Smell, Taste and Flavor

By
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The chemical senses of taste and smell are crucial for survival since all animals depend on the consumption of nutrients. These senses evolved to reject that which is harmful and to seek out that which is beneficial and pleasurable. They are among the oldest, the most primitive and the least analytic of the senses. But perhaps their most significant contribution comes when the combine to form the flavor of the foods and beverages we ingest. As will be discussed, infants are born with the ability to taste and to smell and they rely on these senses to search for comfort and food. For infant mental health clinicians, the knowledge of the capabilities of infants and the frontiers of research on their development is important. As we learn about the sensory world of human infants, it will enhance our understanding and in turn, we will be able to advise parents correctly.

Although there are only a small number of primary taste qualities (e.g., sweet, salty, bitter, sour and savory tastes) which can be perceived in all areas of the tongue, olfactory sensations result from the activation of a thousand or more distinct types of chemical receptor proteins located on millions of receptor cells lining the upper recesses of the nose (Buck and Axel, 1991). The receptors for the olfactory system are stimulated when we inhale through our nose (orthonasal route) as well as when molecules reach the receptors by passing from the oral cavity through the nasal pharynx (retronasal route) when foods or liquids are in the mouth. This latter route, often referred to as retronasal olfaction, contributes more significantly than does taste to the complexity of flavor (Rozin, 1982). To demonstrate this, if you pinch your nostrils closed while eating you will interrupt retronasal olfaction and thereby eliminate many of the subtleties of food, leaving the taste components remaining. This is clearly noted by head cold sufferers who lose the ability to discriminate common foods when their olfactory receptors are blocked by a head cold. Similarly, foods often 'taste' better after a person quits smoking perhaps because their sense of smell has improved, allowing them to detect more subtleties of flavor.

The senses of taste and smell are quite developed before birth (see Ganchrow and Mennella, 2003 for review). That is, by the last trimester of pregnancy, the taste and olfactory

receptors, the machinery which detects tastes, smells and flavors, is capable of conveying information to the central nervous system, and this information is available to systems organizing changes in sucking, facial expressions, and other affective behaviors. At birth, infants are sensitive to a wide range of odors, especially those emanating from their mothers (see Schaal, 1988; Ganchrow and Mennella, 2003 for review). Within hours after birth, mothers and infants can recognize each other through the sense of smell alone. Newborns will prefer their mothers' breast unwashed as compared to when it had been thoroughly washed and thereby less odorous. Like that observed in other mammalian young, this recognition of and preference for maternal odors may play a role in guiding the infant to the nipple area and facilitating early nipple attachment and breastfeeding. Whereas odors emanating from mothers cue feeding and digestive functioning and calm infants, those emanating from infants affect maternal responses such as regulation of empathy and influence on the lactational process.

Similarly, infants are sensitive to the odor and taste component of flavors and can detect sweet, sour, and bitter tasting foods as well as a wide variety of flavors. However, sensitivity to salt and other flavors don't emerge until infants are approximately four months of age. In other words, infants are not merely miniature adults since their sense of taste continues to develop during infancy and childhood. The large olfactory component of flavor may shed light as to why flavors experienced early in life remain preferred, and to some extent, provide "comfort". That is, memories evoked by odors and flavors are more emotionally charged than those evoked by other sensory stimuli because of the olfactory system=s intense and immediate access to the neurological substrates underlying emotion. The emotional potency of odor- and flavor-evoked memories, and the reward systems that encourage us to seek out pleasurable sensations together play a role in the strong emotional component of food habits – an integral part of all cultures that has its beginnings during pregnancy and breastfeeding.

One of the earliest sources of flavor experiences is amniotic fluid and mothers' milk since these first foods directly reflect the flavors of the foods and beverages ingested or substances inhaled (e.g., tobacco) by the mother.

During the past few decades, scientific research revealed that not only learning about flavors is occurring during pre-natal life and but these early experiences contribute to long-term food preferences. In other words, sensory experiences provide continuity between the fetal and postnatal environments. The European rabbit provides an elegant example of such learning. Researchers found that when they fed the mother rabbit juniper berries during either pregnancy or lactation, young rabbit pups ate more of this food at weaning. This learning was quite robust and the preference lasted for several months (Bilko et al., 1994).

A similar phenomenon was reported in human infants. Psychophysical research studies conducted at the Monell Chemical Senses Center in Philadelphia, USA, revealed that like other animals, a variety of flavors such as garlic and carrot are transmitted to and flavor human amniotic fluid and mothers' milk. Human infants can not only detect the flavors but experiences lead to increased enjoyment and preference for the flavor later in life (Mennella et al., 2001). That amniotic fluid and breast milk share a commonality in flavor profiles with the foods eaten by the mother suggests that breast milk may 'bridge' the experiences with flavors in utero to those in solid foods. Moreover, the sweetness and textural properties of human milk vary from mother to mother, thus suggesting that breast feeding, unlike formula feeding, provides the infant with the potential for a rich source of varying chemosensory experiences. In this way, culture-specific flavor preferences are likely initiated early in life and early experiences in a sense, educate the young child to appreciate the flavors typical of the culture into which she or he was born. Significant traces of this may remain as children become adults and pass on their food habits to the next generation. Of interest are recent findings infants during from an intra-cultural study of women living in several regions of Mexico (Mennella et al., 2005a). Despite the differences in cuisine, there were striking similarities in the types of foods fed to weaning and eaten more of by mothers during pregnancy. In a sense, the foods eaten by the mother (e.g., fruits) formed the basis of their children's weaning patterns.

Perhaps the most striking taste difference between children and adults is the strong liking for sweet-tasting foods and beverages, and the dislike of bitter-tasting vegetables during childhood. Is the strong preference that children have for sweets solely a product of modern marketing, technology (e.g., sugar refining) and availability or does it reflect some aspect of their basic biology? Research suggests that these likes and dislikes reflect the latter. From an evolutionary perspective, these responses serve important biological functions. Preference for sweet tasting foods may have evolved to solve a basic nutritional problem of attracting children to sources of high energy during periods of maximal growth since foods (e.g., mother's milk, fruits) that are rich in energy often taste sweet. The rejection of bitter tastes may have evolved to protect from poisoning since many toxic substances are, by their nature, bitter and often distasteful (Mennella et al., 2005b).

Because the senses of taste and smell are the major determinants of whether young children will accept a food (e.g., they eat only what they like), they take on greater significance in understanding the biological basis for children's food choices. Although we are beginning to learn how the chemical senses develop during infancy and its impact on food choice and other behaviors, there are many gaps in our knowledge. In particular, we know little about the contingencies for early learning and how the absence of chemosensory experience, disruptions in mother-infant attachment, or the negative associations with early feeding interferes with the acquisition of feeding skills. The increasing importance of infant dysphagia makes it imperative to determine the extent to which restoration of normal oral motor

and sensory experience impact upon the feeding skills and nutrition. We present here some examples of gaps in knowledge:

The necessity of tube-feeding presents a paradox in the care of infants because it precludes sensori-motor experience that could be expected to promote feeding skills. Tube-fed infants have a relatively constrained olfactory and flavor experience in the context of feeding that is not fully understood.

A common feature of dysphagia is discomfort and interruption of the continuity of feeding behavior. Over time, negative feeding experiences lead to aversive feeding behaviors that create a self-perpetuating cycle. Such negative feeding experiences and aversive feeding behavior are evident in a wide variety of medical contexts of infant dysphagia such as infants with gastroesophageal reflux, chronic respiratory disease, neuromuscular disease, and cerebral palsy. That learning plays a role in the pathogenesis of feeding difficulty is therefore fundamental to the clinical practice of infant dysphagia specialists.

In the NICU or even normal infants wards in hospitals, infants often do not experience the smell of 'adult food' or have others eat in their presence. Instead, infants are exposed to specific smells of NICUs which can be described as "hospital smell" consisting of detergents, antibacterial fluids and other cleaning items. The long-term consequences remain unknown.

Clearly, more research is needed to develop evidence-based practices aimed at infant feeding difficulty (dysphagia) which constitutes a medically and economically important complication for some neonatal diseases. Applying the knowledge gleaned from such research and clinical practice which takes into account the developing sensory world of the child could have long-term consequently in preventing eating disorders in early infancy. Moreover, understanding the development and functioning of these senses may assist in the development of evidence-base strategies to improve their diets since many of the illnesses that plague modern society (e.g., obesity, diabetes and hypertension) are the consequence of poor food choices.

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