

**ABSTRACT:** The aim of this research was to investigate cardiac autonomic changes associated with acute exposures to airborne particulates. *Methods* High fidelity 12-lead ECG (CardioSoft, Houston, TX) was acquired from 19 (10 male / 9 female) non-smoking volunteers (age 33.6 ± 6.6 yrs) during 10 minutes pre-exposure, exposure and post-exposure to environmental tobacco smoke (ETS), cooking oil fumes, wood smoke and sham (water vapor). To control exposure levels, noise, subject activity and temperature were monitored and held inside an environmental chamber. *Results* The short-term fractal scaling exponent (Alpha-1) and the ratio of low frequency to high frequency Heart Rate Variability (HRV) powers (LF/HF, a purported sympathetic index) were both higher in males (p<0.017 and p<0.05, respectively) whereas approximate entropy (ApEn) and HF/(LF+HF) (a purported parasympathetic index) were both lower in males (p<0.036, and p<0.044, respectively). Compared to pre-exposure (p<0.0002) and sham exposure (p<0.047), male heart rates were elevated during early ETS post-exposure. Our data suggest that, in addition to tonic HRV gender differences, cardiac responses to some acute airborne particulates are gender related. *Supported by Philip Morris USA.*

**BACKGROUND:** Exposure to environmental tobacco smoke has been found to result in potentially harmful changes in autonomic balance, heart rate variability and heart rate. The purpose of this study was to determine if these effects could be observed in volunteers sitting for two hours in airport smoking rooms (Pope, 2001)

# METHODS:

**Subjects:** 19 (10 male / 9 female) non-smoking volunteers (age 33.6 ± 6.6 yrs)

**Protocol:** Seated subjects for 10 minutes pre-exposure, exposure and post-exposure conducted inside an environmental chamber in order to control exposure levels, noise, subject activity and temperature

**Stimuli:** Environmental tobacco smoke (ETS), cooking oil fumes, wood smoke and sham (water vapor)

**Measurements:** High-fidelity 12-lead ECG (CardioSoft, Houston, TX). HRV was calculated using N=256 beats (sliding window configuration).

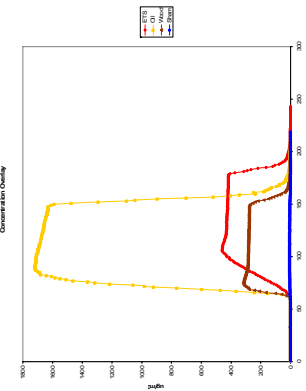


Study PI's with instrumentation inside of the environmental chamber

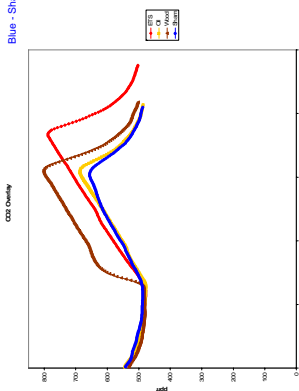
## ENVIRONMENTAL CHAMBER CONDITIONS:

Particulate concentration, CO<sub>2</sub>, CO, and Temperature

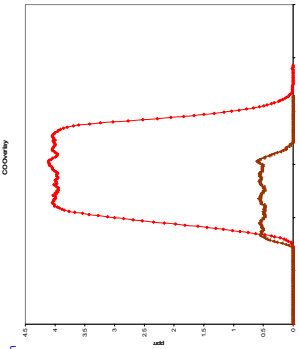
## Particulate Concentration (ug/m<sup>3</sup>)



## Carbon Dioxide CO<sub>2</sub> (ppm)



## Carbon Monoxide CO (ppm)



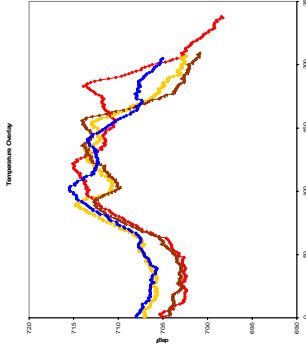
## METHODS OF PRODUCING AEROSOL PARTICULATE STIMULI:

Two glove boxes (One for ETS and Wood) and (One for Oil and Sham Water Vapor)



Automatic smoking machines (2 cigarettes) and bricks for which to burn cedar wood pieces

## Temperature (deg F)



## SUMMARY OF RESULTS:

**Statistics:** Statistical testing (SAS 9.1) used a mixed analysis of variance (ANOVA), composed of one between subject factor (gender) and two within factors (exposure stage [5 stages] and exposure species [4 species]). Post hoc testing consisted of least significant difference comparisons between desired states. p<0.05 was considered to be significant.

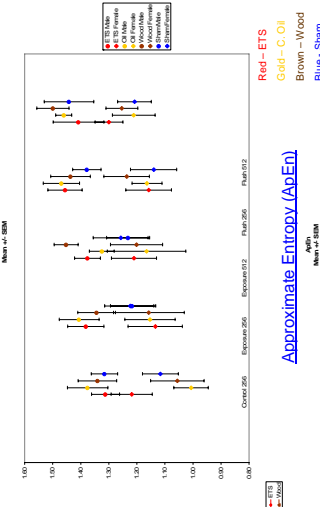
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Compared to pre-exposure (p<0.0002) and sham exposure (p<0.047), male heart rates were elevated during early ETS post-exposure.

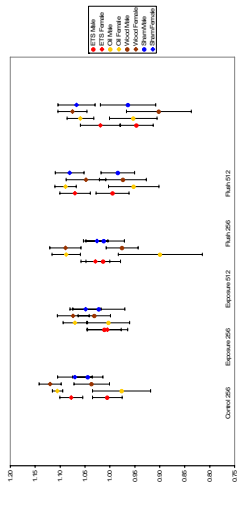
## BELOW

The short-term fractal scaling exponent (Alpha-1) and the ratio of low frequency to high frequency Heart Rate Variability (HRV) powers (LF/HF, a purported sympathetic index) were both higher in males (p<0.017 and p<0.05, respectively) whereas approximate entropy (ApEn) and HF/(LF+HF) (a purported parasympathetic index) were both lower in males (p<0.036, and p<0.044, respectively).

## Short-term Fractal Scaling Exponent (Alpha 1)



## Approximate Entropy (ApEn)



**CONCLUSION:** Our data suggest that, in addition to tonic HRV gender differences, cardiac responses to some acute airborne particulates are gender related.

**FUTURE PERSPECTIVE:** The first author is awaiting notification from the American Heart Association (AHA) in regards to a Pre-Doctoral Fellowship proposal to conduct several new and/or emerging advanced ECG analysis techniques from collaborative efforts with NASA. The techniques include: 1) parameters obtained via Signal Averaged ECG (SAECG), including high frequency QRS (HF-QRS) ECG, the ventricular gradient, and the variability of the ventricular gradient; 2) several parameters of beat-to-beat QT interval variability (QTV); and 3) several parameters of T-wave morphology (TWM) derived from singular value decomposition (SVD).

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**REFERENCES:** Pope CA, Eatough DJ, Gold DR, Pang Y, Nielsen KR, Nath P, Verrier RL, and Kanner RE (2001). Acute exposure to environmental tobacco smoke and heart rate variability. *Environ Health Perspect* 109(7):711-6.