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► **To cite this version:**

Sophie Nicklaus. The role of dietary experience in the development of eating behavior during the first years of life. *Annals of Nutrition and Metabolism*, 2017, 70 (3), 10.1159/000465532 . hal-01492067

HAL Id: hal-01492067

<https://hal.science/hal-01492067>

Submitted on 17 Mar 2017

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The Role of Dietary Experience in the Development of Eating Behavior during the First Years of Life

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Keywords

Complementary feeding · Breastfeeding · Eating behavior · Infancy and childhood · Feeding practices

Abstract

Infants are born equipped to ingest nutrients, but because of the transitions in the mode of feeding in the first years (from “tube” feeding in utero to eating table foods with the family), they have to learn how, what and how much to eat. Eating behavior established during early years may follow throughout childhood; therefore, it is fundamental to understand the most important drivers of the early development of eating behavior. Beyond the first flavor discoveries during the gestational and lactation periods (through the infant's exposure to flavors from foods of the mother's diet), the most important phases for learning food preferences and appetite control may be the beginning of complementary feeding (CF). Infants discover the sensory (texture, taste and flavor) and nutritional properties (energy density) of foods that will ultimately compose their adult diet. This brief review shows that several feeding practices influence the development of eating behavior: breastfeeding; repeating the presentation of a food, even if it seems initially disliked; introducing a variety of different foods rapidly in the CF process; offering foods in an appropriate way to make their sensory characteristics appealing to infants. More research is

needed to understand in a combined way the effectiveness and long-term effect of these practices to promote healthy eating behaviors.

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Introduction

Eating is essential for survival, and human infants are born equipped to ensure proper food ingestion. However, learning to eat has to occur quickly, in particular because the mode of feeding evolves dramatically during the first thousand days of life, from “tube” feeding through the cord in utero, through oral feeding with milk after birth, complementary feeding (CF) around mid-course of the first year [1], until eating family foods by the end of the first year. After this period, neophobia/fussiness starts peaking and introduction of new foods becomes more difficult [2, 3]. Moreover, longitudinal studies showed that eating behavior established by the end of the first thousand days period is predictive of eating behavior up to early adulthood [4–7]. Additionally, feeding practices in the first year are likely to determine the nutritional status, with likely long-term consequences on weight status [8, 9]. Altogether, during a short time frame, infants have to learn how, what and how much to eat, and these learning processes are likely to influence the eating behavior

and weight status on the short and long terms. For these reasons, it is important to examine more closely the determining factors of the early development of eating behavior. This paper presents the learning processes that take place during the first 2 years of life, focusing mainly on the early development of hedonic aspect of eating (food likes and dislikes), and to a lesser extent on the motivational aspect of eating (food intake). Despite their importance, it will not cover the psychosocial aspects of eating, such as the dynamic interrelationships between parental feeding behavior and children's eating behavior.

Very few food likes are inborn, except the enjoyment of the sweet taste: food preferences are learned, essentially during the first years of life [6]. The taste and olfactory systems are functional at birth, but taste preference continue to evolve over the course of the first year, with the notable increase in salty taste preference between 3 and 6 months [10], probably as a result of dietary experience [11]. Olfactory preferences are not marked at birth [12] but may be influenced by prenatal exposure to food flavors in the amniotic fluid [13], coming from the maternal diet, although the extent of this phenomenon is currently debated [14]. Over the course of the first 2 years, infants start to show rejection behavior towards odors judged unpleasant by adults [15]. During this period, oral abilities strongly evolve, with increased autonomous movements of the tongue, lips and jaws in a first stage, and with their increased coordinated movements in a second stage, which ultimately enables the transition from sucking to munching to chewing that is necessary to make CF possible [16].

Role of Mode of Milk Feeding

Maternal choice in term of milk feeding mode (breast vs. bottle) may be associated with a differential acceptance of foods at later ages. The nutritional composition of breast milk varies across lactation [17]; and concurrently breast milk flavor composition may vary from one feeding episode to another, in relation to maternal diet quality [18]. The flavors (tastes and aromatic properties) of formula may also differ according to their types (regular, anti-allergic [i.e., with hydrolyzed protein], anti-diarrheic, fermented [19]). Infants breastfed for a longer duration accepted more a umami-tasting solution at 6 months, maybe as a result of exposure to the higher glutamate content of breast milk than formula [20]. Consumption of formulas with hydrolyzed-protein, which are more bitter, results in different taste preferences at later ages, up to 5 years [21, 22]. Having been breastfed

results in a high acceptance of a new food at the onset of CF [23–25], or within 1 month [26]; but not if acceptance of new foods is averaged over the first 2 months post-CF [27]. This positive effect of breastfeeding on food acceptance at the onset of CF may be associated with the more varied flavor variety in breast milk, linked to the transfer of flavor compounds in breast milk [23, 26]. However, even a short dietary experience (2 weeks) is sufficient to even the difference in new food acceptance between breastfed and bottle fed infants [26], so the positive effect of breastfeeding on complementary food acceptance may be limited to the very beginning of CF.

Effect of Sensory Properties of Foods on Their Acceptance along the CF Process

Beyond the first flavor discoveries during the gestational and lactation periods, the most important phase for learning food preferences and appetite control may be CF. Infants discover the sensory (texture, taste and flavor) and nutritional properties (energy density) of foods that will ultimately compose their adult diet. It has been suggested that the period from 4 to 6 months of age is a favorable window for the introduction of foods with new flavors, while the period from 6 to 10 months is a favorable window for the introduction of complementary foods with more complex textures [28]. Due to limited oral skills at the onset of CF, texture is one of the sensory properties that requires the most adaptation to enable the infant to process and swallow the food [16]. About a quarter of infants experience difficulties with pieces in foods [29], but such difficulties should not drive parents to delay introduction of more solid textures, since delaying introduction to lumpy foods beyond 10 months is associated with texture acceptance problems at later ages [30].

An observational study was conducted in France to evaluate the effect of flavor on complementary food acceptance, with the OPALINE cohort (Observatory of food preferences in infants and children): it showed that infants who were fed vegetables around 5 months rather than around 6 months accepted better these vegetables [27]. Within this cohort, a comprehensive examination of acceptance of food between the onset of CF and 15 months showed that most food categories were well accepted during this period (average acceptance rate of any food was 88%), with a slightly lower acceptance of vegetables and fruits than of other food categories [27]. So during the period of the first discoveries of foods, most food items are easily accepted by healthy infants.

Nevertheless, taste may influence acceptance of new foods at the beginning of CF. A detailed examination of the taste of complementary foods offered between 5 and 7 months to infants of the OPALINE cohort and of their acceptance showed that reactions to new vegetables were more positive if the vegetable was salted or contained a salty ingredient than if it was bitter [31]. Of course, this should be interpreted with caution because sodium is not recommended for infants. More experimental data are needed to evaluate the influence of taste properties on complementary food acceptance, in particular for taste qualities that may be associated with high acceptance, such as the sweet taste. An examination of the exposure to sweet taste in OPALINE infants showed that it increases from 3–6 until 10–12 months [32]. This increase in sweet food consumption may only be driven by maternal cooking habits or attitudes, or this may be reinforced (consciously or not) by the caregiver's observation of infant satisfaction while eating sweet foods [10, 31]. Further studies should help disentangle these aspects, because of strong concerns related to sugar consumption, even at an early age [33].

Role of Dietary Exposures: Repeated Exposure and Dietary Variety

Being exposed repeatedly to a food is the primary factor that determines its acceptance [25]. Exposing repeatedly an infant to a food, even foods identified by the mother to be disliked (such as vegetables for instance), strongly enhance its acceptance [34]. Modification of foods may alter this learning process, for instance modification of its flavor or of its energy density. In infants at the onset of CF, repeated exposures were as effective to enhance the intake of a new vegetable (artichoke in this case) as associating this vegetable with a liked flavor (the sweet taste); whereas associating it with a higher energy content (by adding oil) did not increase its intake, probably through learned satiation [35]. This suggests that after having been repeatedly exposed to a food, infants learn to recognize and like its sensory properties, to associate its sensory properties to its energy density, and to use the energy-density information mediated by sensory properties to modulate the eaten amount of food, at least to some extent. The replication of this study with older infants (up to 38 months) showed that the effects of the learning mechanisms were the same in all age groups [36], but also that the vegetable intake was lower in toddlers than in infants [37]. Altogether, this suggests that at

the onset of CF, infants have a high ability to learn to like new foods, including vegetables, an ability that is not extinguished when infants grow into toddlerhood. However, when infants grow older, they may learn to make choices among a more complex offering with potentially several dishes within a meal which may not drive them to high consumption of some food categories such as vegetables. However, when vegetables are offered at the beginning of a meal, they are highly consumed by toddlers [38].

The previous section describes the effect of repeated offerings of a specific food on the increase of its acceptance. Furthermore, it has been shown by experimental studies that repeated offerings of a variety of different food items at the onset of CF may also enhance the acceptance of unfamiliar foods. Six-month old infants better accepted carrot (a new food to them) if they had been previously fed either carrot (repeated offering effect) or a variety of vegetables different from carrot, than if they had been fed potato, a bland food [39]. This effect of repeated offering of a variety of foods is potentiated by a previous breastfeeding experience, which is likely to expose the infant to a variety of flavors, as described previously [24]; and it is more pronounced if infants are introduced to complementary foods after 5.5 months than before [40]. The effect of repeated offering of a variety of foods is especially important if offered foods vary from 1 day to the next [24], or even within a meal [41]. Importantly, it has been recently shown that the benefit of introducing a variety of vegetables at the onset of CF maintains at least up to the age of 6 years [42]. This mechanism which enhances the acceptance of new food at an age when learning is facilitated may appear easy to apply at a large scale. However, the effect of exposure to a variety of foods is more pronounced in countries where a low variety of foods are offered to infants than in countries where a high variety of foods are fed from the beginning of CF [43].

A study interestingly evaluated the effect of a combined learning strategy on the acceptance of unfamiliar foods (vegetables), by manipulating flavor exposure, through a progressive introduction of flavor variety in the infant diet, first in milk, then in cereals [44]. Immediately after the intervention (but not after 6 or 18 months), infants who received a variety of flavors in milk then in rice cereals liked and ate the target foods more than infants with regular care. This underlines that these mechanisms, when applied in practice, can foster the consumption of some food categories which intake must be promoted, such as vegetables.

Individual Differences in Learning to Eat

The previous sections mainly described how food preferences and eating behavior are shaped through experience; however, average observations often hide important inter-individual differences in learning how to eat. Such differences may be related to different genetic background, which will not be covered here for the sake of space. Individual differences in eating behavior may also have very early origins: for instance, it was shown that eating behavior at the age of 2 years differed in term-born and pre-term born children [45]; in particular, it was shown that infants born with low birth weight have a lower motivation to eat than regular birth weight infants.

Temperamental differences in eating behavior (whatever their etiology) were shown to be associated with different learning patterns: for instance in learning trials, higher fussiness in infants and toddlers was associated with lower increase in vegetable intake [37], and lower inhibitory control in harsh caregiving condition was associated with lower increase in vegetable intake than higher inhibitory control in gentle caregiving condition [46]. Moreover, infants with a different taste or olfactory sensitivity may also react differently to vegetables: some infants are more prone to accept foods (in particular vegetables) with a sweet, sour or savory taste [31]; some infants who are highly reactive to food odors may show higher dislike for these foods [47, 48]. The high reactivity toward odors, not tastes, was shown to be associated with a higher food neophobia at 24 months of age [49], underlying the interrelationship between the infant's sensitivity to flavor compounds in foods and his/her eating behavior, in particular at an age

when autonomy develops and children have acquired enough mobility to make their own food choices. It was indeed observed that between the ages of 2 and 3 years, when children are offered to the possibility of making their own food choices for lunch, the variety of their choices decreases, even if the offered foods are familiar [50], suggesting that by this age, children have learned to recognize foods and make choice decisions according to their preferences.

Conclusion

This brief review shows how eating behavior develops during the first years of life, as a result of modifiable feeding practices. This shows the importance of the CF period for the development of eating behaviors that can be maintained throughout childhood. Several feeding practices influence the development of eating behavior: breastfeeding; repeating the presentation of a food several times, even if it appears to be initially disliked; introducing a variety of different foods rapidly in the CF process; offering foods in an appropriate way to make their sensory characteristics appealing to infants. For some aspects, more research is needed to understand in a combined way the effectiveness and long-term effect of these practices to promote healthy eating behaviors.

Disclosure Statement

The author has no conflicts of interest to disclose related to the preparation of this article.

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