Learning to eat: birth to age 2 y[1–4]

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ABSTRACT

During the first 2 y of life, development is rapid and includes dramatic changes in eating behavior. Individual patterns of food preferences and eating behaviors emerge and differ depending on the foods offered and on the contexts of feeding during this early period of dietary transition. In this review, we discuss evidence on ways in which early learning influences food preferences and eating behavior, which, in turn, shape differences in dietary patterns, growth, and health. Although the evidence reviewed indicates that this early period of transition provides opportunities to influence children's developing intake patterns, there is no consistent, evidence-based guidance for caregivers who are feeding infants and toddlers; the current *Dietary Guidelines* are intended to apply to Americans over the age of 2 y. At present, the evidence base with regard to how and what children learn about food and eating behavior during these first years is limited. Before developing guidance for parents and caregivers, more scholarship and research is necessary to understand how infants and toddlers develop the food preferences and self-regulatory processes necessary to promote healthy growth, particularly in today's environment. By the time they reach 2 y of age, children have essentially completed the transition to "table foods" and are consuming diets similar to those of other family members. This article discusses parenting and feeding approaches that may facilitate or impede the development of self-regulation of intake and the acceptance of a variety of foods and flavors necessary for a healthy diet. We review the limited evidence on how traditional feeding practices, familiarization, associative learning, and observational learning affect the development of eating behavior in the context of the current food environment. Areas for future research that could inform the development of anticipatory guidance for parents and caregivers responsible for the care and feeding of young children are identified. *Am J Clin Nutr* 2014;99(suppl):723S–8S.

INTRODUCTION

The focus of this article, written as a contribution to the National Institute of Child Health and Human Development "B-24" project, is on how infants' and toddlers' experiences and learning within the caregiver-child feeding relation shape the development of eating behavior. In line with the charge of the B-24 working group, this article identifies and reviews existing evidence on factors that influence the diets of children <24 mo of age and parents' and caregivers' ability to provide adequate nutrition to their children. These topics are being considered for inclusion in future systematic reviews needed to provide the evidence base for the development of dietary guidelines for this age group. Areas for future research that would address gaps in what is known about the development of eating behavior and that could inform the development of dietary guidelines are also identified.

Infants and toddlers achieve many developmental milestones during the first 24 mo of postnatal life: learning how to sit, crawl, stand, walk, and talk. Eating behavior also develops dramatically during this period as children transition from consuming only breast milk or formula to "table foods" (ie, nonpuréed fruit and vegetables, grains, meats, eggs) by the time they reach 2 y of age (1). Because infants and toddlers are dependent on parents and other caregivers for sustenance, parent feeding practices, including what, when, and how parents and caregivers feed their children, play a critical role in the formation of young children's food preferences and eating behaviors. Understanding the learning processes that underlie the development of food liking and self-regulation of intake during first 24 mo of life is important because what children learn in this domain during infancy and toddlerhood affects subsequent eating behavior, growth, and weight status (2).

The infant and toddler period is an opportune time to promote the acceptance of foods that are characteristic of healthy diets, such as fruit and vegetables (3). Evidence-based dietary guidance to help parents and caregivers decide what, when, and how to feed their children is clearly needed during infancy and toddlerhood, a period when dietary change is rapid (1), early growth affects later outcomes (4), and epigenetic processes affected by diet shape individual differences in risk of obesity and related metabolic outcomes (5). Parents and caregivers lack consistent dietary guidance for children <24 mo of age; there are currently no guidelines that are similar to the *Dietary Guidelines for Americans* (6) that apply only to individuals older than 2 y. The nutrient needs of infants and toddlers are different from those of older children and adults; separate dietary guidelines are needed for this reason. However, because infants and toddlers are dependent on others to feed them, in addition to guidance about what infants and toddlers should be eating, caregivers also need

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guidance about how to feed their young children. Evidence regarding the poor nutritional quality of young children's diets (1, 7, 8) and the prevalence of excessive weight gain and overweight among infants and toddlers (9) underscore the need for dietary guidance specifically focused on feeding infants and toddlers.

The existing literature on how infants and toddlers learn about food preferences and eating behavior within the context of the caregiver-child feeding relation is limited, but there is evidence to support contributions made by early exposure to traditional feeding practices and by 3 forms of learning: familiarization, associative learning, and observational learning. This article provides examples of what is known and points out areas in which evidence is lacking, especially for infants and toddlers. Much of this literature is based on studies in infants <12 mo old or in preschool children >24 mo of age. This is a major research gap; few studies have focused on the "toddler" period between 12 and 24 mo when the majority of the transition to table foods tends to occur.

PARENTS, PARENTING, AND TRADITIONAL FEEDING PRACTICES: EFFECTS ON THE DEVELOPMENT OF CHILDREN'S FOOD LIKES, DISLIKES, AND INTAKE

During this early period, caregivers have the responsibility for making the decisions about feeding. Much of the early learning about food and eating occurs in the family or in other child care settings, environments that are shaped by parents and other caregivers. These adult caregivers may serve as models for children's eating and activity patterns. They teach eating behaviors (eg, how to use a spoon), determine which foods are available and portion sizes offered, select the timing and social context of meals, and may attempt to pressure or coerce children to eat. Parents also shape other contexts that influence eating behavior: access to screen time, active play, and sleep schedules. On the basis of their early experience with these routines, infants and toddlers learn about whether eating begins and ends in response to their internal hunger and fullness cues, or in response to environmental cues such as the amount of food remaining on the plate (10). Given that approximately two-thirds of adults are currently overweight or obese (11), most infants and young children live in families in which at least one parent is overweight or obese, and they may be at elevated risk due to parental genetic factors. However, potential differences in lifestyle and family environments created for children by parents who are or are not obese have been a focus of only a few studies (12, 13), and little is understood about how children's gene expression is affected by the family environments created by overweight and obese parents (14). Parents provide both genes and environments during children's early development; genes are expressed in family contexts differing in foods available, routines around food and eating, and early feeding practices, such as prolonged bottle feeding or the timing of introduction to solid foods, which may conjointly increase risk of an obese phenotype. Because environmental aspects of childhood obesity risk are modifiable, additional research on how parenting and feeding strategies can be influenced to promote healthy eating behavior in young children is needed to inform guidance (15).

In the absence of dietary guidelines about how to promote age-appropriate healthy diets for infants and toddlers from birth to age 24 mo, young children's diets resemble those of adults: they are too high in energy, saturated fat, sugar, and salt and too low in fruit, vegetables, fiber, and complex carbohydrates. Data from the 2008 Feeding Infants and Toddler Study (FITS) show that infants and toddlers consistently exceed their daily calorie needs and are more likely to consume a sweet (eg, cookies or candy) than a vegetable or fruit in a day (8). Results from the 2008 FITS and recent NHANES data suggest that children consume too many high-calorie foods and drinks such as whole milk, fruit juice, sugar-sweetened beverages, dairy and grain desserts, and pasta dishes, which contribute ~40% of total energy to their diets (7, 16). Given these dietary patterns, it is not surprising that ~25% of preschool-aged children have already become overweight or obese, with higher rates among some subgroups (9). However, research is needed that goes beyond establishing correlations, to an understanding of how caregivers can improve children's diet quality and reduce early obesity risk (15).

Although parents have opportunities to establish healthy dietary patterns in their toddlers during the transition to the adult diet, the persistence of traditional feeding practices in contemporary food environments can be problematic (17). Traditional parenting and feeding practices evolved over thousands of years to protect children in the context of food scarcity (ie, inadequate and/or unpredictable food availability, low palatability, low energy density, and/or limited food choice and variety), which, until recently, constituted the major environmental threat to infants' and young children's healthy growth and development. Traditional feeding practices include offering food as a first response to infant crying and distress ["feeding to soothe" (FTS)], feeding frequently when food is available, providing large portions, offering preferred foods, and pressuring children to eat what is given to them (18). The nutrition transition has created dramatic changes in the food supply and increased the availability of palatable, energy-dense, inexpensive foods (19). Most children in United States are now at a higher risk of overnutrition than undernutrition, yet feeding practices have not changed to protect against this new environmental threat.

Although the evidence is scant, it has been hypothesized that the persistent use of traditional feeding practices can exacerbate the impact of our obesogenic environment on early obesity risk by promoting excessive weight gain early in development (17). There is emerging evidence that one traditional feeding practice, FTS, can promote excessive energy intake and weight gain, at least among some children. Recent research shows that higher levels of FTS are related to higher BMI z scores but only among infants whose mothers described them as high in temperamental negativity (20). A recent review reported that excessive weight gain and obesity reported among infants who are higher in negativity may result from the more frequent use of FTS (21).

Research in preschool-aged children indicates that traditional feeding practices can foster both "picky eating" and excessive energy intake in today's food environment, but evidence for the effects of these practices with infants and toddlers is more limited. Experimental studies have provided evidence that pressuring preschool-aged children to eat "healthy" foods such as vegetables can promote dislike of those foods (22), making it less likely that those foods will be consumed, especially if a variety of more palatable foods are readily available. For example, parental use of pressure to eat "healthy" foods has been associated with greater consumption of energy-dense sweet and

savory snacks in preschoolers (23). With regard to the impact on intake of serving large portions of palatable foods, there is evidence that infants and young children will eat more when given larger portions (24, 25). A recent study showed that offering preschoolers larger portions of a palatable entrée reduced dietary variety and vegetable intake at that meal; whereas intake of the entrée increased with increasing portion size, intake of vegetable side dishes decreased significantly (26). Again, because most of the evidence available comes from research conducted in slightly older children (2- to 5-y-olds), research is needed to determine the effects of these practices among infants and toddlers.

Traditional feeding practices may compromise the development of self-regulation of intake, in which eating is initiated in response to hunger and terminated in response to satiation signals. There is evidence implicating controlling child feeding practices, particularly the use of restrictive feeding practices, in the development of eating behaviors that contribute to overeating and obesity (27). However, once again, research to date has been conducted in children of preschool age (age 2–5 y) or older (27–30). The potential for iatrogenic effects of traditional feeding practices, such as teaching children to eat past feelings of fullness or in response to emotional distress, and limited evidence on other approaches underscore the need for research on alternatives to traditional feeding practices, particularly during the first 2 y of life.

LEARNED LIKES AND DISLIKES: FAMILIARIZATION IN OBESOGENIC ENVIRONMENTS

Through experience, things become familiar. Familiarization is a simple form of learning: a process of acquiring familiarity with objects, people, actions, and their consequences (31). The distinction between the familiar and unfamiliar is important because familiarity has a very strong evaluative component: what becomes familiar tends to become preferred, and the unfamiliar tends to be avoided and disliked (32). Infants learn to prefer people, objects, and activities that become familiar. Milk, as the single first food for infants, also becomes familiar. When weaning begins, milk provides the standard against which all other new foods and flavors are evaluated. Only formula flavors are familiar for formula-fed infants, but because a variety of flavors from the mothers' diet are introduced to the infant through breast milk, breastfed infants have already become familiar with a variety of food flavors (33). Research of Mennella et al (34) has shown that these familiar flavors provide a "flavor bridge," easing the transition to the foods of the adult diet consumed by the mother. For example, breastfed infants show more rapid acceptance of puréed vegetables during weaning (35), and experience with specific flavors (eg, carrot) in breast milk promotes acceptance of that same flavor during complementary feeding (36). Early experience with a variety of flavors in puréed foods also promotes acceptance of other unfamiliar flavors (3). This early familiarization influences the infants' reactions to foods introduced at weaning and shapes the development of likes and dislikes for table foods. Liking is a key determinant of intake of infants and young children who tend to eat only preferred foods (37). This is especially possible in our current environment, which is characterized by the abundant availability of inexpensive, energy-dense, palatable foods.

The effects of exposure on the development of food and flavor preferences may be greatest as weaning begins (3), although this is another topic where evidence is limited. At weaning, all foods other than milk are new, and acceptance of a variety of solids is essential to consuming an omnivorous diet that supports growth and health. There is evidence that these early preferences can affect preferences for foods later in childhood (38). Relatively minimal exposure can promote liking during this early period, and this may prove to be a sensitive period for learning flavor preferences (39). Infants who were just beginning to be offered puréed foods increased their intake of new fruit and vegetables after a single exposure, and the effects of exposure generalized to other similar puréed foods (40). Limited evidence is consistent with the idea that with age, negative affective responses ["neophobia" (fear of the new)] to novel foods and flavors increase. Research in toddlers, preschoolers, and school-aged children tends to show increases in neophobia among children with increasing age, at least until middle childhood (41), although this observation is based on cross-sectional data. Unfortunately, most caregivers are not aware of the importance of familiarization in determining infants' and young children's food preferences and could benefit from guidance in recognizing the neophobic response and understanding that it is a normal reaction to new foods, not a reflection of "picky eating."

In addition to learning to prefer the familiar, infants also come equipped with predispositions to prefer or reject the basic tastes (42–44). These predispositions include unlearned positive responses to sweet, salty, and umami tastes and rejection of bitter and sour tastes (45), although these initial responses to basic tastes can be modified through subsequent experience with food (46–48). Our current food environment is tuned to our unlearned predispositions and characterized by the ready availability of inexpensive, energy-dense foods that are high in sugar and salt. Infants and young children will accept these foods and beverages the first time they are offered, even without repeated experience. It is therefore relatively easy to establish unhealthy dietary patterns, consisting primarily or exclusively of foods high in sugar, salt, and energy, and more difficult to promote acceptance of a variety of foods including vegetables that will only be accepted if children have repeated experience with them.

LEARNING TO ASSOCIATE FOODS WITH THE CONTEXTS AND CONSEQUENCES OF EATING

Learned liking or disliking of foods can occur through associative learning, which involves the association of the food or flavor with the affect generated by an unconditioned stimulus. Extensive research has provided evidence that such associative processes affect liking and intake in animal models (49, 50). However, evidence that associative learning processes also play an important role in the acquisition of food likes and dislikes in children (37) is limited and another area in which additional research is needed. Especially for young children who are dependent on others to feed them, eating tends to be a social occasion. Associations with the emotional tone of social interactions during feeding can shape food likes and dislikes, but evidence is limited primarily to studies conducted in 2- to 5-y-olds. Preschool children's liking for familiar snack foods was increased when the food was either given as a reward or paired with positive adult attention [(51); or *see* reference 37 for

a review]. In a recent study, preschoolers were served 2 different flavors of puréed vegetable soups at lunch in a preschool setting (22). In the experimental condition, children were pressured by the adult at the table to "finish their soup," whereas no pressure to eat was applied in the control condition. Relative to the controls, children consumed less soup and made more negative comments about the soup that they had been pressured to eat (22). Research is needed on how parental feeding style and caregivers' emotional tone during feeding influence liking and intake of foods during the 0- to 24-mo period.

In addition to the influence of feeding practices, eating also has physiologic consequences and generates postingestive feelings of satiation or fullness, which can increase liking for the foods eaten. There is extensive evidence on flavor-consequence learning from experimental studies of other omnivores, showing that flavors paired with ingestion of higher energy density foods are preferred to those associated with lower energy density foods (*see* reference 49 for a review). The evidence in children is limited to a few studies in 2- to 5-y-old children (52, 53). For example, when 2- to 5-y-old children repeatedly consumed 2 different novel-flavored yogurts as snacks on alternate days that were either high or low in energy density, greater increases in liking were obtained for flavors associated with higher energy density yogurts than for those paired with low-energy yogurts (53).

The pairing of novel flavors with familiar ones is another form of associative learning that can influence the development of food preferences in children. In flavor-flavor learning, the conditioned stimulus is an unfamiliar flavor and the unconditioned stimulus a familiar, preferred taste or flavor. After repeated pairing of the 2 during a series of tasting trials, the unfamiliar flavor becomes associated with the preferred flavor, increasing liking of the new flavor, even when it is consumed without the preferred unconditioned stimulus flavor. A recent study compared the effects of a "mere exposure" familiarization control condition to flavor-flavor conditioning on 2- to 5-y-olds' vegetable liking and intake (54). Over several weeks in their usual child care program, children had repeated exposure trials in which they tasted an unfamiliar vegetable (red bell pepper or yellow summer squash) initially rated as "yucky." In the familiarization control, children tasted the vegetable alone; in the flavor-flavor condition, the vegetable was served with a small amount of a liked dip initially rated as "yummy." It was hypothesized that flavor-flavor learning would produce greater increases in liking and intake, but the findings indicated that both familiarization and flavor-flavor conditioning produced significant increases in liking and intake at the posttest (54).

One of the challenges with familiarizing children with new foods and flavors is that tasting the food is necessary to alter preference and intake, yet children are often reluctant to taste new foods. In an experiment in which the effects of tasting exposures were compared with looking and smelling samples of new foods, only exposure to the taste of the food produced significant increases in liking (55). Inducing children to take an initial taste of food can be difficult, but the evidence shows that pairing novel foods with familiar, preferred foods in flavor-flavor conditioning can quickly increase liking and intake (54, 56). One reason flavor-flavor conditioning appears to change liking more quickly than exposure alone is that the addition of the familiar, preferred flavor increases children's willingness to taste the novel disliked vegetable (54). Research on whether these associative learning processes function similarly during the 0- to 24-mo period is a next step to inform the development of evidence-based guidance for parents and caregivers of infants and toddlers.

OBSERVATIONAL LEARNING: SOCIAL INFLUENCES ON FACILITATING TASTING, LIKING, AND INTAKE

Social influence provides another powerful tool for promoting tasting and intake of novel foods. Children show a tendency to taste unfamiliar foods more readily when they observe adults eating them than when the food is merely offered to the child (57). Peer modeling can also be effective; observers who watched peer models eating a food that the observer disliked promoted the observer's willingness to choose and eat that food subsequently (58–60). There is some evidence that social influence affects even very young children. Harper and Sanders (57) noted no differences in the effects of social influence on tasting novel foods between toddlers (14- to 20-mo-olds) and older preschoolers (42- to 48-mo-olds). A more recent study assessed young children's (2- to 5-y-olds) responses to novel foods when an adult model *1*) was not eating the food, *2*) was eating a food of a different color, or *3*) was eating a food of the same color as that offered to the child (61). Children accepted and ate more of the novel food in the "same" color condition, providing evidence that in young children, food acceptance is promoted by specific social influence [(61); *see* also reference 62 for similar findings with vervet monkeys]. More research is necessary to understand what infants and toddlers learn about food and eating through observation, such as the relative influence of various caregivers on eating behavior, particularly if children are exposed to different models of eating across settings (eg, child care and home).

SUMMARY AND CONCLUSIONS

Guidance for caregivers is needed on how to help children learn to prefer and consume more nutritious foods. Unfortunately, the evidence on how children learn about food and eating behavior during the first 24 mo is limited, particularly in the 12- to 24-mo-old period when the majority of the transition to table food occurs. Traditional feeding practices used with infants and toddlers have negative effects on intake patterns in the current obesogenic context by promoting dislike for foods parents coerce children to eat and by fostering liking for palatable, energy-dense foods that parents try to limit. In addition, feeding practices that encourage eating for reasons other than hunger may compromise self-regulation of intake and promote eating in absence of hunger in response to external cues, which is not adaptive in the current environment in which palatable, inexpensive, high-energy-dense foods are readily available. There is insufficient evidence on whether differences in the continued use of traditional practices are associated with socioeconomic status and/or ethnicity differences and whether these practices may mediate differences in obesity prevalence across groups.

More research on approaches to feeding infants and toddlers to promote healthier patterns of intake through familiarization, associative learning, and observational learning is necessary to inform the development of evidence-based anticipatory guidance for parents and caregivers. A small body of research on these learning processes suggests that they can increase liking and intake of a variety of foods and flavors. Infants initially reject

bitter flavors such as those found in vegetables; however, breastfeeding and early, repeated exposure to a variety of flavors at weaning have been shown to increase acceptance of initially rejected flavors. Longitudinal research is necessary to understand how neophobia changes over the first years of life. Evidence has shown that children's intake is affected by associative learning processes, including their experiences with eating in social contexts, energy density, or pairings with other foods and flavors; however, more research is necessary to understand how these processes influence eating behavior from birth to age 2 y. Lastly, observing peers and caregivers eating behavior has been shown to affect food acceptance and intake. Future work should focus on the relative impact of various sources of influence, such as caregivers, siblings, peers, and media, on eating behavior.

Because feeding decisions during the dietary transition from milk to table foods shape what is familiar and preferred, they can have lasting effects on children's developing intake and weight status. Early experiences with food can either limit or expand the boundaries of the familiar. If early experience includes exposure to a variety of foods and flavors, then a wider range of foods and flavors will be accepted. If not, the diets of young children will likely continue to be dominated by sweet or salty foods that are readily accepted without familiarization.

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