



INFLUENCE OF ELEVATED PO₂ ON CARBON DIOXIDE (CO₂) NARCOSIS

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BACKGROUND

- Divers risk CO₂ retention from inadequate ventilation or inspired CO₂
- CO₂ is narcotic and affects cognitive performance & consciousness
- Donald's WW II studies led him to hypothesize that hyperoxia reduced the hazardous symptoms of hypercapnia (Donald. *AEDU Report XVI*, 1945)
 - Donald's work, however, did not use normoxic controls.
- We investigated O₂ & CO₂ effects on cognitive performance & discomfort

METHODS (1)

- Twelve males (37 ± 11 [28-59] years [mean \pm SD, range]) breathed four gases for 4 min at 1.45 ata:
 - Gas A (normoxic/normocapnic) – 0.21 atm O₂/0.0 atm CO₂
 - Gas B (hyperoxic/normocapnic) – 0.21 atm O₂/“high CO₂”
 - Gas C (normoxic/hypercapnic) – 1.3 atm O₂/0.0 atm CO₂
 - Gas D (hyperoxic/hypercapnic) – 1.3 atm O₂/“high CO₂”
- “High CO₂” was defined for each subject as the maximum inspired CO₂ tolerable for 4 min among gases presented in order: 0.055, 0.065, 0.075, or 0.085 atm CO₂

METHODS (2)

- Gas A was paired with gases B, C & D in a Latin Square design of nine experimental pairs
- Experiments were conducted at rest (12 subjects) and 75 watts dry, cycling exercise (10 subjects)
- Cognitive function was assessed by an auditory n-back test
- Subjects reported a rating of perceived discomfort (RPD; 0-10 scale)
- Minute ventilation (V_E) & end-tidal CO_2 ($P_{ET}\text{CO}_2$) were recorded
- Measurements were assessed by multiple linear regression with repeated measures

Results (1)

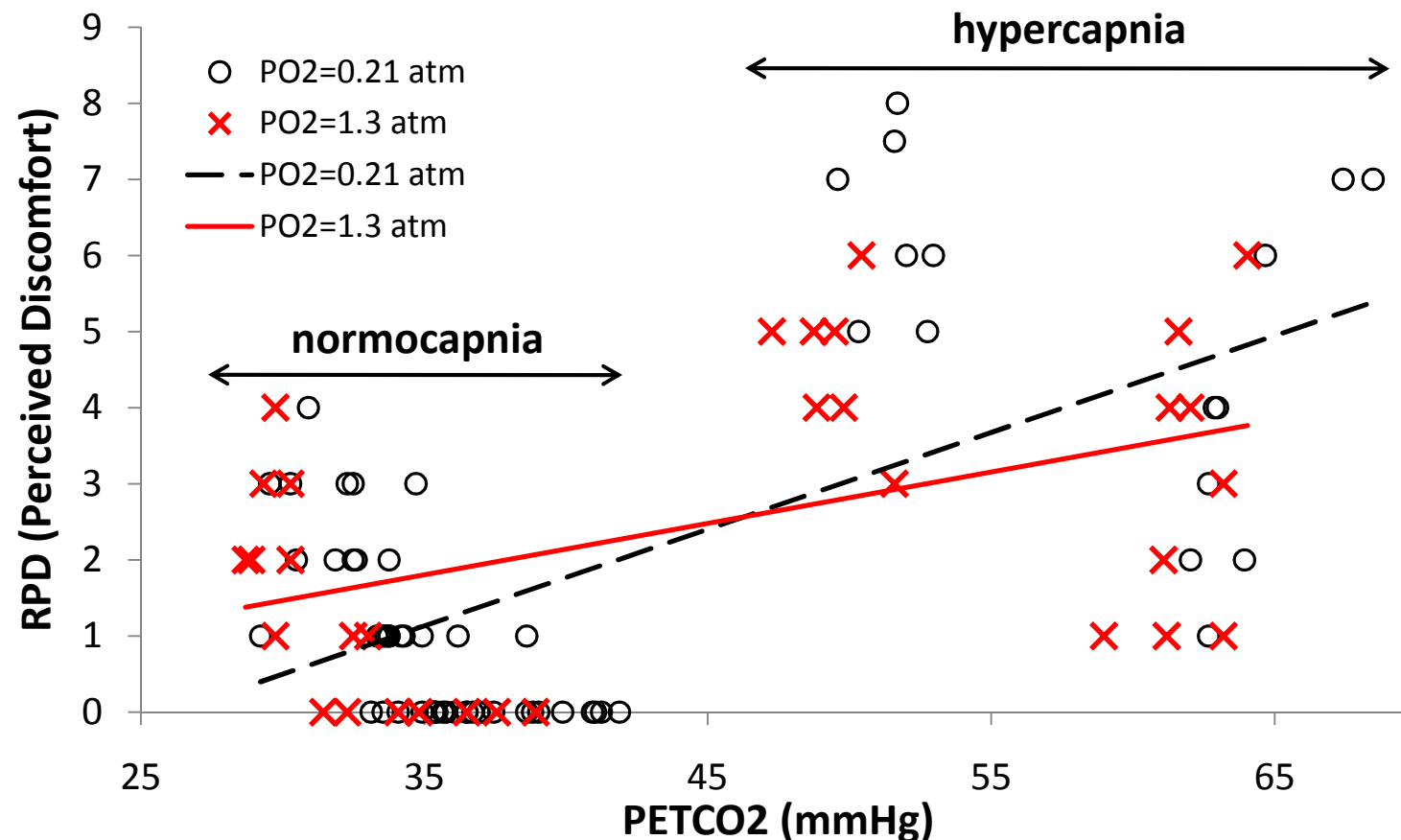
- Complete data were collected for all gases
- Tolerable CO_2 ranged from 0.065 to 0.085 atm at rest
 - Exercise often lowered CO_2 tolerance by 0.01 atm
- Results were comparable for rest & exercise
- $P_{\text{ET}}\text{CO}_2$ decreased (3-4 mmHg) with hyperoxia ($p < 0.0001$) but hyperventilation was unaffected

Results (2)

- Four subjects who breathed normoxic/hypercapnic gas C had tunnel vision, dizziness, panic, exhaustion, or near-syncope.
 - 2 resting: $P_{ET}CO_2 = 57.4, 61.3$ mmHg
 - 2 exercising: $P_{ET}CO_2 = 51.3, 74.8$ mmHg

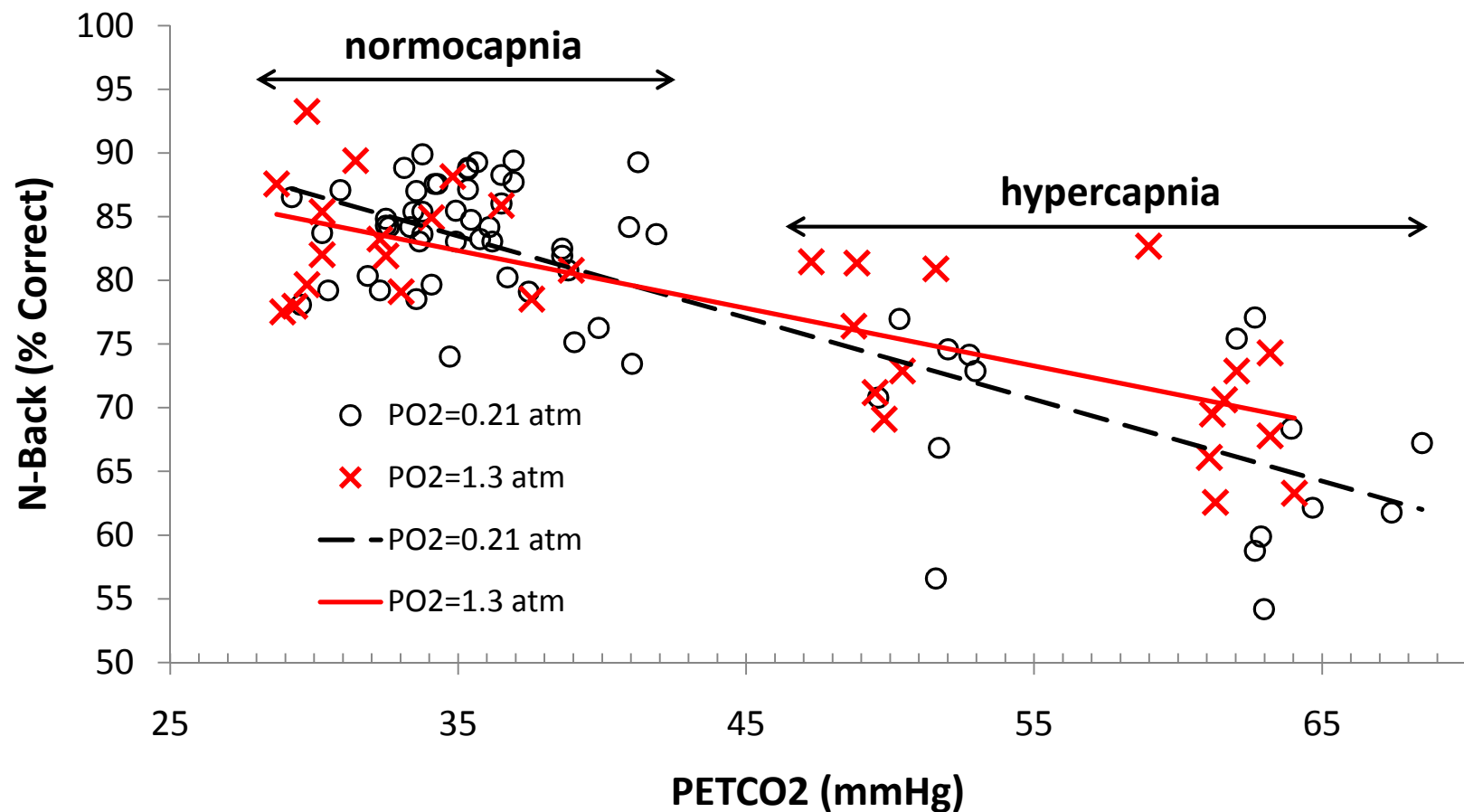
Results (3)

- Hyperoxia reduced perceived discomfort ($p=0.0006$) in subjects breathing hypercapnic gas.



Results (3)

- Hyperoxia improved n-back performance ($p=0.0002$).
 - Whether reduced discomfort or improved cognitive function was responsible for improved performance is unknown.



Conclusions

- Hyperoxia was associated with reduced discomfort when breathing hypercapnic gas
- Severe hypercapnic symptoms occurred during normoxia rather than hyperoxia
- We were unable to confirm Donald's hypothesis that hyperoxia reduced hazardous symptoms during hypercapnia