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Development of food preferences: Lessons learned from longitudinal and experimental studies

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Flavor preferences begin to be shaped long before one's first taste of solid food. Here we summarize the insights gleaned from scientific research from both experimental and longitudinal studies. As will be discussed, this research suggests that infants learn about the types of foods eaten by their mothers during pregnancy and lactation. Such experiences bias acceptance of particular flavors and may 'program' later food preferences. In this way, this is the first way (but not the only way) in which culture-specific food preferences are likely initiated early in life.

During the past decade, experimental studies revealed that the environment in which the human fetus lives, the amniotic sac, changes as a function of the food choices of the mother since dietary flavors are transmitted and flavor amniotic fluid (Mennella, Johnson, & Beauchamp, 1995). Experiences with such flavors lead to increased enjoyment and preference for these flavors at birth and during weaning. For example, exposure to dietary transmitted flavors such as garlic or anise in amniotic fluid has been shown to influence the newborn's facial, mouthing, and orienting responses to those odors immediately postpartum (Hepper, 1988; Schaal, Marlier, & Soussignan, 2000). Some of these same flavors will later be experienced by infants in their mother's milk since human milk is composed of flavors which directly reflect the foods, spices and beverages ingested by the mother (Mennella & Beauchamp, 1991; Mennella et al., 1995).

Like that observed in other mammals, infants who were exposed to a flavor (i.e. carrots) in either amniotic fluid or mother's milk behaved differently in response to that flavor in a food base than did non-exposed control infants (Mennella, Jagnow, & Beauchamp, 2001). Specifically, previously exposed infants displayed fewer negative facial expressions while feeding the carrot-flavored cereal when compared to the plain cereal. Moreover, those infants who were exposed to carrots prenatally were perceived by their mothers as enjoying the carrot-flavored cereal more when compared to the plain cereal. Postnatal exposure has similar consequences thus highlighting the importance of a varied diet for both pregnant and lactating women.

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, such as viscosity and mouth coating, vary from mother to mother, thus suggesting that breastfeeding, unlike formula feeding, provides the infant with the potential for a rich source of varying chemosensory experiences. The types and intensity of flavors experienced in breast milk may be unique for each infant and serve to identify the culture to which the child is born. Of interest are recent findings from an intra-cultural study of women living in several regions of Mexico (Mennella, Turnbull, Ziegler, & Martinez, 2005). Despite the differences in cuisine, there were

striking similarities in the types of foods fed to infants during 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 the child's weaning patterns.

Experimental research has also revealed that the type of exposure needed to enhance later acceptance may not require experience with the actual flavor, however. Experience with flavor variety enhances the acceptance of novel foods during weaning in human infants (Gerrish & Mennella, 2001) and animal models (Capretta, Petersik, & Steward, 1975). Of interest is the finding that breastfed infants were more willing to accept a novel vegetable upon first presentation than are formula-fed infants (Sullivan & Birch, 1994). One explanation for this finding is that, unlike the formula-fed infant who experiences a monotony of flavors in infant formula, the breastfed infant is exposed to a variety of flavors in breast milk, setting the pattern for a diversified diet.

The long-term consequences of early milk feeding on the development of aspects of food and flavor preferences have been the subject of a few longitudinal studies in recent years. In an 8-year longitudinal study conducted in the United States, fruit and vegetable consumption by school-aged children was predicted by either breastfeeding duration, food-related experiences during early life, or mothers' preferences (Skinner, Carruth, Wendy, & Ziegler, 2002). Similar findings have been recently reported in the United Kingdom (Cooke et al., 2004) and France (Nicklaus, Boggio, Chabanet, & Issanchou, 2004). Clearly, more research is needed, but the finding that infants are learning via flavor cues in breast milk suggest one (but not the only) mechanism underlying these associations.

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