Written in the body: What biomarkers reflecting brain-body communication can tell us about addiction recovery

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The importance of two-way communication between the brain and the heart during emotion has been known for over 100 years. Darwin, commenting on the work of the French physiologist Claude Bernard wrote:

“...and this deserves special notice, that when the heart is affected it reacts on the brain; and the state of the brain again reacts through the pneumo-gastric nerve (vagus) on the heart; so that under any excitement there will be much mutual action and reaction between these, the two most important organs of the body.” (Darwin, 1872).
Central Autonomic Network (CAN)

- Medial prefrontal cortex
- Insular cortex
- Amygdala
- Hypothalamus
- Parabrachial nucleus
- Nucleus of the solitary tract
- Preganglionic neurons in brainstem and spinal cord
- Primary motor neurons in autonomic ganglia
- End organs (smooth muscle, cardiac muscle, and glands)

Sympathetic
- Eye
- Salivary glands
- Larynx
- Trachea
- Lungs
- Heart
- Stomach
- Liver
- Bile duct
- Pancreas
- Adrenal medulla
- Kidney
- Intestines
- Uterus
- Bladder
- External genitalia

Parasympathetic
Because the CAN affects regulatory actions via the cardiovascular system, indices of neurocardiac processes provide reliable measures of dynamic emotion regulation processes.
Heart rate variability (HRV) reflects fine-grained, moment-to-moment changes initiated by the CAN in response to environmental and interoceptive stimuli.
• Bodily mechanism that, together with the CAN, generates HRV. Determines how well the body can respond to neural commands.

• Hypothesize that BRS is a mechanism that is protective by increasing HRV and stress resilience, and reducing HR, cue reactivity and craving (↓ sympathetic activity)
Alcohol impairs feedback between the brain and body

- Increases sympathetic arousal, as measured by heart rate and muscle sympathetic activity (Buckman, Eddie et al., 2015; Eddie et al., 2013; van de Borne, Mark, Montano, Mion, & Somers, 1997)

- Decreases parasympathetic vagus nerve activity, as measured by heart rate variability (Buckman, Eddie et al., 2015; Eddie et al., 2013; Levanon, Goss, & Chen, 2002; Reed, Porges, & Newlin, 1999)

- Negatively influences blood vessels (Bau et al., 2007)

- Dampens baroreflex sensitivity (Buckman, Eddie et al., 2015; Romanowicz et al., 2011; Bar et al., 2006)
Log Baroreflex Sensitivity

Bates et al., Unpublished

Notes, **p < 0.001, ***p < 0.0001; tslope = baroreflex sensitivity to tachycardic events; JSDsym = joint symbolic dynamics sympathetic
Acamprosate (Campral) may reduce alcohol use/craving by restoring autonomic balance.
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- Physiological reactivity to craving induction before and after three weeks of medication in adults with alcohol use disorder.
- Left bar represents cue-exposure session 1, right bar cue-exposure session 2.
- HR = heart rate, SCL = skin conductance level

Prazosin also reduces alcohol use/craving

Noradrenergic targets for the treatment of alcohol use disorder

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Prazosin Effects on Stress- and Cue-Induced Craving and

Double-Blind Randomized Clinical Trial of Prazosin for

A Randomized, Placebo-controlled, Clinical Trial of Prazosin for the Treatment of Alcohol Use Disorder

Claire E. Wilcox, MD, J. Scott Tonigan, PhD, Michael P. Bogenschutz, MD, Joshua Clifford, BA, Rose Bigelow, MS, and Tracy Simpson, PhD

- Significant group x time interaction. Prazosin associated with greater reductions in number drinks and heavy drinking days.

Prazosin also reduces alcohol use/craving
Prazosin reduced DBP during cue exposure (main effect, $p = 0.01$), and resulted in decreased DBP reactivity to alcohol, vs. neutral cues ($p = 0.0003$).

Prazosin reduced alcohol craving during cue exposure (main effect, $p = 0.0001$).

Trend observed for prazosin reducing SBP (main effect, $p = 0.06$).

Prazosin reduced DBP during cue exposure (main effect, $p = 0.01$), and resulted in decreased DBP reactivity to alcohol, vs. neutral cues ($p = 0.0003$).

Prazosin was associated with greater rates of reduction in drinking compared with placebo in individuals with high, but not low diastolic blood pressure.

Before and After

Blue = Respiration

Red = Heart Rate

Regular Breathing
(Chaos)

Paced Breathing
(Resonance)
Heart Rate Variability
Biofeedback Apps
Control

Craving scores < 4

Craving

Control

Craving scores 4-6

Craving

Control

Craving scores 8+

Craving

Experimental

Craving scores < 4

Craving

Experimental

Craving scores 4-6

Craving

Experimental

Craving scores 8+

Craving

Experimental

β = −0.08 (0.17)

β = −0.22 (0.07)*

Take Home Points

- Brain/body communication plays an important role in addiction and addiction recovery.
- Need to be considering the brain/body relationship in the addictions treatment space (not just the brain).
- Treatments exist that can buffer relapse risk by restoring autonomic balance.
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