Feeding Behavior 2

• Optimal Foraging Theory

• Honeybee Foraging

• Human Feeding Behavior, Obesity & Brain Health
Obesity rates

Canada:
1 in 4 adults
1 in 10 children

Associated with: diabetes, CVD, AD…

Diet, exercise and/or other factors?

BMI = m/h² (> 30 kg/m², obese)
• Exercise & low-fat/low-cal diet
• Not very effective…! Why?

• Shocking lack of properly conducted scientific expts for many of these diets, especially long term.
  – observational studies (correlational, across countries, self report)
  – human expts are very difficult (in hospital vs natural, compliance)
  – weight loss, other end points?
Macronutrients

- macronutrients
  - carbohydrates: ~4 kcal / gram, e.g. starch, sucrose, glucose, fructose
  - fats (lipids): ~9 kcal / gram, e.g. saturated fats, unsaturated fats
  - proteins: ~4 kcal / gram

- “standard” advice: 50% carb, 30% fat, 20% protein
  - by calories (not mass)

- low fat vs. low carbohydrate

- Not all calories are equal!
  - 2000 to 2400 kcal / day
  - different effects on pancreas, liver, brain, and other organs
• Not all calories are equal

• e.g. different effects on insulin from pancreas

• sugar & highly refined carbs strongly increase blood glucose and thus stimulate insulin secretion

• insulin promotes glycogen synthesis

• …also promotes fat storage!
What Makes You Fat: Too Many Calories or the Wrong Carbohydrates?
Calories vs. Carbohydrates

In the next couple of years, investigators funded by NuSI plan to test two competing hypotheses about the dietary causes of obesity under scientifically rigorous conditions that are designed to force one of the possibilities to emerge as the clear winner.

**Energy Imbalance**
The conventional explanation focuses on how the body regulates the intake and expenditure of energy (measured in calories). Consuming too much of anything—whether fats, carbohydrates or proteins—increases body fat. The only way to lose weight is to eat fewer calories or to expend more calories.

**Hormone Imbalance**
The alternative hypothesis focuses on the complex physiological regulation of fat cells. Consuming carbohydrates raises levels of sugar (glucose) in the blood, which in turn activates the release of the hormone insulin. Fat cells respond to insulin by holding on to their fat stores and even adding to them. Weight gain occurs when insulin levels—triggered by eating carbohydrates—remain elevated for long periods.

Taubes (2013)
Global sugar supply (in the form of sugar and sugar crops, excluding fruit and wine) expressed as calories per person per day, for the year 2007.

https://www.youtube.com/watch?v=0ndTEu_qDGA&index=2&list=PL39F782316B425249
What to eat? How much? When to eat?

• 3 questions to consider

• One size does **not** fit all.
  – individual genetics and microbiomes differ
  – individual goals differ
  – individual food preferences differ

• Timing of food intake is very important.
  – Time restricted feeding (TRF)
  – Intermittent fasting (IF)
Intermittent fasting

- No or greatly reduced calories during a fasting period
- **Not** chronic (moderate) caloric restriction
- In human studies:
  - alternate day fasting; or 1-2 fast days per week
  - no calories; or reduced calories (500-600 kcal) per fast day
- In rodent studies:
  - typically alternate day fasting
  - fast day: no food, ad libitum water
  - feed day: ad libitum food and water
- Increasing evidence for neural and behavioral benefits
  - Michael Mosley, Mark P. Mattson (Alzheimer’s disease)

http://www.dailymotion.com/video/x18a1b6_michael-mosley-eat-fast-live-longer_lifestyle
Alzheimer’s disease (AD)

- In Canada
  - 2015: ~750,000 have AD or a related dementia
  - 2035: ~1.5 million will have AD

- About 1 in 10 Canadians over 65 years has AD or a related dementia
Risk Factors for AD

- Age
- Genetics
- Female gender
- Obesity
- Diabetes
- Cardiovascular disease
- High cholesterol

- Can dietary manipulations help?
- Few pharmacological treatments
Intermittent fasting and caloric restriction ameliorate age-related behavioral deficits in the triple-transgenic mouse model of Alzheimer’s disease

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- Mouse model of AD (3xTgAD mouse)
- Amyloid (Aβ) plaques & neurofibrillary (phosphoTau) tangles
• Male and female mice (n = 80 males, 80 females)
• Non-transgenic (nonTg) or 3xTgAD
• At 3 months of age: assigned to 1 of 4 groups
  – NonTg, AL
  – 3xTgAD, AL
  – 3xTgAD, CR (given 60% of food eaten by AL group)
  – 3xTgAD, IF (no food on every other day)
• Tested when 10 months or 17 months old (water maze)
• One week after testing, hippocampus was collected
• Body weight measured weekly
  – significant effect of CR
  – no significant effect of IF in this study
Fig. 3. Old male 3xTgAD mice exhibit a deficit in performance in the hidden platform test in the water maze that is ameliorated by caloric restriction and intermittent fasting. Male mice of the indicated genotypes (non-transgenic and 3xTgAD) were maintained on the indicated diets (ad libitum, caloric restriction or intermittent fasting) for 14 months. The goal latency (a) and path length (b) were measured in the hidden platform test. Values are the mean and SEM ($n=7$–10 mice per group). 1DayP and 2DayP, first and second days of the visible platform test.
Fig. 5. Caloric restriction, but not intermittent fasting, reduces levels of Aβ1–40 and Aβ1–42 in the hippocampus of older 3xTgAD mice. Levels of Aβ1–40 and Aβ1–42 in hippocampal tissues from the indicated groups of mice were quantified by ELISA methods. Values are the mean and SEM (n=13–19). *p<0.05 compared to the AL and IF values.
Fig. 6. Caloric restriction, but not intermittent fasting, suppresses tau pathology in the hippocampus of older 3xTgAD mice. Levels of total tau and phospho-tau were measured by immunoblot analysis using HT7 and AT8 antibodies, respectively, in hippocampal tissues from the indicated groups of mice. (a) Immunoblot probed with the indicated antibodies. (b) Results of densitometric analysis (values are the mean and SEM; n = 3–5). *p < 0.05 compared to the AL and IF values.

https://www.youtube.com/watch?v=4UkZAwKoCP8
• Breakfast: water and black tea or black coffee (0 kcal)

• Lunch: 2 boiled eggs, large green salad with lemon juice, water, black coffee (~300 kcal)

• Dinner: miso soup, salmon sashimi (3 oz), steamed vegetables, water, and green tea (~300 kcal)