

Research report

# Food-related sensory experience from birth through weaning: Contrasted patterns in two nearby European regions

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Received 8 August 2006; received in revised form 13 February 2007; accepted 14 February 2007

## Abstract

This study describes infant feeding practices among mothers from two European regions from the perspective of early sensory experiences. Two groups of mothers, one in Dijon, France ( $n = 139$ ), the other in Aalen, Germany ( $n = 157$ ) with infants aged 4–9 months were interviewed using a structured questionnaire. Clear between- and within-group differences in weaning practices were found, particularly with respect to breastfeeding duration (Aalen > Dijon) and exposure to flavour variety early in weaning (Dijon > Aalen). By 4 months, 65% of infants in Dijon and 20% in Aalen, had received their first non-milk, solid foods. Before beginning to wean, 39% of mothers in Dijon offered their infant a variety of foods “just for a taste”. This was the case for only 25% of mothers in Aalen. During the first 28 days of weaning, infants in Dijon were offered a greater number of vegetables compared to those in Aalen and more frequent changes from day-to-day. Thus, while Aalen infants were likely to be exposed for a longer period to different sensory experiences via breast milk, Dijon infants tended to be exposed to a greater flavour variety during the first weeks of weaning.

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**Keywords:** Breastfeeding; Weaning; Flavour perception, variety; Non-milk foods; Early experience; European regions; Germany; France

## Introduction

There is considerable evidence that sensory experiences early in life can influence later flavour preferences and food acceptance (Birch, 1999; Leathwood & Maier, 2005; Schaal, 2005, 2006). How these results relate to early sensory experiences and development of sensory preferences in everyday settings is still poorly understood. In particular, relatively little is known about the range and variety of food-related sensory stimuli infants are exposed to in real life conditions. The present study examines feeding practices in two European regions during the first year of life from the perspective of early sensory experiences.

Foetal exposure to odours of foods in the pregnant mother’s diet can influence responses to the same odours shortly after birth (Schaal, Marlier, & Soussignan, 2000)

and may even influence food acceptance at weaning (Mennella, Jagnow, & Beauchamp, 2001). Tastes and flavours experienced during the suckling period can influence subsequent food preferences. Flavours from foods consumed by the mother and transmitted to her milk are detected by the infant and can influence preference and acceptance (Mennella & Beauchamp, 1991a, 1991b, 1993, 1996). In the short term (a few days), a new flavour, such as garlic in breast milk can temporarily increase milk intake (Mennella & Beauchamp, 1991a). In the medium term (a few months), Mennella, Griffin, and Beauchamp (2004) showed that infants who experienced hydrolysed formula (which has a distinctive acid, bitter, ‘burnt’ flavour due to the free amino acids and small peptides it contains) during the first 4 months of life readily accepted it at 7.5 months whereas infants who had not experienced hydrolysate earlier rejected it strongly.

The effects of flavours in breast milk or in infant formula on food and flavour preferences may even last for years. Thus, children who had experienced hydrolysed formula

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for several months early in life were more likely to accept acid tasting drinks at 4–5 years of age compared to those without such experience (Liem & Mennella, 2002; Mennella & Beauchamp, 2002). This effect was no longer evident at 7 years (Liem & Mennella, 2002). However, an even longer term effect is suggested by the work of Haller, Rummel, Henneberg, Pollmer, and Köster (1999) who showed that adults, who, as infants had been exposed to vanilla-flavoured infant formula, were significantly more likely to prefer ketchup flavoured with vanilla while those who had been breastfed were not. In addition, the variety of foods received in the first weeks of weaning can, at least in the short term, influence acceptance of new foods (Gerrish & Mennella, 2001).

The possibility for such milk-related flavour exposure has greatly fluctuated over the last 60 years. Breast- and formula-feeding practices have changed dramatically. In the 1930s, in the USA and in Western Europe, nearly 80% of infants were breastfed (Atkins, 2003; Fomon, 2001; Wright & Schanler, 2001); by the mid 1960s, this figure was less than 30% in both continents (WHO, 1965; Wright & Schanler, 2001). Since then, the proportion of mothers breastfeeding has gradually increased again, reaching 50–60% in the early 1990s and is still rising but with large variations between and within countries (Freeman, Van't Hof, Haschke, & Euro-Growth Study Group, 2000; Kramer & Kakuma, 2002; Ryan, 1997; Skinner et al., 1997). In France, a prospective study carried out in 1999 (Labarère et al., 2001) reported that breastfeeding was initiated by 71% of mothers and continued for a median duration of about 3 months (11.6–14.4 weeks). Similar findings were reported by Bigot-Chantepie et al. (2005), who found that although 67% of mothers initiated breastfeeding, 33% of infants were still breastfeeding at 4 months and 17% at 6 months. In Germany, at about the same time, Kersting and Dulong (2002) reported that 91% of mothers started to breastfeed, and by 2, 4 and 9 months this had dropped to 70%, 59%, and 26%, respectively. Similarly, Brockow et al. (2003) reported that 86% of all newborn children in Germany were breastfed.

In parallel with the increase in breastfeeding, onset of weaning is getting later. The Euro-Growth study reported that, at the three French sites examined, mean ages at introduction of the first complementary food were 2.4, 2.5 and 3.3 months, and in the two German sites, they were 2.6 and 3.8 months. In both Germany and France, there were between-site differences in timing of introduction for all the categories of complementary foods, so a pattern of weaning practice observed in one region cannot be generalised to the whole country.

### *Objectives of this study*

In this study, we explored sensory experiences related to infant feeding practices among mothers from the Dijon region in France and from the Aalen region in Germany. We focus on length of breastfeeding, frequency of offering

foods and beverages well before weaning<sup>1</sup> began, age at start of weaning and at introduction of specific foods and food groups, together with the variety and range of foods (particularly vegetables) offered during the first month of weaning. Based on the available information on weaning practices in France and Germany, we expected to find systematic differences between (and within) the two sites in patterns of introduction of different food flavours during weaning. Within each region, we also compared weaning patterns of breastfed and formula-fed infants. In addition, the results were used to construct an experimental study on effects of breastfeeding duration and experience with variety early in weaning on later acceptance of new foods in these two regions.

## **Methods**

### *Participants*

Mothers were recruited using flyers posted at local hospitals and paediatric practices asking them to contact the research team by telephone if interested to participate in a survey of infant feeding practices. They were enrolled into the study if: (1) their child was aged between 3.5 and 15 months, was not a twin, and had no sickness or disability, (2) they had begun to wean their infant, and (3) they agreed to complete the questionnaire. This age segment of infants was chosen because the pilot studies indicated that the mothers remembered well how they weaned their infant. Most of the infants (85% in Dijon and 67% in Aalen) had been receiving complementary foods for at least 1 month and were younger than 9 months. Numbers of participating mothers were, as far as possible, balanced across regions in terms of age, education, professional category, and parity, and in terms of infants' gender. One hundred and thirty-nine mothers from Dijon and 157 from Aalen participated. Table 1 shows the demographic characteristics of the respondents and their infants. Mothers in the two regions showed similar distributions for age, education and parity but a much higher proportion of mothers in Aalen did not work

<sup>1</sup>The words used when speaking about “weaning” have different meanings in English, French and German. In German, “beikost” literally means a “beside meal” and conveys the idea of a supplementary food given in parallel with breast milk and/or formula (Duden, 1996). In French, the word “sevrage”, derived from the Latin “separare”, conveys a sense of cessation or separation (Robert, 2001). Interestingly, “sevrage” is gradually being replaced by “diversification”, perhaps with the aim of better communicating the idea of starting complementary feeding rather than ceasing breastfeeding. In English, the verb “to wean” means to accustom a child to take food otherwise than by nursing (Webster, 1970). The term “complementary feeding”, instead of “weaning”, is used to define the process starting when breast milk alone is no longer the only nutritional substrate (Dewey, 2001). Dewey also notes that the target age range for complementary feeding is generally taken to be 6–24 months of age, even though breastfeeding may continue to beyond 2 years. In this paper, the term weaning is used to describe the transition period from feeding milk, either of human or industrial origin, to complementary feeding (i.e., semi-solid and solid foods).

Table 1  
Socio-demographic characteristics of mothers and infants participating in the questionnaire study on weaning practices in Dijon and Aalen

Characteristic	Dijon	Aalen
<i>Infants</i>		
Age in months (means $\pm$ SD)		
Female	7.4 (1.6)	8.9 (2.8)
Male	7.2 (1.7)	7.9 (2.2)
Gender	<i>n</i>	<i>n</i>
Female	69	78
Male	70	79
<i>Mothers</i>		
Age in years		
$\leq 25$	20	8
26–30	56	53
31–35	44	82
$\geq 36$	19	14
Parity		
1 child	70	79
2 children	48	56
$\geq 3$ children	21	22
Education category <sup>a</sup>		
< A-level	34	45
A-level	34	30
> A-level	71	82
Work status category		
Full-time	58	14
Part-time	39	28
No work	42	115

There were no significant differences between Dijon and Aalen for infant's age, gender and mother's parity and education level. However, the two regions differed significantly in maternal work status ( $\chi^2(2) = 61.8$ ,  $p < 0.0001$ ).

<sup>a</sup>Education level = mothers were classified into those who had completed secondary school or below (<A-level), those who had completed their baccalaureate (equivalent to UK "A-levels"), and those who had completed higher education or a university degree (>A-level).

outside the home. This difference in maternal work status is characteristic for the two countries (Morgan, 2003). In both regions there were equal numbers of girls and boys. Infants in Aalen were about 1 month older. This was simply a reflection of the later weaning age in Aalen.

### Questionnaires with the mothers

All the mothers completed a written questionnaire covering information on milk feeding (breast milk and/or infant formula) and weaning practices, concentrating particularly on aspects of early feeding linked to sensory experiences of the child and how mothers organised the change from exclusive milk feeding (breast and/or formula) to feeding a range of complementary foods.<sup>2</sup> For most mothers, the first questionnaire was administered at home or during a visit to the Research Centre in Dijon (100 mothers) or in the well-baby clinic at the local hospital in

Aalen (110 mothers) in the presence of the same bilingual researcher (AM) and took about 1.5 h. For 39 respondents in Dijon, and 47 in Aalen, the questionnaire was sent with detailed instructions to the mothers and was completed at home. Results using the two modes of administration (interview vs. self-completion) were compared graphically (Kaplan–Meier (K–M)) and statistically (Mantel–Haenszel log-rank test on the distributions of ages at introduction of each food). There were few statistically significant differences. In Dijon, mothers who completed the questionnaire at home reported slightly later ages for introduction of herb teas, fish, yoghurt and bread ( $p \sim 0.05$ ), while in Aalen, those completing the questionnaire at home reported slightly later ages at introduction of fruit juices and vegetables ( $p \sim 0.05$ ). These differences were small compared to the differences between Dijon and Aalen, so the interview and self-completed results were combined.

A pilot version of the questionnaire was prepared in French, partly based on earlier research (Gojard, 1998; Nestlé, 1997 Note 1), translated into German and then back-translated to check precision. It was then tested with 30 mothers to ensure that the questions were well understood, had similar meanings and sensitivity in French and German, and provided the required information on early sensory experiences. Final versions were then prepared and administered.

The different topics addressed in the questionnaire are described below.

*Milk feeding (breast and/or formula), transition from breast milk to formula or directly to complementary foods.* The mother was first asked if she: (1) was still breastfeeding, (2) had breastfed but had now stopped, or (3) had never breastfed her infant. If she had already stopped breastfeeding, she was then asked for how long she had done so, and the length of the transition time from breast to formula milk, and why she stopped breastfeeding.

*Pre-weaning exposure to non-milk foods and beverages.* Each mother was asked if she had offered her infant small amounts of foods or drinks "just for a taste" well before beginning to wean. The question specified that, to qualify, these small amounts must have been given at least 2 weeks prior to weaning and not as a replacement of milk in the daily feeding regime. Mothers who had given foods "just for a taste" were asked the age of the infant when they started this practice (often termed 'finger tasting'), which foods or drinks were offered and on which occasion(s). Each mother was also asked if she had offered herbal tea, fruit juice or any other beverage during the milk-feeding period at least 2 weeks before beginning to wean, and if so, from what age. Based on earlier research (Hörnell, Hofvander, & Kylberg, 2001) and on our own preliminary tests, mothers did not perceive giving foods "just for a taste" or giving herbal teas to be a stage in the introduction of complementary foods.

*Age at first consumption for different food categories.* Beverages and foods consumed by the infants during

<sup>2</sup>The questionnaire can be obtained in French or German versions upon request from [Andrea.Maier@rdls.nestle.com](mailto:Andrea.Maier@rdls.nestle.com)

weaning were categorised as follows: liquids (fruit juices, herbal teas), semi-solids (gruels, porridge, cereals, puréed fruits, puréed vegetables, puréed meats, puréed fish), unflavoured dairy products (e.g., natural yoghurt, “*Petit Suisse*”, cream cheese) or flavoured dairy products (e.g., flavoured yoghurt, cream desserts), and solid foods (bread and biscuits). For each category, mothers were asked if they had given it to their baby, and if so, at what age they began. If the mother responded that she has not yet introduced a particular food or category of food listed, a follow-up question asked the reason(s) why.

*Order and timing of introduction of foods in each category.* Mothers were asked, for specific foods in each category, the order, timing and form of introduction.

*Number and changes in vegetables given during the first 28 days of vegetable feeding.* We were particularly interested in the order and frequency with which mothers gave different vegetables early in weaning. As, in the preliminary test, most mothers said they remembered which vegetables they had given and how often, we asked each mother to complete a table noting which vegetables she had given each day during the first 4 weeks of vegetable feeding. If she had not yet fed vegetables for 28 days, she completed this table when she had done so.

*Refusal of foods.* Each mother was asked if her infant had ever refused to eat a vegetable and, if so, at how many subsequent meals she offered it again before definitively deciding that the infant did not like it and it was not worth trying again.

On completion of the questionnaires mothers were given a small gift (a toy or baby care product) in thanks for her participation in the study.

#### Questionnaire for paediatricians

In addition, a face-to-face structured interview was carried out with 10 paediatricians in each region in order to compare their recommendations with mothers’ practices in terms of breast- and exclusive milk-feeding duration, age at introduction of different foods and drinks and feeding practices for complementary foods.

#### Data coding and statistical analyses

Following WHO definitions (Kramer & Kakuma, 2002; WHO, 2001), an infant was considered to be receiving “*Exclusive Milk feeding*” if given only breast and/or formula milk(s), with no other liquid or solid foods (including no foods just “for a taste”) and to be receiving “*Partial Breastfeeding*” if any breast milk was included in the infant’s diet (i.e., breast milk together with formula milk(s) and/or complementary foods). “*Formula*” included infant formula or follow-on formula; *Food or drink given “just for a taste”* was defined as small quantities of a food or beverage offered at least 2 weeks prior to the start of weaning. Finally, “*Age*” was noted as completed

Table 2

Breastfeeding duration, exclusive milk feeding and introduction time (months) of all food categories before and during weaning: mothers’ practice vs. paediatricians’ advice

	Dijon		Aalen	
	Mother <sup>a</sup> (medians)	Paediatrician (min–max)	Mother <sup>a</sup> (medians)	Paediatrician (min–max)
Breastfeeding duration	1.25	4–6	6	5–7
Exclusive milk feeding	3	4–12	4	5–12
Herbal tea	–	4–9	5.5	1–6
Fruit juice	7	4–6	8	6–12
Weaning food	4	4–6	5.5	5–6
Vegetable	4.5	4–6	6	5–6
Fruit	4.5	5–6	6	5–7
Cereal	5	4–9	6.5	5–12
Meat	6	6–9	7	6–8
Fish	7	6–9	12	7.5–12
Unflavoured dairy products	6	4–9	12	7–12
Flavoured dairy products	7	4–9	12	10–12
Bread + biscuits	8	6–12	7	6–12

<sup>a</sup>Comparisons between the two sites showed that infants in Dijon received all foods (except bread and biscuits) earlier than those in Aalen (Mantel–Haenszel log-rank tests:  $p < 0.001$  for vegetables, fruit, cereals, fish, unflavoured and flavoured dairy products;  $p < 0.05$  for meat).

months and fractions of months (rarely more precise than to within half a month; thus, ‘at 3 months’ means ‘when the infant was at least 3 months old but not yet 3.5 months’). The variables recorded are shown in Tables 2 and 3.

#### Survival analysis

Comparing times to the occurrence of events (e.g., age at end of breastfeeding, start of weaning, introduction of specific foods, etc.) is most appropriately carried out using survival analysis techniques. In our data set, for some events (and especially those normally occurring late in the weaning process) there were frequently some missing values. The introduction time had not yet occurred, so its exact time was unknown, but it was later than the current age of the infant. Survival analysis takes such observations into account as censored instead of missing values, since they provide useful information. The percentages of censored values are shown in Fig. 2.

The K–M procedure developed by Therneau and Lumley (survival library R, version 1.9.1, 2004) was used to take into account censored values when plotting distributions of introduction times and calculating median age at introduction of each food for each population or each socio-demographic group within a given population. The Mantel–Haenszel log-rank test (Collett, 2003; Tableman & Kim, 2003) was used to compare introduction times for each food. For all analyses, statistical significance was set at  $p < 0.05$ .



Table 3  
Patterns of weaning practices (medians) in the four clusters in Dijon and Aalen

Cluster	Dijon				Aalen			
	D1*	D2*	D3*	D4*	A1*	A2*	A3*	A4*
Months of breastfeeding	1.1 <sup>a</sup>	0.8 <sup>a</sup>	6.0 <sup>b</sup>	0.5 <sup>a</sup>	6.5 <sup>b</sup>	1.0 <sup>a</sup>	6.0 <sup>b</sup>	11.5 <sup>c</sup>
Months of exclusive milk feeding	3.0 <sup>b</sup>	2.0 <sup>a</sup>	5.0 <sup>d</sup>	4.0 <sup>c</sup>	5.0 <sup>b</sup>	3.0 <sup>a</sup>	4.0 <sup>a</sup>	7.0 <sup>c</sup>
All tastes prior to weaning	0 <sup>a</sup>	2.0 <sup>c</sup>	0.0 <sup>a</sup>	1.0 <sup>b</sup>	0 <sup>a</sup>	1.0 <sup>a,b</sup>	2.0 <sup>b</sup>	0 <sup>a</sup>
Age at weaning	4.0 <sup>a</sup>	4.0 <sup>a</sup>	5.5 <sup>b</sup>	6.0 <sup>b</sup>	6.0 <sup>b</sup>	5.0 <sup>a</sup>	5.0 <sup>a</sup>	7.8 <sup>c</sup>
Age at 1st vegetable	4.0 <sup>a</sup>	4.5 <sup>a</sup>	6.0 <sup>b</sup>	6.0 <sup>b</sup>	6.0 <sup>b</sup>	5.0 <sup>a</sup>	5.0 <sup>a</sup>	8.5 <sup>c</sup>
Age at 1st fruit	4.0 <sup>a</sup>	4.0 <sup>a</sup>	6.0 <sup>b</sup>	6.0 <sup>b</sup>	7.0 <sup>b</sup>	5.0 <sup>a</sup>	5.5 <sup>a</sup>	10 <sup>c</sup>
Age at 1st meat	6.0 <sup>a</sup>	6.0 <sup>a</sup>	8.0 <sup>b</sup>	8.0 <sup>b</sup>	7.0 <sup>b</sup>	6.0 <sup>a</sup>	6.2 <sup>a</sup>	10.5 <sup>c</sup>
Number of vegetables (1st month)	6 <sup>a</sup>	7 <sup>ab</sup>	5 <sup>a</sup>	8 <sup>b</sup>	3 <sup>a</sup>	3 <sup>a</sup>	5 <sup>b</sup>	3 <sup>a</sup>
Number of changes (1st month)	23 <sup>b</sup>	23 <sup>b</sup>	9 <sup>a</sup>	23 <sup>b</sup>	2 <sup>a</sup>	2 <sup>a</sup>	6 <sup>b</sup>	2 <sup>a</sup>
Cluster size	50	45	17	15	49	49	26	12

<sup>a,b,c</sup>Numbers within a row having letter superscripts in common either in Dijon or in Aalen do not differ significantly ( $p > 0.05$ ).

\*Months (except for number of vegetables and number of changes).

1st month = first month of vegetable introduction.

### Cluster analysis

K-means cluster analysis (Hartigan & Wong, 1979; Hintze, 2001) was used to describe the range and frequency of infant feeding practices in each region. The variables included in the analysis were: breastfeeding and exclusive milk feeding duration; number of foods given “just for a taste” and of herbal teas given before weaning began; age at start of weaning; age at introduction of first vegetable, fruit, and meat; number of vegetables and number of changes from day-to-day for vegetables offered during the first 28 days after the start of vegetable feeding. Censored values were replaced by the median age at which that item was first consumed by other infants from the same region who had been first offered it at a greater age. Thus, if an Aalen infant aged 7 months had not yet been offered meat, the censored value was replaced by the median age at first consumption of meat by all other infants from Aalen who started to eat meat later than 7 months of age and for whom the age at first consumption of meat was recorded.

### Results

In all, 139 mothers in Dijon and 157 in Aalen completed the main questionnaire and 127 Dijon and 136 Aalen mothers completed the table of vegetable consumption during the first 28 days of vegetable feeding.

#### Breast- and formula-feeding practices

Change in rates of breastfeeding over time in Dijon and Aalen are shown in Fig. 1. In Aalen, 90% of mothers initiated breastfeeding compared to 65% in Dijon. These values fell to 71% and 35% at 2 months, 63% and 14% at 4 months and 36% and 7% at 6 months. In Aalen, reported breastfeeding rates dropped abruptly (from 52% to 36%) immediately after infants reached 6

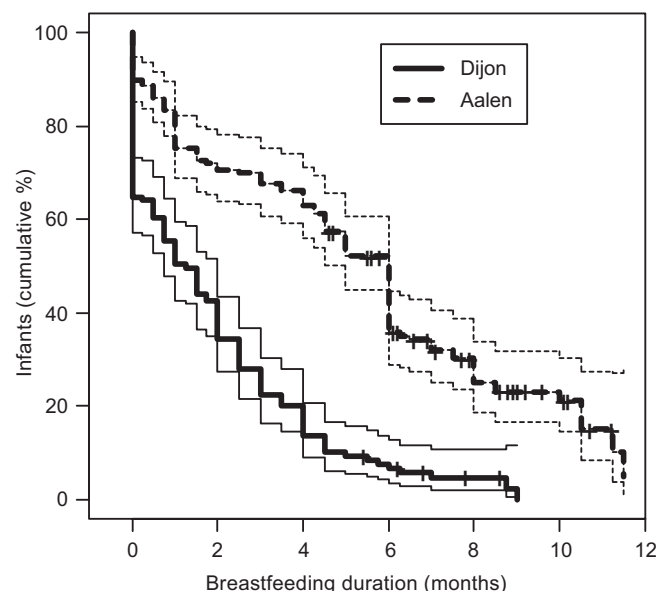


Fig. 1. Distribution of breastfeeding duration (exclusive or partial) in months with 95% confidence intervals (Kaplan–Meier estimation). The vertical lines indicate censored values. The distributions were significantly different ( $\chi^2(1) = 78.9$ ,  $p < 0.001$ ; Mantel–Haenszel log-rank test).

months. Median durations of breastfeeding and exclusive milk feeding with no taste of other foods (including no finger tasting) were higher in Aalen than in Dijon (Table 2).

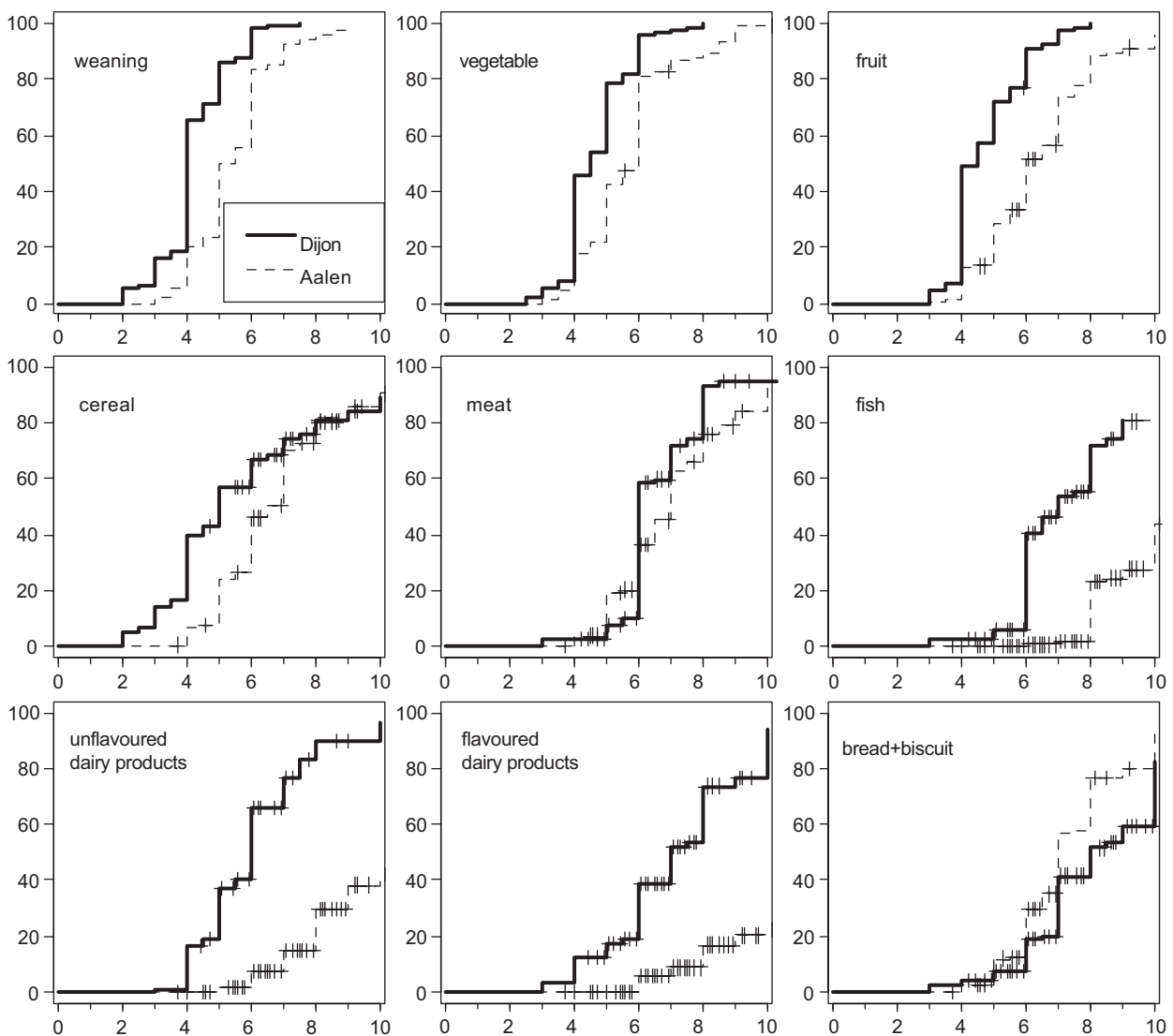
More than half the infants (60% in Dijon; 55% in Aalen) received formula after being breastfed. The transition from breast to formula milk took the same median time (2 weeks) in each region, but the patterns of distribution were significantly different (Mantel–Haenszel log-rank  $\chi^2(1) = 4.43$ ,  $p < 0.05$ ). In Aalen it was more skewed to the right (Q1 = 0.5 in both regions; and Q3 = 3 weeks in Dijon and 6 weeks in Aalen), indicating that some mothers in Aalen continued to breastfeed for much longer.

In Aalen, 32% of infants were introduced to complementary foods while the mother was breastfeeding. This occurred for only 4% of infants in Dijon. The complete transition from breast milk to either solid food or formula took a median time of 2 weeks (Q1 = 0.5; Q3 = 4) in Dijon and of 4 weeks (Q1 = 1.0; Q3 = 8) in Aalen. Again, the difference between these distributions was significant (Mantel–Haenszel log-rank  $\chi^2(1) = 19.80$ ,  $p < 0.001$ ).

In Dijon, 15 infants were already receiving cow's milk (12 were less than 10 months old). In Aalen, 17 were receiving cow's milk and 13 of these were less than 10 months old. Hypoallergenic milk was given to 5% of Dijon infants and 9% of Aalen infants.

#### Exposure to foods and beverages prior to weaning

Overall, similar proportions of mothers in each region (53% Dijon; 51% in Aalen) gave their child some kind of food or beverage well before weaning began. The types of food given, however, were different: 39% of mothers in Dijon and 25% in Aalen ( $\chi^2(1) = 6.7$ ,  $p = 0.01$ ) reported offering their child foods “just for a taste” (usually offered on a finger tip). In Aalen, 40% of mothers regularly gave herbal tea to their infant before the start of weaning, while this was the case only for 19% of Dijon mothers ( $\chi^2(1) = 15.2$ ,  $p < 0.001$ ). Fruit juices were rarely given before weaning: 7% in Dijon and 4% in Aalen.



Figs. 2. Age at introduction of first weaning food and all semi-solid and solid foods in Dijon and Aalen presented as survival plots. The vertical lines indicate censored values. For all foods the difference in distribution of the survival plots was significant ( $p < 0.001$  for vegetables, fruit, cereals, fish, dairy products and breads/biscuits; and for meat  $p < 0.05$ ; Mantel–Haenszel log-rank test). The percentages of censored values for Dijon were as follows: for age at start of weaning: 0; age at 1st vegetable: 0; age at 1st fruit: 1; age at 1st cereal: 25; age at 1st meat: 29; and age at 1st fish: 48; age at 1st unflavoured dairy product: 24; age at 1st flavoured dairy product: 47 and age at 1st bread and/or biscuit: 61. For Aalen, the percentages of censored values were: for age at start of weaning: 0; age at 1st vegetable: 5; age at 1st fruit: 17; age at 1st cereal: 22; age at 1st meat: 25; age at 1st fish: 77; age at 1st unflavoured dairy product: 75; age at 1st flavoured dairy product: 83, and age at 1st bread and/or biscuit: 29.

In Dijon, but not in Aalen, offering tastes of foods before weaning occurred more frequently if the infant was formula-fed (formula vs. breast: 60% vs. 39%;  $\chi^2(1) = 7.5$ ,  $p < 0.001$ ).

#### Weaning practices—introduction of complementary foods

Herbal teas and fruit juices were also introduced during weaning so that, by 8 months, approximately 70% of all mothers in Aalen and 40% in Dijon had given them.

Almost all Dijon infants received their first semi-solid weaning complementary foods before 6 months of age (Fig. 2). By 3 months, weaning had begun for 16%; by 4 months, for 65%; by 5, for 86%, and by 6 months, for 99%. Aalen infants were weaned later. The percentages receiving complementary foods at 3, 4, 5 and 6 months were 2%, 20%, 50% and 83%, respectively. The difference in age at start of weaning between the two regions (Table 2) was significant ( $\chi^2(1) = 70.9$ ,  $p < 0.001$ ).

The order of introduction of different complementary foods was similar in both regions, but the relative timing differed considerably (see Table 2 and Fig. 2). Infants in Dijon received all foods (except bread and biscuits) earlier than those in Aalen (Mantel–Haenszel log-rank tests:  $p < 0.001$  for vegetables, fruit, cereals, fish, unflavoured and flavoured dairy products;  $p < 0.05$  for meat). In Fig. 2, differences between the two regions in patterns of introduction for each food are shown as survival plots. For fish, dairy products and biscuits, even though there were large numbers of censored values, the patterns were clearly very different.

Median ages for introduction of all weaning foods recommended by paediatricians are shown in Table 2. Paediatricians in Dijon were more flexible in their advice to mothers concerning breastfeeding and weaning practices. For example, a typical comment by a French paediatrician during interview was as follows: “It is the mother who decides. If she can breastfeed, I recommend at least for 4

months. But I do not force her. Mothers often already come to my office knowing exactly what they want to do and when. They want me to confirm this is OK, and I usually do”. All except one of the paediatricians in Aalen recommended 6 months of exclusive breastfeeding. Generally, the recommended introduction ages for foods by paediatricians were later than the actual introduction age by the mothers.

Another potential source of difference in sensory experience was the frequency of feeding home-prepared and ready-to-eat baby foods: 106 Aalen mothers (68%) prepared baby food at home more frequently than once/week. Of these, 96 added extra ingredients such as oil, salt, sugar or spices. In Dijon, 64 mothers (46% of the total) prepared foods at home and 59 said they added extra ingredients. Patterns of adding ingredients to home-prepared vegetables differed in the two regions. In Aalen, 74 mothers added oil and 59 added butter while only 11 and 33 did so in Dijon. Cream was added by 12 mothers in Aalen and by 19 in Dijon. In both regions, about a quarter (Aalen: 37; Dijon: 40) of the mothers added salt. Finally, 25 mothers in Aalen and 13 in Dijon said they added spices. In Dijon these were mainly curry, pepper, cinnamon and in Aalen they were more often mixtures of different spices. Sugar was added to fruit purées by 10 mothers in Aalen and 18 in Dijon. When mothers gave ready-to-eat baby foods, they did not add any extra ingredients.

#### Number of different vegetables and daily changes during the first 28 days of vegetable introduction

There were major differences in both the number of vegetables given (Fig. 3A) and in the number of changes from day-to-day (Fig. 3B) during the first 28 days of vegetable feeding. In Dijon, mothers gave  $6.3 \pm 2.0$  (SD) vegetables and made  $18.5 \pm 8.2$  (SD) changes from day-to-day over the 28 days. In Aalen, infants were given  $3.1 \pm 1.2$  vegetables and there were only  $2.8 \pm 2.3$  changes from

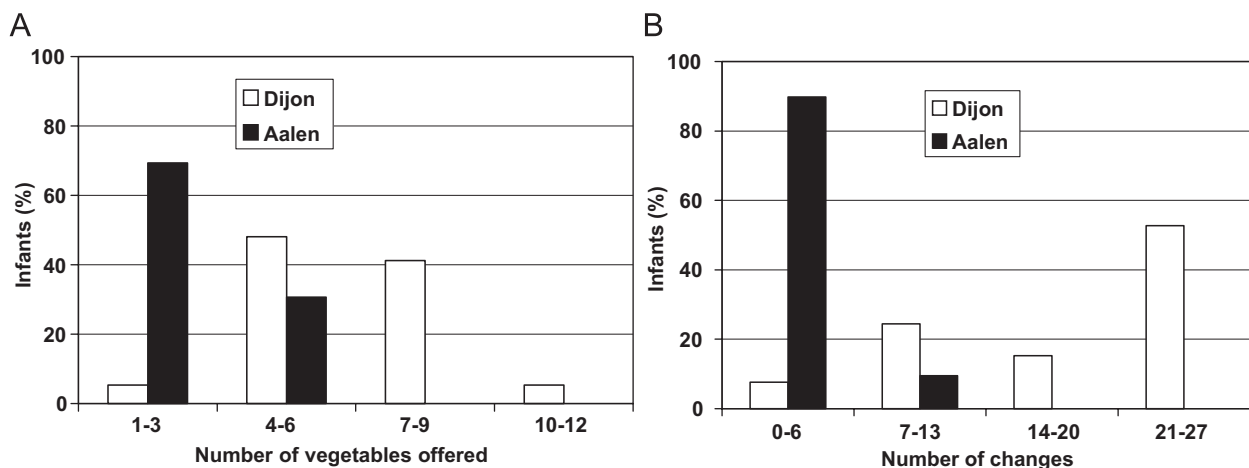


Fig. 3. (A) Number of vegetables offered, and (B) number of changes from day to day during the first 28 days of vegetable feeding.

day-to-day. The differences between regions were significant ( $F(1,262) = 272.4$  and  $463.6$ , respectively;  $p < 0.0001$  in both cases).

In both regions, carrot purée was almost invariably the first vegetable offered (78% in Dijon; 87% in Aalen). In Dijon, this was usually followed by green beans or potato, and then by spinach, artichokes, peas, zucchini, pumpkin, and broccoli, while in Aalen, carrot purée was usually followed by a mixture of potato and carrot or potato and pumpkin (or more rarely, by potato or pumpkin alone). Infants in Dijon rarely received mixtures of vegetables (on only 4 of the 28 days) while in Aalen, mixtures were given on 15 days ( $F(1,262) = 162.0$ ,  $p < 0.0001$ ). Thus, there were likely to be considerable differences in the sensory experiences of infants in the two regions studied.

### Vegetable refusal

Vegetable refusal was quite frequent with 112 mothers in each region reporting that their infant rejected at least one vegetable. In Aalen, mothers were significantly ( $\chi^2(3) = 33.8$ ,  $p < 0.001$ ) more persistent, usually offering the initially rejected vegetable at 3–5 meals before giving up while most mothers in Dijon gave up after 1 or 2 tries (Fig. 4).

### Within-region variability

There were clear differences in infant feeding practices between Dijon and Aalen. However, practices *within* each region were far from homogeneous. K-means cluster analysis identified four stable and homogeneous clusters for each region. Discriminant analysis classified 96% of the infants into the correct cluster.

The four Dijon clusters differed widely (Table 3). The largest ( $n = 50$  members), breastfed for a median of 1 month, gave practically no pre-weaning “tastes”, began weaning at 4 months and gave a wide variety of vegetables during the first month of weaning. The second ( $n = 45$ ) differed mainly from the first in terms of the number of pre-

weaning “tastes”, with a median of two foods “for a taste” before weaning. Cluster 3 ( $n = 17$ ) breastfed the longest (over 6 months), weaned later (at nearly 6 months), and offered the least changes of vegetables. Finally, the fourth cluster ( $n = 15$ ) had the shortest breastfeeding duration (2 weeks), began weaning the latest (at 6 months) and gave a large variety of vegetables during the first month of weaning.

The four Aalen clusters were also very different from one another. The first ( $n = 49$ ), breastfed for a median of 6 months, started weaning at 6 months and gave little variety of vegetables during the first month of weaning. The second ( $n = 49$ ), breastfed for 1 month, began weaning at 5 months, and gave little variety during the first month of weaning. The third ( $n = 26$ ) breastfed for 6 months, more frequently gave pre-weaning tastes of foods and beverages, began to wean at 5 months and gave a greater variety of vegetables during the first month of weaning. The last cluster ( $n = 12$ ) breastfed the longest (more than 11 months) began weaning the latest (at nearly 8 months) and also gave little variety during the first month of weaning.

In spite of these differences within regions, only clusters 3 in Dijon and 1 in Aalen showed much similarity. They had similar milk feeding patterns, introduced fruits and vegetables at similar times and gave a similar number of vegetables during the first month of weaning but cluster 3 in Dijon still gave more frequent changes in vegetables offered. Thus all four clusters in Dijon were different from those in Aalen in terms of breastfeeding duration and weaning patterns.

## Discussion

This study revealed marked differences in infant feeding practices and early sensory experiences between two nearby regions in Europe.

The questionnaire was developed from earlier work (Gojard, 1998; Nestlé, 1997 Note 1) and adapted for the specific populations studied during preliminary tests. The retrospective cross-sectional design used here had the advantage that mothers were questioned shortly after the events being studied. It had the disadvantage that there were some censored values (i.e., for some infants, some of the events of interest had not yet occurred). However, survival analysis copes well with this type of data and allowed reliable calculation of the median time to each event. In addition this approach has also the disadvantage that many mothers had difficulty giving answers with an accuracy of better than  $\pm 1$ –2 weeks. This was in part due to problems of exact recall but in part because mothers’ perception was that the events themselves were not that precise: for example, some mothers said it took several tries before the infant ate a significant (for the mother) amount of the first weaning food. However, the differences between regions in terms of infant’s age at occurrence of different

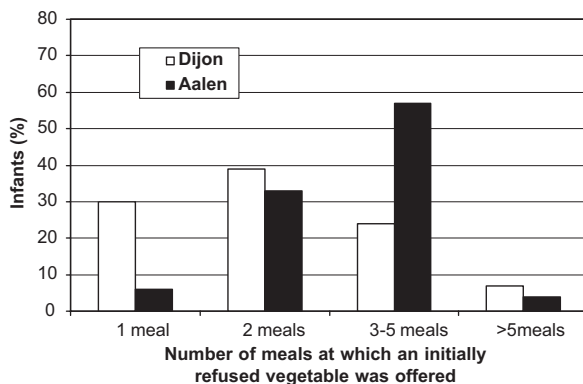


Fig. 4. Percentages of mothers offering an initially rejected vegetable at the specified numbers of meals before mothers decided not to offer that vegetable again.



events before and during weaning were almost always much larger than differences in accuracy of recall.

Because of the recruitment procedure, it is probable that the samples were not fully representative of the population in each region and they were certainly not representative of all mothers in each country. They were, however, representative of the mothers who could be recruited for the planned follow-up studies evaluating effects of different breastfeeding and weaning practices on later food acceptance (Maier, Leathwood, Chabanet, Issanchou, & Schaal, 2006). Since mothers started weaning later in Aalen, the two groups were not balanced for infant age. However, this difference is an inevitable consequence of a main goal of the study (to compare introduction of complementary foods). We will now discuss the results in terms of how these experiences might be expected to influence food preferences.

In Aalen, 90%, and in Dijon 64%, of mothers at least initiated breastfeeding. These differences in breastfeeding are likely to lead to differences in sensory experience because human milk can be expected to provide the infant with a variety of sensory experiences depending on the foods the mother eats. Infant formula will not provide this variety in sensory experience (Jiang, Schaal, Marlier, & Soussignan, 1999).

The most striking taste quality of human milk is its sweetness, which is approximately equivalent to that of a 6% lactose solution (McDaniel, 1980). McDaniel noted that milks from different women (and from the same woman at different times) varied enormously in fat content (up to 10-fold) and viscosity (up to 2-fold), and could have a variety of aromatic (fruit, vanilla), spicy, or peppery notes. These seemed to depend in part on the foods the women had consumed during the testing period. Human milks are also more variable than formula milks in both intensity and quality (Jiang et al., 1999). Although different brands of infant starter formula differ significantly in taste, aroma and texture, each individual brand has very constant sensory characteristics (M. Voltz, personal communication). Hypoallergenic (partially hydrolysed) formulae are slightly more bitter than standard formulae (Lee, 1992; Mennella et al., 2004). Thus, the breastfed infants are likely to have more diverse sensory experiences during the suckling period than infants who are given formula. The different sensory experiences provided by breast or formula milk can have measurable consequences lasting from a few hours to many years (Haller et al., 1999; Mennella & Beauchamp, 1991a, 2002; Sullivan & Birch, 1994).

For many infants, breast or formula milk is not the only pre-weaning source of taste or odour experience. In Dijon, a larger proportion of infants were exposed to food “for a taste” prior to weaning compared to those in Aalen, and more than half the formula fed infants in Dijon were offered this type of sensory stimulation. Thus, while German breastfed infants are likely to experience greater flavour variety from breast milk, French children are likely

to be exposed to food flavours from the foods just given ‘for a taste’.

Before and during weaning, a higher proportion of Aalen mothers gave their infants commercial herbal teas. Mothers in Dijon mainly reported giving a specific commercial herbal tea flavoured with orange blossom that contains 4.6% glucose when made up. The sugar content of German commercial herbal teas varies and few of the mothers knew if the teas they gave contained added sugars. It was, therefore, not possible to know how many infants in Aalen were exposed to sweetened drinks before weaning began. In addition, some mothers (19% in Aalen) said they mixed herbal teas with fruit juices, which would give the infant exposure to sweet (and possibly sour) tastes. Evidence from research on sugar water suggests that consumption of a specific sweetened drink before 6 months of age may influence subsequent preference for the level of sweetness in that drink (Beauchamp & Moran, 1982). Thus it is possible that early exposure to sweetened herbal teas will influence later preferences for sweetness at least in such drinks.

Consistent with results from earlier studies comparing different regions in France and Germany (e.g., Freeman et al., 2000), we observed that mothers in Dijon began to introduce complementary foods (mainly vegetables purées) earlier than in Aalen, although the order of introduction of the various food categories was quite similar in both regions. Most mothers began with vegetables or fruits, and continued with cereals and meats. Fish was introduced very late in Germany with one third of the mothers stating they planned to delay giving fish until the infant was 1 year old.

One remarkable difference between the two regions was in the number of vegetables and number of changes of vegetables given during the first month of weaning. In Dijon, infants received on average about six different vegetables while those in Aalen experienced only three. Nearly 90% of mothers in Dijon gave each vegetable separately while more than half the German mothers gave mixtures of vegetables. In Dijon, mothers frequently changed the vegetable offered from day-to-day while in Aalen each vegetable was usually given for 4 or more consecutive days (see Fig. 4). As the cluster analysis reveals, a small group of mothers in Dijon (cluster 3) did show patterns of milk-feeding and introduction of complementary foods similar to those of the dominant pattern in Aalen (cluster 1) but they still gave more vegetables and more daily changes in the first month of weaning than any group in Aalen.

When we explored the reasons for these differences in feeding patterns in the two regions, mothers in Aalen were more likely (81%) to mention that they were concerned about allergy. In contrast, mothers in Dijon were more likely (78%) to mention the importance of “taste development” as a reason why they frequently changed the vegetables offered. Although this seems to suggest that a concern about allergy may be the reason

why the German mothers offered each vegetable for several consecutive days, it is also possible that this feeding pattern follows a traditional practice that happens to fit well with current recommendations aimed at reducing allergy (Kersting, 2001; Federal Institute for Risk Assessment, 2005).

Although most of the paediatricians in Aalen justified their recommendations on introduction times and feeding practices as motivated by allergy concerns and although many of the mothers in Aalen said their feeding strategy was aimed at reducing allergy, no clear differences between countries can be seen. The prevalence of food allergy in infants and young children is 5–8% in both France and Germany (Penard-Morand et al., 2005; Rancé, Grandmottet, & Grandjean, 2005; Roehr et al., 2004).

In both regions, if the infant refused a new food, mothers rarely offered it at more than five subsequent meals before giving up and deciding definitively that her child did not like it. This is consistent with previous work (Carruth, Ziegler, Gordon, & Barr, 2004) reporting that, with US infants aged from 7 to 11 months, less than 7% of caregivers offered an initially disliked food more than 5 times before deciding that, if the food was still not accepted and liked, it was not worth trying any longer. The US pattern of persistence is closer to the pattern we saw in Aalen than in Dijon (where mothers tended to give up earlier). It is possible that this difference may be linked to the observation that the Dijon mothers also offered their infants a greater range of foods and thus had more alternatives available if their infant disliked a particular food.

In the present study, the various foods given to infants may also differ in texture and thus bring about distinct experiences that may also influence later food acceptance. In a survey of foods eaten at 6 and 12 months of age, Blossfeld, Collins, Kiely, and Delahunty (2007) observed that acceptance of chopped carrots at 12 months was significantly correlated with previous experience of more varied and/or more richly textured foods and concluded that early experiences with different textures may be beneficial for infants' dietary variety. Similarly, Northstone, Emmett, and Nethersole (2001) noted that infants who were introduced earlier to "lumpy" foods also tended to be easier to feed. It is not yet clear that experience with complex texture actually caused this improved acceptance, nor how improved acceptance was related to experiences with other sensory modalities. The relative importance of experiences with different flavours, textures and colours of foods on subsequent preferences has not yet been sufficiently studied.

The cluster analyses confirmed that: (1) there were marked differences in feeding patterns *within* each region and (2) there were few similarities in feeding patterns across the two regions studied. These differences in feeding patterns would lead to differences in early sensory experiences of the infants both between and within the

regions. Maier et al. (2006) subsequently showed that such differences in breastfeeding and weaning experience can lead to differences in later acceptance of new foods.

Differences in the number of vegetables offered early in weaning have been shown to influence subsequent acceptance of new foods. Thus, Gerrish and Mennella (2001) observed that infants given daily changes in vegetables during the first 10 days of vegetable feeding more readily accepted new foods during the next 2–3 days than did infants offered the same vegetable for 10 days. Recently, Maier et al. (2006) showed that this increased acceptance can last for up to 2 months. As yet, there is no experimental evidence that the effects last any longer than this. It is not known if these differences in early eating patterns have long-lasting effects of food acceptance. In general, vegetable consumption is higher in France than in Germany (Leonhauser, Dorandt, Willmund, & Honsel, 2004) but this could be due to many factors other than early taste experiences.

## Conclusions

These results show large differences in early feeding patterns and early sensory experiences between two almost neighbouring regions in Europe. Furthermore, some of the differences observed are likely to be enough to influence later food preferences and acceptance of new foods. Thus, the longer period of breastfeeding in Aalen and the greater variety of foods offered during the first month of weaning by mothers in Dijon can both be expected to facilitate acceptance of new foods, at least in the short term. Experimental studies recently completed in our laboratories quantify the relative importance of duration of breastfeeding and variety of foods offered shortly after weaning on acceptance of new foods during the following months.

## Acknowledgements

The authors thank Nestlé Nutrition, Vevey, Switzerland for funding this study. We would like to acknowledge the osteopath Mrs. Monika Funk and the midwife Mrs. Ester Schiessl for their help in recruiting and all the mothers (and infants) who so generously answered our questions. Our gratitude is extended to the three anonymous reviewers for their valuable comments on a previous version of this paper.

## References

- Atkins, P. J. (2003). Mother's milk and infant death in Britain circa 1900–1940. *Anthropology of Food*, 2.
- Beauchamp, G. K., & Moran, M. (1982). Dietary experience and sweet taste preferences in human infants. *Appetite*, 3, 139–152.
- Bigot-Chantepie, S., Michaud, L., Devos, P., Depoortère, M. H., Dubos, J. P., Gottrand, F., et al. (2005). Feeding practices in infants: A 6-month prospective cohort study. *Archives de Pédiatrie*, 12, 1570–1576.

- Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition*, 19, 41–62.
- Blossfeld, I., Collins, A., Kiely, M., & Delahunty, C. (2007). Texture preferences of 12-month-old infants and the role of early experiences. *Food Quality and Preference*, 18, 396–404.
- Brockow, I., Franke, K., Zirnigbl, A., Grubl, A., Bauer, C. P., Koletzko, S., et al. (2003). Breastfeeding habits with regard to a different family history of atopic diseases and additional information about allergy-preventive nutrition. *Monatsschrift Kinderheilkunde*, 151, 61–67.
- Carruth, B. R., Ziegler, P. J., Gordon, A., & Barr, S. I. (2004). Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food. *Journal of the American Dietetic Association*, 104, 57–64.
- Collett, D. (2003). *Modelling survival data in medical research* (2nd ed.). Boca Raton: Chapman & Hall/CRC.
- Dewey, K., (Ed.). (2001). *Guiding principles for complementary feeding of the breastfed child*. Geneva, Switzerland: World Health Organization.
- Duden. (1996). *Rechtschreibung der deutschen Sprache*, 21 (Vol. völlig neu bearbeitet und erweiterte Auflage). Mannheim/Leipzig/Wien/Zürich: Dudenverlag.
- Federal Institute for Risk Assessment. (2005). *Nutritional plan for the first year of age: Guidelines of the German Research Institute for Infant Nutrition*. Internet Communication: German Research Institute for Infant Nutrition.
- Fomon, S. J. (2001). Infant feeding in the 20th century: Formula and breast. *Journal of Nutrition*, 131, 409–420.
- Freeman, V., Van't Hof, M., Haschke, F., & Euro-Growth Study Group. (2000). Patterns of milk and food intake in infants from birth to age 36 months: The Euro-Growth Study. *Journal of Pediatric Gastroenterology and Nutrition*, 31, 76–85.
- Gerrish, C. J., & Mennella, J. A. (2001). Flavor variety enhances food acceptance in formula-fed infants. *American Journal of Clinical Nutrition*, 73, 1080–1085.
- Gojard, S. (1998). *Nourrir son enfant: Une question d'éducation. Normes savantes, usages populaires et expérience familiale*. Unpublished Thèse de 3<sup>ème</sup> cycle, Ecole des Hautes Etudes en Sciences Sociales.
- Haller, R., Rummel, C., Henneberg, S., Pollmer, U., & Köster, E. P. (1999). The influence of early experience with vanillin on food preference later in life. *Chemical Senses*, 24, 465–467.
- Hartigan, J. A., & Wong, M. A. (1979). A K-means clustering algorithm. *Applied Statistics*, 28, 100–108.
- Hintze, J. (2001). *NCSS and PASS*. Kaysville, Utah: Number Cruncher Statistical Systems.
- Hörnell, A., Hofvander, Y., & Kylberg, E. (2001). Introduction of solids and formula to breastfed infants: A longitudinal prospective study in Uppsala, Sweden. *Acta Paediatrica*, 90, 477–482.
- Jiang, T., Schaal, B., Marlier, L., & Soussignan, R. (1999). The food-related odor environment of French newborns: Human and formula milk odors compared by adult nose. *Chemical Senses*, 24, 80.
- Kersting, M. (2001). Nutrition of the healthy baby. Food and meal related recommendations. *Monatsschrift Kinderheilkunde*, 149, 4–10.
- Kersting, M., & Dulon, M. (2002). Assessment of breastfeeding promotion in hospitals and follow-up survey of mother-infant pairs in Germany: The SuSe Study. *Public Health Nutrition*, 5, 547–552.
- Kramer, M., & Kakuma, R. (2002). *The optimal duration of exclusive breastfeeding. A systematic review*. Geneva: World Health Organization (WHO).
- Labarère, J., Dalla-Lana, C., Schelstraete, C., Rivier, A., Callec, M., Polverelli, J. F., et al. (2001). Initiation et durée de l'allaitement maternel dans les établissements d'Aix et Chambéry (France). *Archives de Pédiatrie*, 8, 807–815.
- Leathwood, P., & Maier, A. (2005). Early influences on taste preferences. In O. Hernell, & J. Schmitz (Eds.), *Feeding during late infancy and early childhood: Impact on health*, Vol. 56 (pp. 127–141). Basel: Karger AG.
- Lee, Y. H. (1992). Food-processing approaches to altering allergenic potential of milk-based formula. *Journal of Pediatrics*, 121, 47–50.
- Leonhauser, I. U., Dorandt, S., Willmund, E., & Honsel, J. (2004). The benefit of the Mediterranean diet—Considerations to modify German food patterns. *European Journal of Nutrition*, 43(Suppl. 1), 31–38.
- Liem, D. G., & Mennella, J. A. (2002). Sweet and sour preferences during childhood: Role of early experiences. *Developmental Psychobiology*, 41, 388–395.
- Maier, A.S., Leathwood, P., Chabanet, C., Issanchou, S., & Schaal, B. (2006). Breastfeeding and experience with a variety of vegetables increases acceptance of new flavours by infants at weaning. *Paper presented at the 17th congress of the European Chemoreception Research Organization*, Grenada, Spain.
- McDaniel, M. R. (1980). Off-flavors of human milk. In G. Charalambous (Ed.), *The analysis and control of less desirable flavors in food and beverages* (pp. 267–291). New York: Academic Press.
- Mennella, J. A., & Beauchamp, G. K. (1991a). Maternal diet alters the sensory qualities of human milk and the nursing's behavior. *Pediatrics*, 88, 737–744.
- Mennella, J. A., & Beauchamp, G. K. (1991b). The transfer of alcohol to human milk. Effects on flavor and the infant's behavior. *The New England Journal of Medicine*, 325, 981–985.
- Mennella, J. A., & Beauchamp, G. K. (1993). The effects of repeated exposure to garlic-flavored milk on the nursing's behavior. *Pediatrics Research*, 34, 805–808.
- Mennella, J. A., & Beauchamp, G. K. (1996). The human infants' responses to vanilla flavors in human milk and formula. *Infant Behavior & Development*, 19, 13–19.
- Mennella, J. A., & Beauchamp, G. K. (2002). Flavor experiences during formula feeding are related to preferences during childhood. *Early Human Development*, 68, 71–82.
- Mennella, J. A., Griffin, C. E., & Beauchamp, G. K. (2004). Flavor programming during infancy. *Pediatrics*, 113, 840–845.
- Mennella, J. A., Jagnow, C. P., & Beauchamp, G. K. (2001). Prenatal and postnatal flavor learning by human infants. *Pediatrics*, 107, e88.
- Morgan, K. J. (2003). The politics of mothers' employment: France in comparative perspective. *World Politics*, 55, 259–289.
- Northstone, K., Emmett, P., & Nethersole, F. (2001). The effect of age of introduction to lumpy solids on foods eaten and reported feeding difficulties at 6 and 15 months. *Journal of Human Nutrition and Dietetics*, 14, 43–54.
- Penard-Morand, C., Raherison, C., Kopferschmitt, C., Caillaud, D., Lavaud, F., Charpin, D., et al. (2005). Prevalence of food allergy and its relationship to asthma and allergic rhinitis in schoolchildren. *Allergy*, 60, 1165–1171.
- Rancé, F., Grandmottet, X., & Grandjean, H. (2005). Prevalence and main characteristics of schoolchildren diagnosed with food allergies in France. *Clinical & Experimental Allergy*, 35, 167–172.
- Robert, P. (2001). *Le Petit Robert. Dictionnaire de la langue française*. Paris: Dictionnaires Le Robert.
- Roehr, C. C., Edenharter, G., Reimann, S., Ehlers, I., Worm, M., Zuberbier, T., et al. (2004). Food allergy and non-allergic food hypersensitivity in children and adolescents. *Clinical & Experimental Allergy*, 34, 1534–1541.
- Ryan, A. S. (1997). The resurgence of breastfeeding in the United States. *Pediatrics*, 99, e12.
- Schaal, B. (2005). From amnion to colostrum to milk. Odour bridging in early developmental transitions. In B. Hopkins, & S. Johnson (Eds.), *Prenatal development of postnatal functions. Advances in infancy research*, Vol. 2 (pp. 51–102). New York: Praeger.
- Schaal, B. (2006). The development of flavour perception from infancy to adulthood. In A. Voilley, & P. Etiévant (Eds.), *Flavour in food* (pp. 403–436). Cambridge: Woodhead.
- Schaal, B., Marlier, L., & Soussignan, R. (2000). Human fetuses learn odours from their pregnant mother's diet. *Chemical Senses*, 25, 729–737.

- Skinner, J. D., Carruth, B. R., Houck, K., Moran, J., Jr., Coletta, F., Cotter, R., et al. (1997). Transitions in infant feeding during the first year of life. *Journal of the American College of Nutrition*, *16*, 209–215.
- Sullivan, S. A., & Birch, L. L. (1994). Infant dietary experience and acceptance of solid foods. *Pediatrics*, *93*, 271–277.
- Tableman, M., & Kim, J.-S. (2003). *Survival analysis using S: Analysis of time-to-event data*. Boca Raton: Chapman & Hall, CRC.
- Webster (1970). *Webster's seventh new collegiate dictionary*. Springfield, MA: Merriam Company.
- WHO. (1965). *Nutrition in pregnancy and lactation: Report of a WHO Expert Committee*. Geneva: World Health Organization.
- WHO. (2001). *Report of the expert consultation of the optimal duration of exclusive breastfeeding*. Geneva, Switzerland: World Health Organization.
- Wright, A. L., & Schanler, R. J. (2001). The resurgence of breastfeeding at the end of the second millennium. *Journal of Nutrition*, *131*, 421S–425S.

#### Reference Note

Note 1: Nestlé, 1997; internal document.