Commentaries

Commentaries on *Premastication: the second arm of infant and young child feeding for health and survival?*

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The paper on premastication by Peltó, Yuanyuan and Habicht published in this volume raises important issues for all readers and editors who work across disciplines. Often, we only pay lip service to disciplines other than our own. I am certainly guilty of this; my orientation has always been anthropological. When I move outside this disciplinary framework, reviewers notice, and I receive 'revise and resubmit' instructions with great regularity. But lodged as I am in anthropology, I have a certain advantage over those in nutrition, epidemiology or public health. Anthropology, in its mandate to understand the human condition, past and present, must embrace biological, cultural and historical evidence. Failure to do so encourages the narrow specialization that makes it ever more difficult to talk to one another. Our discipline fights this battle at annual meetings, as it herds archaeologists, linguists, biological and cultural anthropologists into a single gigantic conference, struggling to find themes that speak to all subfields. Sit in the wrong salon, and you may as well be in a meeting of epidemiologists (the specialty I find most difficult to understand).

It is difficult for anthropologists to get away with giving a brief multidisciplinary literature review and writing a paragraph on cultural factors (for biological anthropologists) and biological factors (for cultural anthropologists). But when a problem like premasticated food comes up, interdisciplinary tolerance is stretched thin, as anthropological reviewers look for the cultural context of premastication and nutritionists look for the nutrient content. What are confounding variables to a nutritionist are often clues to context to an anthropologist.

My interest in premastication comes from fieldwork in Lao People's Democratic Republic (PDR), where the United Nations Children's Fund and Food

and Agriculture Organization constantly decried the traditional rural Lao practice of feeding infants a wad of smoked premasticated glutinous rice, in addition to breastfeeding. But in the food-insecure communities of rural Laos, alternative complementary foods are hard to obtain, and a lump of sticky rice given to toddlers to 'feed themselves' is a disastrous alternative. Foreign consultants and local urban Lao viewed this food practice as a primary cause of the high infant and young child mortality in the country. Consultants may have been influenced by the 'yuck factor'. But when public health officials intervene to end such 'yucky' practices, are they fully aware of what will substitute for prechewed foods? Is prechewed glutinous rice preferable to melamine-laced baby foods from China, or Bear Brand sweetened condensed milk, both appearing in the markets of rural Lao PDR?

Although a single paper cannot hope to capture the complexity of local infant feeding regimens, a commitment to interdisciplinary research and publication opens the way for others to pick up the pieces of the puzzle that lie within their disciplinary grasps. How can we avoid premature closure between disciplines? First, we should maintain flexibility in publication formats, and not measure all submissions by their ability to conform to the biomedical model. Second, we might rethink triangulation to account for the integration of multiple sources of evidence, each acceptable from different disciplinary perspectives. Third, can we develop more analogies across the multiple disciplines that address the subject of maternal and child nutrition? As more terms from anthropology are used in nutrition, more concepts from epidemiology are used by midwives and more terms used by lactation consultants are also used by health economists (with the definitions stretched, refined or

narrowed as appropriate), we can build a common set of terms and analogies across the domain of inquiry. It will be the task of editors and reviewers to ensure the clarity of these definitions. The result will be the publication of more truly interdisciplinary papers that address key problems in maternal and child nutrition.

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A straw poll of my clinical colleagues suggests that premastication of complementary foods is some way off the radar of British clinical practitioners, even in the prevailing context of swine flu prevention. Yet the ethnographic studies described by Peltó *et al.* show us that it is clearly a widespread behaviour. The authors have shown here and elsewhere that it is widespread amongst people living in non-industrialized societies, particularly in Asia and Oceania. Presumably, it would also be observed amongst diaspora in industrialized Western countries; indeed, another of the author's publications (Peltó *et al.* 2003) refers to a study in Baltimore, United States. It has also been reported that 14% of US mothers chewed their infants' food (Fein *et al.* 2008); yet there appear to be no reliable data on its prevalence in the United Kingdom. Even the extensive national surveys of infant and young child feeding in the United Kingdom, such as the quinquennial surveys of infant feeding, offer no information.

Is it a desirable or undesirable infant-feeding practice? The authors speculate about its potential physiological role in the transition from breastfeeding, adducing convincing arguments particularly about predigestion of starches and possibly lipids, and the transfer of both non-specific and specific mucosal immunity. However, it is clear that premastication is practised in very varied contexts, which may have different implications for breastfeeding and health. On the one hand, the mother may premasticate and introduce foods into the infant's diet after several months. On the other hand, foods such as premasti-

cated rice may be introduced as early as the first weeks of life and possibly be premasticated by other carers. In the latter context, the practice would seem more likely to be acting as a substitute for breast milk that may adversely affect breastfeeding, rather than assisting diversification of the diet during the complementary feeding transition. As the authors point out, without such information, it is very difficult to move beyond hypothesis to measurable benefit and risk. It is important to distinguish carefully between such behaviours.

Amongst the more direct risks potentially associated with premastication vertical transmission of viral infection is potentially of greatest concern. Attention has been drawn to human immunodeficiency virus (HIV) recently (Gaur *et al.* 2009). It is argued that the risk of HIV infection is very low, both on the grounds that salivary exchange through other behaviours (such as licking or kissing) are not discouraged and on the basis of *in vitro* work which shows that saliva is cytotoxic to lymphocytes. Can we be sure, however, that premastication results only in the transfer of saliva, or might chewed food be contaminated by maternal blood cells perhaps as a consequence of coexisting periodontal disease? Herpes infection also deserves consideration. Saliva has been considered a potential vector in the transfer of human herpesvirus 8 in endemic areas such as sub-Saharan Africa, but herpes simplex type 1 (HSV type 1) infection may be more relevant to the United Kingdom (Wojcicki 2003). Infection in the very young may be disseminated and severe; moreover, the proportion of neonatal infection attributable to HSV type 1 (normally associated with oral infection) is increasing relative to that of HSV type 2 (genital infection). About 1 in 3 cases can be linked to a caregiver other than the mother.

Questions like these are important but, as Peltó *et al.* argue, cannot be answered without more reliable estimates of exposure. There is a clear need to incorporate questioning about this practice in surveys of infant feeding, so that more reliable estimates of prevalence can be obtained. Context also needs careful description, with particular respect to age at commencement, duration, type of food, role and demographic characteristics of the caregiver. There is

also a role for *in vitro* studies to delineate the effect of the practice on nutrient availability and microbial or other contamination.

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Pelto and colleagues present a compelling argument that premastication was an essential behavioural adaptation adopted by our ancestors to ensure adequate nutrition during the months of infancy, where exclusive breastfeeding alone no longer provides an adequate nutrient supply, but before the infant has sufficient teeth to chew and ingest a nutritionally adequate diet himself. They further argue that, while the cereals produced in agricultural societies and modern food processing techniques may seemingly have rendered premastication unessential, it could in fact have a crucial role in supporting infant health, particularly in developing country settings, where inadequate nutrition and infection are prevalent. Indeed, the prevention of iron and zinc deficiency during the complementary feeding period in resource-poor settings is highly topical and the focus of considerable research. Red meat – one of the richest natural sources of iron and zinc, as well as protein – is difficult to feed to young infants without

some form of processing or puréeing; premastication could provide a solution to this problem.

The potential nutritional benefits of premastication are thus compelling, but there may be other, as yet largely unexplored benefits. For example, it is possible that early exposure to food allergens in premasticated foods, particularly alongside breastfeeding, could promote immune tolerance and perhaps modulate subsequent allergic responses. This is relevant in the context of the current debate on the timing of introduction of potentially allergenic complementary foods such as eggs and tree nuts.

However, the most controversial and potentially worrying aspect of premastication is the issue of transmission of pathogens – notably HIV. This is particularly relevant when performing a risk–benefit analysis of premastication in settings where the practice may be of great nutritional benefit but where HIV infection is also prevalent. The authors point out that, although pathogens are found in saliva (as in breast milk), saliva also contains numerous anti-infective agents including immunoglobulins that may inhibit or neutralize infective agents and prevent infection or colonization. With regard to HIV, a substantial body of research has shown that there are mechanisms that reduce the infectivity of HIV in saliva, thus making the risk of transmission low, lower than for breast milk. Hence, the authors consider that the risk of transmission of HIV via premastication is likely to be low. However, in a recent paper, Gaur *et al.* (2009) reported three infants in whom HIV infection was linked to the feeding of premasticated foods by an HIV-infected carer. In all cases, perinatal HIV transmission had been excluded, and the infant had not been breastfed. In two cases, the caregiver had concurrent oral bleeding at the time of premastication. Phylogenetic analyses also supported the epidemiological conclusion that the children were infected through exposure to premasticated food in two of the three cases. Based on these findings, Gaur *et al.* suggest that this route of transmission might explain some of the previously reported cases of 'late' mother-to-child transmission of HIV, and that, pending further research, premastication by HIV-positive carers should be discouraged. Habicht and Pelto *et al.* strongly refute the suggestion that premastication is likely to be a route of transmission

for HIV, and claim that it is biologically implausible (Habicht & Pelto 2009). However, it is perhaps worth considering that the literature on transmission of HIV by saliva comes largely from studies of orogenital sexual contact in adult subjects; it is by no means certain that these observations are directly transferable to the transfer of premasticated food between adult and infant.

In conclusion, premastication may well have been an important practice in promoting infant nutrition and health in our ancestors, and it could have similar benefits for contemporary infants, especially in resource-poor settings. However, further research is required to assess the balance of benefit and risk – and in particular to determine whether HIV can be transmitted in this way. Given the potential benefits of the practice and the fact that it is probably already widespread in certain cultures where HIV is prevalent, this should be a priority.

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My initial reaction to this paper was one of disbelief. However, since the question is asked within a hypothetical format, it deserves a more academic response, which is to pose another question in return: ‘What do you have in mind, precisely?’ After reading and digesting the paper, it becomes clear to me that the authors are not pretending to have found the ‘Holy Grail’ for solving the nearly insolvable problem of inadequate weaning practices and complementary feeding of infants in the numerous poor parts of the world, double burdened by infections. Yet, on the

other hand, they are urging us seriously to research whether premastication ‘can solve not only the “weanling dilemma” but also some of the health problems among the better-off’. Based on the presumption that premastication may have anti-infectious properties by neutralizing microbial contamination of complementary feeding, they hypothesize that the ‘weanling dilemma’ may in part be due to failure to practise premastication in early childhood feeding. Here we move into the field of nutritional epidemiology and also Gordon, who in 1963 coined the term ‘weanling diarrhoea’ in one of his chapters, ‘Synergism of malnutrition and infectious disease’, in the World Health Organization (WHO) monograph ‘Nutrition in Preventive Medicine’. In this work, Gordon illustrates Scrimshaw’s concept of ‘Interactions of nutrition and infection’, taking weanling diarrhoea and measles as example (Gordon 1976).

I remember the maternal practice of ‘prechewing’ from my work as medical officer in Zambia in the early 1970s, but I did not observe this during my nutritional practice and research in Lesotho a decade later. I considered that my disbelief might have been conditioned by such limited geographically determined experience. After reading the paper, I appreciated that the authors’ conclusions on premastication (or equivalent) were obtained by findings from searching and digging an ethnographic database (Human Relations Area Files, Yale University), interviewing rather well-off Han Chinese students on their infant feeding history (thereby assisted by parents and grandparents if needed) and available information and opinion on the properties of (maternal) saliva. Not being too keen on database research, I decided to find out whether ‘pre-mastication, chewing or prechewing’ of food was mentioned in any of my favourite texts on infant and child nutrition in traditional and transitional societies. Thinking of Cornell, I started with Michael Latham, who after being medical officer in charge of the Nutrition Unit of the Ministry of Health in Tanzania, occupied the chair of International Nutrition at that University for more than 30 years. Inspired by his African experiences, he composed a seminal handbook ‘Human nutrition in Tropical Africa’ with focus on East Africa, published by the Food and Agriculture Organization (FAO) of the United Nations in 1965. A

revised edition was published in 1972 (Latham 1965, 1972), and much of this experience was incorporated in the more general nutrition text FAO handbook 'Human Nutrition in the Developing World', which appeared in 1997 (Latham 1997). Scrutinizing all three texts, I do not find any mention of premastication, nor its equivalents. Neither did I find any mention of it in Leonardo Mata's classic prospective field study on health and growth of 45 Mayan children in rural Guatemala (Mata 1978). However, out of the 'Cambridge World History of Food', in the paragraph on 'Infant and Child Nutrition' by Sara Quandt, 'pre-mastication' does pop up, but only once (Quandt 2000). She puts it into the historical perspective of hunting and gathering, which were the only methods of obtaining food until 10 000 years ago or less. Following this lead, I found corroborative reports of premastication practice amongst the Kung San of the Kalahari, who were extensively studied, between 1963 and 1975, by Lee and others (Konner 1976; Cohen 1989). The Kung San have birth intervals of average 44 months and practise gradual weaning, with cessation of breastfeeding only occurring when the next child is born. Premasticated foods (e.g. roots, tubers and nuts, green food plants but on occasion meat, which must have been quite tough) are gradually added to the diet because there are few available foods that can otherwise be managed by very small children. Truswell reported that Southern African rock paintings show women digging, presumably roots and tubers and indeed seemingly much as contemporary San women still do (Truswell 1977).

Inspired by my own experience around Lake Bangweulu in Zambia, I turned to the social anthropology and nutrition studies of Audrey Richards (1899–1984). In the 1930s, she studied the sedentary Bantu peoples of Southern Africa, particularly the Bemba of Northern Rhodesia, i.e. present Zambia (Richards 1932, 1961). Disappointingly, while she provides detailed information on the feeding of infants and young children, no mention of premastication of food is made at all. However, unpublished findings during a study carried out by us in the 1990s, in Bemba-speaking tribes living adjacent to Lake Bangweulu, do show that premastication was then practised by a relatively small number of mothers, starting somewhere around 3–4 months of age (J.L.A. Hautvast & J.J.M.

Tolboom, 'personal communication'). As Audrey Richards had observed in the Bemba proper, during the first year of life, breastfeeding is universal and may last for 2 years or even more. In our study, which dealt with linear growth retardation in young rural Zambian children, complementary feeding as a whole falls short of recommended intakes of energy and protein which, in synergy with a high-infectious burden (i.e. malaria), is the most likely cause of the growth faltering and anaemia observed between 6 and 41 months of age (Hautvast *et al.* 1999, 2000).

In his WHO monograph 'Infant nutrition in the subtropics and tropics', Derrick B. Jelliffe covers 'present infant feeding practices' (in 52 pages) and makes extensive reference to premastication, or equivalent (Jelliffe 1968). In a global overview, he noted that in all Arabic-speaking countries, e.g. in the (Northern) Sudan, mothers may first give foods that do not need any chewing at all, i.e. cream ('jumada') from the second month of age. In contrast to South East Asia, where more solid foods are introduced early on, and premastication of these is practised; for example, in Burmese infants, the first semi-solid food is introduced either as rice porridge ('congee') or as 'prechewed' by the mother; in Cambodia, Laos and Vietnam prechewed cooked white rice is given as alternative for rice-water soup ('chao'); and in Bali, from a few days after birth onwards, a mixture of prechewed rice and banana is 'arranged in a mound on the child's mouth and when the child cries, food is poked into the open mouth'. Similar practices may have been carried out in Java. In the former New Hebrides (Vanuatu) and the Solomon Islands, from a very early age, children are given premasticated taro while in New Guinea, it is taro, sweet potato, yam or banana, all also prechewed by the mother. Australian aborigines also declared practising premastication. Jelliffe makes no reference to premastication practices in China, Hong Kong and Korea, the Caribbean and Central and South America. From sub-Saharan Africa, Jelliffe describes 'tongue-feeding' as a more old-fashioned practice in Nigeria (Lagos), where the mother chews the food into a pulp and then transfers it into the baby's mouth with her tongue, but he does not mention it from other parts of West and Central Africa (including Southern Sudan). In most parts of

East Africa, complementary feeding may start early, sometimes by forced hand-feeding of only 10-day-old-infants, without premastication being practised. However, among the Kikuyu (Kenya), masticated yams and bananas may be used firstly at the start of complementary feeding and, thereafter, at the age of 4–6 months, maize gruel is introduced. Among the Hadza hunter-gatherers of Northern Tanzania by the time a child has 2–4 teeth, he is fed prechewed meat by his mother. From Uganda, Jelliffe quotes studies by Trowell (and Davies) in Buganda which show that at the age of 4–6 months, gruel of ground millet or chewed banana is given by the mother ‘by mouth-to-mouth-injection’. Surprisingly, I do not find this information in Ainsworth’s respected monograph on Ganda infant care (Ainsworth 1967).

Returning to the paper by Pelto, Zhang and Habicht, their findings that premastication is mentioned in 38/119 culture reports on infant feeding very well correspond with Jelliffe’s observations. The start of premastication practice appears to vary highly, with an average at around 6 months of age. A potential ‘bottle neck’ in premastication practice may be a too early start, which in 5/12 of reports was at the age 1–4 months, before complementary feeding is thought to become indicated. That leaves us with 7/12 culture cases where it is practised during the age 5–12 months, where a start of complementary feeding would be acceptable or needed.

Many practical issues remain for low income communities: for example, which complementary foods need to be offered premasticated? Certainly, high-quality foods as animal meat and fish, particularly when procured smoked dry would need to be prechewed; however, meat is costly and therefore scarce, and freshly prepared fish is only available to those living near a river or lake and dried fish is also expensive (Hautvast *et al.* 2000). It appears wise to prechew nuts, for safety reasons too. Alternatively, nuts can be pounded and to make peanut butter can be learned. Energy density and consistency of bulky starchy weaning (staple) food can be improved by adding oils, so prechewing is not an issue.

Looking at the very detailed studies of Mata in Guatemala, Richards in Zambia and Ainsworth in Uganda and from our own observations in Zambia

and Southern Africa, I find it difficult to envisage an important role for premastication to improve the adequacy of complementary feeding apart from providing the child with some extra anti-infectious defences from sixth months of age onward. The authors agree that exclusive breastfeeding is sufficient for infant’s growth, health and development until the age of 6 months. To induce a change in timing of introduction of premasticated complimentary foods, in cultures that already practise it, to sixth months of age or later will be formidable job. To introduce premastication in cultures that do not know it all, truly appears to me a ‘Sisyphus labour’, both in terms of nutrition as well as behaviour.

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Premastication occurs when a mother or caregiver chews solid foods and feeds the resulting mash to the infant. Although the historical and anthropological literature on this practice is not extensive, there are sufficient reports to suggest that this is an ancient practice that was widely undertaken. A description of premastication practice in ancient Egypt was documented 1500 years ago (Radbill SX, 1981).

In this journal, Pelto *et al.* demonstrated that in an anthropological review of 119 cultures, at least 30% documented premastication. They also showed that in a survey of students from a Chinese University premastication was a common practice during infancy (63%) (Pelto GH, 2009). Publications in the last 20 years have evidenced that premastication remains prevalent in both developed and developing countries. A report of a cohort of 62 mother-infants pairs found that up to 17% of infants received premasticated foods

as early as their 2nd week of age and 81% by 6 weeks of age (Imong SM, 1995). In a non-randomly selected population of 68 black child care providers in Omaha it was found that 65% of them used to premasticate food for the infant (aged 1–7 years) (Walburn JN, 1988). In South Africa, a non-random sample of relatives of 896 children aged 6 years or less in both urban and rural settings were interviewed and premastication was practiced by 67% of the mothers and 44% of the fathers (Butler LM *et al.*, 2009).

Fein *et al.* estimated from a nationally distributed sample of predominantly Caucasian infants 2436 in the US, an overall prevalence of premastication of 14%. They found an inverse relationship between the educational level and premastication; 18.6% of the mothers with a high school education or less reported this practice compared with 10% of college graduates (Fein SB *et al.*, 2008).

Premastication is a clearly widespread practice which appears to decrease with transition from a traditional to modern lifestyle. The practice of premastication has declined worldwide over the past decades and will continue to do so. Interestingly, over the same time period, there has been an emerging epidemic of allergies and autoimmune diseases, especially in the developed world (Bach JF, 2002; Grundy J, 2002). There have been numerous hypotheses to explain the rise in atopy arising from possible environmental changes. Although there is no direct evidence that the decline of premastication is directly linked to the rise in allergic and autoimmune diseases (both of which result from a failure of immunological tolerance), it is conceivable that these two phenomena are related. Traditionally, premastication played an important role in the transition from exclusive breast feeding to the autonomous consumption of solids whilst children developed proper dentition. However today the WHO guidelines advocate exclusive breast feeding until 6 months of age followed by direct introduction of solids (Butte NF, 2002). Premastication may have an important role in the development of oral tolerance mechanisms and the prevention of atopic and autoimmune diseases.

Adult human saliva contains an array of cytokines, chemokines, antibodies and other molecules. It includes IL-1 β , IL-2, IL-4, IL-5, IL-6, IL-8, IL-10,

TGF- β , IFN- γ , TNF α and β , MIP-1 α and β , RANTES, Vitamin D, Iron, IgA, IgG4 and IgM (Humphrey SP, 2001; Teles RP, 2009; Sistig S, 2002). Saliva contained in pre-chewed foods could transfer passively IL-10, TGF- β , vitamin D, secretory IgA (sIgA), and IgG, and potentially could induce the development of oral tolerance in the infant. Maternal saliva contains significant levels of sIgA compared to the neonate. sIgA has been detected in the neonate's saliva as early as 3 days after birth, it increases rapidly during the next 6 months, but then stabilised at a level only one-sixth that of the mother's salivary sIgA (Fitzsimmons SP, 1994). TGF- β promotes the switch to IgA production and it is present in adult saliva at 75% of the plasma levels (Yousefzadeh G, 2006). TGF- β is abundant in mammalian milk in a latent form and is activated by gastric acid following oral administration in mice. TGF- β retains sufficient biologic activity in intestinal mucosa could thus enhance oral tolerance (Ando T, 2007; Nakamura Y, 2009). IL-10 is a predominant cytokine in saliva (Teles RP, 2009). IL-10 is also thought to be an important cytokine in the development of oral tolerance and promotes Ig switching to IgG4. It is interesting that both sIgA and IgG4 immunoglobulins – thought to be important antibodies in tolerance – are predominant in human saliva relative to other isotypes (Sistig S, 2002). Thus premastication may provide antigen in an immunologically favourable milieu that promotes the development of oral tolerance to specific dietary antigens that prevents the development of allergies.

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