The Art & Science Of Satiety

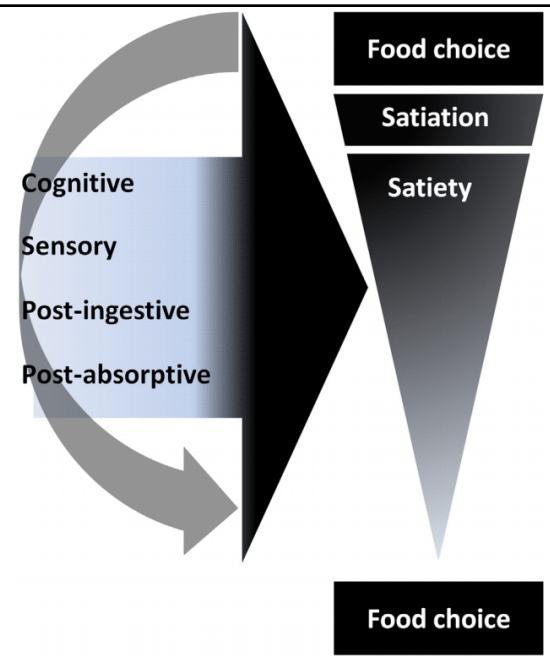
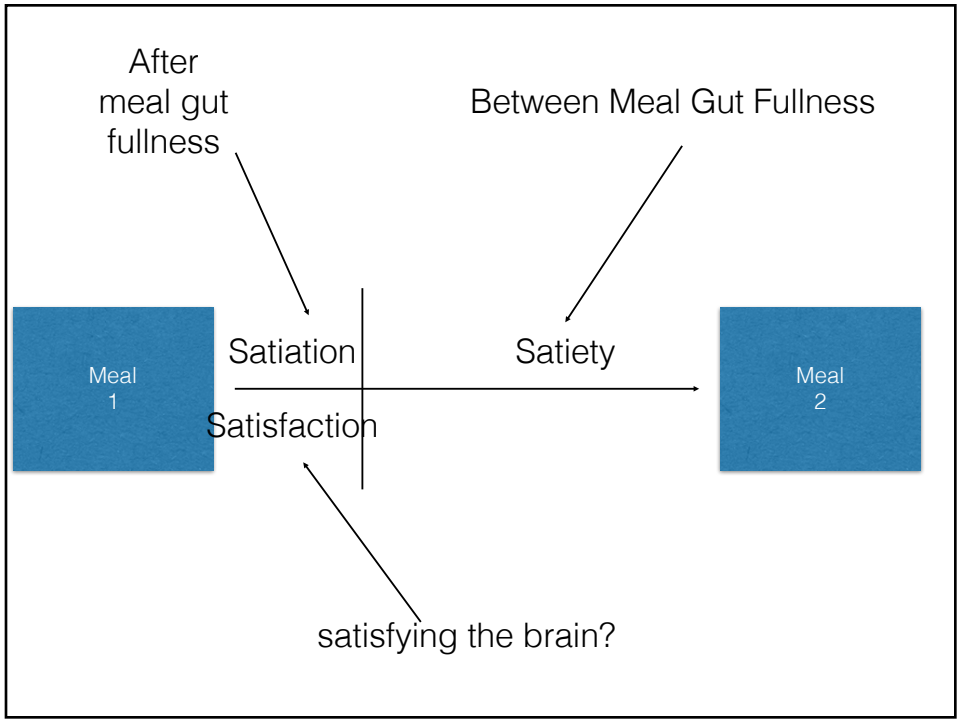
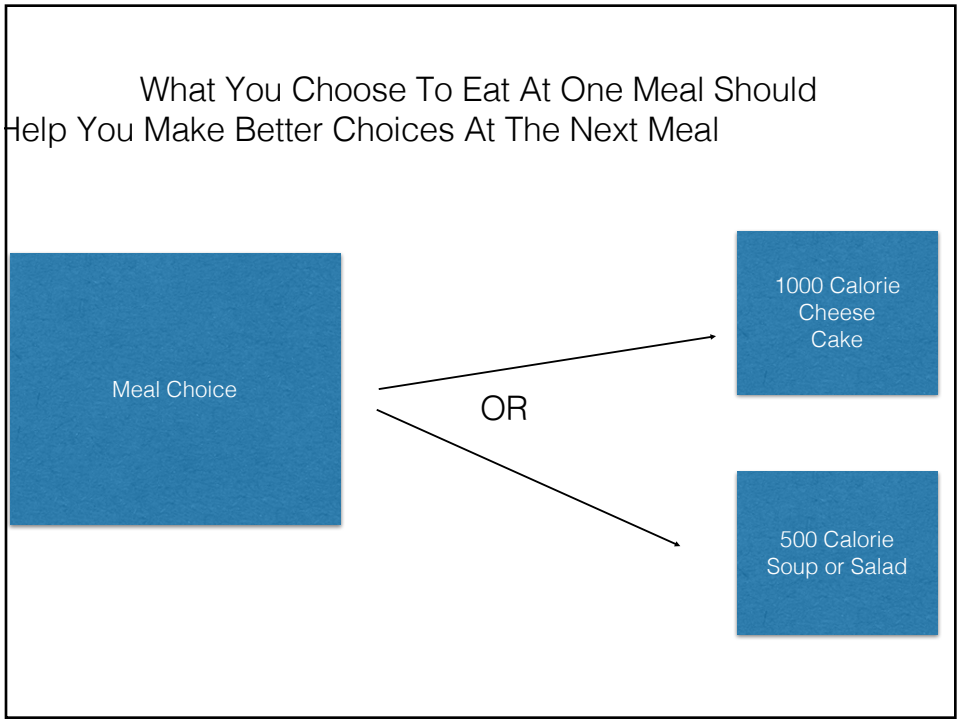


Fig. 1. The satiety cascade. Adapted from Blundell *et al.* (1987).


After
meal gut
fullness
Between Meal Gut Fullness
Meal
1
Satiation
Satiety
Meal
2
Satisfaction
satisfying the brain?


What You Choose To Eat At One Meal Should
Help You Make Better Choices At The Next Meal
Meal Choice
OR
1000 Calorie
Cheese
Cake
500 Calorie
Soup or Salad

What you eat, or don't eat at one meal, directly impacts what you crave to eat and how much you eat at the next meal

Helpful way to think of this?

Satiation is about short term fullness in the gut
Satisfaction is about short-term pleasure in the brain
Satiety is about long-term absence of hunger and cravings

What To Eat

- Quick Satiation
- Maximum Satiety
- Minimum Calories
- Maximum Nutrition

Huge Variability

- Which Macro Satiates, Produces Satiety & Satisfies?
- Which meals?
- Start With The Research Then Tweak
- Test Your Meals

Example

- Salty Fatty Breakfast= Cravings
- Not eating or coffee help in morning
- Small Amount Of Starch In Morning is Good
- Must Focus On Heavier Protein & Fat At Night

Buffer Foods I Trigger Foods

Any food, "junk food"
or not that helps you eat better

Any food, "health food"
or not that makes you eat worse

Me

Context, Expectations & Habit

As soon as you think about a meal the process starts

Context

- Where are you eating
- Who are you eating with
- How big are the plates
- Have you eaten here before
- What are other people ordering
- Is it loud or quiet, relaxing or stressful

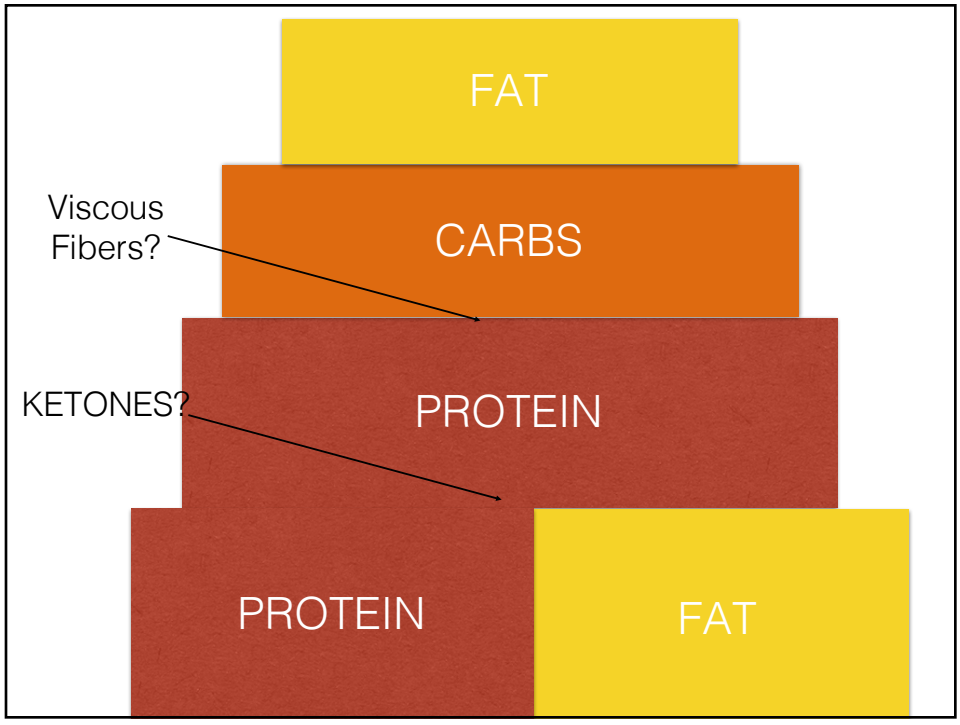
Everything Influencing:

1) Where You Are Eating
2) The People You Are Eating With
3) Your Past Experience Eating…with these people, these thin
4) How Big Is Your Plate
5) What Is On Your Plate…. Macros, Texture, Serving Size
6) What Did You Eat At Your Last Meal
7) How Fast Are You Eating
8) What Mental Emotional State You Are In
9) How Present Are You

Before Or After A Workout?
Halo Effect? Increased Hunger?

Me

Macronutrient Effects:
Carbs, Protein & Fat



Protein/Fat > Protein > Fiber Carbs > Fats

Me

Textures

Textures

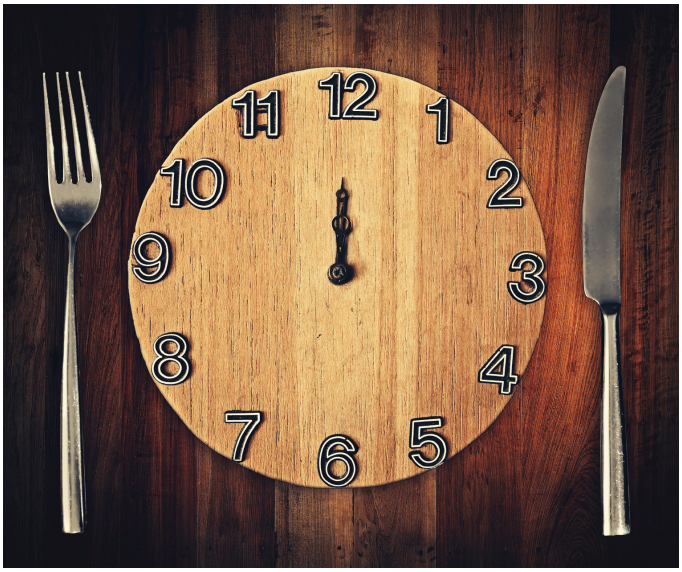
- Crunchy
- Airy
- Creamy
- Viscous
- Chewy
- Heavy
- Light

Flavors

- Salty
- Sweet
- Savory (Umami)
- Bitter
- Sour

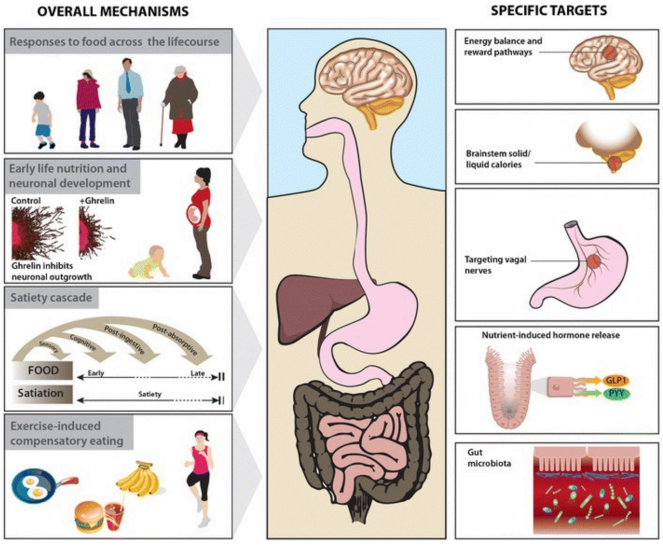
Me

Preloads, Meal Timing & Meal Order


12
1
2
3
4
5
6
7
8
9
10
11

Me

High Palatable, Calorie Dense, Hedonistic Foods


OVERALL MECHANISMS
SPECIFIC TARGETS
Responses to food across the lifecourse
Early life nutrition and neuronal development
Control
+Ghrelin
Ghrelin inhibits neuronal outgrowth
Satiety cascade
Cephalic
Gastric
Post-digestive
Post-absorptive
FOOD
Satiation
Early
Late
Satiety
Exercise-induced compensatory eating
Energy balance and reward pathways
Brainstem solid/ liquid calories
Targeting vagal nerves
Nutrient-induced hormone release
GLP1
PYY
Gut microbiota

The Art & Science Of Satiety

- Food expectation, along with texture sensations along with stretch receptors in the stomach and nutrient sensing cells in the intestines all converge together on the brain.
- Signals from the fat tissue (leptin) and other organs send signals to the brain as to stored fuel
- What you have stored and what you eat determine your overall hunger hour to hour and day to day.

- Satiation is after meal fullness
- Satiety is between meal fullness
- Environmental cues such as context, expectations, setting, serving size, plate size, color, smell, texture and others determine response of food before you even swallow.
- Palatable foods stimulate the reward center of the brain making you more likely to crave more of those foods

- Brain makes an analysis based on cost, convenience and calorie density of foods
- Brain seeks the cheapest, most convenient and calorie dense foods it can find
- The reward centers and cost/convenience processing push the brain towards fast-foods
- More variety, more flavor, more textures of food all drive us to overeat

- In terms of satiation and satiety of macronutrients Protein > Carbs > Fat
- Fat is least satiating
- Fat + protein MAY be greater than either separately
- Ketones are satiating on a par with protein and may be the reason low calorie diets work.
- Fiber (only the viscous kind) is very satiating
- Water, because of the volume effect, is satiating.

- Eat as much protein, fiber and water as possible (this gives a large volume with low calories)
- Eat moderately palatable food (enough, but not too much, fat, sugar salt, alcohol).
- Avoid highly palatable foods (combine large amounts of sugar, fat, starch, salt, and/or alcohol)
- Use Preloads when needed to control hunger
- Eat buffer foods and avoid trigger foods

Ketogenic Diets.

- Human metabolism is a flexible and adaptive machine
- During states of low food intake and starvation ketosis was used to feed the brain
- Ketones have powerful metabolic effects
- Stabilize neurons, decrease reactive oxygen species, alternative source of fuel, stabilizes DNA (histone deactylase), anti-aging, increased recovery and increased performance.

- Ketones are produced in very low levels as a natural consequence of metabolism
- As blood sugar (glucose) falls the brain requires energy. Since the brain can only use glucose or ketones for energy (not fat), the body generates ketones
- Ketones are made in the liver from fatty acids and amino acids
- The three main ketones are Acetoacetate (AcAc), beta-hydroxybutyrate (BHB)…not technically a ketones) and Acetone.

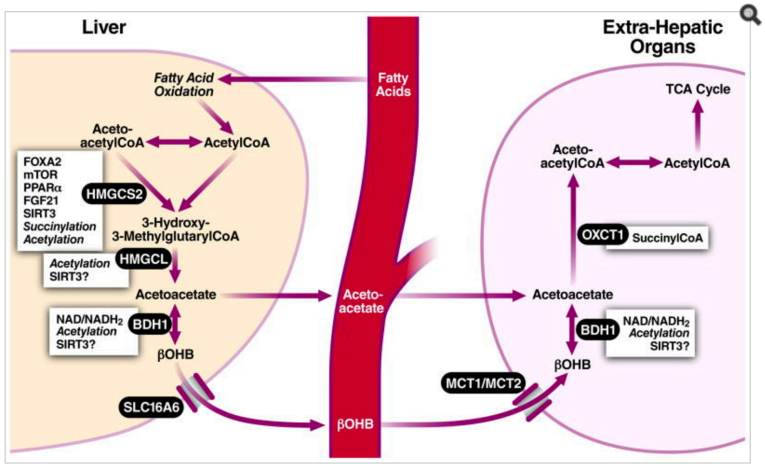
- Ketonuria = ketones in the urine
- Ketonemia = ketones in the blood
- AcAc is measured in the urine, BHB is measured in the blood, acetone is measured in breath
- BHB is the major ketone in the blood and the one with the major benefits
- Measuring ketone production with urine dip-sticks is an unreliable means of determining ketosis because it measures AcAc NOT BHB and the two don't always correlate

- True nutritional ketosis is 1-3mmol blood levels.
- Acetone does correlate with BHB levels and therefore a ketone breath meter can be used (i.e. ketonix)
- Preferred measuring comes through blood (precision XL dual glucose & ketone monitor)
- Ketoacidosis is a state where there is high blood glucose (>120) AND high ketones (>10mmol).
- Nutritional Ketosis is a state where blood glucose is normal to low (70-100) and blood ketones and moderate 1-10 mmil)

- A very low carb diet (VLCD)…different then a low carb diet (LCD)
- 05% Carb 20% Protein 75% Fat
- Individuals vary on how low carbs must be in order to reach true nutritional ketosis (typically less than 50mg/dl)
- MUST MEASURE

- 2000 calories of stored glycogen= 2-3 days to deplete
- Too much protein= gluconeogenesis (do NOT overdo protein)
- When in doubt, eat more fat.

Figure 1



Outline of ketone body metabolism and regulation

The key irreversible step in ketogenesis is synthesis of 3-hydroxy-3-methylglutaryl-CoA by HMGCS2. Conversely, the rate limiting step in ketolysis is conversion of acetoacetate to acetoacetyl-CoA by OXCT1. HMGCS2 transcription is heavily regulated by FOXA2, mTOR, PPARα, and FGF21. HMGCS2 activity is post-translationally regulated by succinylation and acetylation/SIRT3 deacetylation. Other enzymes are regulated by cofactor availability (e.g., $NAD/NADH_2$ ratio for BDH1). All enzymes involved in ketogenesis are acetylated and contain SIRT3 deacetylation targets, but the functional significance of this is unclear other than for HMGCS2. Although ketone bodies are thought to diffuse across most plasma membranes, the transporter SLC16A6 may be required for liver export, while several monocarboxylic acid transporters assist with transport across the blood-brain barrier.

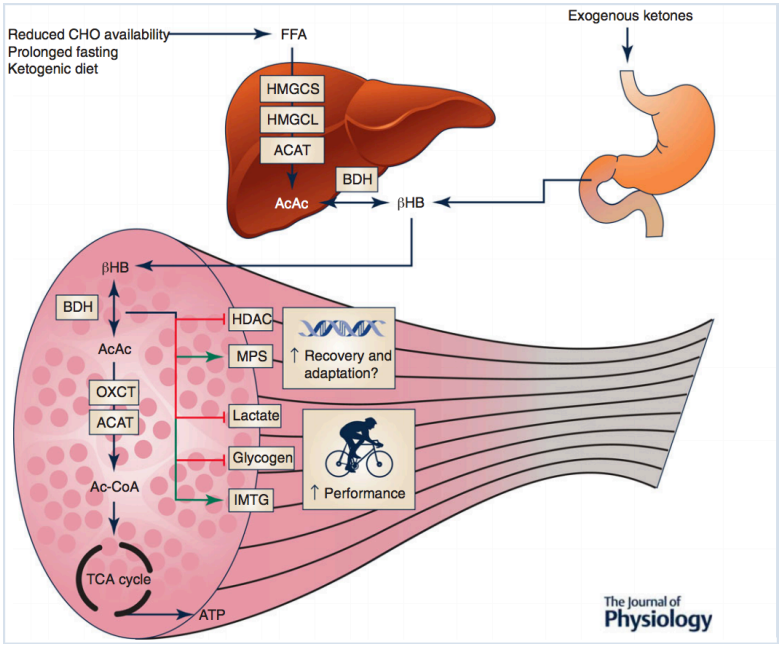
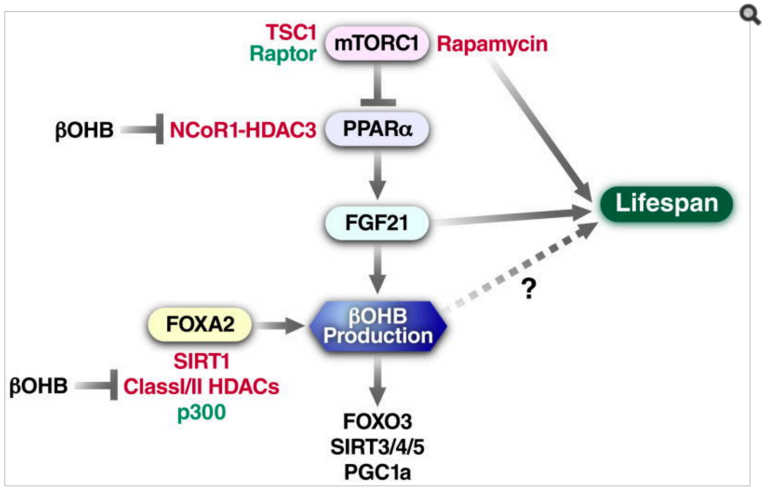


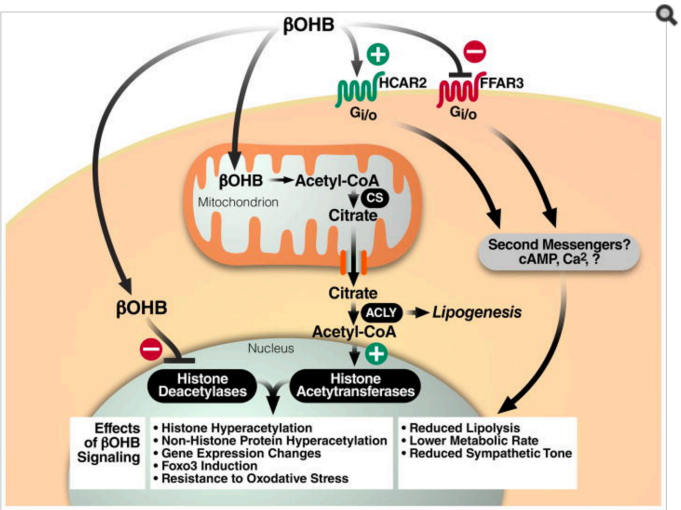
Figure 2



Intersection of longevity pathways and regulation of βOHB production

βOHB production is controlled by at least two nutrient-responsible pathways that are implicated in longevity and may be subject to regulation by βOHB via HDAC inhibition. Rapamycin and down-regulation of the mTOR pathway promote ketogenesis; rapamycin and FGF21 enhance mammalian longevity. FOXA2 also enhances ketogenesis, and its activation is regulated by both class III (sirtuins) and class I/II HDACs.

Figure 3



Cellular signaling mediated by βOHB

βOHB is a ligand for at least two cell-surface G-protein-coupled receptors that modulate lipolysis, sympathetic tone, and metabolic rate. In addition, βOHB alters protein acetylation through at least two mechanisms: increasing the cellular pool of acetyl-CoA that is a substrate for histone acetyltransferases, and directly inhibiting the activity of class I histone deacetylases. Abbreviations: CS, citrate synthase. ACLY, ATP-citrate lyase.

Table 1

Comparison of longevity pathways regulated by ketogenic diets and CR

		Ketogenic Diet	Calorie Restriction	References
	Glucose content of diet	⬇⬇	–	[140]
	Energy content of diet	–	⬇	[140]
	βOHB production	⬆⬆	⬆	[140]
	Insulin levels	⬇⬇	⬇	[2, 64–68]
	IGF signaling	⬇	⬇	[2, 69–71]
	AMPK activity	⬆	⬆	[2, 71, 72]
	mTOR activity	⬇	⬇	[2, 71]
βOHB	Foxo3	⬆	⬆	[5]
	Protein acetylation	⬆	⬆	[5, 141]
	Stress resistance	⬆	⬆	[5, 84, 98–113]
	Longevity	?	⬆	[1]

New Science Of WillPower

- Willpower is exhaustible
- Willpower is also trainable
- Unconscious brain centers over-ride our executive functions
- Our goals are constantly sabotaged by our habits
- Use willpower to develop habits NOT to try and over-ride unconscious actions

- Stress activates reward centers and shuts down motivation centers
- Stress and overwhelm make us default back to our habits
- Being “busy” and doing “more” and bragging about “no sleep” drain willpower battery, reactivate negative habits and make you crave soothing food.

- Rest-Based living is a necessary skill and the antidote to stress
- Sub in other rewarding and relaxing behaviors other than eating
- Mindfulness is a critical aspect of overriding food related dysfunctions
- Movement decreases sensitivity of the reward centers of the brain
- Can’t move too much though….

- Energy use is not additive, but rather restrained.
- NEAT and other metabolic components will be surpassed the greater the movement output
- Exercise enough, but not too much
- Walk as much as you can tolerate
- Always measure responses in SHMEC (sleep, hunger, mood, energy, cravings)

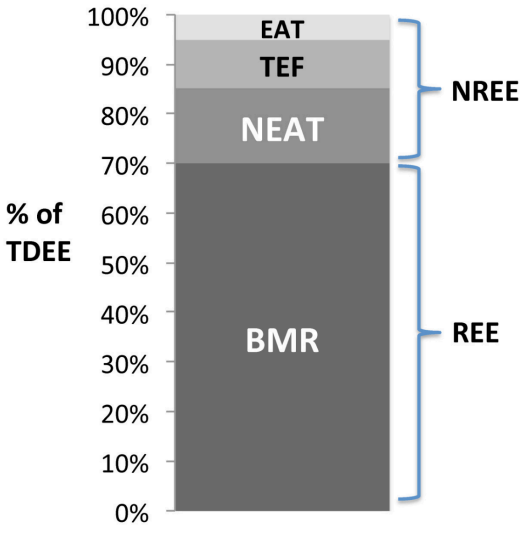


Figure 1
Components of total daily energy expenditure (TDEE). BMR = basal metabolic rate; NEAT = non-exercise activity thermogenesis; TEF = thermic effect of food; EAT = exercise activity thermogenesis; REE = resting energy expenditure; NREE = non-resting energy expenditure. Adapted from Maclean et al., 2011.

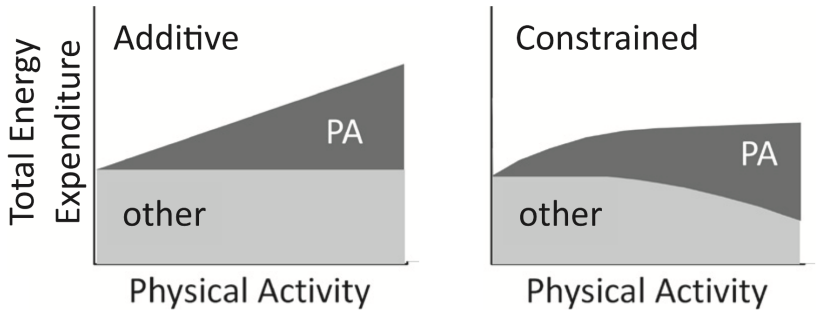


Figure 1. Schematic of Additive Total Energy Expenditure and Constrained Total Energy Expenditure Models

In Additive total energy expenditure models, total energy expenditure is a simple linear function of physical activity, and variation in physical activity energy expenditure (PA) determines variation in total energy expenditure. In Constrained total energy expenditure models, the body adapts to increased physical activity by reducing energy spent on other physiological activity, maintaining total energy expenditure within a narrow range.

- Restrictions psychologically have opposite effect
- Must “watch your eating”
- Controlled Eaters versus Mindful Eaters.
- Controlled eaters weigh and measure everything and are actually MORE, rather than less, susceptible to overeating in response to a diet misstep
- Mindful eaters eat when they are hungry and stop when they are not completely full.

- Certain foods trigger our pleasure centers
- This is like great success….we want it again and think about it over and over
- Being away from your lover make you want them more
- Being away from foods you love make you crave them more and eat more of them.

- Food exposure therapy says we expose ourselves slowly to the foods we love and slowly exert more and more control
- Willpower challenges allow us to construct an intentional food intervention.
- Focus on buffer foods
- Avoid trigger foods

- Those who imagined eating and savoring as many chocolates as they wanted ended up eating less chocolates when they were covertly monitored than those who were told to imagine eating and savoring only three chocolates
- Restriction mindset leads to binging behaviors