FLYING ABOVE 8K MILD HYPOXIA AND PILOT PERFORMANCE

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AITHRE®


TRANSIENT

FEW RULES & NO SPECIAL TRAINING

NO TRAINING

NO HIGH-ALTITUDE ENDORSEMENT

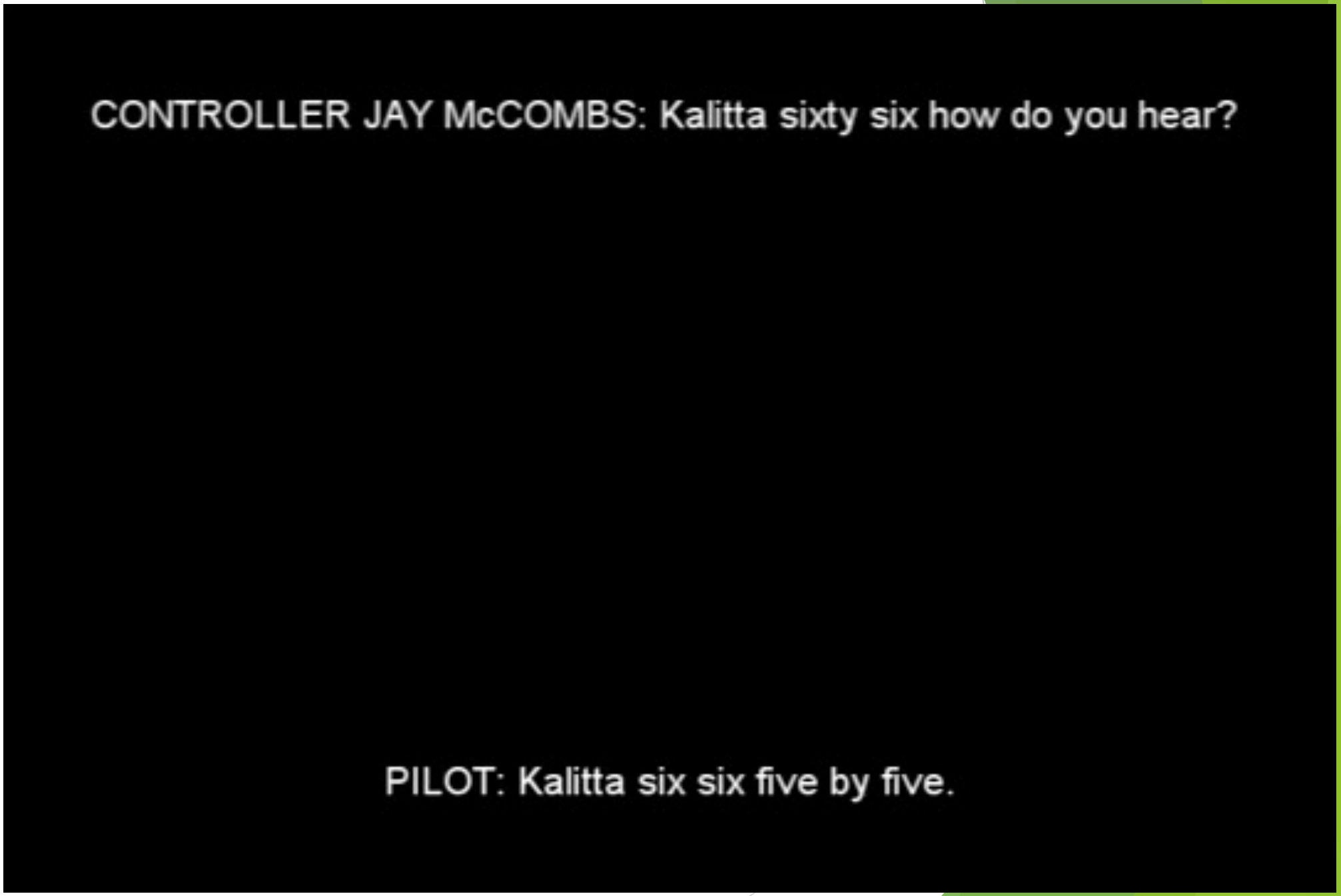
OXYGEN STARTS 12.5K AND >30 MIN.

WHAT IS HYPOXIA

- LOWER THAN NORMAL OXYGEN
- EFFECTS ARE PROBLEMATIC FOR PILOTS
  - REPETITION
  - DIFFICULTY DIAGNOSING PROBLEMS
  - TIME DISASSOCIATION
  - IRRATIONALITY
  - OVER-CONFIDENCE
  - LOSS OF FLEXIBILITY

MILITARY ALTITUDE TRAINING | 27k

LEARJET 32k


CONTROLLER JAY McCOMBS: Kalitta sixty six how do you hear?
PILOT: Kalitta six six five by five.

SR-22 | 17k

SEVERE HYPOXIA IS DANGEROUS

Altitude (feet)	Altitude (meters)	Effective Oxygen %	Altitude Category	Example
0	0	20.9	Low	Boston, MA
1000	305	20.1	Low	
2000	610	19.4	Low	
3000	914	18.6	Medium	
4000	1219	17.9	Medium	
5000	1524	17.3	Medium	Boulder, CO
6000	1829	16.6	Medium	Mt. Washington, NH
7000	2134	16.0	Medium	
8000	2438	15.4	High	Aspen, CO
9000	2743	14.8	High	
10000	3048	14.3	High	
11000	3353	13.7	High	
12000	3658	13.2	High	
13000	3962	12.7	Very High	
14000	4267	12.3	Very High	Pikes Peak
15000	4572	11.8	Very High	
16000	4877	11.4	Very High	Mont Blanc
17000	5182	11.0	Very High	
18000	5486	10.5	Extreme	

SOURCE: HIGHER PEAK ALTITUDE TRAINING

LINEAR LOWER OXYGEN PRESSURE

EXPONENTIAL HEMOGLOBIN BINDING

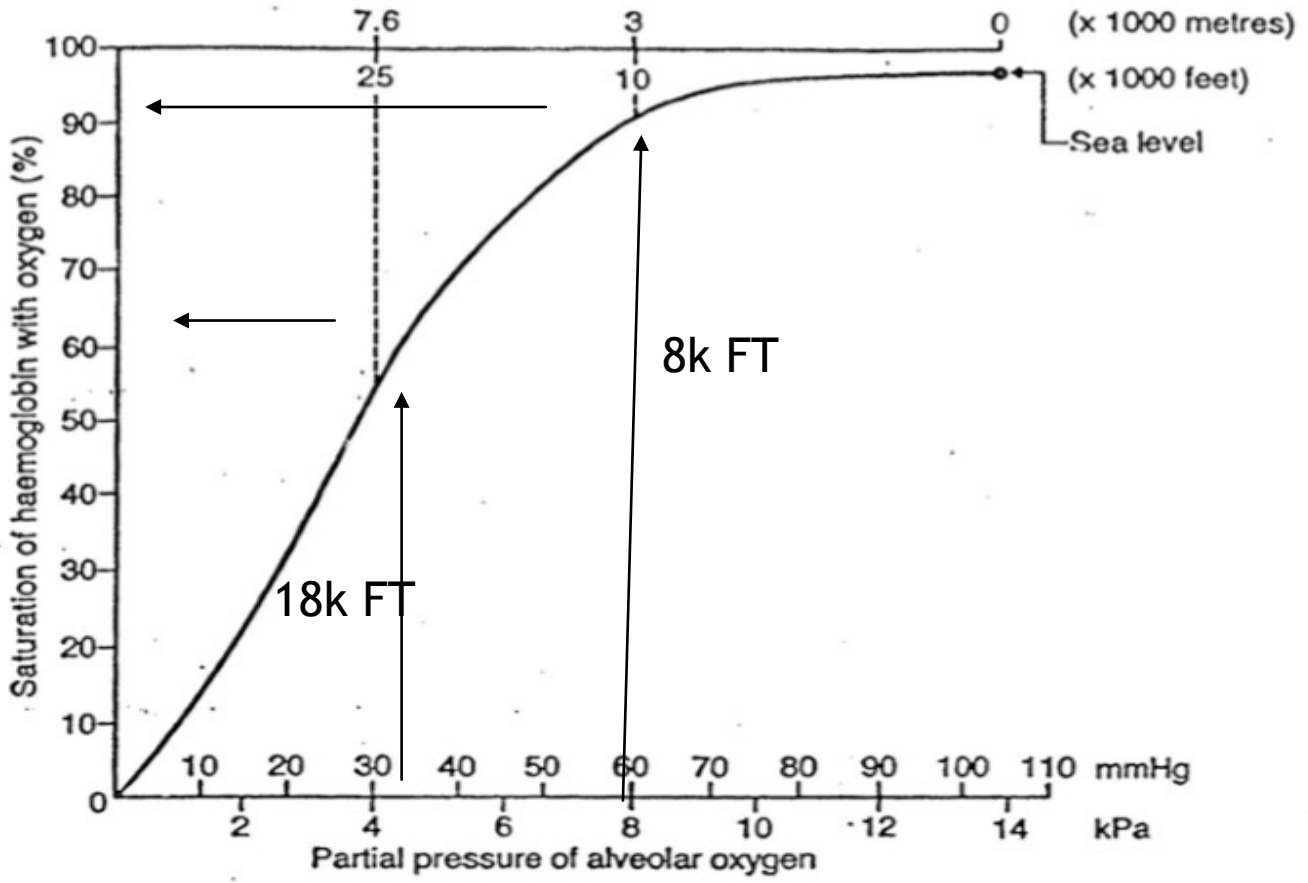
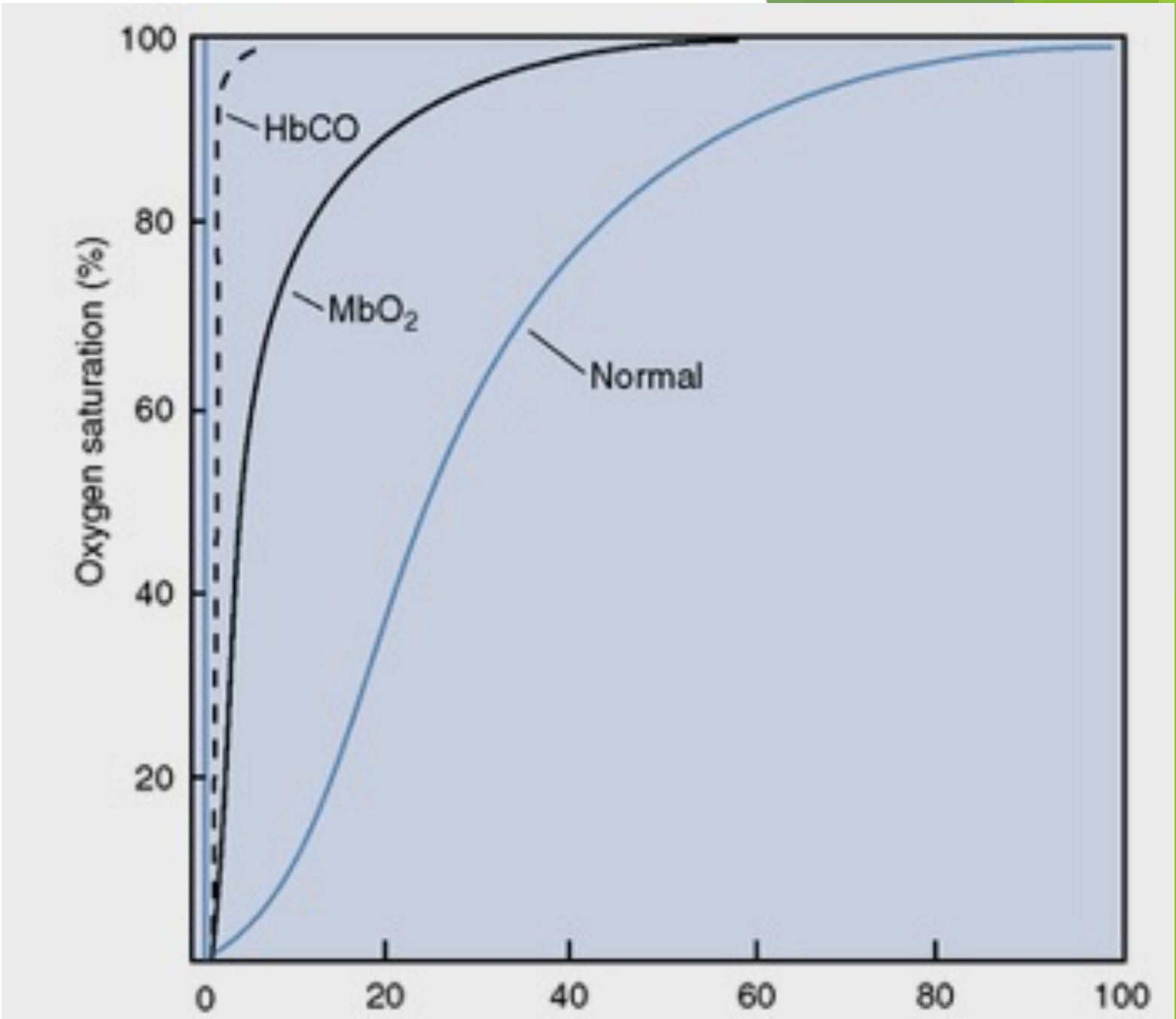


Figure 1. Oxyhemoglobin Dissociation Curve

WILD CARD AFFECT OF CARBON MONOXIDE

- SOURCES: PHYSIOLOGY, ED 5



MILD HYPOXIA AND PILOT PERFORMANCE

- Mild hypoxia: what are the cognitive or flight performance changes, if any, when hypoxia is just setting in
- Two leading research papers on point provide some potential insight
  - 1997 FAA Civil Aeromedical Institute Research Paper: Effects of Mild Hypoxia on Pilot Performances at General Aviation Altitudes
    - 8-12.5K MSL vs. control group
  - 2012 Embry-Riddle Research Theses: Effects of Oxygen Deprivation on Pilot Performance and Cognitive Processing Skills: A Pilot Study
    - 5k vs. 14k MSL same pilot

FAA 1997 Research Paper

- Used control group with oxygen vs. hypoxic group without oxygen
- Altitudes of 8k, 10k, and 12.5k MSL for 2 hr trips
- Designed to look at flight following XC type flight skills in a simulator
- Findings
  - No significant difference for physical-type flight skills
    - Maintaining altitude, course, heading AOK
  - Significant difference for mental-type flight skills
    - More procedural errors
    - Specifically appeared at high workload descent to land phase

More Procedural Errors in Hypoxic Group

- Misdialed frequency or transponder code
- Fail to use reciprocal value when setting OBS to inbound radial
- Fail to report intercept, level at altitude as instructed by ATC
- Fail to follow specific ATC instruction
- Premature manuever
- Fail to recognize airport

Interesting Procedural Error Summary

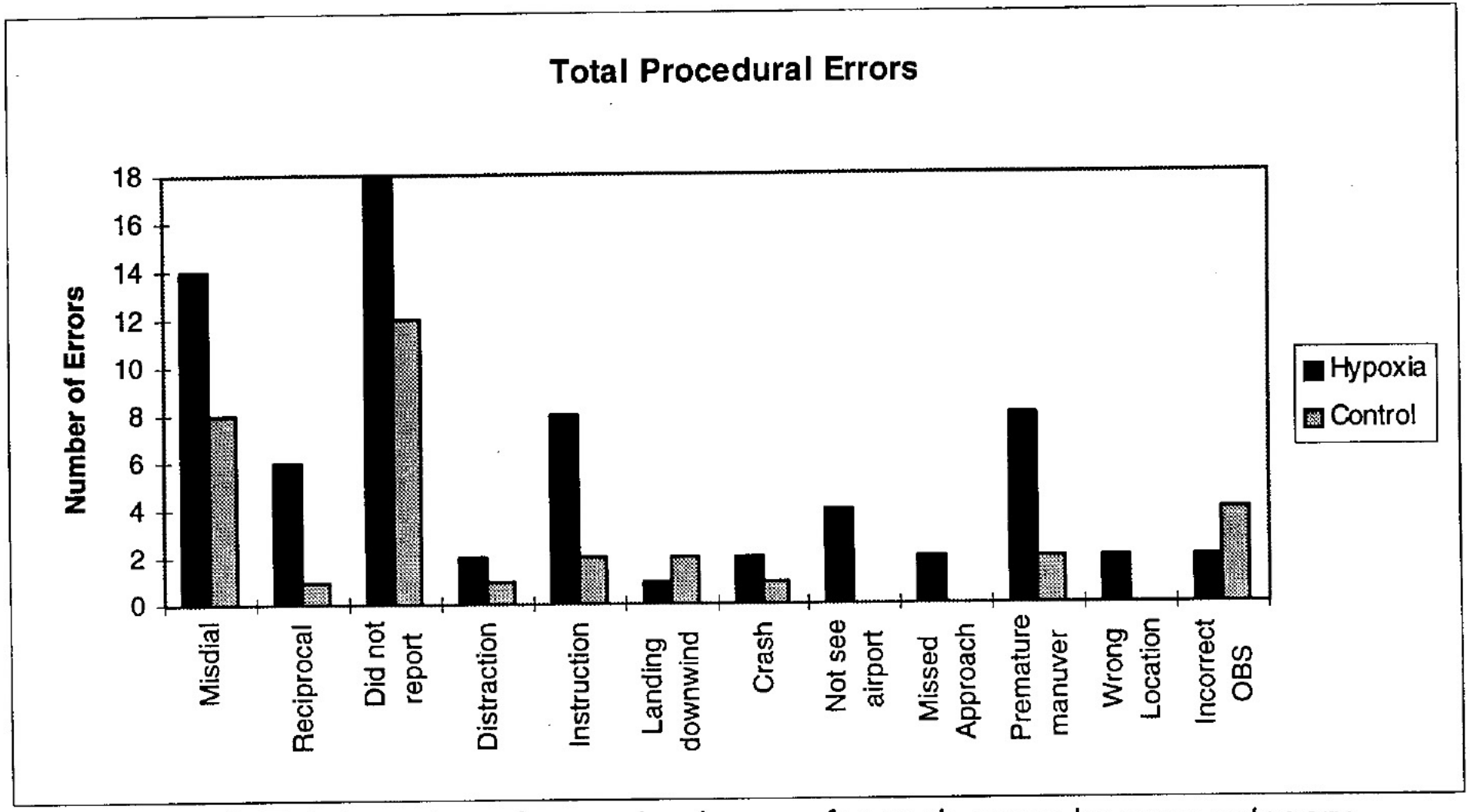
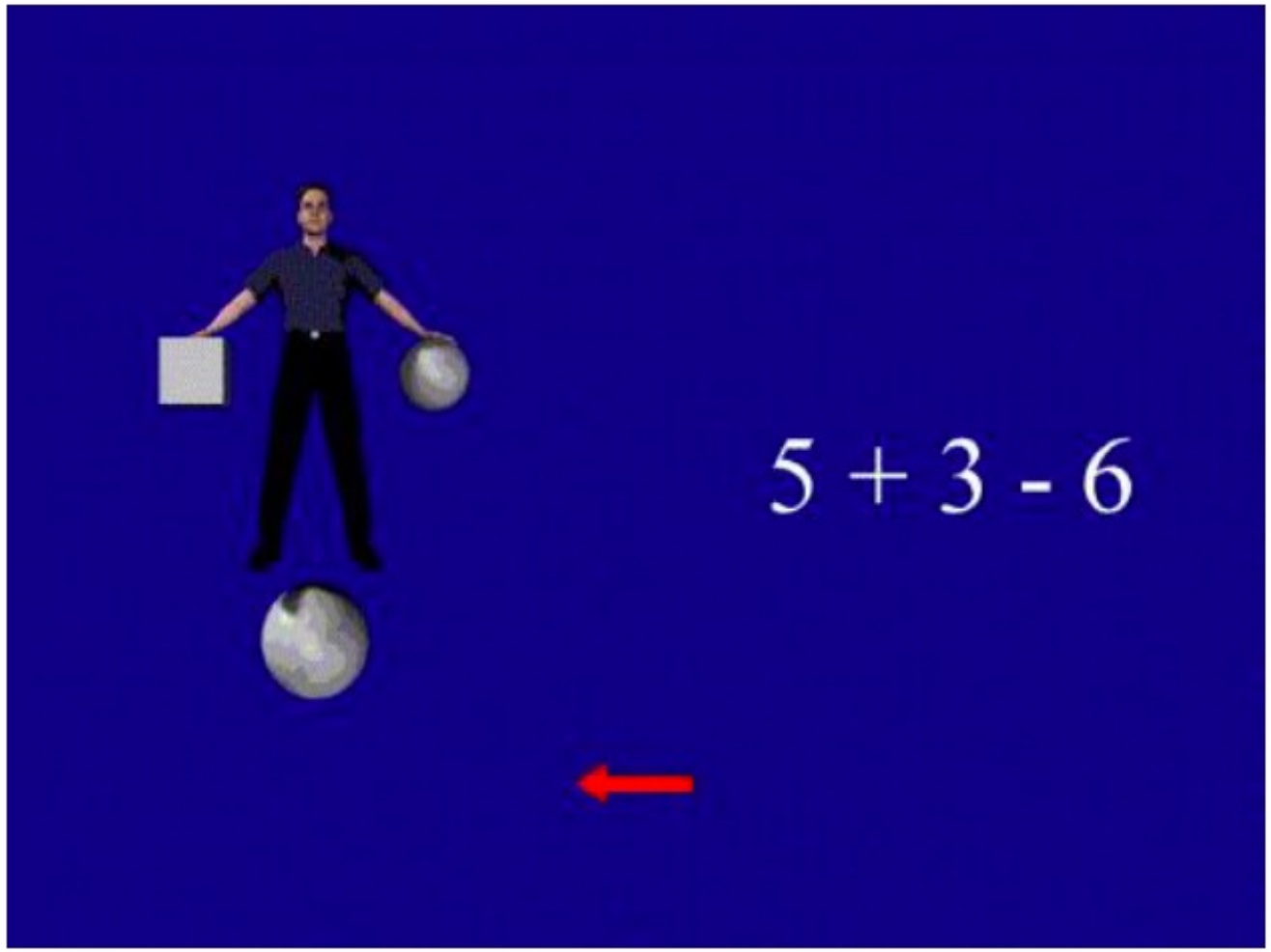


Figure 6: Total number of procedural errors for each group by error category.

Embry-Riddle Theses

- Tested same instrument pilots with and without oxygen
- Measured at the 5k and higher 14k MSL levels
- Evaluated physical-type flight skills
- Evaluated mental-acuity with spatial & math problem tests
- Stayed within 30 minutes to push the boundaries of the part 91 oxygen allowances
- Findings
  - Worse performance almost across the board at 14k MSL
    - Mental-type skills worse
    - Physical-type flight skills ALSO worse

Example of Spatial and Math Problems



Math Problem Solving Stats

Table 10

Throughput Math Descriptive Statistics

Altitude	*N*	Mean	Std. Deviation	Std. Error	Min	Max
Sea Level	5	20.81	5.85	2.61	15.99	29.42
5,000	5	21.06	6.62	2.96	13.17	30.70
14,000	5	18.84	6.54	2.92	13.49	29.92

Course Deviation Stats

Table 1

Localizer Excursion Descriptive Statistics

	Paired Samples Statistics				
Altitude	Mean	*N*	Std. Deviation	Min	Max
5,000	0.37	5	0.23	0.12	0.64
14,000	2.12	5	3.46	0.23	8.30

Glideslope Deviation Stats

Table 2

Glideslope Excursion Descriptive Statistics

	Paired Samples Statistics				
Altitude	Mean	*N*	Std. Deviation	Min	Max
5,000	35.14	5	25.36	13.79	79.08
14,000	63.92	5	71.08	19.80	189.77

Target Speed Deviation Stats

Table 3

Target Speed Excursion Descriptive Statistics

	Paired Samples Statistics				
Altitude	Mean	*N*	Std. Deviation	Min	Max
5,000	2.52	5	0.63	1.78	3.29
14,000	5.37	5	6.14	1.72	16.25

IN CLOSING

- SEVERE HYPOXIA IS A VERY CLOSE NEIGHBOR TO MILD HYPOXIA
- CARBON MONOXIDE MAKES ALL HYPOXIA OCCUR AT LOWER ALTITUDES
- COGNITIVE ABILITIES APPEAR TO BE THE FIRST TO SUFFER WITH MILD HYPOXIA
  - ESPECIALLY AFTER SPENDING HOURS ABOVE 12K AND THEN ENAGING IN HIGH WORKLOAD
- PHYSICAL FLIGHT SKILLS APPEAR TO REMAIN INTACT FOR LONGER
  - APPEARING AT ALTITUDES AROUND 14K FOR 30 MINUTES

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