Premastication: the second arm, after breastfeeding, of infant and young child feeding for health and survival?

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With editorial by P. Agget,
And commentaries by P. Van Esterik, A. Williams,
M. Fewtrell, J. Tolboom, G. Lack and
M. Penagos

Neotany and Human Development

Neotony:

…the reduction in the rate of somatic development, relative to other species, which has permitted the evolution of critical human capacities, especially related to brain size and upright posture (McNamara 2002)

Mammalian Nutritional Strategy

- All mammals rely on mother's milk as the source of first postnatal nutrients.
- Most mammals have a transition period when offspring continue to receive milk and begin eating solid food.
- Some mammals provision solid food for offspring.
- With one exception, mammals do not facilitate ingestion of solid food by infants.

Humans are the only mammals that practice premastication.

WHY?

Selection for Neotany included Delayed Tooth Eruption

The hunter-gatherer challenge:

How to ensure infant nutrition when breastmilk alone is not enough and infants lack the dentition to consume an omnivorous diet?

The hypothesis:

Premastication of foods from adult diet ensured adequate intake of protein, energy and micronutrients to meet requirements not met by breastmilk alone

The rationale:

1) The need for energy, protein and micronutrients from non-breastmilk dietary sources occurs before dental development is adequate enough to permit infants to consume family foods.

2) During our long evolution as a hunting-gathering species foods were not easily processed into a form that children without a full set of teeth could consume.

3) Populations in which adults pre-chewed foods for infants had a strong survival advantage, to such an extent that this behavioral trait was sustained through selection.

Ethnographic Evidence for the Practice of Premastication

If premastication was once ubiquitous:

- It should be found found globally, not just in some “culture areas”

- It should be found in a majority of “non-modern” societies

To assess the hypothesis that premastication was widespread in human societies we conducted a cross-cultural study using the

Human Relations Area Files

Examples of statements indicative of premastication

Kung San "..they feed by chewing their tough meat harsh roots and nuts and feed the infant premasticated food from their own mouths"

Garo "…with a banana leaf beside her containing food which she chews mouthful by mouthful before spitting it into her hand and placing it in the baby's mouth. Gradually she feeds the baby meat, dried fish and all the other Garo foods."

Occurrence of Premastication in e-HRAF reports (N= 119 societies)

Geographic Area	Coded for infant feeding	Report Premast.
Africa	24	4
No. and Middle Amer.	37	9
South Amer.	17	8
Asia	21	10
Europe, MidEast	11	2
Oceania	9	5

To assess potential of under-reporting: "The China study"

Why China?

1) Premastication reported from 1/2 of all Asian cultures in e-HRAF, but no mention in the 1 Han Chinese culture in the file

2) Co-investigator, Yuanyuan Zhang, from an educated, middle-class family was sure, that her mother had premasticated food for her only 22 years ago.

Han Cultures in HRAF

ID	Loc.	# Docs	# Doc with Feeding	# Premast. info
AF1	China	80	4	0
AF12	N. China	8	1	0
AF13	NW China	3	1	0
AF14	C. China	2	1	0
AF15	E. China	3	0	0
AF16	SW China	7	1	0
AF17	S. China	8	1	0
AH6	I.Mongolia	13	2	0

The China Study

Part II. How students at Beijing Agricultural University were fed 20-25 years ago

The results

Premastication reported as a practice (with details about specific foods/food categories) = 65 respondents

Premastication not practiced = 39 respondents

Percent of students whose caregivers premasticated for them 20-25 years ago = 63%

Caregivers of Chinese University Students: Types of Foods Premasticated

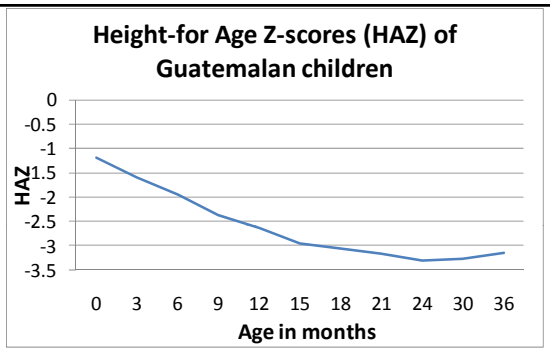
Animal Foods Meat Dried meat Fish Dried fish Eggs *Staples* Rice Millet Porridge Noodles Potato Corn bread Steamed buns	*Fresh Fruits and Vegetables* Apple Orange Tomato Tangerine *Nuts* Walnuts Peanuts Dumplings Cookies

Decline in the practice of premastication

- Recently: the influence of the germ theory of disease
- Historically: development of agriculture

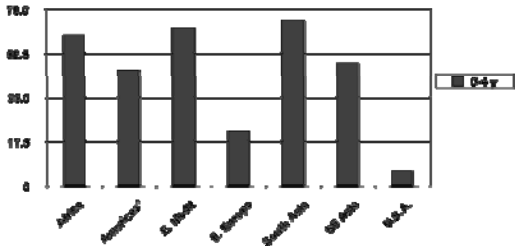
Nutritional consequences of no premastication in poor societies

- Growth faltering due to PEM
- Anemia and other micronutrient deficiencies



Anemia: a micronutrient example

Anemia prevalence in young children, by global region



*excludes North America

Stoltzfus, Mullany & Black. Iron Deficiency. In: Comparative Quantification of Health Risks, 2004.

WHO/PAHO guidelines:

"average intakes of breastfed infants in industrialized countries would fall short of the recommended intake of iron if iron-fortified products were not available"

Given the clear negative consequences for survival, health and cognitive development of IDA, how could Homo sapiens have sustained itself as a species if its infants became iron deficient before they could consume foods to meet their iron requirements?

Premastication

Was it a trade-off:
better infant nutrition for greater risk of infant disease from maternal saliva?

Diseases Transmitted Through Saliva

Streptococcus mutans
Streptococcus sobrinus
Hepatitis G virus (HGV)
HHV-8
Helicobacter pylori

Diseases passed through saliva, continued

TT-virus
HHV-6
Hepatitis B
HIV ?

Diseases passed through breastmilk

Human cytomegalovirus (HCMV)
E. coli, other GNR
Staphylococcus aureus
Mycobacterium tuberculosis
Group B streptococci
Listeria monocytogenes
Coxiella burnetii
Cytomegalovirus

Diseases transmitted through breastmilk, continued

Hepatitis C
HTLV-I& II
Herpes simplex virus
Rubella
Varicella Zoster virus
Epstein-Barr virus
HHV-7
HIV
Toxoplamosis (parasites)

Nutrition and Health-promoting Substances in Breastmilk include:

- **Antimicrobial factors : sec**retory IgA, IgM, IgG, complement C3
- **Anti-inflammatory factors:** interleukins, interferon-γ, prostaglandins
- **Growth factors:** EGF, NGF,IGF,TGF
- **Digestive enzymes:** amylase, lipoprotein lipase
- **Hormones:** insulin, ACTH, erythropoietin
- **Transporters:** Fe, IgF binder, thyroxine binder

Nutrition and health-promoting substances in saliva

Amylase: aides starch digestion

Lingual lipse: enzyme that aides fat digestion

Electrolytes: sodium, potassium, calcium, magnesium, bicarbonate, and phosphates

Saliva, continued

Imunoglobulins: secretory IgA, IgG, and IgM

Proteins: glycoproteins, statherins, agglutinins, histadine-rich proteins, and proline-rich proteins that are involved in aggregating bacteria and controlling bacterial, fungal, and viral colonization

Growth factors: EGF (provides cytoprotection against irritants, decreases the permeability of the esophageal mucosa to hydrogen ions)

New Hypotheses about the benefits of premastication

Hypothesis 1

In addition to nutrients, the nutritional benefits of premastication include facilitation of digestion from the maternal digestive enzymes in saliva

Hypothesis 2

Premastication protects infant health by providing infection-fighting immunoglobulins from maternal saliva

The ingestion of maternal antibodies to common community pathogens reduces the severity of infant disease, including diarrheal disease.

Hypothesis 2a

A corollary of hypothesis 2:

The "weanling dilemma" of increased diarrheal disease with the advent of complementary feeding is a consequence of the loss of premastication, associated with substitution of paps and gruels for premasticated adult foods.

Hypothesis 3

Premastication introduces pathogens in infancy when they cause no or mild disease and produce long lasting immunity that protects against diseases that are serious in later life (eg poliomeylitis, Epstein-Barr).

Hypothesis 4

Premastication introduces antigens in a favorable immunological environment at the right times to promote the development of immunological tolerance that prevents the development of asthma and other allergies.

Hypothesis 5

Premastication supports psycho-socially effective"responsive feeding" of complementary foods through face-to-face interaction, appropriate pacing of feeding, and positive affective engagement

Hypothesis 6

The potential nutritional benefits of premastication are contingent on:

- Content of the maternal (parent) diet

- Not displacing breastmilk

The Two Arms of Successful Infant Feeding

Breast feeding

Premastication

What next?

Research to follow-up on the six hypotheses

A research agenda to determine risk-benefit ratios in different environments

Assessment of the current distributions of the practice of premastication