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Research report

Children's acceptance of new foods at weaning. Role of practices of weaning and of food sensory properties

Sophie Nicklaus

Centre des Sciences du Goût et de l'Alimentation, UMR6265 CNRS, UMR1324 INRA, Université de Bourgogne, Agrosup Dijon, F-21000 Dijon, France

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ABSTRACT

Weaning (i.e. introduction of complementary foods) is a transitional process between the consumption of a unique food, milk, and family foods. This review of existing literature regarding factors favouring the development of food acceptance at the beginning of weaning underlines in particular the roles of repeated exposure, of introduction of a variety of foods, of timing of introduction of weaning foods, and of food sensory properties (texture, taste and flavours). All factors appear to play a role in the acceptance of weaning foods. The efficiency, most favourable windows and long-term impact of each of these factors is not known accurately.

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Introduction

Food habits form early in childhood and are likely to track over childhood until the beginning of adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2004, 2005). Understanding the factors driving the acceptance of the very first foods other than milk, is therefore of particular importance, since these foods will form the basis of the child's future food repertoire.

Several factors are now known to be involved in the acceptance of foods at weaning. In particular, the role of previous, indirect sensory experience has gained attention, as described in another paper in the present supplemental issue (Cooke and Fildes, 2011). Here we will ocus on the role of direct experience with food on their acceptance, describing in particular the role of the practices of weaning, i.e. timing of introduction of solid foods, repeated exposure, and variety of foods offered together with the role of the sensory properties of foods.

Introduction of weaning foods is a process which helps the transition between a unique single food, milk, toward a diversity of family foods. At the age when weaning is generally conducted in developed countries, that is during the middle of the first year, the infant displays limited abilities in terms of physiological capacities (i.e. intestinal maturity, renal functions and oral development), therefore family foods need to be adapted to enable the developing infant to process them. They are adapted in terms of texture and are initially offered in the form of purées or soup; they are also adapted in terms of sodium and fibre contents, which intake should be limited at the beginning of weaning. Weaning is defined here as the transitional process between milk and family foods through the progressive introduction of weaning foods and therefore can be considered as having been achieved by around the end of the second year at the latest. In the light of this specification, the present review will mainly (but not exclusively) focus on studies presenting results covering this age range (6–24 m).

How the practices of weaning might influence the acceptance of weaning foods

Weaning will be defined here as the transitional process from milk to family foods. Human infants are born with very few 'innate' food preferences, but with a strong ability to learn to like new foods (Davis, 1939). In relation with such learning abilities, some practices of weaning are likely to affect the acceptability of weaning foods by the infant. The impact of some practices on acceptance of foods such as timing of introduction of solid foods, repeated exposure, and variety of foods offered has received attention and is documented. We will summarize the main findings from this literature.

Role of the timing of introduction of solid foods

Across countries, recommendations may vary as to when to start introducing infants to weaning food, ranging from between 4 and 6 months to the 6th month on (see also Schwartz, Scholtens, Lalanne, Weenen & Nicklaus, 2011 in this issue). This discrepancy may result in practical questions from the parents regarding when and what to introduce the infant to first. Nevertheless, guidelines clearly state that parents should wait at least until the age of 4

E-mail address: sophie.nicklaus@dijon.inra.fr.

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months before introducing solid foods, but it was observed in different countries that mothers do not wait until this age (Alder et al., 2004; Anderson et al., 2001; Le Heuzey, Turberg-Romain, & Lelièvre, 2007; Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2007).

From a physiological and psychological point of view, one might wonder whether specific time windows are more favourable to the introduction of weaning foods, independent of the importance of sustaining breastfeeding until the 6th month of life (WHO, 2003), and of the role of timing of weaning on the development of allergies (Anderson, Malley, & Snell, 2009; Zutavern et al., 2008). The hypothesis of the existence of a "sensitive period" for the introduction of solid foods was previously raised (Beauchamp & Mennella, 1998; Illingworth & Lister, 1964; Mason, Harris, & Blissett, 2005). However, consequences of timing of introduction of complementary foods in terms of food behaviour and acceptance are not very well documented. Studies focusing on a specific milk formula such as casein hydrolysate formula, which bears distinct, unpleasant flavour notes, suggest that there may be a specific window to favour its acceptance: it is easily accepted at the age of 2 months but not at the age of 7 months (Mennella & Beauchamp, 1996). At the age of 7 months, such a formula is accepted provided the infant had received previous exposure to this type of formula but exposure during the first three months of life or during months 3–5 did not make a difference (Mennella, Griffin, & Beauchamp, 2004). Concerning solid foods, a study with 12 subjects showed that the acceptance of salty cereals compared to plain cereals was higher in infants aged 16–17 weeks than in infants aged 18–25 weeks (Harris, Thomas, & Booth, 1990). Whether acceptance of other complementary foods might differ according to the age of the child at weaning is not completely elucidated yet.

The consequences of an early introduction to fruit and vegetables have been analysed in different ways. One study reported a positive relationship between early consumption of fruits and consumption of fruits at 18 months old, and this relationship was mediated by the acceptance of the sour taste, which is pronounced in fruits (Blossfeld et al., 2007). Another study based on parental report revealed in particular that early introduction to fruit or vegetables (with no indication of specific age) was associated with higher consumption of fruit or vegetables, respectively, at 2–5 years of age (Cooke et al., 2004). In this analysis, after adjustment for effects potentially influencing consumption, such as parental intake or parental neophobia, only fruit intake was significantly related to early introduction of fruit. A similar finding was also shown in a study conducted in the USA (Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002), suggesting that the early introduction of fruit has more impact on later consumption of fruit than the early introduction of vegetables. It is difficult to interpret such a finding. One might conclude that it is not necessary to introduce vegetables early in the infant's diet. However the specific nature of vegetables is that they are much less energy dense than other foods and than fruits (Gibson & Wardle, 2003) which does not favour their consumption in young children (Nicklaus, Boggio, & Issanchou, 2005). So altogether, vegetables are easily accepted at the beginning of weaning, but not when the child has reached a more advanced age around 2–4 years old (Gibson & Wardle, 2003; Nicklaus, Boggio, & Issanchou, 2005), revealing a transition in acceptance which might be related to their nutritional properties, their sensory properties (see section on sensory properties below), or to a competition from other more palatable foods introduced later on after the beginning of weaning.

Role of repeated exposure

The repetition of exposure of a food to a child is one of the primary determinants of its acceptance. Several studies have shown that a food is consumed more and is judged as more liked by an adult (generally the mother) after a number of presentations. The first study related to the effect of exposure in infants at the beginning of weaning clearly demonstrated an increase in acceptance of a novel green vegetable (green beans or peas) after 10 exposures to this food (Sullivan & Birch, 1994). A further study also showed a similar exposure effect: after 8 exposures to a novel fruit, intake increased (Birch, Gunder, Grimm-Thomas, & Laing, 1998). Such an exposure effect was further shown to be effective even for foods which were initially refused by the infant during the course of the weaning process (most often green vegetables, but also pumpkin) in contrast to foods initially accepted at the beginning of the weaning process (such as carrots for a majority of infants) (Maier, Chabanet, Schaal, Issanchou, & Leathwood, 2007). The exposure effect thus seems so consistent, powerful and universal that in later studies, it was considered as the "gold standard" against which any studied mechanism should be tested (see below).

However, despite the power of practices of repeated exposure in terms of increase of weaning food acceptance, surveys conducted in different countries across the world underline that most often, foods are only presented a limited number of times (in a majority of cases less than 5 times) before the parent(s) decide that the infant dislikes this food (Carruth, Ziegler, Gordon, & Barr, 2004; Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2007). Therefore, it is likely that the most frequently offered foods are those that are the most liked initially. The effect of exposure might thus act principally by reinforcing acceptance of initially liked foods.

After the beginning of weaning, other studies showed that in 2-year-old children, taste exposure to the food, involving ingestion of the food, is necessary to increase acceptance of the food whereas visual exposure is not sufficient (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987). Moreover, repeated exposure to a food can be offered either in a neutral context, or in a context where parents interact more directly with the child. For instance, in 2- to 6-year-old children providing the child with additional information on the benefits of a vegetable did not result in a higher liking of the vegetable relative to exposure alone (Wardle, Cooke, et al., 2003). Moreover, offering a reward (sticker) to the child if she/he agrees to taste a vegetable results in a lower increase in acceptance of the vegetable than simply exposing the food without contingency (Wardle, Herrera, Cooke, & Gibson, 2003). These results suggest that exposure is sufficient on its own in young children to promote food acceptance, provided they actually taste the food.

Repeated exposure can also lead to over-exposure and boredom, as discussed elsewhere, but it is not known exactly which 'amount' and/or frequency of exposure is optimal to promote food acceptance (Cooke, 2007). It may be also that there are individual variations in acceptance of repetitions: some infants might appreciate more than others to be given the same food repeatedly.

Role of the variety of foods offered

Not only do the repeated presentations of a given food influence acceptance of weaning foods, but also the repeated presentation of a variety of foods. Studies in this area were initially inspired by research in rodents demonstrating that exposure to a variety of flavours around the time of weaning was associated to a higher acceptance of new foods (Capretta, Petersik, & Stewart, 1975; Gerrish & Mennella, 2001). In human infants, exposure to a variety of foods at weaning also matters. Infants better accept carrot, a new food, either if they had been repeatedly exposed to carrot (repeated exposure effect) or to a variety of foods differing from one day to the next, but not if they had been repeatedly exposed to

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