Impact of the Built Environment on the Neuroendocrine Immune Axis & Health: Implications for Green Building Design

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Disease: Neuroendocrine Stress Response
Out of Balance

Too Much
- Infection
- Vaccine take-rate
- Wound healing
- Cancer Growth/Angiogenesis
- Chromosomal Aging

Too Little
- Autoimmune/Inflammatory
- CVD
- Diabetes/Metabolic
- Osteoporosis
- Depression

Anti-inflammatory

Pro-inflammatory
Elements of Place
that can trigger the stress response:

• Noise
• Crowding
• Light - too much/too little
• Odors
• Mazes
Include Spaces to Reduce Stress & Enhance Wellbeing:

• Green - gardens, views of nature
• Social Support
• Exercise
• Contemplation, meditation, prayer
• Activities that engage the senses (art, music etc.)
Study Design

- 63 white-collar workers (39 women)
- Evaluation performed at work place
- 8 AM - 24 h

OLD WORK SPACE
(poor lighting & ventilation)
(n= 43)

NEW WORK SPACE
(improved airflow; natural light )
(n=20)

Thayer et al European J. Cardiovascular Prevention & Rehabilitation, 2010
Lower Stress/Higher Relaxation Response
New Space compared to Old Space

OLD office:
- night HF decreases
- day HF increases

NEW office:
- night HF increases
- day HF decreases

Diurnal Variation
HF HRV

Thayer et al European J. Cardiovascular Prevention & Rehabilitation, 2010
Lower Stress Response
New Space compared to Old Space

OLD office:
 rise in morning cortisol

Thayer et al European J. Cardiovascular Prevention & Rehabilitation, 2010
THE FUTURE
Draft Recommendations 11-12-13:

- Building labeling should report on potential stressors
  - Low hanging fruit: stay within known ranges of human comfort supporting health & wellbeing
    - e.g.
      - noise levels
      - temperature
      - air flow
      - light
      - pollutants etc.
  - Future labels: human responses to building IEQ in real time & place (tie metrics to the occupants rather than to building).
  - Recommend: future research to refine and define ranges.
## TABLE 3: Potential Measures to Assess Outcomes

<table>
<thead>
<tr>
<th>IEQ Factor</th>
<th>Suggested Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>Radiance Gun for air temperature</td>
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<tr>
<td></td>
<td>Ventilation rates, air change rate</td>
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<tr>
<td></td>
<td>Surface temperatures</td>
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<tr>
<td></td>
<td>Spot measures using portable data collectors</td>
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<td></td>
<td>In place data collectors for longer time periods</td>
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<tr>
<td>Light</td>
<td>Lux (iPhone app) for spot checks</td>
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<tr>
<td></td>
<td>Luminous ratios (IES Handbook)</td>
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<tr>
<td>Pollutants/VOCs</td>
<td>California 01350 List of Pollutants</td>
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<tr>
<td></td>
<td>CO2 monitoring</td>
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<tr>
<td></td>
<td>Aircuity monitor or other device</td>
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<tr>
<td>Acoustics</td>
<td>Decibels - dBA</td>
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<tr>
<td></td>
<td>Acoustic meter (iPhone app) for spot checks</td>
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<td></td>
<td>Acoustic consultant for more rigorous analysis</td>
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<tr>
<td></td>
<td>Behavioral observations to identify human inputs to acoustic conditions</td>
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</tbody>
</table>

### Human Health and Well Being

<table>
<thead>
<tr>
<th>Suggested Methods and Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort and satisfaction Center for the Built Environment on line survey</td>
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<td>Interviews, focus groups, walk-throughs</td>
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<td>Movement and exercise Pedometer to measure steps; behavioral observation; stairwell counters</td>
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<tr>
<td>Physiological Stress (Heart rate variability, salivary cortisol, non-invasive stress and</td>
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<td>immune biomarkers from sweat and skin); health surveys; light exposure (“daysimeter”);</td>
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<td>circadian effects (sleep quality)</td>
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<tr>
<td>Psychological Mood, subjective well being, happiness, alertness (survey instruments)</td>
</tr>
<tr>
<td>Organizational Engagement (Gallup Q12), complaint logs, turnover rates, absenteeism</td>
</tr>
</tbody>
</table>