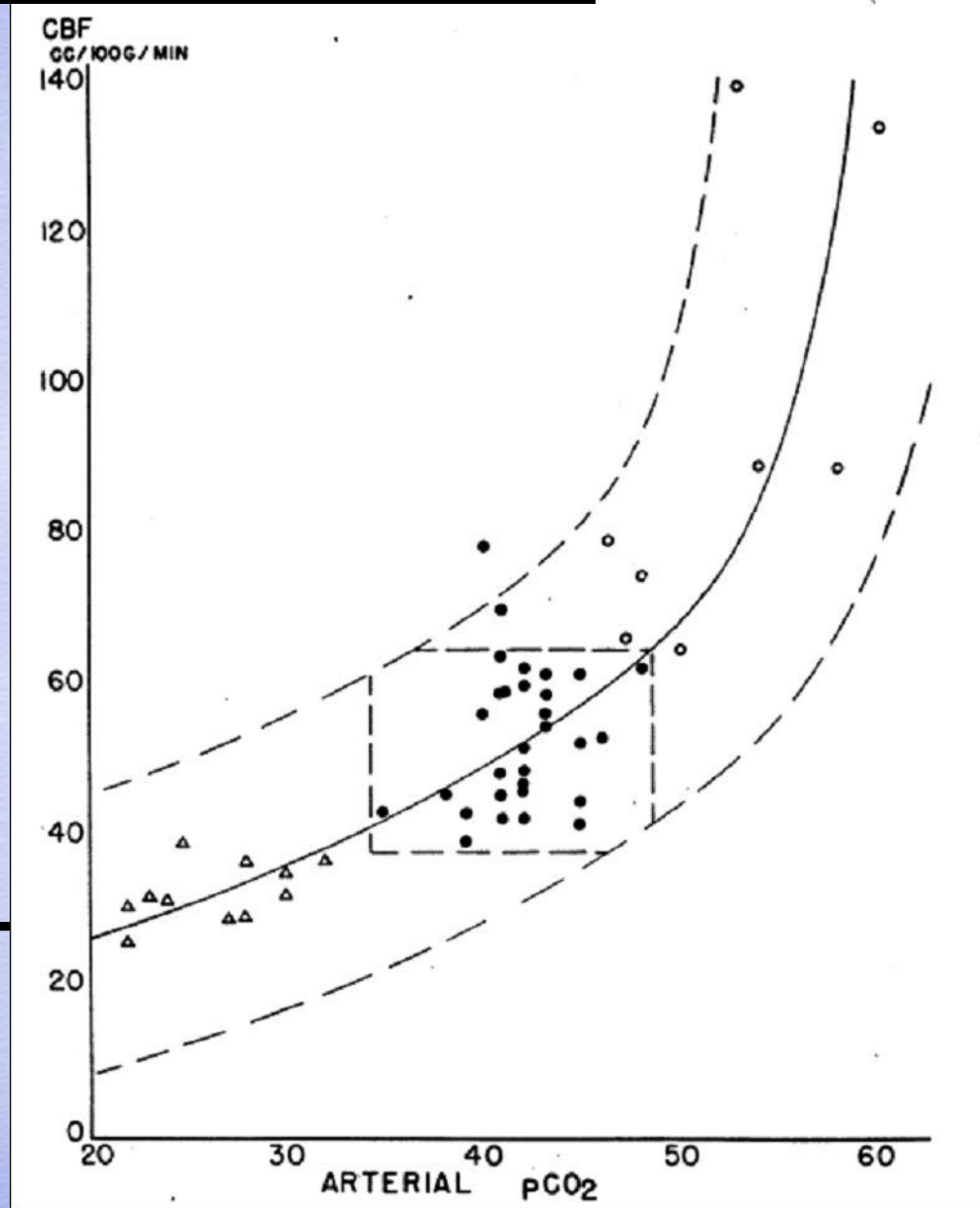
- % Saturation of haemoglobin with oxygen
- Non-invasive measurement
- Finger mounted
- Recently marketed to pilots
- “Surrogate method of measuring the degree of hypoxia”



# Cerebral blood flow

- ↓ CO<sub>2</sub> causes cerebral vasoconstriction
- ↓ cerebral blood flow
- ↓ oxygen supply to the brain

**AS LONG AS ARTERIAL  
PO<sub>2</sub> > 40 mmHg**



# Hyperventilatory response

- ↑ oxygen saturation of the blood
- **HYPERVENTILATION IS EFFECTIVE AT INCREASING ARTERIAL OXYGEN SATURATION**
- ↓ arterial CO<sub>2</sub> = ↓ cerebral blood flow in the absence of severe hypoxia





# Flying = exercise

- Workload of pilot conducting 'normal' flying routine equivalent to light exercise
- Approx. 30 W
- Other crew ↑ workload
- ?exacerbate any reduction in performance



# Those at risk

- Those that fly above 13,000ft without supplemental oxygen supplies
- Recreational Flyers:
  - Gliders
  - Microlights
  - Light Aircraft
- Military:
  - Helicopter operations

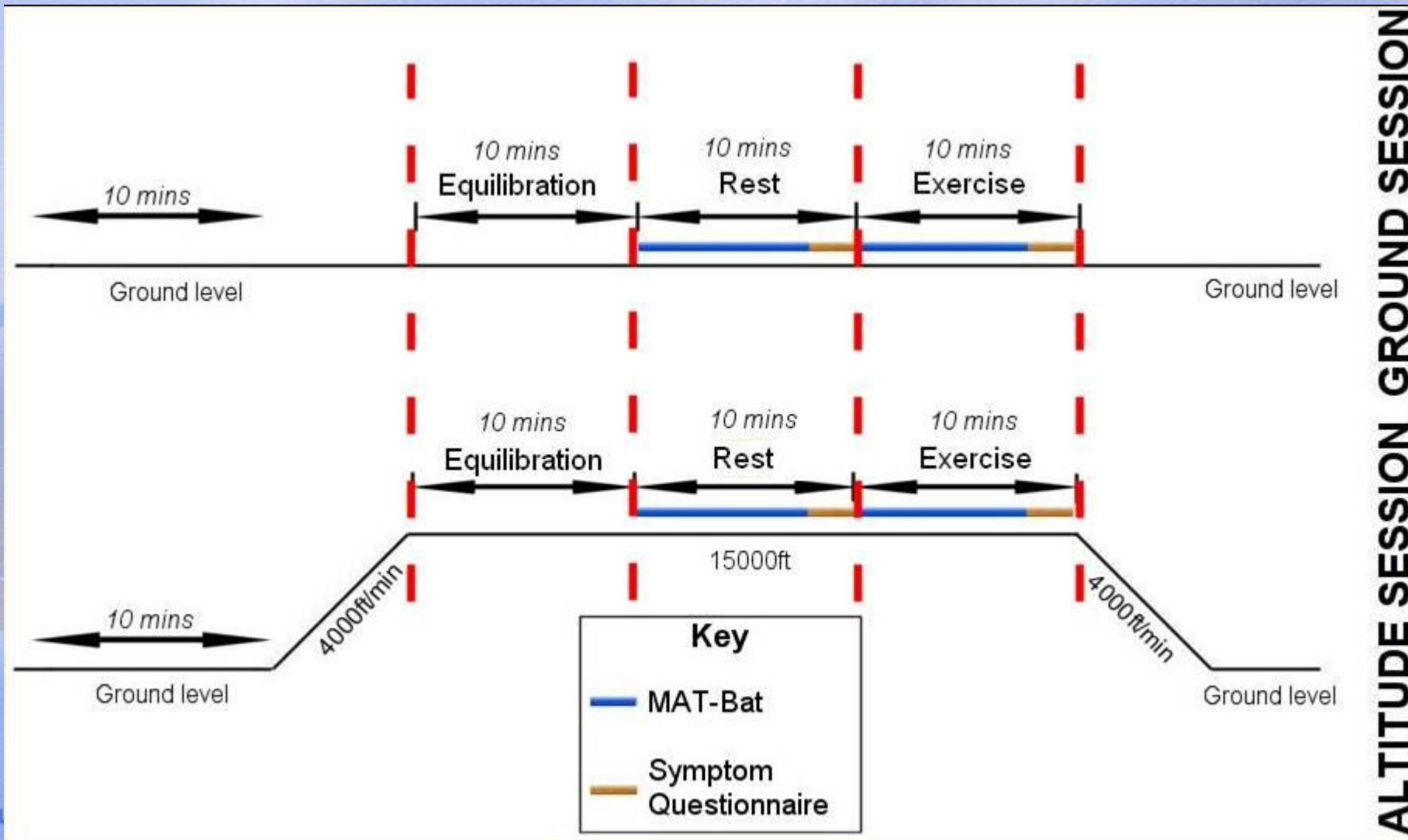


# Method

- 7 subjects (21 – 23 years)
- Ground and simulated altitude of 15,000ft
- Rest and exercise (30 Watts)
- Completed a psychomotor performance task = NASA Multi-Attribute Task Battery
- Arterial oxygen saturation
- Symptom questionnaire
- and others

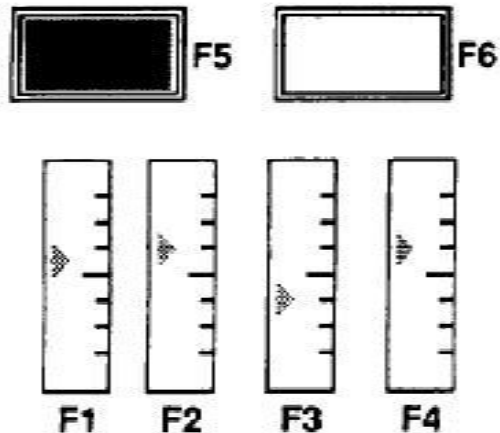


# Method

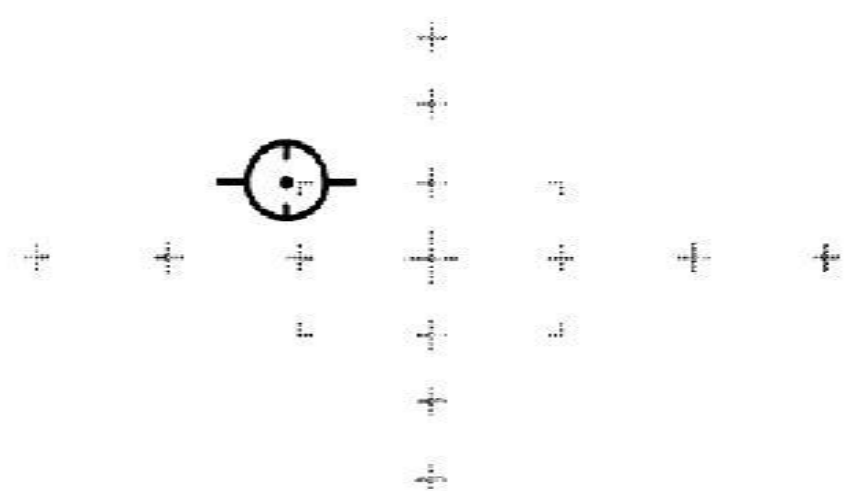




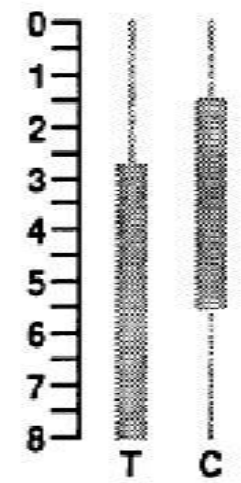
### SYSTEM MONITORING



### TRACKING



### SCHEDULING



00:05:23 10-14-1991

AUTO AVAIL

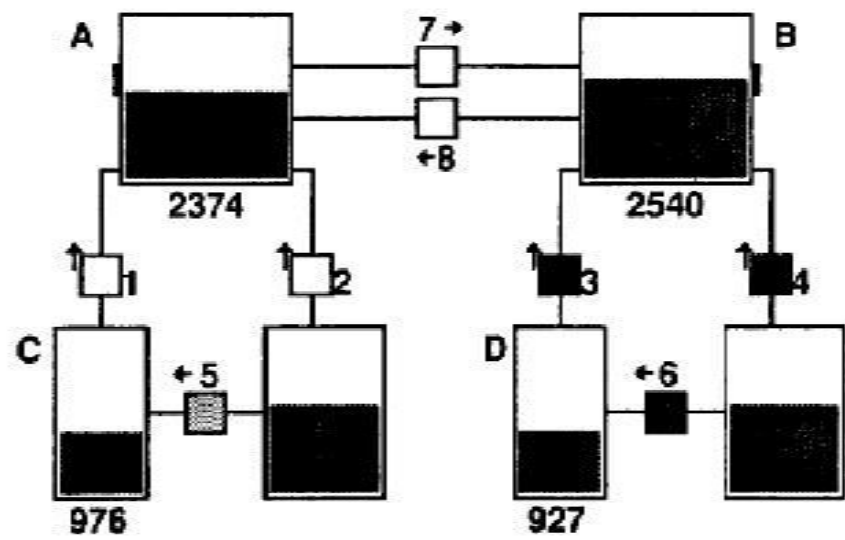
MANUAL

### COMMUNICATIONS

Callsign NGT504

↑↓ NAV1 108.5 ↔  
 NAV2 110.3  
 COM1 119.7  
 COM2 120.9

### RESOURCE MANAGEMENT



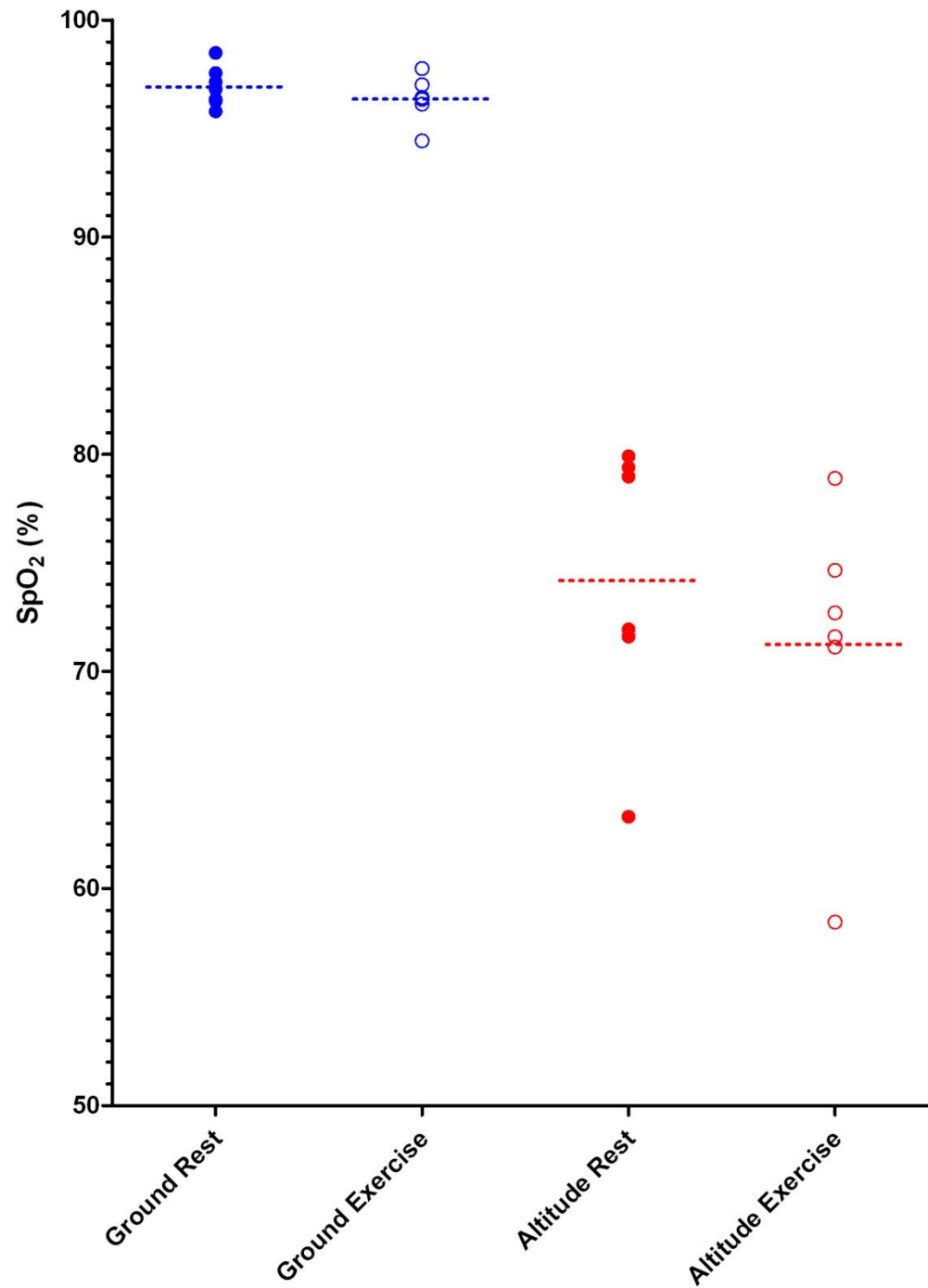
### PUMP STATUS

Flow Rates	
1	0
2	0
3	800
4	600
5	0
6	600
7	0
8	0

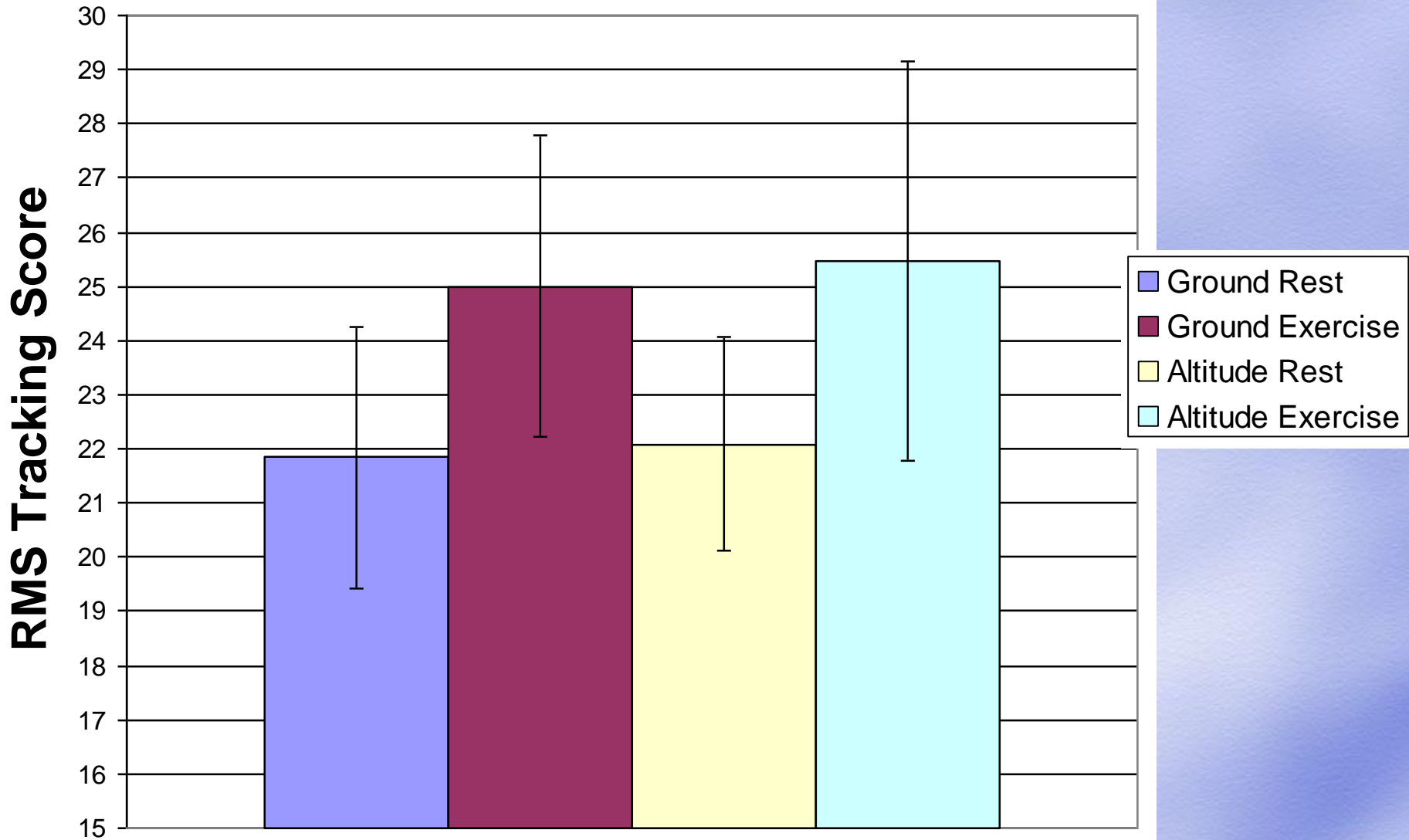


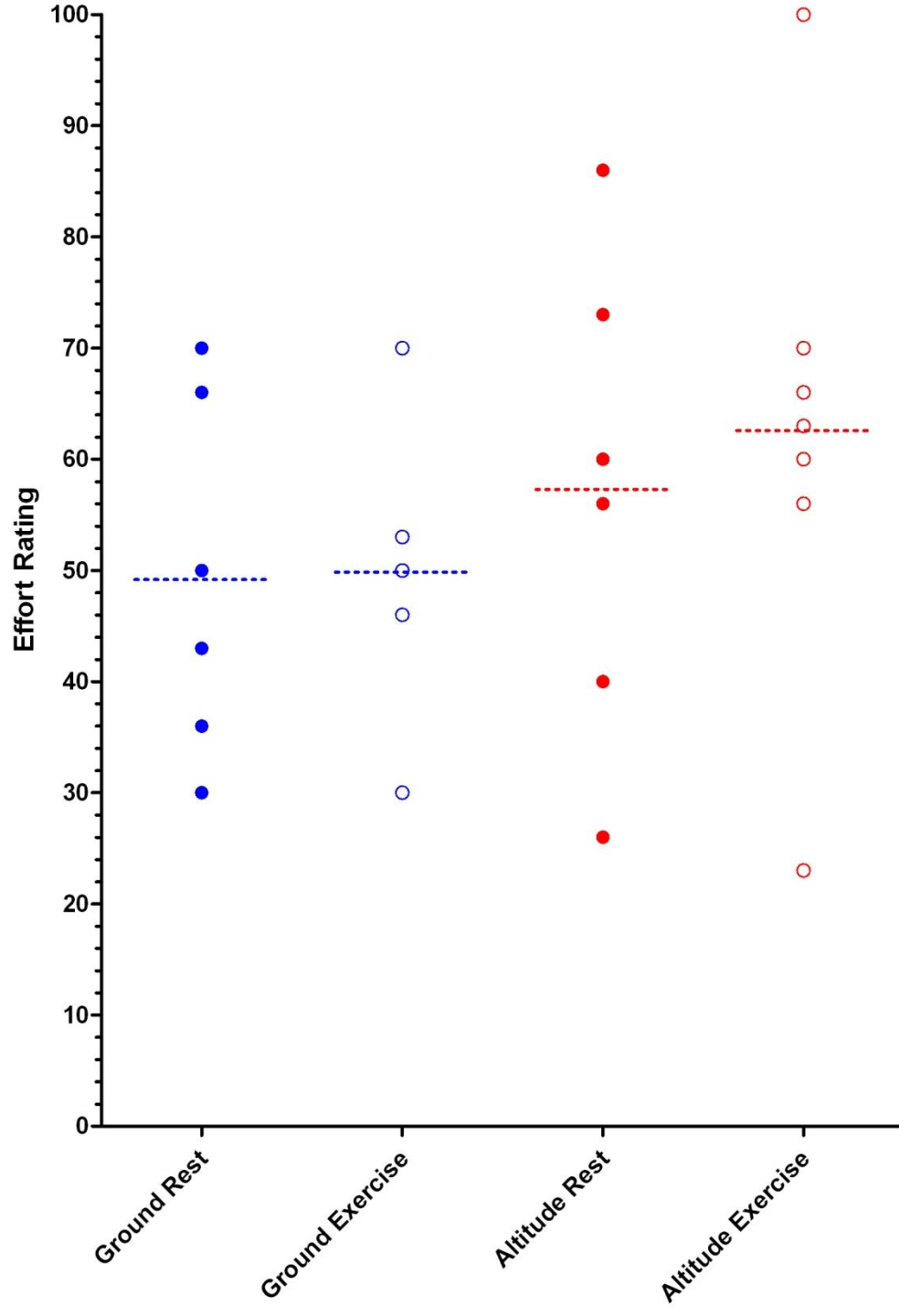
# Results











Subject ID Number .....

Date .....

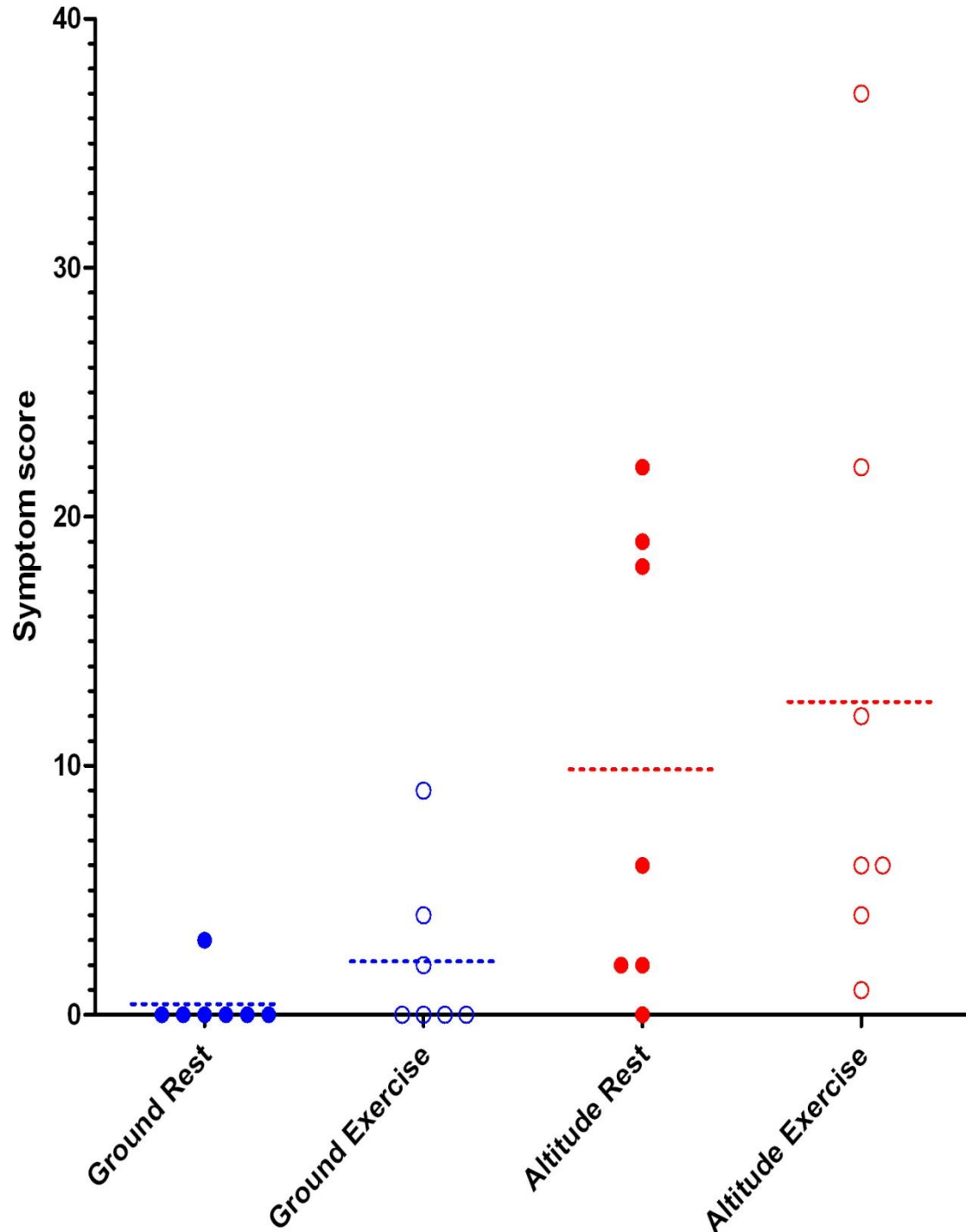
Time .....

Indicate whether you experienced any of the symptoms below by circling NO or YES to each item. If answer is YES, circle the number which best describes the severity of the symptom.

				Slight			Moderate			Severe	
1	Headache	NO	YES	1	2	3	4	5	6	7	
2	Light-headedness/dizziness	NO	YES	1	2	3	4	5	6	7	
3	Nausea	NO	YES	1	2	3	4	5	6	7	
4	Weakness	NO	YES	1	2	3	4	5	6	7	
5	Sweating	NO	YES	1	2	3	4	5	6	7	
6	Visual disturbance	NO	YES	1	2	3	4	5	6	7	
7	Muscular in-coordination	NO	YES	1	2	3	4	5	6	7	
8	Muscle cramps	NO	YES	1	2	3	4	5	6	7	
9	Fatigue	NO	YES	1	2	3	4	5	6	7	
10	Numbness	NO	YES	1	2	3	4	5	6	7	
11	Tingling	NO	YES	1	2	3	4	5	6	7	
12	Apprehension	NO	YES	1	2	3	4	5	6	7	
13	Euphoria	NO	YES	1	2	3	4	5	6	7	
14	Irritability	NO	YES	1	2	3	4	5	6	7	
15	Inability to think clearly	NO	YES	1	2	3	4	5	6	7	
16	Any other symptoms?	NO	YES	1	2	3	4	5	6	7	

NUMBER OF SYMPTOMS **1**

SYMPTOMS SCORE **3**



# Conclusions

- No significant effect on psychomotor performance or arterial oxygen saturation was found between rest and exercise at ground or altitude sessions.
- This study does not confirm that exercise has a detrimental or favourable effect on the impact of hypoxia



# BUT:

- ↑ in number and severity of hypoxia related symptoms
- Physiological differences including slight differences in arterial oxygen saturation
- Pulse oximetry is an unsatisfactory indicator of mental performance when breathing air at altitude
- Use in aviation should be discouraged



# Acknowledgements

- Study was conducted at the Royal Air Force Centre of Aviation Medicine (RAF CAM)
- Staff at RAF CAM:
  - Air Commodore Coker
  - Group Captain Gradwell
  - Wing Commander Green
  - Sergeant Russell
  - Corporals Adams and Jarvis
- BSc Student Colleagues
- Professor John Ernsting

