

Indoor Air Quality Data Captured from Consumer-Grade Devices and Its Effect on Occupant Mood



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WHAT STARTS HERE CHANGES THE WORLD



Objectives

How do home IAQ conditions prior to submitting EMAs influence mood reports?

Are mood responses more pronounced following “extreme” IAQ measurements?

Device Deployment

Indoor Environmental Monitor



Smartphone App



Study Details



Parameters

Measurement

CO₂
PM_{2.5}
TVOCs
Temperature

1-minute
 resolution

Parameters

Measurement

GPS continuous
EMA (morning) 9:00 4x per week
EMA (evening) 19:00 4x per week

24 Participants

11 weeks

1210

1196

Mood Reported on EMA

Content

RIGHT NOW, I am feeling CONTENT:

0: Not at all 1: A little bit 2: Quite a bit 3: Very much

Stress

RIGHT NOW, I am feeling STRESSED:

0: Not at all 1: A little bit 2: Quite a bit 3: Very much

Loneliness

RIGHT NOW, I am feeling LONELY:

0: Not at all 1: A little bit 2: Quite a bit 3: Very much

Sadness

RIGHT NOW, I am feeling SAD:

0: Not at all 1: A little bit 2: Quite a bit 3: Very much

Energy

RIGHT NOW, my ENERGY LEVEL is:

0: Low 1: Somewhat Low 2: Neutral 3: Somewhat high 4. High

Examining IAQ's Effect on Mood

Determine if median IAQ parameter is “poor” or “satisfactory”:

Parameter	Threshold	From	Notes
TVOC	200 ppb	WHO	Twice sensory irritation
CO ₂	1100 ppm	ASHRAE	Based on Standard 62.2
PM _{2.5}	12 $\mu\text{g}/\text{m}^3$	US EPA	Half NAAQS annual exposure
Temperature	25.2°C (77.4°F)	This Study	median nightly concentration

Compare mood scores from EMAs submitted after periods with opposite IAQ conditions

Results

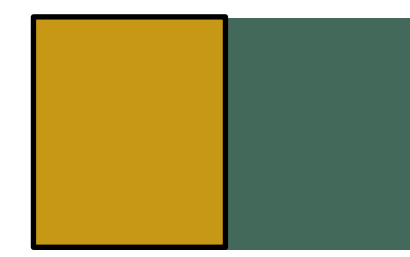
** $\alpha = 0.1$
 * $\alpha = 0.05$

CO₂

	Fair: n=269	Poor: n=117
Discontent	0.98	1.11 **
Stress	0.76	0.93*
Sad	0.33	0.54*
Lonely	0.35	0.57*

Mean Mood Response

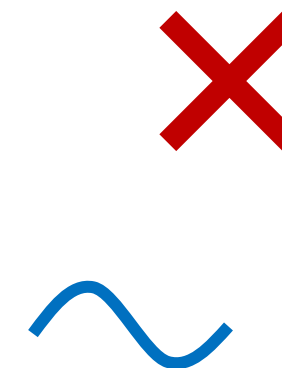
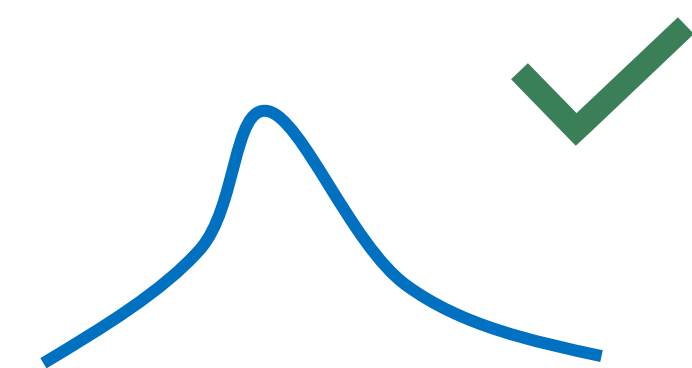
Effect of "Extreme" IAQ Events on Mood



Find Time at Home
Prior to submission



Identify IAQ Window
At most 4 hours
before submitting



Find Extreme IAQ
>2 σ above participant
mean

Results

** $\alpha = 0.1$
 * $\alpha = 0.05$

CO₂

Normal: n=495 Extreme: n=43

Discontent	0.96	1.16**
Stress	0.81	1.0**
Sad	0.45	0.47
Lonely	0.44	0.30

PM_{2.5}

Normal: n=541 Extreme: n=52

Discontent	0.93	1.31*
Stress	0.76	1.02*
Sad	0.39	0.65*
Lonely	0.42	0.60*

TVOC

Normal: n=500 Extreme: n=42

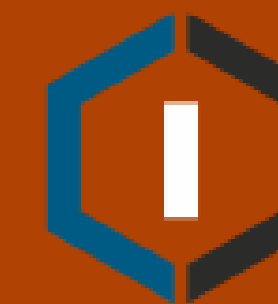
Discontent	0.93	0.79
Stress	0.79	0.62
Sad	0.43	0.43
Lonely	0.50	0.38

Temperature

Poor: n=133 Extreme: n=246

Discontent	0.93	1.15**
Stress	0.75	0.82
Sad	0.34	0.33
Lonely	0.45	0.48

Mean Mood Response



Conclusion

Limited work assessing relationship between mood and IAQ

CGS for IAQ applications provide advantages over reference monitors:

- Affordability
- Scalable
- Availability
- Hassle
- Application

Elevated $PM_{2.5}/CO_2$ associated with **deterioration** in mood

Greater effect for $PM_{2.5}$ at more extreme measurements

Elevated TVOC associated with **improvement** in mood

Could be due to the complex mixture of compounds

Thank you!

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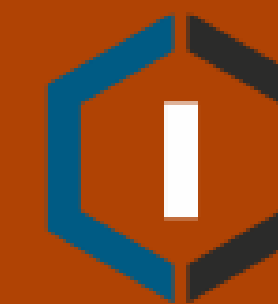
Dr. Cameron Craddock Robin Dara

Dr. Pawel Misztal

Anibal Heinsfeld

Melissa Miller

Reference Slides



Summary of Results

Decline in all four moods for **elevated CO₂**

- Only Discontent and Stress relationships remain for extreme events

Decline in all four moods for **extreme PM_{2.5}**

- Only Discontent and Stress relationships identified for poor concentrations

Improvement in Discontent, Stress, and Lonely for **elevated TVOC**

- **No** relationship between mood and extreme TVOC

Increase in Stress at **elevated Temperature**

Increase in Discontent at **extreme Temperature**