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The Flavor World of Childhood: Basic Biology and Health Implications



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Financial Disclosures

- No relevant financial relationships with any commercial interests.
- Research supported by NIH grants HD37119, HD0723201 and DC01128.

Focus: Normal Development

- Simple question that gets to heart of something quite complex
- How to identify true effects of development;
- Normal function provides insights into vulnerabilities and opportunities.

V. Shukla; 2008 NICHD Image
Competition Entry: Section on Nervous
System Development and Plasticity
(<http://retreat.nichd.nih.gov/pastretreats/2008/2008images.html>)

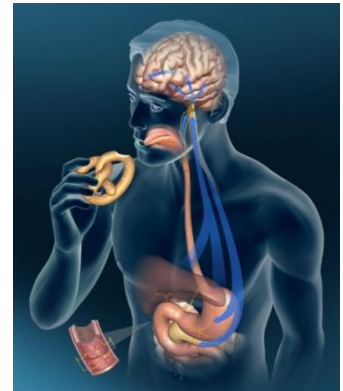
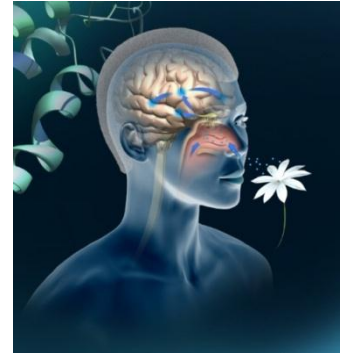
Many chronic illnesses that plague modern society derive in large part by poor food choices, dictated by our taste preferences.

- Too much sugar and salt
- Too few vegetables and fruits
- Pattern is apparent in youngest members of our society.

- How can we account for patterns of food choice that seem antithetical to health, and for the difficulties in changing them?
- How do individuals and society manage the rich abundance of food that now characterizes this evolutionary blink of an eye we find ourselves in?

Biological Substrate

Understanding what children are eating and the obesity epidemic must incorporate the biological substrate.



Biology predisposes children to consume diets that may lead to obesity:

- Mismatch of inborn, evolutionarily driven taste preferences and current food environment.

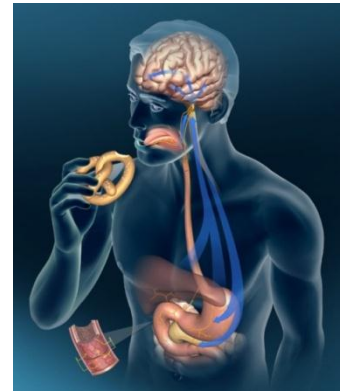
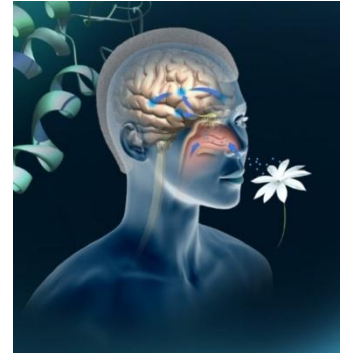
- Humans evolved in *fluctuating* and *uncertain* environments where the primary challenge was to obtain enough nutrients, while avoiding the abundant poisons found in plants.
- In response to challenge, sensory systems evolved to detect and prefer the once *rare* calorie- and sodium-rich foods that taste sweet or salty, while rejecting potentially toxic ones that taste bitter.

Biology predisposes children to consume diets that may lead to obesity:

- Mismatch of inborn, evolutionarily driven taste preferences and current food environment;
- Detrimental consequences of not being exposed to flavors of healthy foods early in life.

Flavor Senses

- Central to identifying food and enable us to perceive our chemical world
 - primary signals of food, a basic biological commodity.
- Gatekeepers and warn GI system of incoming nutrients
- Source of extreme pleasure and pain



Senses of Taste and Smell

- Functioning before birth;
- Not miniature adults;
- Inborn responses yet inherent plasticity.





The Taste of Pleasure Sweet Taste

Infancy

- Within hours of birth, infants exhibit a strong preference for sweet tastes.
- Convergence of findings
 - Intake

Journal of Comparative and Physiological Psychology
1973, Vol. 84, No. 3, 499-501

TASTE IN ACCEPTANCE OF SUGARS BY HUMAN INFANTS¹

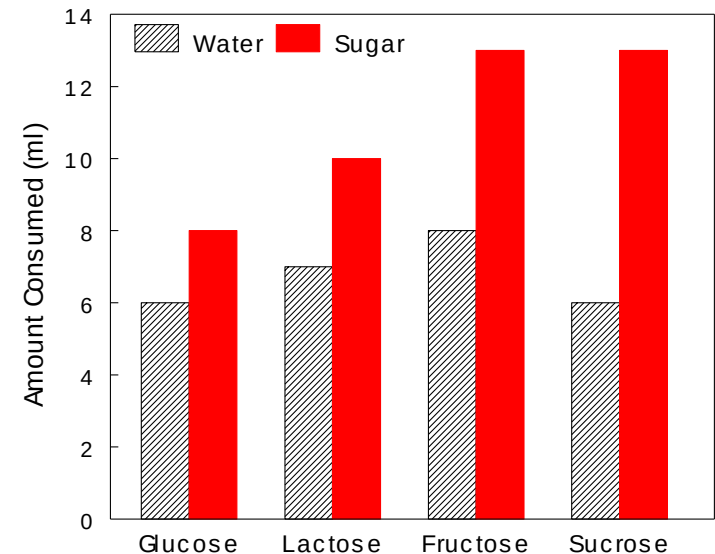
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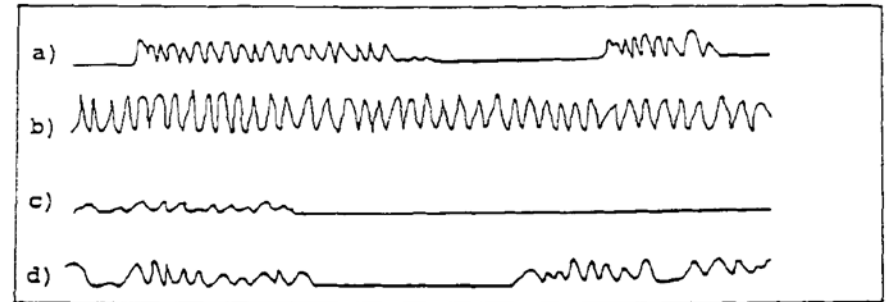
Human infants (1-3 days of age) were offered water and a solution of glucose, fructose, lactose, or sucrose for 3-min. periods. Volumes ingested were measured. Infants discriminated between water and a solution of sugar, demonstrating a distinct preference for the latter. The effectiveness of sugars in evoking ingestion varied with both the compound and the solution concentration.



Infancy

- Within hours of birth, infants exhibit a strong preference for sweet tastes.
- Convergence of findings
 - Intake
 - Suckling patterning

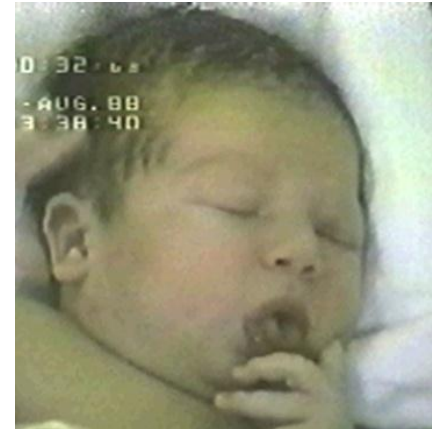
Term (a,b) and Preterm (c,d) Infants



Sucking curves generated by term (a: latex nipple; b: sucrose nipple) and preterm (25-36 wks gestational age) c: latex nipple; d: sucrose nipple) infant. Maone et al., 1990

Infancy

- Within hours of birth, infants exhibit a strong preference for sweet tastes.
- Convergence of findings
 - Intake
 - Suckling patterning
 - Facial expressions



Infancy

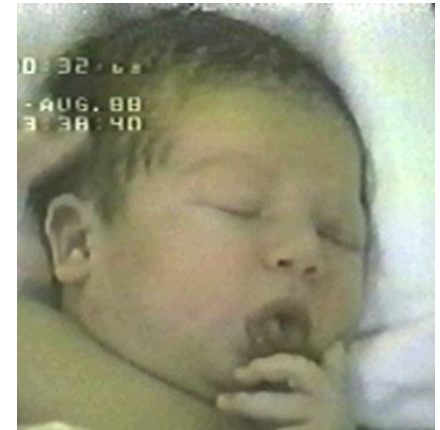
- Within hours of birth, infants exhibit a strong preference for sweet tastes.
- Convergence of findings
 - Intake
 - Suckling patterning
 - Facial expressions
 - Heart rate
 - Blunts expression of pain



Good News:

Baby born attracted to taste signal for mother's milk

- Children are attracted to taste signal for calories (e.g., fruits) during periods of growth;
- Blunts expression of pain;
- Masks the bad tastes.



Bad News: Children's Vulnerability to Current Food Environment

- Understanding their vulnerability is key to develop evidence-based strategies;
- Why is fruit intake below recommended levels?



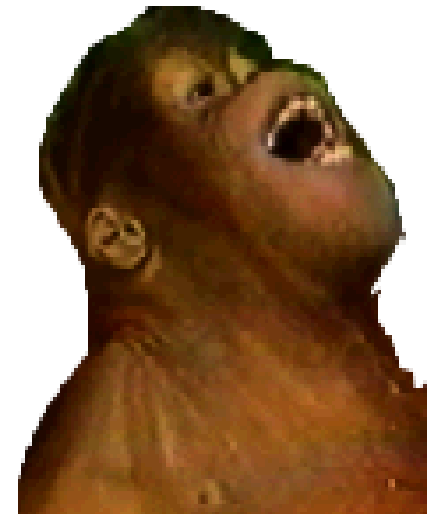
Are refined sugars
supernormal stimuli?



The Taste of Poison
Bitter Taste

Bitter Taste

- Rejection protects against harm from potentially toxic agents
 - protects animal from consuming toxic compounds and being poisoned
 - protects plant producing these chemicals from being eaten
- Heightened sensitivity during childhood.



courtesy of Dr. K. Berridge,
University of Michigan
Neurosci Biobehav Rev 2001

Initial Acceptance of Fruits and Vegetables

- Always will be easier to introduce
 - fruits than vegetables
 - orange than green vegetables

- We cannot easily change the basic ingrained biology of avoiding bitterness and liking sweets to get children to prefer broccoli to candy.
- If this is the bad news, the good news arises from knowledge gained from our experimental research on how, beginning very early in life, sensory experience can shape and modify flavor and food preferences.

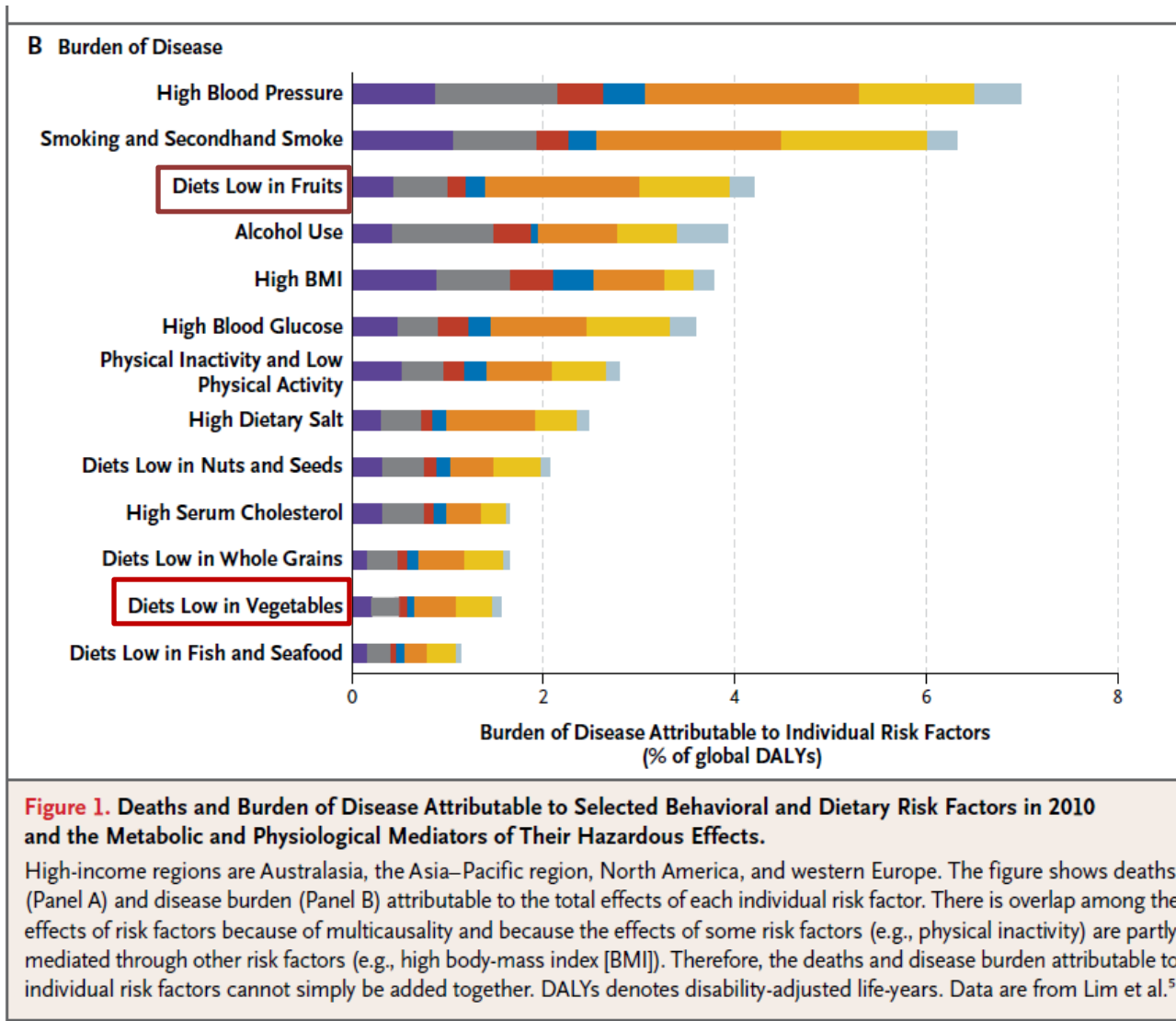
Our biology is not necessarily our destiny!



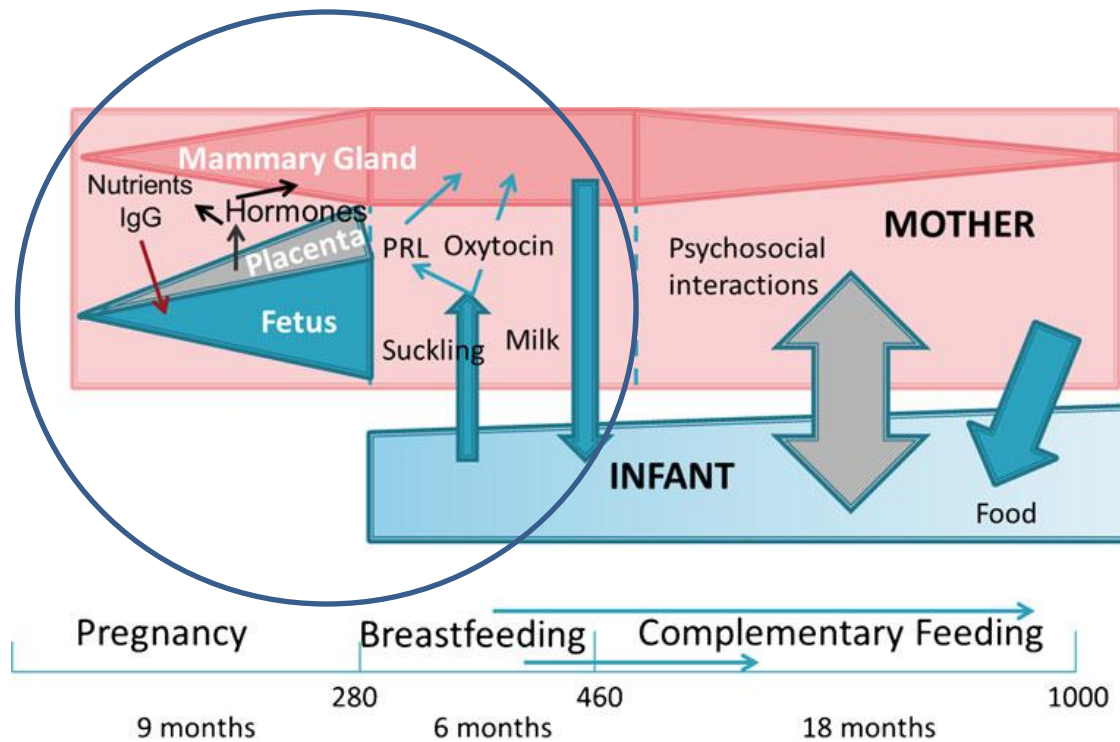
How do we learn to like fruits and vegetables?

Components: Flavor, Texture, Color

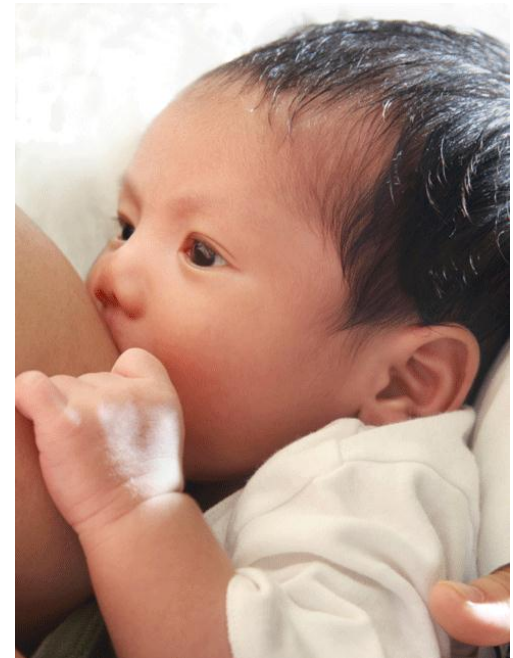
Behavioral and dietary risk factors for non-communicable diseases



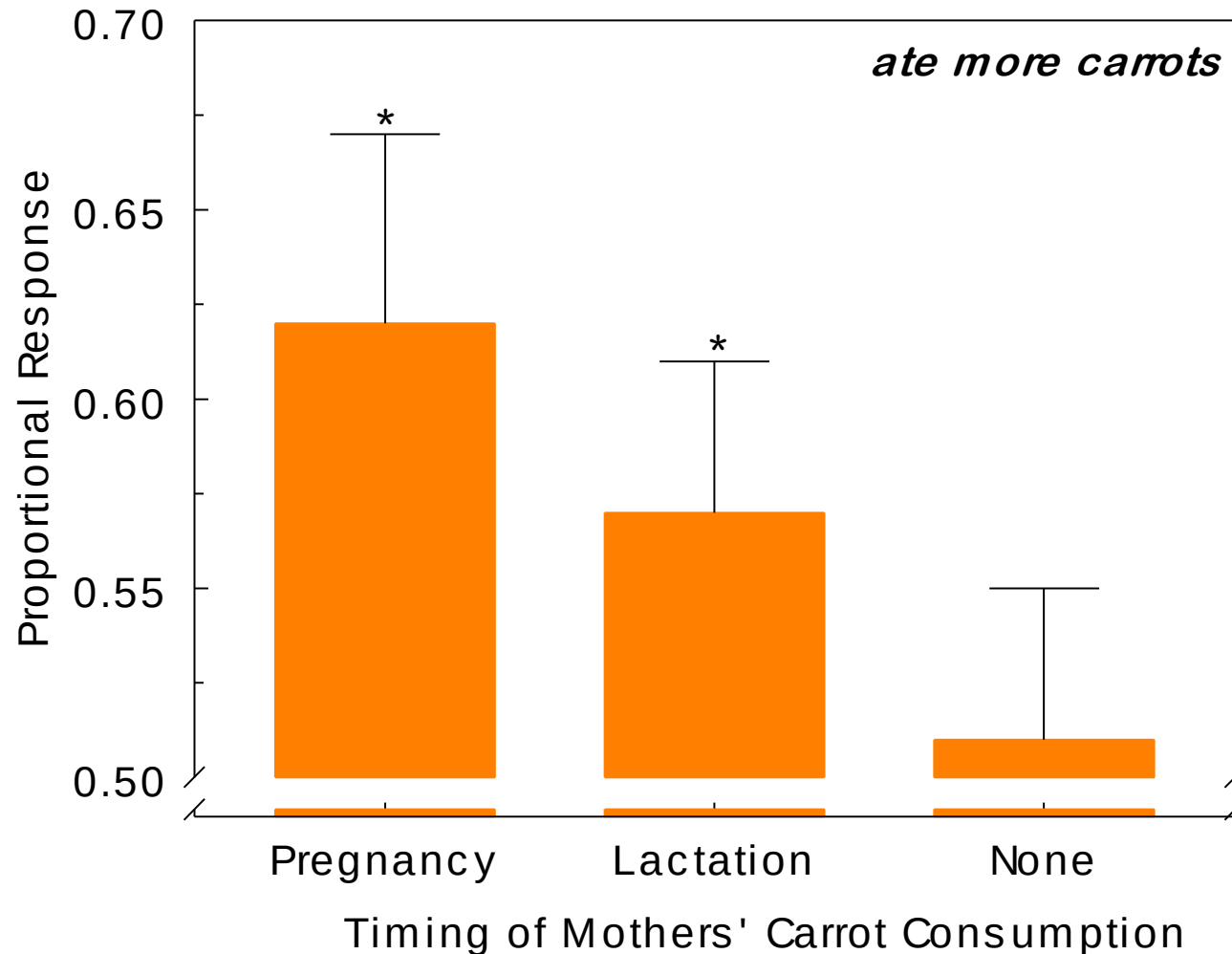
Earliest Information about Nutrition comes from the Mother



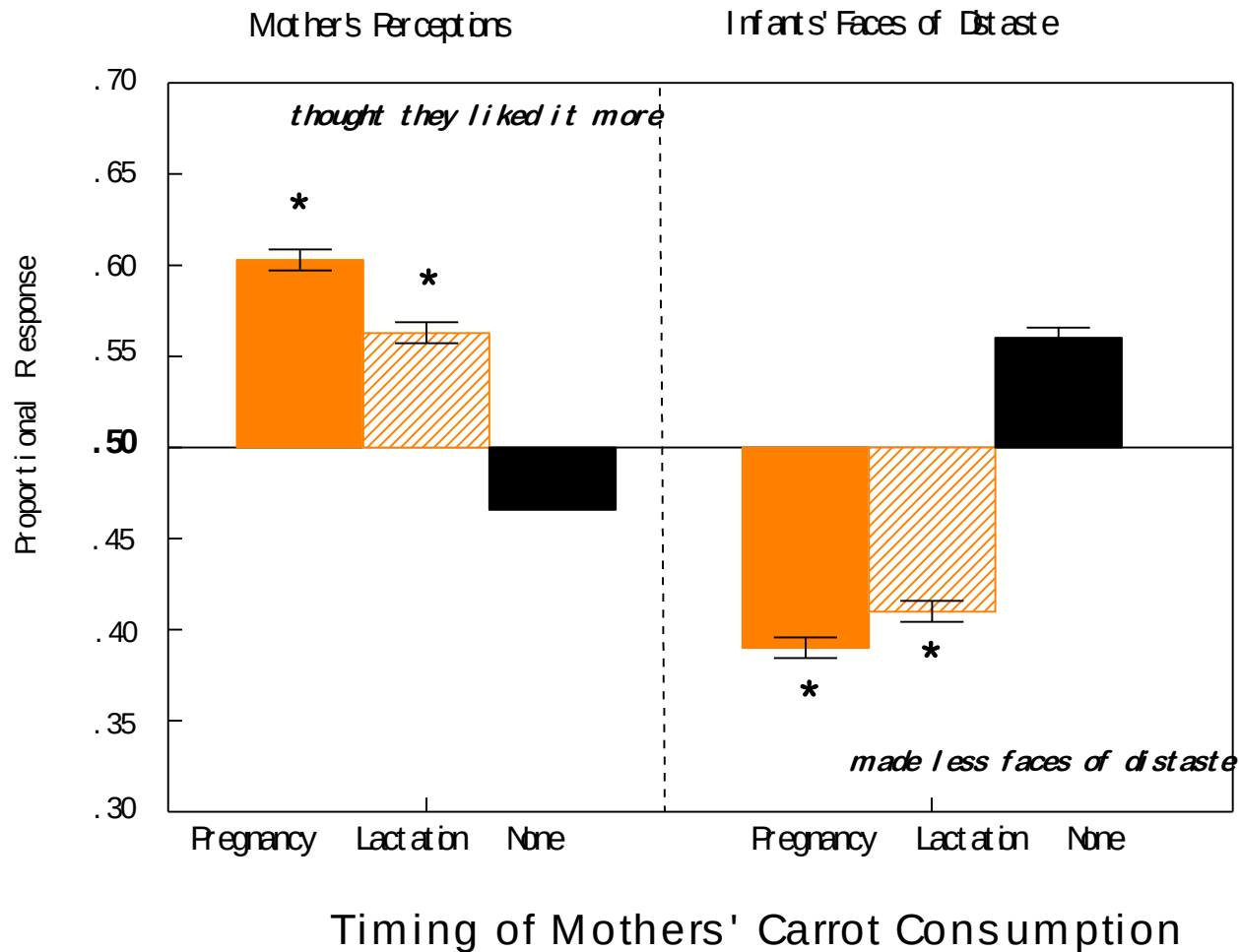
- Variety of flavors are transmitted from mothers' diet to 'first foods'.
- Types of flavors experienced are unique for each infant.
- Flavor memories are formed if mother eats the food.



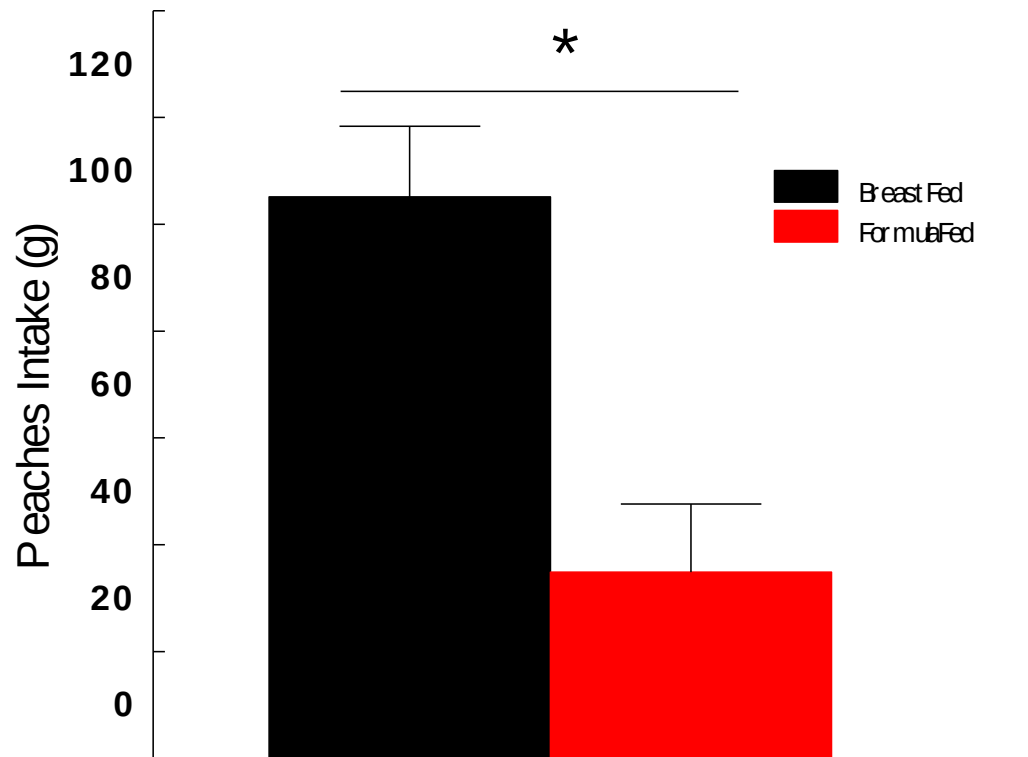
RCT: Infants of mothers randomized to eat carrots during pregnancy or lactation



And liked the taste of carrots.



More fruits in mothers' diet, more accepting their infants will be upon first taste of fruits (if breastfed).



This isn't unique to humans!



Morrill and Dayton, 1978



Aigueperse et al., 2013

“It’s not innate knowledge.
It’s learned and part of their culture.”

Flavor Bridge



- This pattern makes evolutionary sense because the foods that a mother eats when she is pregnant and nursing are the flavors associated with foods she prefers or, at the very least, with foods she has access to.
- First way (not the only way) we learn about flavors of foods.

Learning about Food



- Presence of a food in the environment does not ensure that the animal will learn to eat this particular food.
- Rather, food preferences increase with repeated exposures and variety and are strongly influenced by the conditions in which the exposure occurs.

Both breastfed and formula-fed infants learn via repeated tastings and variety!

Target Food	8-10 days later
Peaches	↑ acceptance of peaches ↔ No effect on green bean acceptance
Pears	↑ acceptance of peaches ↔ No effect on green bean acceptance
Variety of Fruits	↑ acceptance of novel fruit ↔ No effect on vegetable acceptance
Carrots	↑ acceptance of carrots
Green Beans	↑ acceptance of green beans
Green Beans and then Peaches	↑ acceptance and liking of green beans
Variety of Vegetables (between and/or within meal)	↑↑ acceptance of target and novel vegetables ↑ acceptance of novel food (chicken)

How do we learn about foods?



Amniotic Fluid and Milk

Repeated Exposure

We build on the familiar flavor,
increasing complexity

Parental Modeling

Flavor-

Experience

Nutrient

with Flavor

But what about those who are
deprived of these experiences?

Conditioning

Variety

Peer Modeling

Fruit and Vegetable Intake During Infancy and Early Childhood



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PEDIATRICS Volume 134, Supplement 1, September 2014

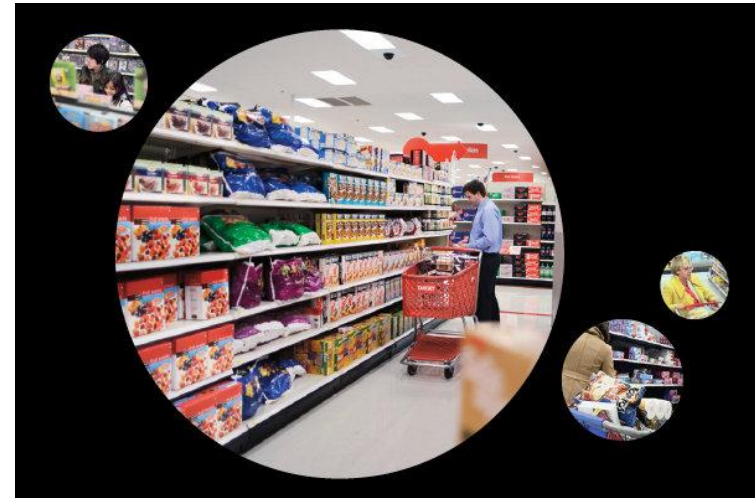
“..infrequent intake of fruits and vegetables during late infancy is associated with infrequent intake of these foods at 6 years of age.”

Bottom Line

- Where you start influences where you end up;
- Deprivation model: Most children don't get the experiences to learn to like certain fruits and vegetables
 - Early taste deprivation remodels CNS
 - From the age of 2 years, an American is more likely to eat a manufactured sweet than a fruit
- Mothers feed their children what they eat (they don't eat baby food; nor do toddlers).

Hope: Celebrate Parenthood

- There are brief periods in life when old routines fall apart and buying habits are suddenly in flux: one such moment is around the birth of a child;
- Same is true for health behaviors;
- Being pregnant and then a parent is strongest motivator to change or modify behaviors.



Child-like Wonder of Science

- Basic research in humans and animal models is the key to continued advances and applications.
- Elegance and simplicity in fundamental principles.
- **Food is more** than source of calories
 - Pleasure, identity, relationship to environment
 - Vulnerability of childhood