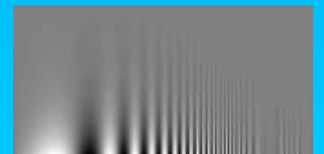
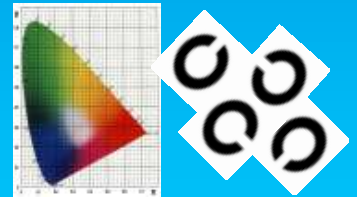


Mild Hypoxia and assisted night vision

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Dr Des Connolly

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Overview

1. Requirement
2. Background to problem
3. Technical approach
4. Current research

Requirement

- This work was carried out on behalf of the UK Ministry of Defence (MoD)
- Requirement to understand environmental factors which affect visual performance
- Including the effects of hypoxia (reduced oxygen)
 - Prior work has utilised well established functional vision tests
 - Demonstrated changes in visual sensitivity under hypoxic conditions
- Updated requirement to understand how visual performance changes under hypoxia in more relevant conditions
 - Flying on Night Vision Goggles
 - Completing complex visual tasks

Background to problem – The visual environment

- Aircrew have to complete complex visual tasks in challenging environments
- The difficulty of these tasks can be affected by;
- Environmental changes
 - Visibility
 - Light level
 - Altitude – effects of hypoxia
- Complexity of task :
 - Take off / landing
 - Low level flight



Background to problem

- Operations in low light levels
- Use of Night Vision Goggles (NVG) or Devices (NVD)
- Changes scanning behaviour
- Other limitations associated with NVG
 - Typically monochrome
 - Reduced resolution
 - Reduced field of view
 - Low light levels - scintillation

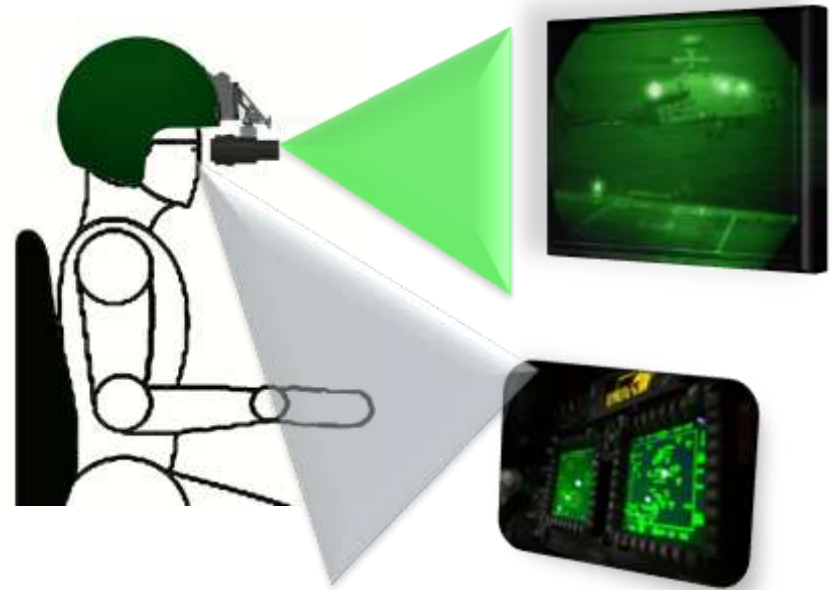


Background to problem

- For rotary wing aircrew three viewing conditions are of interest;
 1. NVG flying (viewing outside world)
 2. In cockpit viewing (beneath NVG)
 3. Switching between these tasks

What challenges does this present to the visual performance of the aircrew?

- Changes in light level
- Changes in chromaticity



Background to problem – Visual Tasks

- Well established that the tasks undertaken demand;

- High levels of visual acuity

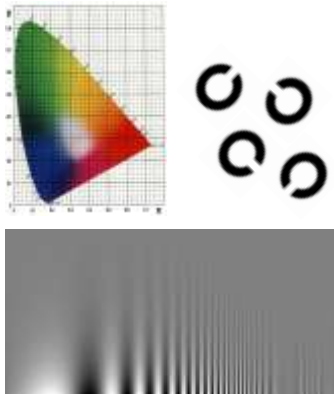
Resolve detail in cockpit displays and in the real world

- Luminance contrast sensitivity

Differentiate object of interest from the background

- Colour vision

Use colour vision for a host of tasks including cockpit instrumentation



We need to be able to investigate these under relevant conditions

Technical Approach

Set Up – Previously reported*

- Configurable displays
 - Control luminance
 - Chromaticity (Colour)
 - Location of test



Photopic, Mesopic,
Scotopic

Spectrally calibrated
filters

Required for
Luminances $< 3\text{cd/m}^2$

No NVG - Simulating a subset
of parameters relevant to NVG

Top display –
Simulated NVG
display

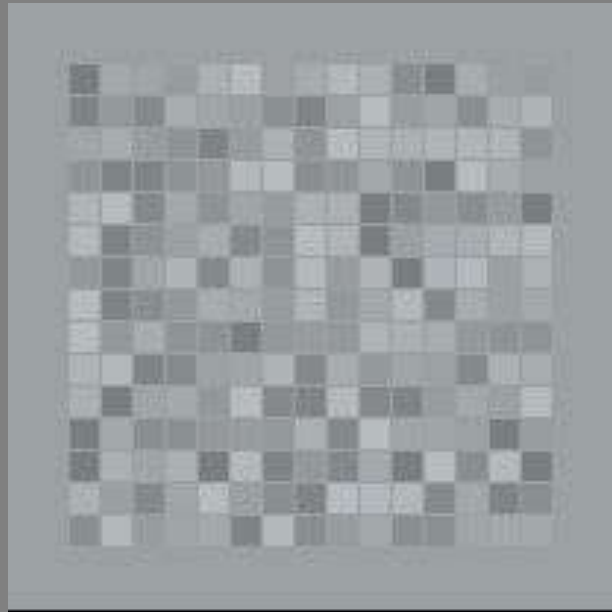
Bottom display –
simulated IP display

* SAFE International 2012

Low Contrast Acuity



Colour Sensitivity



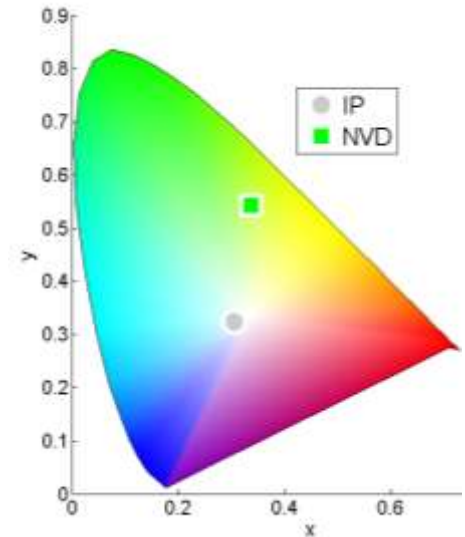
Current Research - Subjects

- Approved by an independent, human research Ethics Committee
- 12 healthy men, all non-aircrew
- Mean age of 32.8 ± 5.8 years (range 21 - 39 years)
- Non-smokers
- 6/6 visual acuity (corrected)
- Normal colour vision (zero errors on the first 16 Ishihara's pseudo-isochromatic plates)

Current Research - Method

- Three respiratory conditions
 - 100% Oxygen
 - Air
 - Hypoxic Mix - 13.7% Oxygen ~10,000ft Pressure Altitude (PA)
- Two visual tasks
 - Low contrast acuity
 - Colour sensitivity
- Two background conditions
 - Simulated IP, Neutral grey background
 - Simulated NVD, Green background

} Two light levels



Current Research - Method

- Physiological monitoring

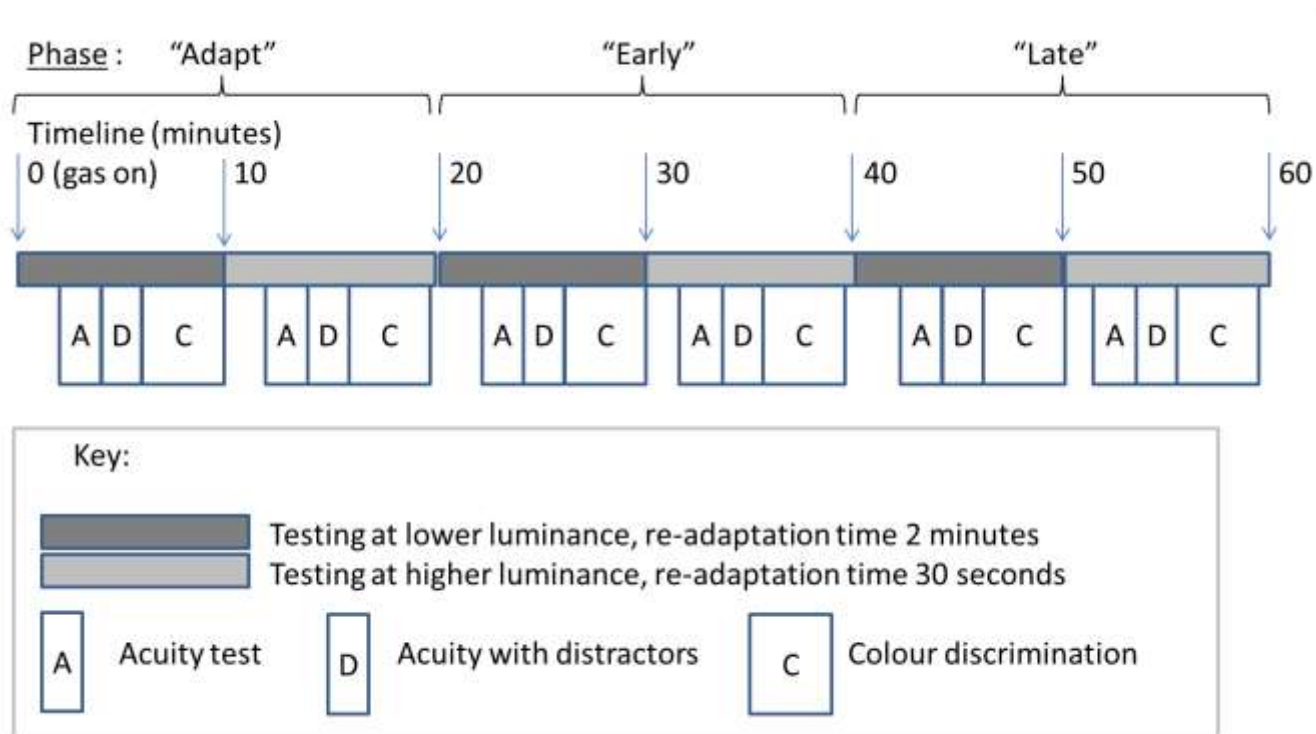
- Breath by breath monitoring of PO_2 , PCO_2
- Heart rate
- Blood pressure
- Peripheral oxygen saturation



- Safety
- Accurately assess level of hypoxia
- Exclude significant hyperventilation

Method - Experimental Design

- Steady state adaptation



Results – Low contrast Acuity

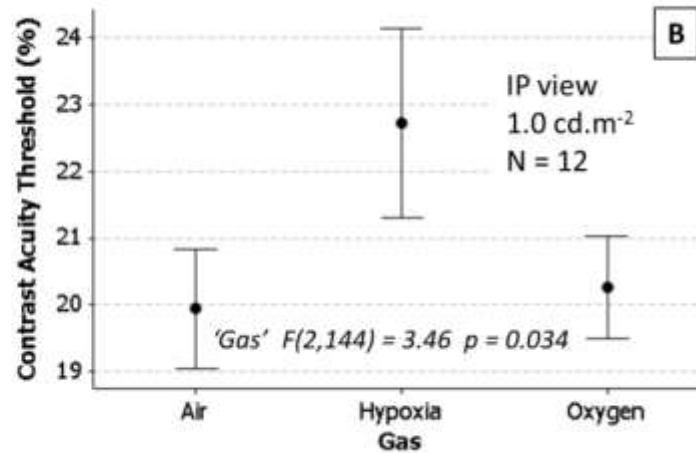
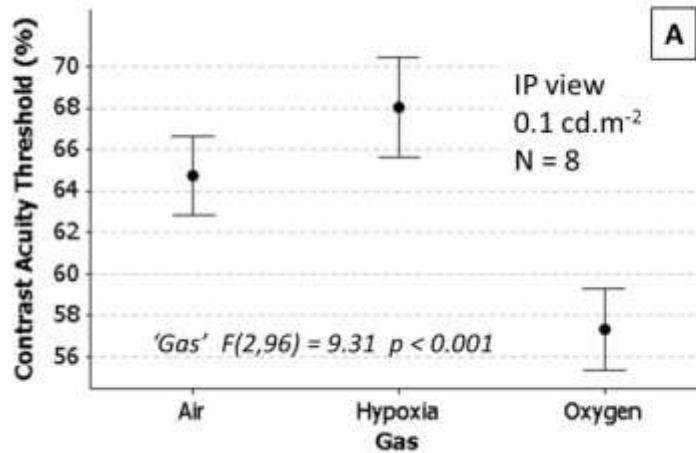
- **Summary**
- No effect of phase
- Elevated thresholds under hypoxia
- Oxygen consistently lowered thresholds
- No effect of chromaticity on task



Results – Low contrast Acuity



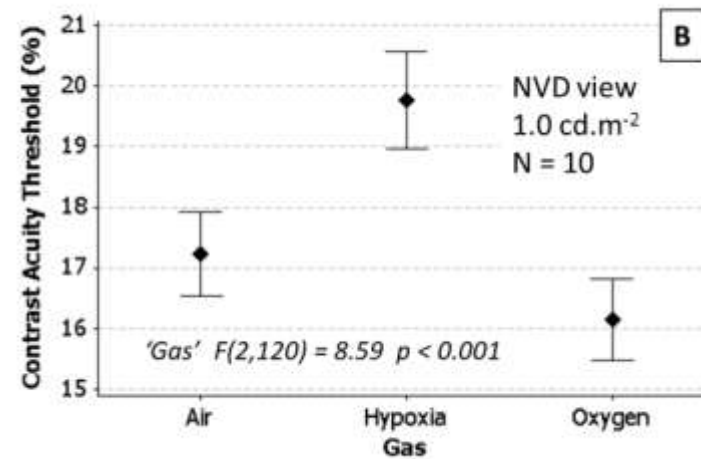
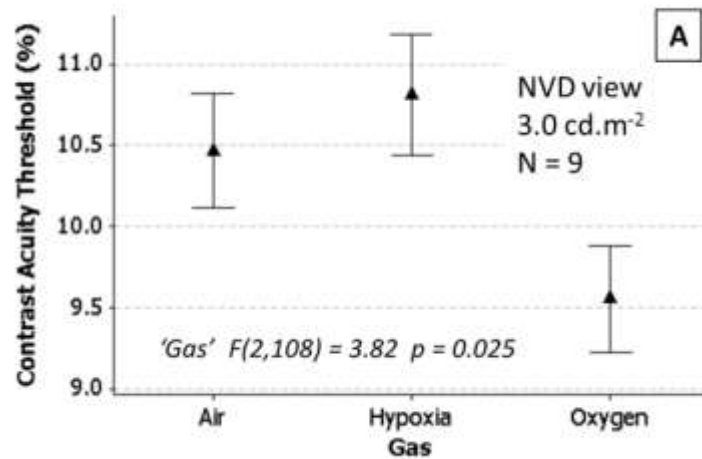
Simulated IP View



Results - Low contrast Acuity

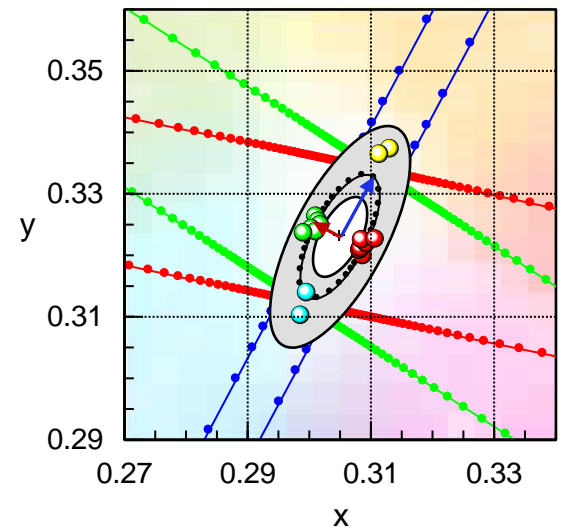
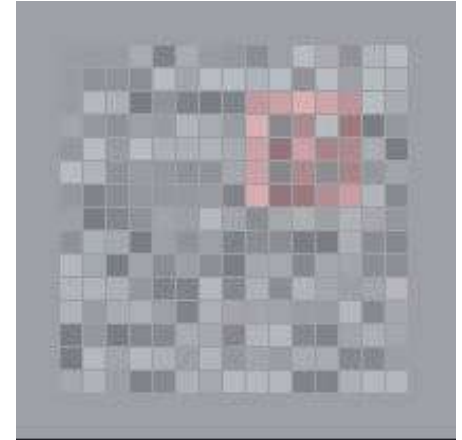


Simulated NVG View



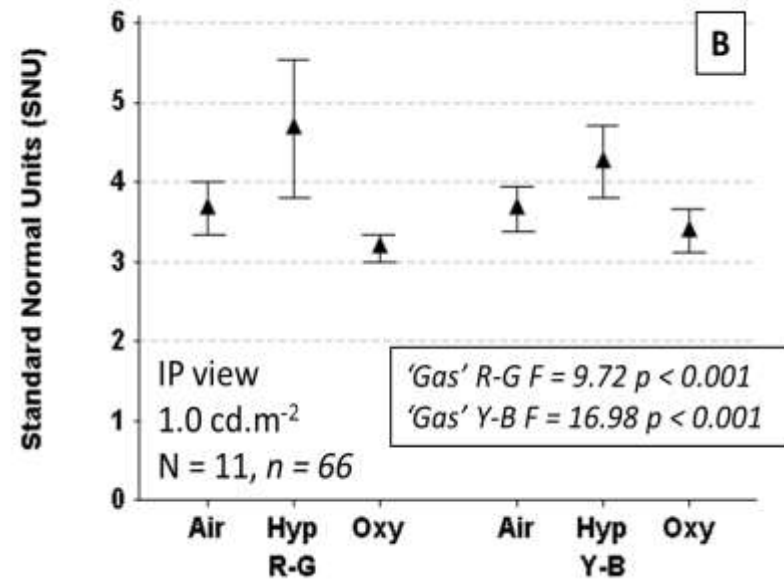
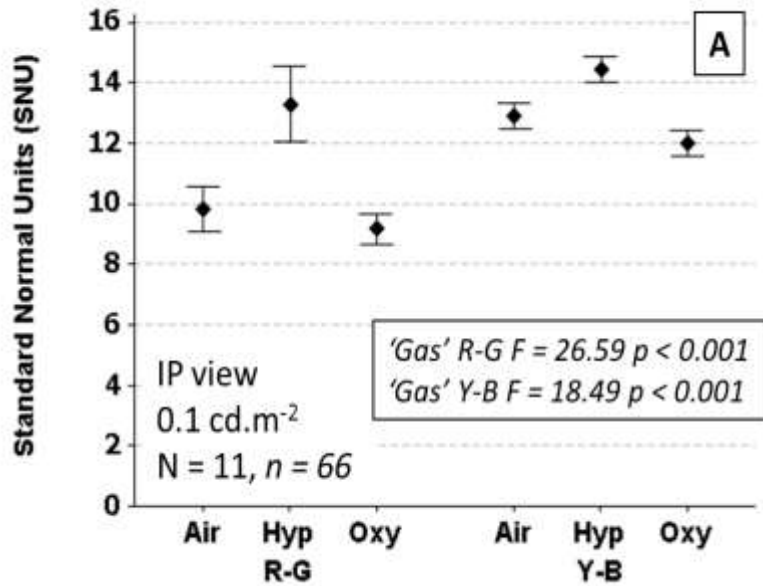
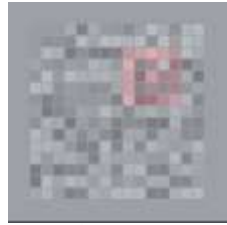
Results - Colour Sensitivity

- **Summary**
- No effect of phase
- Elevated thresholds under hypoxia when compared to oxygen



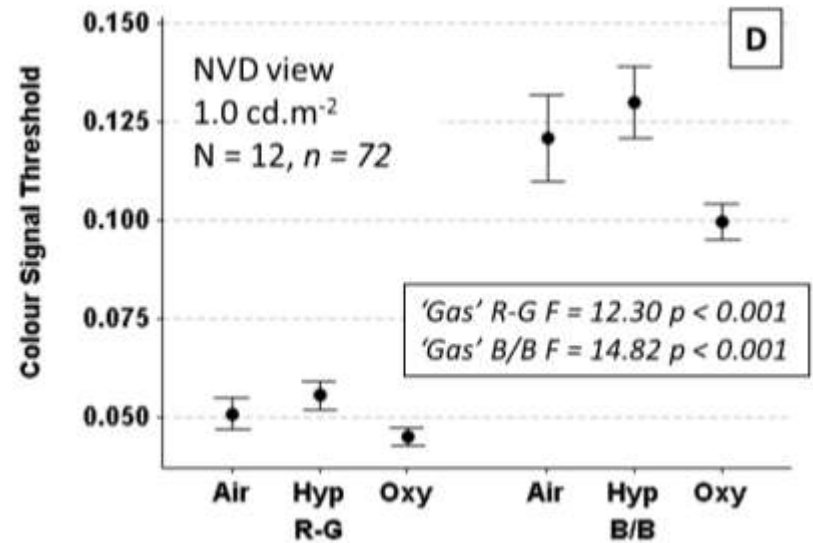
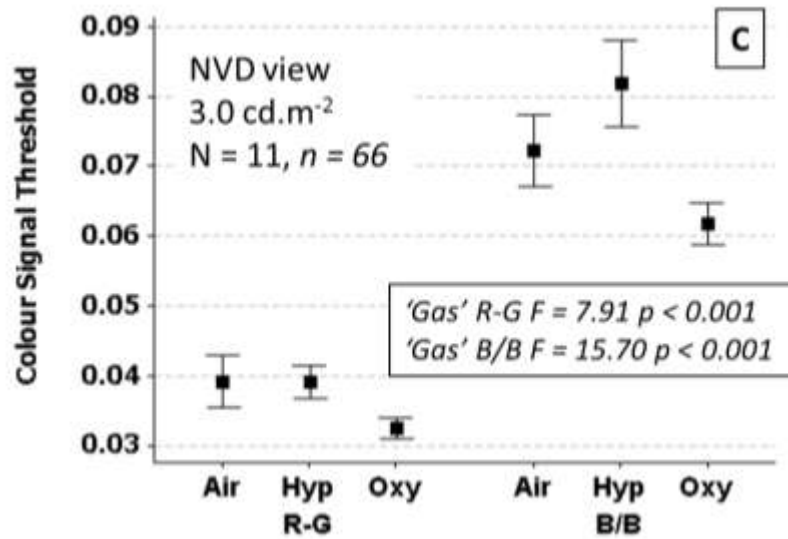
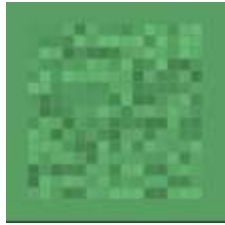
Results - Colour Sensitivity

Simulated IP View



Results - Colour Sensitivity

Simulated NVG View



Conclusions

- Mild hypoxia equivalent to 10,000ft (PA) degrades visual performance under the conditions tested
 - Low contrast acuity
 - Colour sensitivity
- Large variation in “normal” subjects
- Effects are immediate – no “grace” period

Potential Applications

Use data to help optimise visual performance in a dynamic context in relation to;

- Cockpit lighting
- Symbology design
- Optimisation of the use of colour within displays
- Eyepiece-injected symbology for NVDs
- Design of Head-Up Displays.



Acknowledgements

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