Food Choices and Eating Patterns

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Mind and Body – Understanding the Connection between Neurobiology and Food Behavior
Neurobiological Inputs and Outputs
And the Challenge of Being a Globally Distributed Omnivore

**Inputs:** Sensory Cues, Nutrient Signals, Internal Metabolic Consequences, Nutritional Feedback.

**Outputs:** Central Internal States (Rewards & Punishments), Associations, Food Decisions, Expectations, Feeding Habits
Evolution of the Human Brain

Homo habilis  Homo erectus  Homo sapiens

Sex Food  Sex Food  Sex Food

Harold Dibble, Ph.D.
“The Land of Milk and Honey”

• Why do some in our species have a love affair with dairy?
  What makes butter so desirable?

• Why does our species have a love affair with sugar and sweets?

• Why does our species have a love affair with starch?

• Why does our species have a love affair with fermentation?
  - Cheeses
  - Preserved meats
  - Breads
  - Wine
  - Beer

• Why does our species have a love affair with browning reactions from cooking (Maillard Reactions)?
  - Fresh baked bread / cakes / cinnamon buns
  - Fresh baked cookies
  - Grilled meats/ribs/barbecue
Great Ape Time Points of Divergence/Coalescence

Phylogenetic tree of apes and humans. The evolutionary group that led to modern gibbons diverged earlier than other primate groups.

Time:

Gibbons
Orangutans
Gorillas
Chimpanzees
Humans

6 million years ago
Sequence of Hominoid/Hominid Existence

Australopithicines
- A. afarensis
- A. africanus
- A. robustus
- A. boisei
- H. habilis

Hominids (Homo)
- H. erectus
- H. sapiens (archaic)
- H. sapiens (Neandertal)
- H. sapiens (modern)
What Do Great Apes Eat?

The great apes, including us (homo sapiens sapiens), are all of African origin, are all omnivorous, all eat small amounts of meat (except for some humans), and are all largely vegetarian with a particular love for fruit.

According to Jane Goodall, chimpanzees (Pan troglodyte) -- our closest living relatives with whom we share about 99% of our genes -- eat an omnivorous diet consisting of about 10-15% vegetable matter, 5-10% animal flesh including mammals and insects, and about 80% Fruit.

Do the diets of the various great apes resemble the diet of our last shared common ancestor 6 million years ago? Are we still frugivorous by nature? Whence our love of fermentation?
Evolution happens much faster than you might imagine and in our species appears even to be accelerating.

“The past 10,000 years have seen rapid skeletal and dental evolution in human populations, as well as the appearance of many new genetic responses to diet and disease.” Henry Harpending, *Proceedings of the National Academy of Science* 2007

**EXAMPLES OF RECENT AGRICULTURALLY-INDUCED GENETIC ADAPTATIONS:**

1) Malaria & Vector Diseases – Heme groups and Sickle Cell -- duplications /mutations/gene conversions.

2) High Starch Intake – Salivary amylase -- copy number variants.

3) Dairy Farming – Lactase gene to remain active -- regulation.
Teeth and Jawbones of Different Species of Ape and Hominoid

- *Pan troglodytes*
- *Australopithecus africanus*
- *Homo habilis*
- *Homo sapiens neandertalensis*
- *Homo sapiens sapiens*
Whereas North American and European Homo sapiens, including Neanderthals, may have lived a carnivorous, Inuit-like life during the last ice age, most geographic regions in which Homo sapiens sapiens lived were not ever covered by ice and would have not had the same pressure to hunt EXCLUSIVELY and live carnivorously.
Geographic Distribution of Glacial Ice During Last Ice Age

Last Glacial Maximum 18,000 years ago
Map of Early Homo sapiens sapiens and H. sapiens Neanderthals
How did we forage and survive amidst such great breadth of flora and fauna?

Oral detection, nutrition and health

**Macronutrients** – proteins (savory), carbohydrates (sweet), fats (creamy, fat detection)

**Micronutrients** – minerals, vitamins

**Toxin Avoidance**
- detection and avoidance of harmful levels of toxins

**Medicine Seeking: Nutraceutical Detection**
- anti-cancer – metabolic and cell cycle modulators
- anti-oxidant – free radical modulators
- anti-inflammatory – inflammatory pathway modulators
An overall lack of sufficient **energy** and **protein** to enable growth (marasmus & kwashiorkor) is the leading cause of death in children globally today.

Loss of water and minerals from diarrhea is the second, killing approximately 16 million children each year.

Over nutrition or obesity is a relatively modern problem and from an evolutionary perspective would not greatly affect our ability to produce viable offspring.
Globally there are approximately one billion people who are malnourished lacking required minerals and vitamins in addition to calories.

Thus, the everyday need to identify foods that will safely deliver water, macronutrients, and micronutrients is an ancient and, still, very present force shaping human evolution and the dietary practices of our species.
Taste and odor cues guide our intake in that they help us to identify nutritious foods and to avoid toxic foods.
Peripheral and Central Taste Pathways

- Amygdala
- Hypothalamus
- Gustatory Cortex
- Orbitofrontal Cortex
- Ventral Posterior Medial Nucleus of the Thalamus
- Nucleus of the Solitary Tract
- Cranial Nerve VII
- Cranial Nerve IX
- Cranial Nerve X
And flavor cues also become associated with metabolic outcomes (reward and punishment) to guide our digestive processes and help us form dietary habits.
We must worry about avoiding anti-nutrients (toxins) just as much as procuring nutrients. Virtually all foods contain some toxins.

Stereotyped Behaviors: Survival Lesson 1. Rejection Responses to Strong Bitters

Boy Tastes Medicine
Common Ragwort and Cinnabar Moth Larvae

Alkaloids cause neural and liver damage, leading to blindness, paralysis, and death.

A couple plants are sufficient to kill an adult work-horse, if it consumes them.
We hypothesized that oral exposure to bitter tasting stimuli would be nauseating at high concentrations, as it would predict the potential ingestion of toxins, which often taste bitter.

The somatosensation of Nausea is induced when the body identifies a consumed food as poisonous; it connotes strong negative affect, which, like pain, is protective and teaches us “Don’t do it again”.

REWARD AND PUNISHMENT
Can Bitter Tasting Compounds Induce Nausea?
CONCLUSIONS

Our bodies struggle to maintain healthy tissues supplying nutrients when needed – not too little and not too much.

This is an ancient struggle that still affects a billion humans.

Taste guides us toward nutritious food and away from toxins.

Ingestion is a challenge to physiological homeostasis and we can handle the influx of nutrients best when we prepare and anticipate foods and we form dietary habits.

This is true not only in preparing for incoming nutrients but for avoiding and processing anti-nutrients or toxins.

These processes are what fascinated Ivan Pavlov and are ultimately why he was awarded a Nobel.
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