Mellanby Effect, Retrograde Extrapolation, and Homeostasis

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SEATTLE AQUARIUM


ONLY

RESULT ↓ /YEAR →	2018	% of 2018 total	2019	% of 2019 total	2020	%of 2020 total
Alcohol Only	221	33%	231	32%	138	26%
THC Only includes Carboxy THC	72	11%	53	7%	56	10%
DRUGS Only = all hits other than THC or Alcohol (heroin, Meth, Rx, etc…)	126	19%	139	19%	143	27%
Alcohol & THC	109	16%	102	14%	84	16%
Alcohol & DRUGS	38	6%	55	8%	34	6%
THC & DRUGS	56	8%	60	8%	51	9%
Alcohol & THC & DRUGS	20	3%	27	4%	16	3%
Nothing Detected	30	4%	49	7%	16	3%
Total Blood Draws Conducted Yearly	672	100%	716	100%	538	100%
NOTES:	This was the first year this data was kept and compiled.		As of 2/16/22, there are still a couple of results still outstanding.		As of 2/16/22, there are still a couple of results still outstanding.	
Commentary:	These blood draws are the result of: 1) the driver crashed and/or went to the hospital for some reason reasonable grounds to believe drugs were the impairing factor so they sought and were granted a sea with the breath test and left the officer chose to seek a Search Warrant for their blood. It should be no screened for alcohol and/or THC unless otherwise dictated by a Tox Lab request. This may account for					
Total Blood Draws positive w/THC & Drugs	254	38%	252	35%	250	46%
Total Blood Draws positive w/Alcohol & Drugs	385	57%	474	66%	331	62%
Total Blood Draws Postive for THC	257	38%	242	34%	207	38%
Total Blood Draws Positive for Alcohol	388	58%	415	58%	272	51%
Total Blood Draws Postive for Drugs	240	36%	281	39%	244	45%

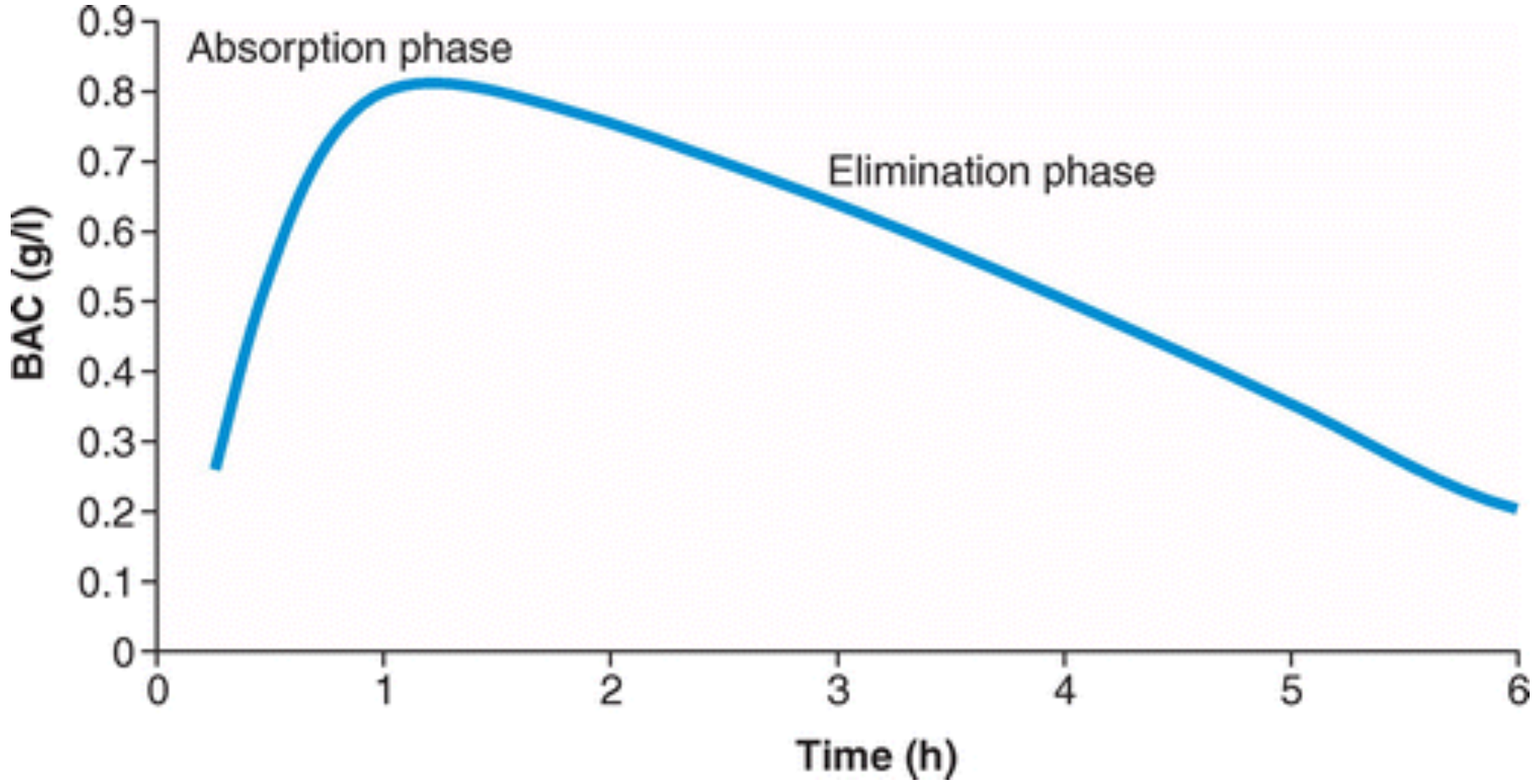
- Former Washington State Traffic Safety Prosecutor Miriam Norman was the creator of the original Mellanby and Homeostasis presentation.
- Opinions here are not necessarily those of the Washington State Traffic Safety Commission, the City of Seattle, or the Seattle Police Department.

Goals by the End of Class

Be able to understand and discuss:

1) The “biphasic” nature of alcohol intoxication
2) Zero order kinetics and retrograde extrapolation
3) Homeostasis as a “negative feedback loop”
4) Putting it all together: Overcoming obstacles in jury trials

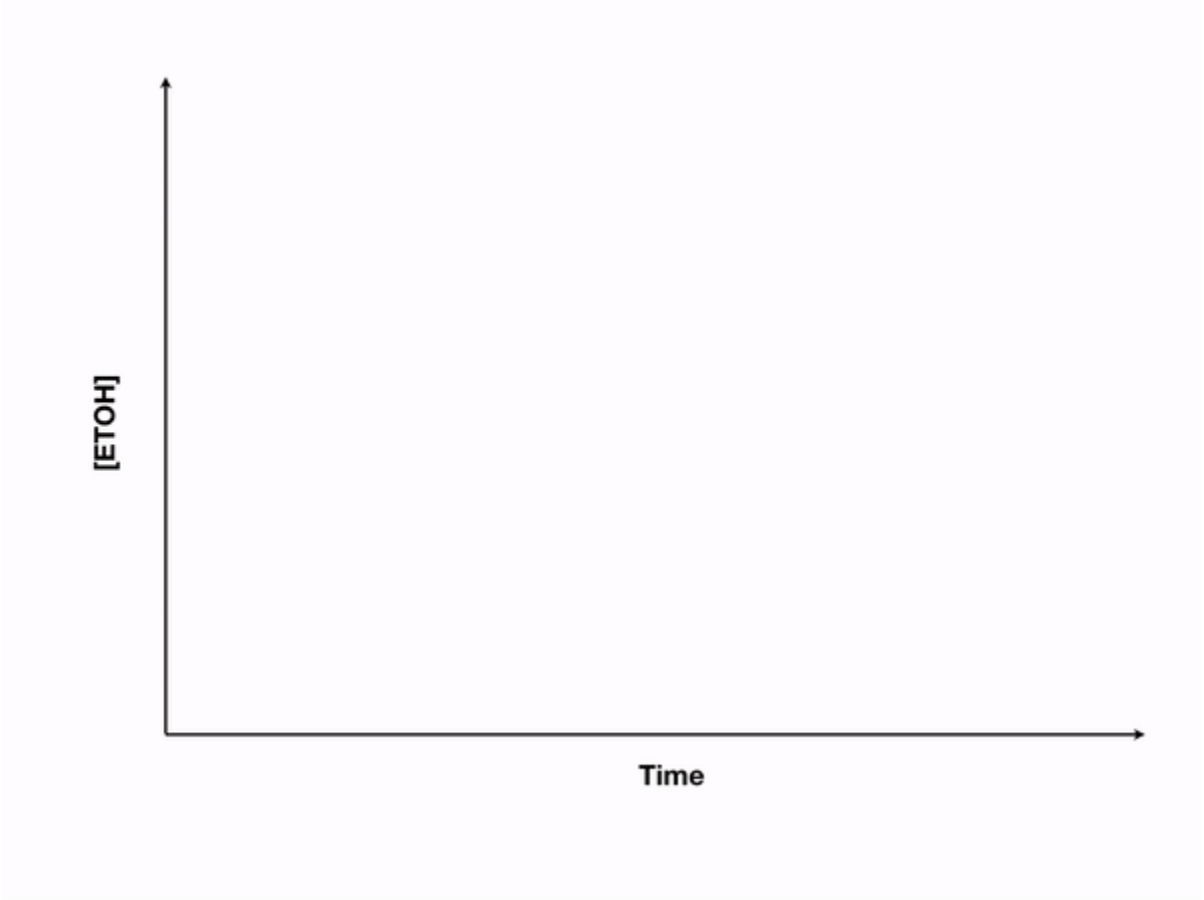
Two Phases of Blood Alcohol Concentration



Sir Edward Mellanby

(1884 –1955)

The Mellanby Effect



Mellanby Effect

- Alcohol negatively affects physical and cognitive performance, and has a differential effect on the descending versus the ascending limb of the BAC curve.

Mellanby Effect

- “Acute Tolerance”
  - The phenomenon that some impairments due to alcohol are decreased, at the same BAC, when the BAC is decreasing than when it is increasing.
    - Subjective state improved
    - Performance in a maze task improved
    - Performance in a peg board task improved
    - Arithmetic ability improved
    - Attempts at abstraction improved
    - Reaction times at certain tasks improved

Willingness to drive increased!

“Acute Tolerance”

- This term is problematic
- If you keep someone at the same BAC for six hours, problems remain with:
    - Sway
    - Keeping simulated airplane on a centerline
    - Eye tracking
    - Feelings of subjective intoxication
    - Response inhibition to a ‘go/no go’ test (actually deteriorated over time)

Mellanby Effect

Is driving better on the descending limb?

- No. It is worse. For example:
  - Lane deviation increased
  - Line crossing increased
  - Speed deviations increased
  - Speed excesses increased

- Inhibitory Controls worse on descending limb:
  - Cued go or no-go response accuracies worse
  - Executive cognitive functioning (planning, abstract reasoning, capacity to govern self-directed behavior) worse.

Probability Discounting

- Do you overvalue less likely but larger rewards?
  - Would you rather have $50 for certain, or a 90% chance of $100?
  - Would you rather have $50 for certain, or a 75% chance of $100?
  - Would you rather have $50 for certain, or a 50% chance of $100?
  - Would you rather have $50 for certain, or a 25% chance of $100?
  - Would you rather have $50 for certain, or a 10% chance of $100?

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Probability Discounting

- Risky decision-making occurred more for men and women during the descending limb of the BAC curve
- Men did it more

Biphasic Effects of Alcohol on Delay and Probability Discounting (2013) L. Cinnamon Bidwell, PhD, James MacKillop, PhD, James G. Murphy, PhD, Andrea Grenga, BA, Robert M. Swift, PhD, MD, and John E. McGeary, PhD

So?

1) On the descending limb, a drinker feels less intoxicated, will make riskier decisions, and is a worse driver.

Elimination Phase

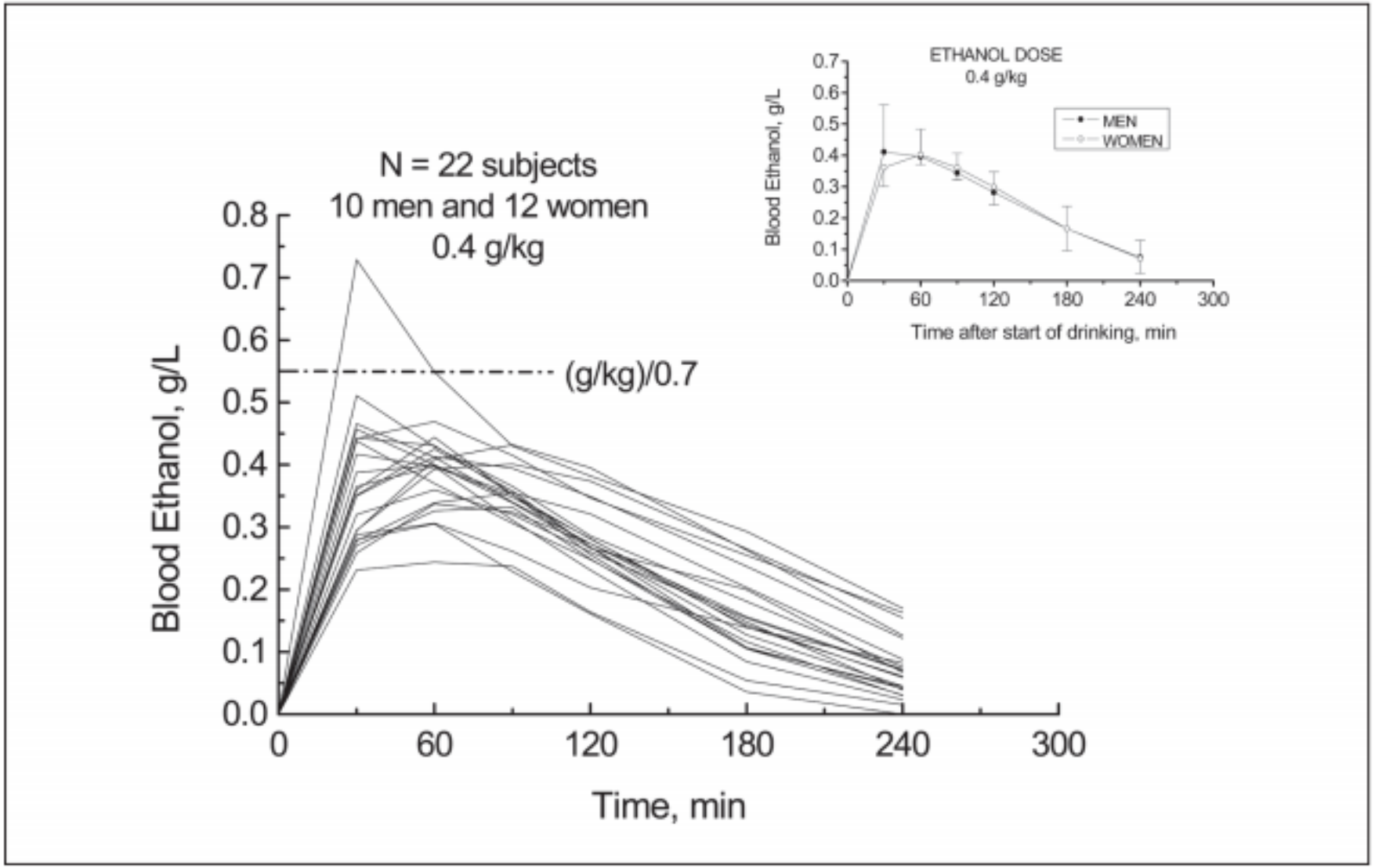


Figure 3.26 *Concentration-time profiles of ethanol in venous blood from 10 men and 12 women after they consumed 0.4 g ethanol per kg body weight about two hours after their last meal. The mean curves are shown as an insert (top right). The dotted horizontal line is the BAC expected for the dose of ethanol assuming a rho factor of 0.7 independent of gender (Fransson et al., 2005).*

Retrograde Extrapolation – The Cop Version

Approximately .015 per hour

Retrograde Extrapolation

We already knew that people on the descending limb feel less intoxicated

We now also know that metabolization is a slow and steady process

So, people tend to overestimate how rapidly they reach sobriety

Retrograde Extrapolation – Practice #1

Tom used to do triathalons as a coping mechanism. But he hurt his leg and can't run anymore.

Tom has no other healthy coping mechanisms.

Tom goes to the bar. He reaches a peak BAC of .15. As soon as he starts the elimination phase, he knows he is too drunk to drive so he falls asleep in his car. Four hours later he wakes up, and feels "totally fine, dude."

What is Tom's BAC?

Retrograde Extrapolation – Practice #2

Tom still can't cope. Tom gets in a collision and flees the scene. The police show up at Tom's house.

Tom is drunk, and tells the cops that he had three beers after he got home, He shows police the bottles. which based on their alcohol content and Tom's weight, each would raise his BAC approximately .02 per bottle.

Tom twirls his moustache and cackles manically, believing himself to be a criminal mastermind.

Tom gives a PBT of .150 BrAC.

Can Tom still get convicted of DUI?

$$BAC = \frac{A_{ingested}\left(1 - e^{-kt}\right)}{rW} - (\beta t)$$

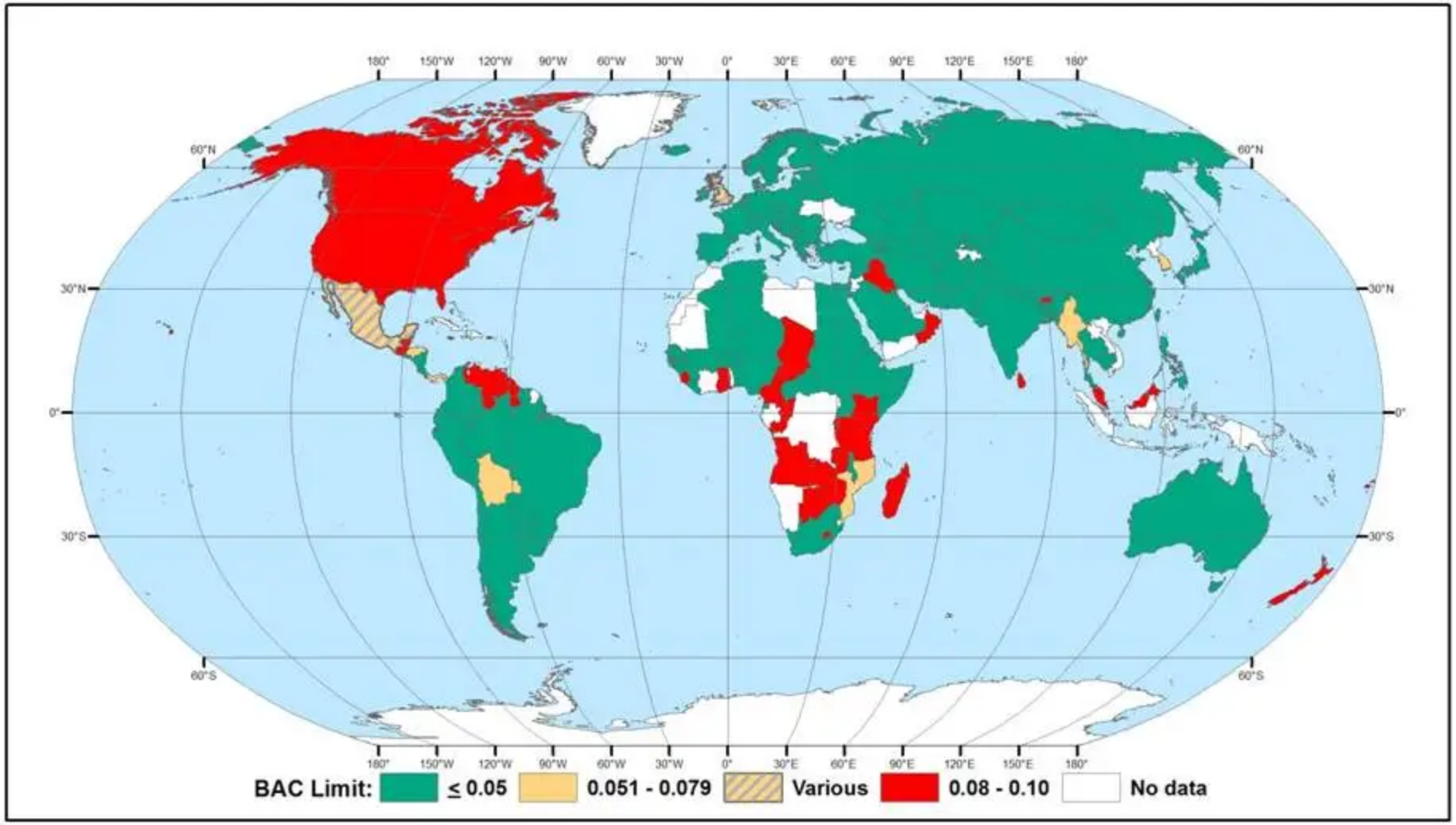
Widmark

- BAC = Blood Alcohol Content (g/l)
- t = time since consumption
- A = Mass of pure ethanol in a drink
- r = “Widmark factor,” which varies by sex and other factors
- W = body weight
- k = rate of alcohol consumption (h-1)
- B = alcohol elimination rate ((g/l)/h)

BACs Below .08

- Social and controlled behaviors are impaired at .030 - .049
- Divided attention and visual functions including tracking are impaired at BACs of .010 - .020
- There are psychological implications of having a per se level of “.08”

BAC Limits World Wide



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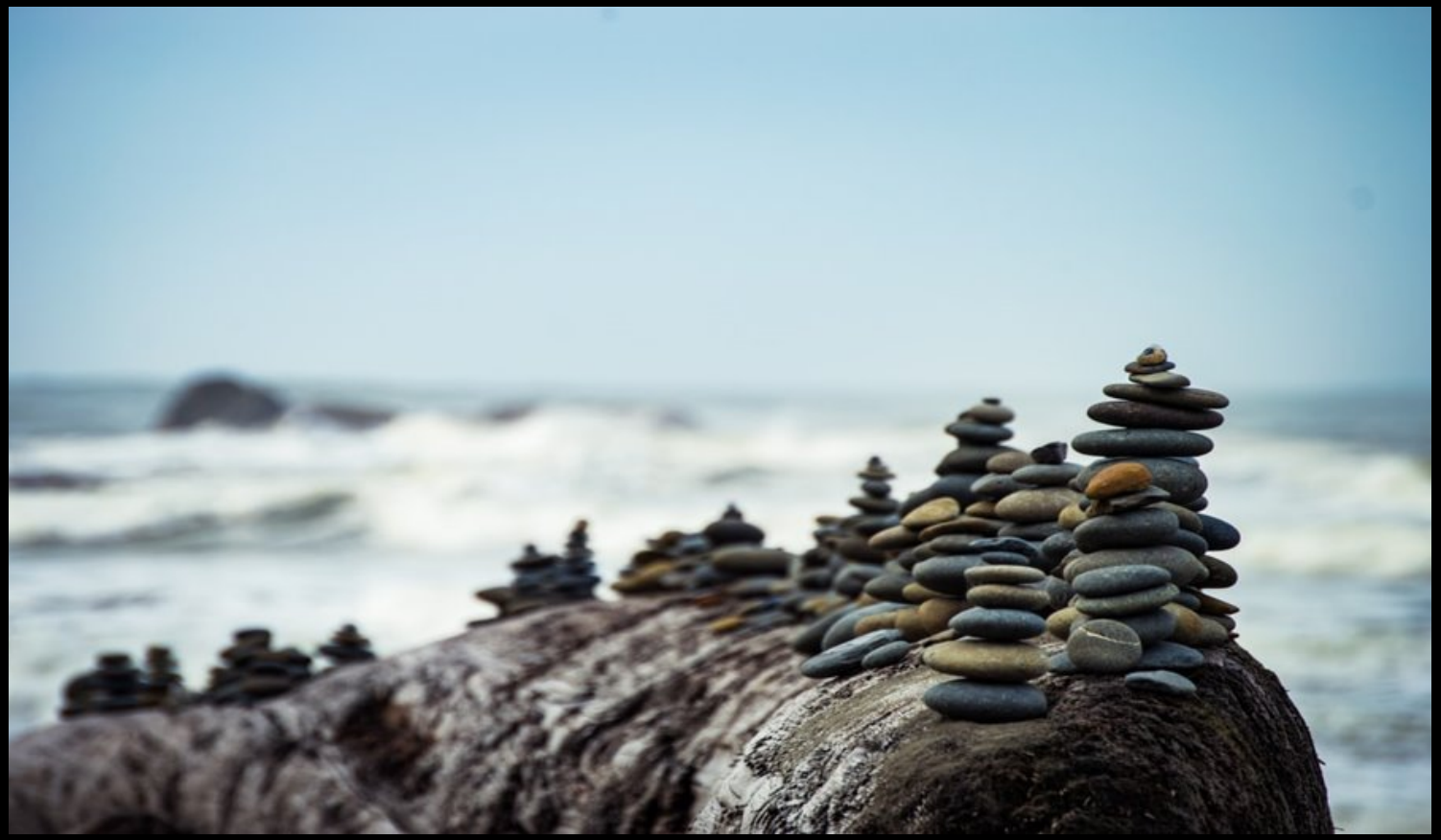
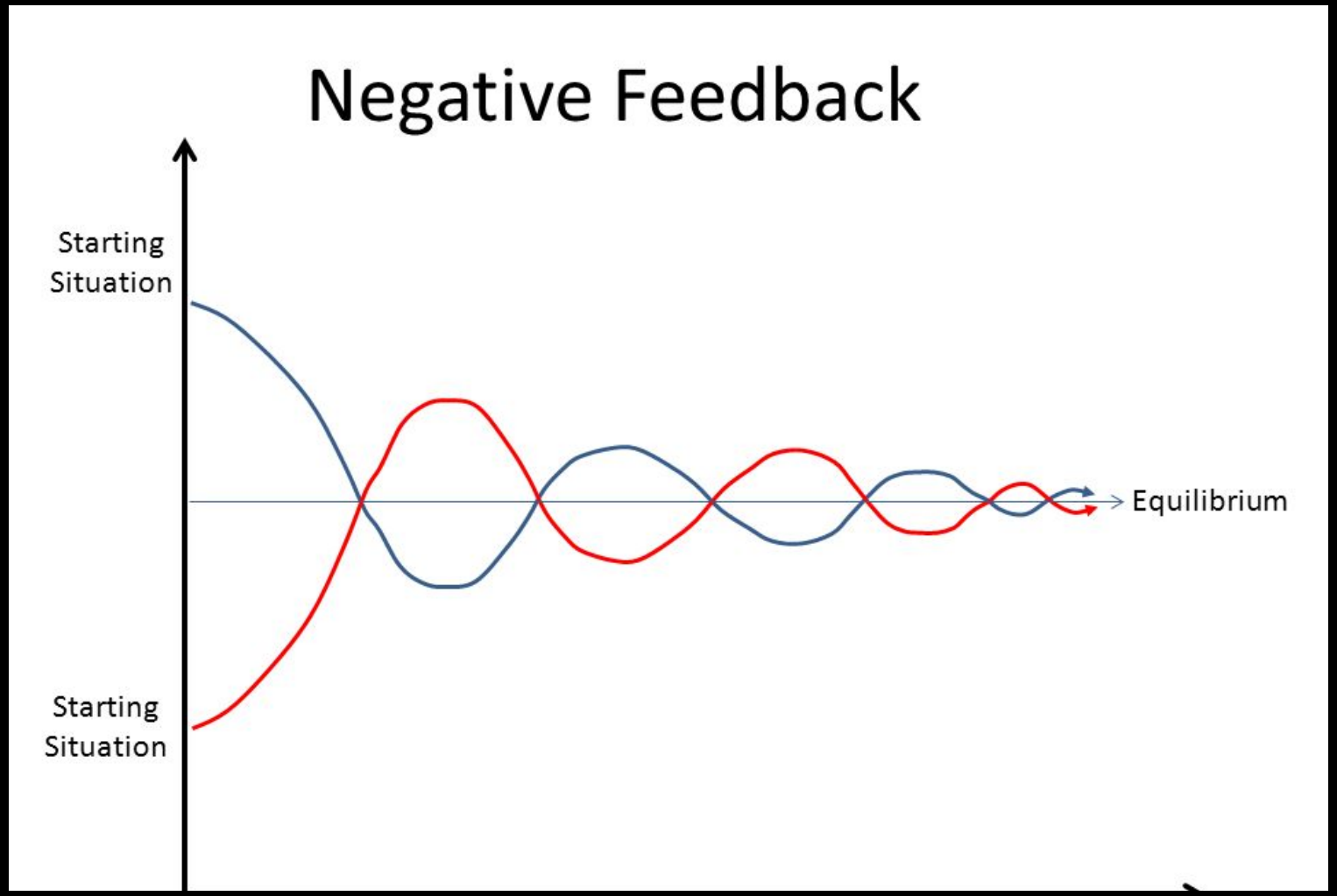
$$BAC = \frac{A_{ingested}\left(1 - e^{-kt}\right)}{rW} - (\beta t)$$

2) People overestimate how soon they are sober. Toxicologists can calculate a BAC at a point in time in the elimination phase. People are impaired at BACs below .08.



- Thermoregulation
- Glucose regulation
- Hydration regulation
- Blood chemistry
  - Minerals
  - Electrolytes
  - Acidity
- Hormones
- Effects of drugs

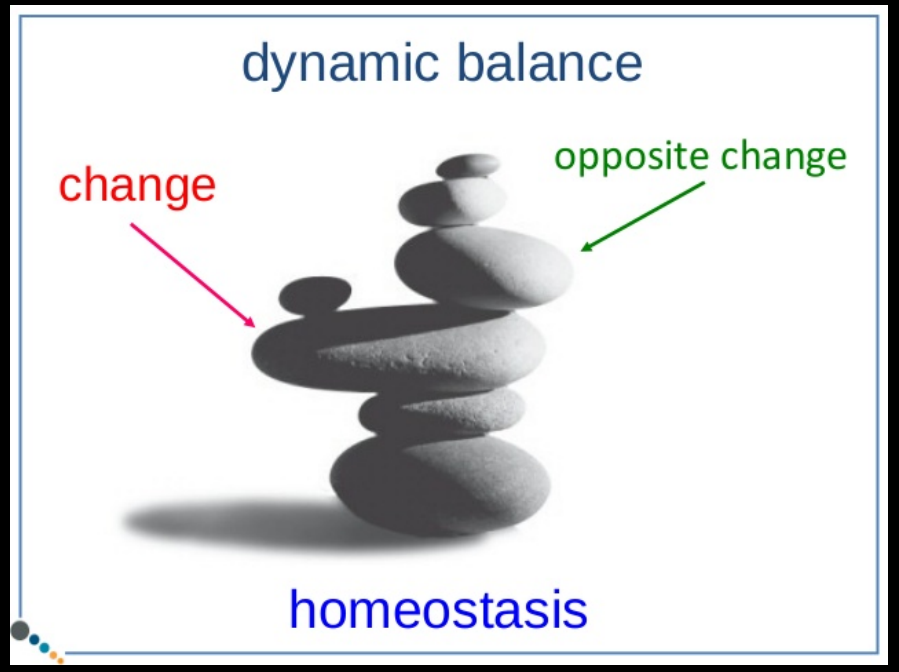
Homeostasis

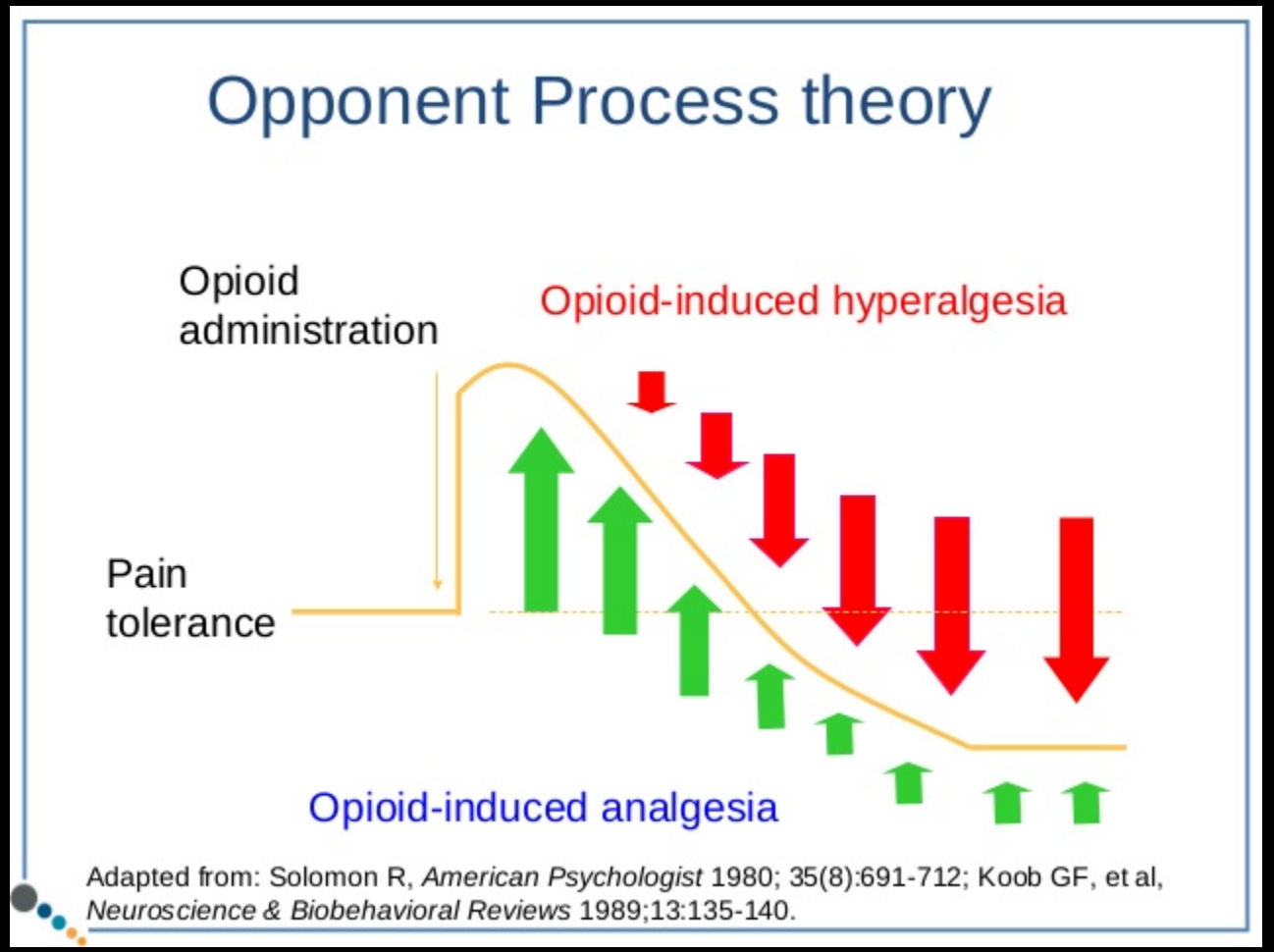


Negative Feedback – An Organism's Braking System

Clinical Example

- Opioid-induced hyperalgesia





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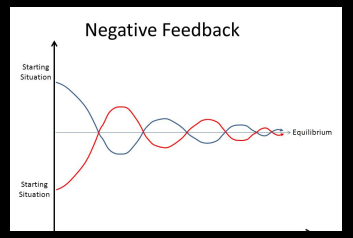

3) The body overshoots on its way to equilibrium, and uses negative feedback to approach the baseline.

Obstacles in Jury Trials

Physical Control

- What can we observe?
- What reasonable inferences can we make?
- Is this safe?

Juries

- What do jurors think about these cases?

Juries

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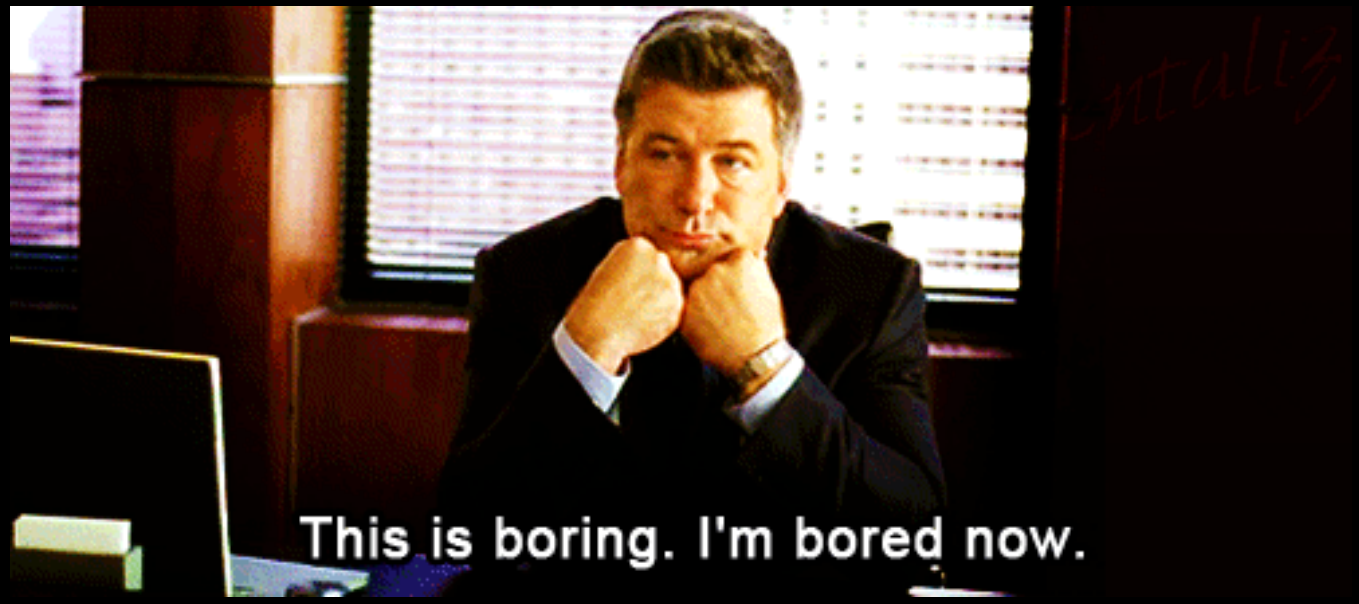

Juries

- What do jurors think about these cases?
- What are the obstacles to effectively influencing jurors in these cases?
- What is at stake?

Juries

- What are some keys to overcoming lack of interest and lack of understanding?
  - Multimedia
    - Tactile Evidence
    - Drawings
    - Videos
    - Photographs
  - Effective Explanations
    - Specific examples
    - Presentation techniques
  - Analogies
    - “Highway effect”
    - “Adrenaline dump”

DRE Matrix

- "Negative Feedback" applies to some indicators
- Many of these indicators can be related directly to impairment.

	CNS Depressants	CNS Stimulants	Hallucinogens	Dissociative Anesthetics	Narcotic Analgesics	Inhalants	Cannabis
HGN	Present	None	None	Present	None	Present	None
Vertical Gaze Nystagmus	Present (High Dose)	None	None	Present	None	Present (High Dose)	None
Lack of Convergence	Present	None	None	Present	None	Present	Present
Pupil Size	Normal (1)	Dilated	Dilated	Normal	Constricted	Normal (4)	Dilated (6)
Reaction to Light	Slow	Slow	Normal (3)	Normal	Little or None Visible	Slow	Normal
Pulse Rate	Down (2)	Up	Up	Up	Down	Up	Up
Blood Pressure	Down	Up	Up	Up	Down	Up/Down (5)	Up
Body Temperature	Normal	Up	Up	Up	Down	Up/Down/ Normal	Normal
Muscle Tone	Flaccid	Rigid	Rigid	Rigid	Flaccid	Normal or Flaccid	Normal

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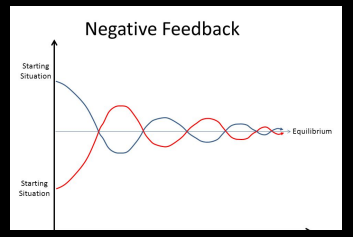

3) The body overshoots on its way to equilibrium, and uses negative feedback to approach the baseline.

4) Impaired people in physical control are likely to drive impaired. It can take extra effort to get a jury to understand impairment, and why they should care.

Questions?