The emotional expression of highly premature infants during initial attempts at diversifying feeding.

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Summary

This study examines the emotional expressions of infants aged 5 – 6 months who taste for the first time a new food out of four (two sweet, two salted). It compares the facial expressions of infants born prematurely (before 33 weeks gestation) with those of infants born at term. The diet is standardized concerning the nature of the food, the form of the spoon and the staging of the meal. The films of four meals for each child, recorded at weekly intervals over one month, were coded objectively by means of the Baby FACS test, and also by naïve judges who had to evaluate the enjoyment value on an analogue scale ranging from “detests” to “loves”. The results indicate that premature-born infants express less negative emotional responses than infants born at term. The enjoyment evaluation by naïve judges attributes manifestations of more intense pleasure than for infants born at term, evaluated in the same conditions. The evaluations of these judges are in agreement with those resulting from application of the Baby FACS test. Analysis of the course of the meal, applied to the first six spoonfuls, indicates that there is familiarization such that the frequency and intensity of negative emotional expression decreases after the second spoonful whatever the sort of food, the period of birth of the infant, and the length of the experience of diversified foods.

The temperamental dimension of “frustration” is correlated with negative emotional expression for the premature group, whereas the dimensions “consolation”, “laughing and smiling” are positively correlated with acceptance of the new foods for the premature group.

Key words : alimentary diversification – premature infants – emotional expression - temperament

Highlights

- Highly premature infants manifest less negative emotional responses than infants born at term when tasting novel foods.
- The number of negative responses decreases over the course of successive meals, whatever the population of infants, the nature of the novel food, and the duration of spoon-feeding.
- The evaluation of emotional expression of infants by naïve adults is strongly correlated with the results of the analysis of Baby FACS tests by experts.
- The dimensions of temperament have different effects on the acceptance of novel foods for the group of premature infants compared to those born at term.

Introduction

The period of diversification in feeding begins towards the end of the first six months of life, with a variation in age according to the country, the region and family cultures (Schaal, Delaunay-El Allam & Soussignan, 2008). It consists of introducing non-milky substances, in the form of mashed food administered by spoon, for at least one meal in the day. This "developmental task" (Schleyer-Lindenmann & Piolat, 2011) is the object of research which aims at formulating recommendations for instigating healthy feeding habits right from the start of life. It is particularly a question of preventing food allergies and obesity in rich countries or, in other territories, of anticipating the risks of malnutrition and bacterial contamination of food substances (Coulthard, Harris, & Fogel, 2014 ; Daniels, Mallan, Nicholson, Battistutta, & Magarey, 2013 ; Lumeng & Blass, 2008 ; Mennella & Trabulsi, 2012 ; Remy, Issanchou, Chabanet, & Nicklaus, 2013). The diversification of feeding patterns is also considered as a key step in the development of feeding preferences of the infant, particularly in the acceptance of fruits and vegetables in the form of mashed preparations or jam by the young child (Hausner, Nicklaus, Issanchou, Mølgaard et Møller, 2009 ; Hetherington, 2015), and in relation with the early exposure of the infant to different tastes (Delaunay-El Allam, Soussignan, Patris, Marlier, & Schaal, 2010 ; Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008 ; Mennella, Jagnow, & Beauchamp 2001 ; Rigal, 2010). Finally, current research investigates how infants accede to a diversified feeding regime when they grow up in particular circumstances such as those created by severely premature birth (Mellier & Marret, 2013 ; Mellier, Marret, Soussignan, & Schaal, 2008 ; Moster, Lie & Markestad, 2008 ; Pridham, Steward, Thoyre, Brown, & Brown, 2007 ; Serenius, Källén, Blennow et al., 2013 ; Töröla, Lehtimalmes, Yliherva, & Olsén, 2012 ; Wolthuis-Stiger, Luinge, da Costa, Krijnen, Van der Schans, & Bos, 2015). It is this context of the development of severely premature infants which concerns us here.

Alimentary diversification in the premature infant

Feeding difficulties, which affect 25% to 45% of healthy infants born at term, are more frequent in the case of premature infants with an incidence of 40 to 70% in infants born before 33 weeks gestation[1] (Le Heuzey, Turberg-Romain & Lelièvre, 2007 ; Linscheid, Budd, & Rasnake, 2003). These developmental difficulties concern all the phases of feeding in the premature infant, from access to active sucking and weaning from gastric intubation (Amaizu, Schulman, Schandler, & Lau, 2008 ; Lau,

[1] A birth is considered as premature when it occurs before 37 WM (Weeks without Menstruation). The classification of the World Health Organisation distinguishes moderately premature births (33 WM to 36 WM+ 6 days), highly premature births (28 WM to 32 WM+ 6 days), and severely premature births (before 28 WM). The duration of a pregnancy at term is 41 WM.

2007), to the acceptance of novel items of food and meals (Bordet, 2010 ; Delfosse, Soulignac, & Crunelle, 2006), including the introduction of non-milky foods around 6 months. These difficulties, which are mentioned by parents during pediatric consultations, persist in studies by questionnaire or interview at least until the children reach the age of 18-42 months (Cerro, Zeunert, Simmer, & Daniels, 2002 ; Garel, Bahuaud & Blondel 2004). Thus Delfosse et al. (2006) report that, according to the parents, the stage of passing to spoon-feeding turned out to be difficult for 27% of severely premature infants. They specify that the introduction of pieces of food was distressing for 44% of these infants, the more so when the acceptance of spoon-feeding was tardy. Tolerance to the consistency of food remains a difficulty for 13% of children at the average age of 3 years and 6 months.

These reported data do not make explicit how the pleasure or displeasure of the infant is manifested when he/she first discovers new food, and in particular whether the infant expresses emotions of disgust or satisfaction according the food being tasted. The present study addresses the analysis of this emotional expression in six-month old infants born prematurely or at term. It is indeed interesting to know whether the infant manifests emotional expressions that the parent could take into account, in addition to the direct motor behaviour of the oral sphere. A differential expression of emotions as a function of the type of food would confirm that premature infants do discriminate tastes and textures, in spite of the particularity of their early experience of feeding by gastric intubation, and taking into account the profile of their temperament. Indeed, studies of socio-emotional development in premature infants are based essentially on questions of temperament. Previous studies conducted during the first year of life have shown that preterm infants were less regular and adaptable, were less intense, were more withdrawing and had more negative mood than term infants (Langkamp & Pascoe, 1998 ; Hughes, Shults, McGrath, & Medoff-Cooper, 2002 ; Spittle et al., 2009). The question may therefore be asked as to whether preterm infants manifest more negative facial expressions than peers born at term, when they experience new foods, i.e. when they process novel gustatory, olfactory and tactile information in the context of a social interaction. This age-period, on which to our knowledge there is little information, could indeed prefigure the emotional profiles reported by studies of temperament from 18 months onwards. Thus, Wolf, Koldewijn, Beelen, Smit, Hedlund, & de Groot, (2002) found scores of emotional regulation measured on the Bayles Scales of Infant Development (Bayley, 1993) which were lower than for infants born at term.

Aim of the study

This study compares the facial responses of 6-month old infants, characterized in terms of the degree of pleasure or displeasure on the occasion of the initiation to novel forms of food, between those born at term and those born prematurely at 33 weeks of gestation. It analyses the positive or negative expressions of the infants when they taste the new food on successive spoonfuls. The study confronts the data from emotional coding of the film of the meal by experts with the data from the subjective evaluation of the facial expressions of pleasure or displeasure on the part of the infant, by naïve judges. On the basis of the objective coding of the images, our hypothesis is that we expect that the premature infants, who are reported as having low acceptance of novel alimentary diversity, will manifest emotions which are more negative and will do so more frequently than infants born at term when they ingest for the first time a spoonful of a novel non-milky food be it sweet or salty. This emotional expression of disgust or rejection will form the basis for the opinions of the naïve judges, and will thus lead them to consider that the premature infants have a lower appreciation of the novel food. Our second hypothesis thus predicts that the evaluations of the naïve judges will be strongly correlated with the results of objective codings by experts. Finally, we expect that the profile of temperament affects the forms of emotional expression in response to novel foods.

Methods

Participants

37 infants, of whom 21 were born at term (**FT**) (8 boys ; 13 girls) and 16 were severely premature (**PT**) (5 boys ; 11 girls) were encountered for the first time at home one month before the onset of alimentary diversification. The premature infants, whose average age at birth is 30,26 WM (±12 days) with a mean birth weight of 1519 g (±356 g), were contacted directly by the neonatal medical service which followed them at birth[2]. The infants born at term at an average age of 39,1 WM (±6 days), with a mean birth weight of 3278 g (±483g), were recruited by the maternity service of the University Hospital of Rouen or the maternity service of Belvédère[3]. The families were then contacted when the infant was 5 months old in order to confirm their participation in the study, to make sure of their consent and to evaluate the temperament of the infant by means of the Infant Behavior Questionnaire (Rothbart, 1981). Children who presented marked retardation in their neuro-motor development or health difficulties during pediatric examination were excluded from the sample. The parents all signed a form of enlightened consent for the study and for filming at home[4].

[2] The neonatal medical service of the University Hospital Charles Nicolle, Rouen.
[3] Belvédère maternity centre, Mont Saint Aignan.
[4] The research programme recorded under the number 06-027-01 received a favorable opinion from the Consultative Committe for the Protection of Subjects in Biomedical Research in Upper Normandy.

The average age of the infants at the beginning of the observations was 5 months 22 days (±16,6 days) for infants born at term. It was 6 months and 16 days (±32,7 days) for the premature infants[5]. We have performed a comparison (Student's t test) of the age of the infants at the time of the first observation, according to the group (birth at term versus premature birth). We note without surprise, like Le Heuzey, Turberg-Romain & Lelièvre (2007), that the premature infants in our sample were first exposed to alimentary diversification significantly later than infants born at term ($t_{(31)}$ = 2.464, p=0.024).

Materials and pre-test procedures

In order to standardize the conditions of observation and filming, the families all used identical spoons and small pots that we provided. The spoon sets the maximum amount of food transported to the mouth of the infant per spoonful. The length of the handle of the spoon is sufficient to avoid masking the face of the infant by the hand of the parent during filming.

We provided standard industrial pots of food in order to render the taste and the texture of the food homogeneous. These products were selected as having typical taste by a panel of eighteen adults during a preliminary study. Taking into account the fact that in the general population the mashed food or jam given to an infant is exclusively, or mainly, of industrial origin for 84,9% of families, as confirmed by Lepicart-Tiebault (2008), our methodological requirement of providing industrial food products does not break with the usual alimentary practices in France. We may note in addition that this protocol, which imposes the consumption of 4 small industrial pots, was accepted without problem by all the families participating in the study.

Procedure

The first step was to request that the parents evaluate the temperament of their child at the age of 5 months, using the Infant Behavior Questionnaire (Rothbart, 1981). We then made an appointment for filming at home the first four trials of alimentary diversification.

Four meals were filmed at the parental home, with a close-up view of the chest and face of the infant during the first tasting of mashed vegetables (carrots or green beans) or a fruit jam (pear or banana). Each filmed sequence corresponds to the tasting of a single type of food for each infant. The order of the four foods was freely chosen by the family. The fruit jam or the mashed carrots were most often chosen first, although there is no particular order of tasting the four foods which prevails for the whole group that was studied. Each infant was thus filmed four times, with an interval of one week between two filmings, resulting in a period of one month between the first and

[5] These are the ages calculated since birth, without correcting for the period of prematurity.

last observation. The infant was placed in a seat facing the parent. The mothers were requested to open their own mouths at the moment when the spoon approaches the lips of their child. This practice, which is very frequent in the spontaneous behaviour of the mothers, was accepted by all the participants in the study.

A corpus of 135 video recordings was thus obtained (Table 1). The unequal number of recordings according to the foodstuffs resulted from the fact that a few families abandoned the study before completion of the whole protocol.

	Foodstuff tasted			
	Carrot	Green bean	Pear	Banana
Infants born at term (n=21)	21	21	18	17
Premature infants (n=16)	12	16	15	15

Table 1. Distribution of the filmed subjects according to term of birth of the infant and the type of foodstuffs tasted.

Procedures for analysing the films

We applied two sorts of analysis of the degree of pleasure manifested by the behaviour of the infants when tasting the four novel foodstuffs.

In the first analysis, using an objective coding system - the Baby version of the Facial Action Coding System (FACS) due to Ekman, Friesen & Hager (2002) - we described the infants' emotional facial reactivity to the first six videotaped spoonfuls. This number of six was chosen retrospectively as corresponding to the minimum number of spoonfuls accepted by all the infants who were filmed (the maximum number was nine). A spoonful is defined by the complete sequence: approach of the spoon, entry of the spoon into the mouth, chewing the food and swallowing. The second analysis is performed by naïve judges who evaluate the degree of pleasure/displeasure on video clips of the third spoonful. The analysis of the results from Baby FACS indicated that the third spoonful was representative of the emotional expression over the whole set of 6 spoonfuls of a meal, beyond the initial effects of novelty and surprise (cf infra).

BABY FACS Coding

Black and white video-clips of infants' facial responses were scored with the Baby-FACS test (Oster, 2007) by two certified coders who were blind to the infant status (pre-term vs full term) and the type of food. The Baby-FACS is an anatomically based instrument in which the action units (AU) are

minimally distinguishable movements of the facial muscles. Each AU is designated by a numeric code and scored on the basis of precise criteria of transitory and subtle changes in the shape and location of facial features. Based on data from previous studies of facial responsiveness to odorants and tastes in infants and children (Rosenstein & Oster, 1988; Soussignan & Schaal, 1996; Soussignan, Schaal, Marlier & Jiang, 1997), an index of negatively-valenced facial expressions was defined and involved the following AUs : 4 (the brows are lowered); 1+3, 1+4 (the inner portions of the brows are raised and pulled together), 3+4 (the brows are knotted and knitted); 1+2+3/4 (the entire brows are raised; 9 (the nose is wrinkled); 10 (the upper lip is raised); 11 (the nasolabial furrow is deepened); 15 (the lip corners are pulled down); 20 (the lower lips are stretched). We also coded facial expressions of disgust involving UA 9 and/or UA 10. Because the frequency of smiles (AU 12) in response to food tasting was low, it was not included in the analysis. The inter-observer reliability for AUs was calculated on the infants' facial behaviour during the 810 videotaped spoonfuls (135 meals X 6 spoonfuls). The agreement ratio, which was 81.4%, was well above the minimal acceptable ratio of 70%.

Subjective evaluation of the degree of pleasure

A panel of 45 naïve judges (men and women with a mean age of 24,5 ± 3,54 years) evaluated the degree of pleasure on ingestion of the foodstuffs. These judges have in common the fact that none of them were parents. Their experience in feeding infants of around 6 months was controlled. The analysis of their evaluations according to whether they had never fed an infant (47%), had done so rarely (44%) or did so regularly (9%) did not indicate any effect of experience on their judgements. There is no evidence either that judgements made by men differ from those by women. These adults are described as "naïve" in the sense that they have no special expertise related to the use of a specific tool for coding emotions. No information was provided concerning the nature of the foodstuff being tasted (carrot, green bean, pear, banana), nor concerning the status of the infant (premature or born at term).

A computer software device enabled the judges to visualize each video clip and to evaluate it directly on an analogue scale running from "detests" to "loves". The videos, each lasting 11 seconds, are in black and white (to maintain the "blind" status of the nature of the foodstuff), and mute (so as to avoid influencing the judges by the comments of the mother). The order of presenting the video clips alternated the foodstuffs and the status of the infant (premature or full term). We regrouped the 135 images in 4 blocks of clips which were presented randomly from one judge to the next.

Each judge was informed that the clip lasts about ten seconds, and that he/she should position a cursor on a line which indicates the degree of pleasure towards the right (likes) or displeasure

towards the left (dislikes). The analogue scale corresponds to the segment of a straight line of 17,5 cm on the screen or 17 units on the computer. The median position on the segment corresponds to a neutral emotion. As soon as the response is validated, the software shows the next clip with the cursor automatically repositioned on the neutral point. The intensity of the emotional expression of the infant is measured between 0 and 100, with “detests” corresponding to the point 0 and 100 as the maximal intensity of pleasure.

Results

Dimensions of temperament

The scores on the various dimensions of temperament (Figure 1) do not differ significantly between the two groups of infants, those born at term versus those born prematurely before 33 weeks gestational age.

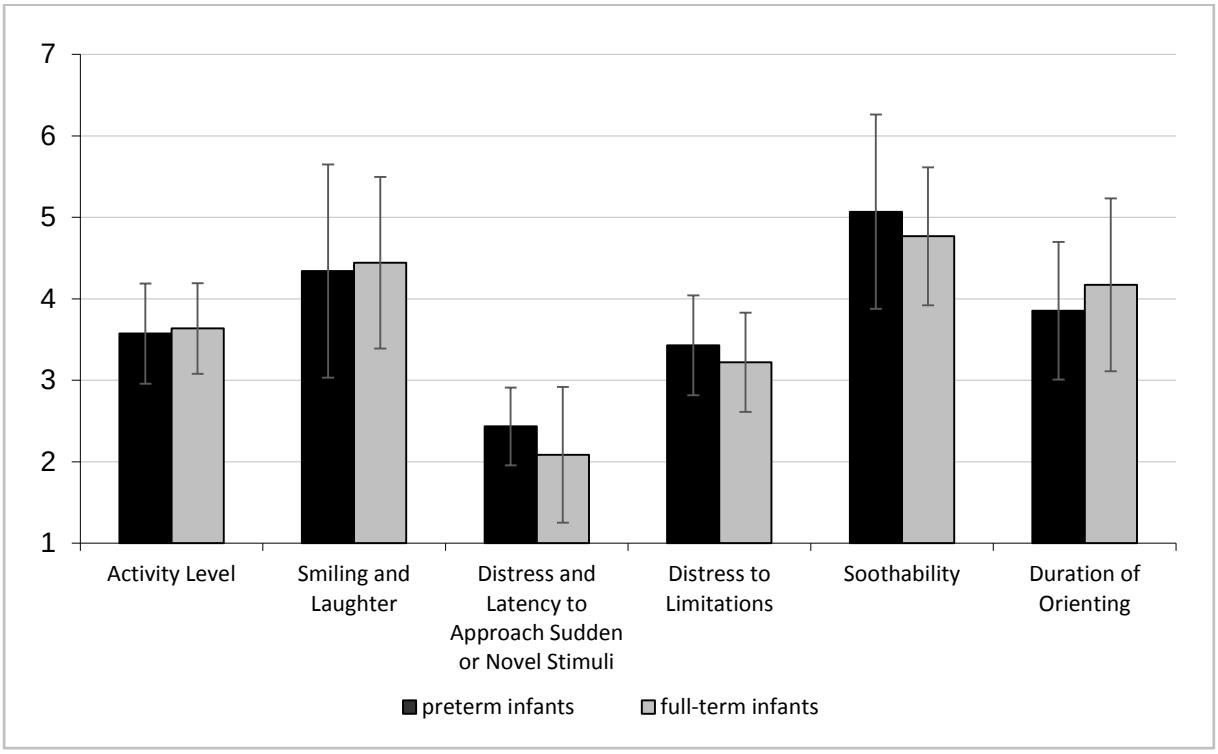

Figure 1. Scores on the dimensions of temperament according to the term of birth

Emotional responses on FACS

We have calculated, following the Baby FACS coding for each meal, for each infant and each foodstuff, the number of spoonfuls (0 to 6) for which a negative expression (dislike or disgust) was noted. An analysis of variance (Anova) with two factors – term of birth (birth at term vs. premature

252 birth) and the foodstuffs tasted (carrot, green bean, pear, banana) indicates a main effect of term of
253 birth on the expression of negative emotions ($F(1,133)=12.383$, $p=0.001$) and disgust
254 ($F(1,133)=11.449$, $p=0.001$). Thus, for all four meals grouped together, we find about two times less
255 negative expressions for premature infants compared to infants born at term (Figure 2). There is no
256 statistically significant effect concerning the type of foodstuff.

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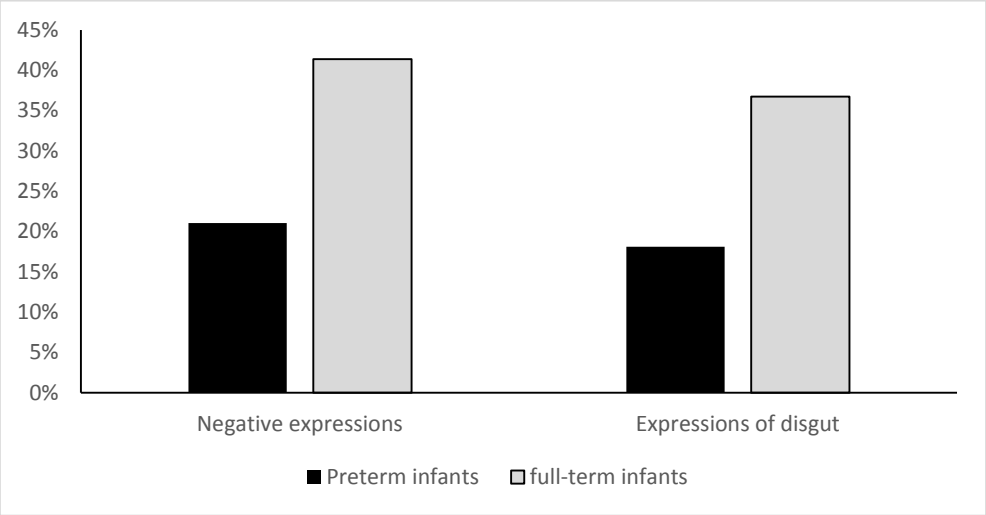

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259 Figure 2. Rates of negative expressions and disgust (in %) according to the term of birth.

260

261 *Evolution of negative responses on the occasion of tasting a novel foodstuff: from the first*
262 *to the sixth spoonful.*

263 The second analysis characterizes the temporal evolution of the responses over the course of
264 the meal. Figure 3 presents, for each spoonful from the first to the sixth, the rate of negative
265 expression and disgust for all four foodstuffs consumed, according to the term of birth.

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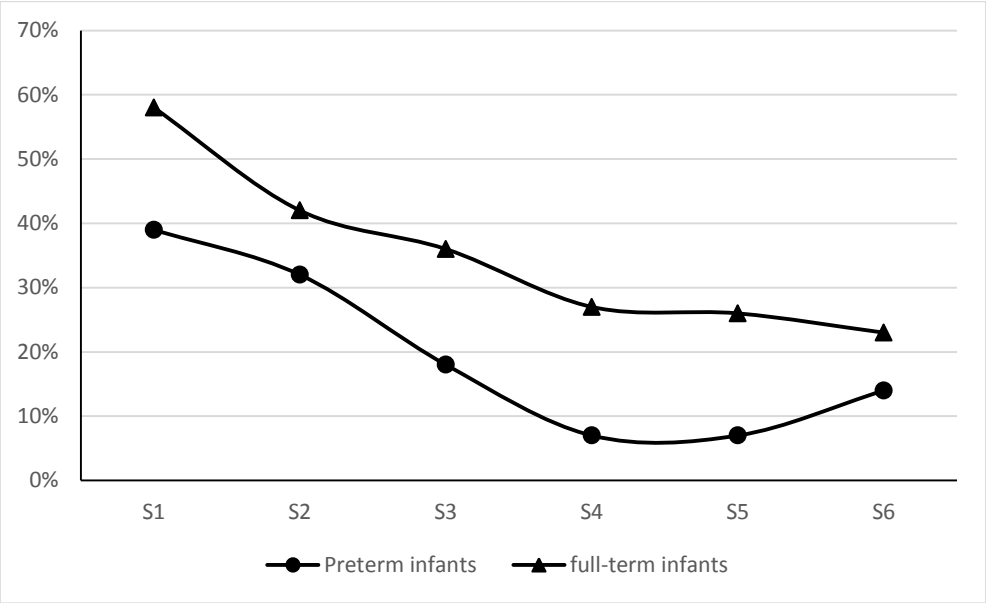

Figure 3. Rates of negative emotional response to tasting the four novel foodstuffs, according to the group and the stage in the course of the meal (spoonful 1 to 6) - *S=Spoonful.*

The statistical analysis of these data indicates that the negative emotional responses of the infants are significantly more frequent for the first two spoonfuls than for the rest of the meal. Thus, the comparison of the number of negative responses for the first spoonful versus the five following spoonfuls (Cochran test) indicates a significant difference both for the group of infants born at term ($Q(5)=42{,}015$; $p<.001$ n=66) and for the group of premature infants ($Q(5)=41{,}700$; $p<.001$ n=56). The difference in the number of negative responses for the second spoonful compared to the 4 following spoonfuls is also significant, both for the group of infants born at term ($Q(4)=16{,}743$; $p<.002$ n=66) and for those born prematurely ($Q(4)=24{,}145$; $p<.001$ n=56). However, the number of negative responses expressed by the infants does not vary significantly beyond the third spoonful. Thus, the comparison of the number of negative responses between the third and later spoonfuls gives no indication of a statistically significant reduction. The same holds for the end of the meal. It thus appears that there is a familiarization, leading to a stabilization, from the third spoonful on, from the point of view of criterion of a negative emotional response.

Figure 4 presents the rate of negative responses over the course of the meal (spoonful 1 to 6) as a function of the type of foodstuff (carrot, green bean, pear, banana).

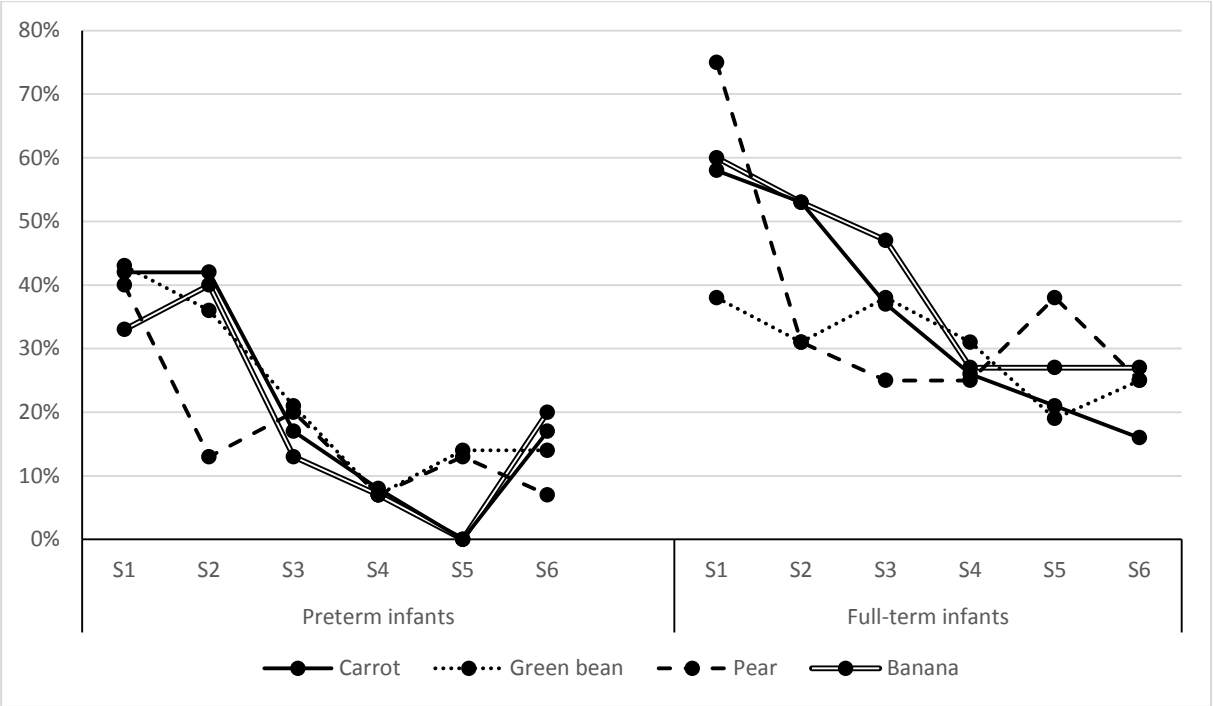

Figure 4. Rates of negative emotional responses according to the type of foodstuff and the progress in the course of the meal (spoonfuls 1 to 6). *S=spoonful ; PT=preterm infants ; FT=full-term infants.*

It is to be noted that the premature infants express fewer negative emotional responses at all stages in the course of the meal than infants born at term, irrespective of the nature of the foodstuff being tasted. However, the profiles of the evolution of negative responses of the infant over the course of the meal differ according to the nature of the food, the exception being the mash of green beans. In this case, the negative responses are overall less frequent than for the other foods, and one cannot conclude that the percentage decreases significantly over the course of the meal. For the three other foods, the infants produce more negative responses to the first spoonful than to the following ones:

- *carrot* mash for infants born at term ($Q(5)= 19{,}048$; $p=0.002$ $n=19$) and for pre-term infants ($Q(5)= 11{,}727$; $p=0.039$ $n=12$) ;

- *pear* jam compote ($Q(5)=24{,}831$; $p<0.001$ $n=16$) for the group born at term, and $Q(5)=12{,}805$; $p=0.025$ $n=15$ for the pre-term infants ;

- *banana* jam ($Q(5)=10{,}833$; $p=0.05$ $n=15$) for infants born at term, and **(**$Q(5)=16{,}429$; $p=0.006$ $n=15$) for the pre-term group of infants.

As in the preceding analysis, the number of infants who express a negative emotion at the third spoonful is not statistically different from that noted for the succeeding spoonfuls.

Figure 5 shows the number of negative responses expressed over the course of the meal (spoonful 1 to 6) according to the experience of novel feeding as measured by the number of weeks on this regime. As a reminder, the observations are filmed at intervals of one week, and allow for possibly at least one spoon-fed meal per day between two films (i.e. around twenty meals at the moment of the fourth film, fifteen at the time of the third observation whereas the second film corresponds to the eighth meal).

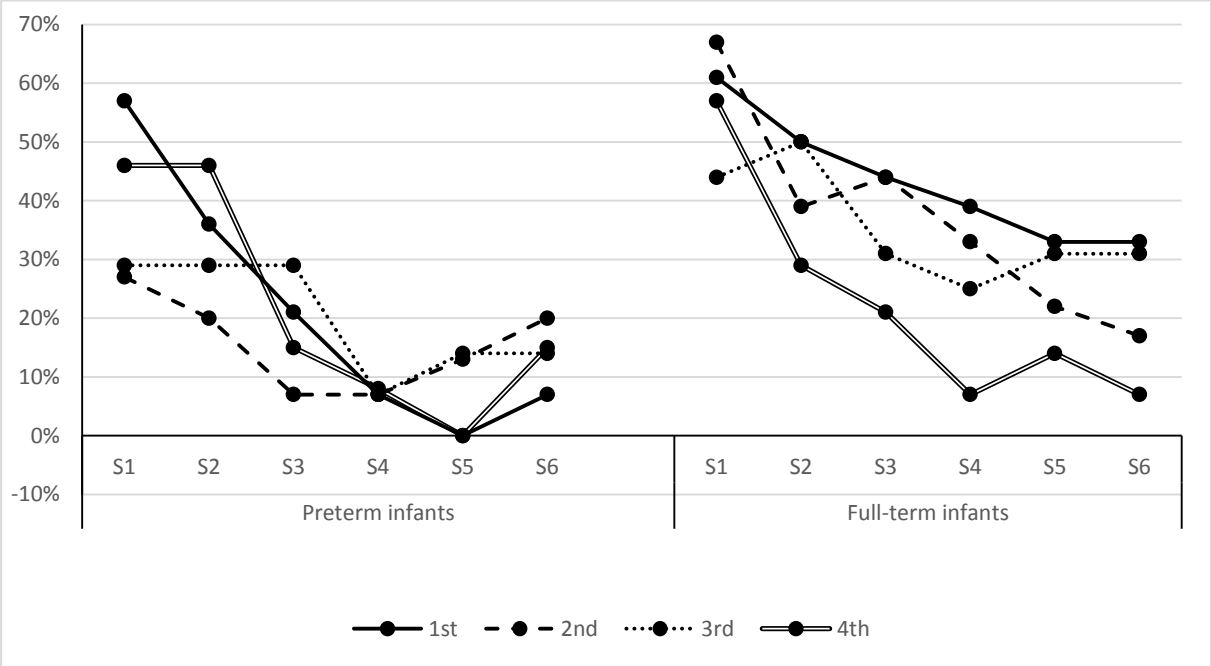

Figure 5. Rate of negative responses according to the length of experience of spoon-feeding.

S=spoonful ; PT=preterm infants ; FT=full-term infants

In the group of infants born at term, one may note a significant decrease in the frequency of negative emotions beyond the first spoonful for the second observation (Q(5)=19,744 ; p=0.001 n=18) and for the fourth observation (Q(5)=16,333 ; p=0.006 n=16). In the group of pre-term infants, the decrease in negative emotions is clearly attested for the first observation (Q(5)=20,294 ; p=0.001 n=14) and for the fourth observation (Q(5)=20,102 ; p=0.001 n=13). The data concerning the experience of spoon-feeding do not permit any conclusion concerning an effect of experience on the expression of negative emotions.

Evaluation of pleasure valency by naïve adults

The results obtained by the objective analysis of the baby FACS data made it possible to lighten the evaluation protocol proposed to naïve adults, by restricting the number of pleasure judgements to the consumption of the third spoonful (135 video clips).

We performed a two-factor analysis of variance (Anova) to evaluate the effects of the term of birth (birth at term versus premature birth), and the food tasted (carrot, green bean, pear, banana) on the pleasure evaluation by naïve judges. The results confirm the findings made after application of the Baby FACS test by expert judges. The images of premature infants were subjectively evaluated as more positive than the images of infants born at term. The index of intensity, calibrated as 0 for "detests" and as 100 for "loves", indicates a mean value of 57,27 (±15,06) for premature infants vs 46,86 (±19,44) for infants born at term ($F(1,133)=12.784$, $p<0.001$).

The comparison of the groups by Chi2 test (birth at term vs. premature birth) on the pleasure valency of the evaluation of the judges (pleasure in the range [0-50] vs. pleasure in the range [50-100]) indicates that, in a general way, prematurely born infants are more often evaluated as manifesting pleasure while eating their food (evaluation of the judges greater than 50) than infants born at term ($\chi^2(1) = 7,041$; $p=0.008$) (Figure 6).

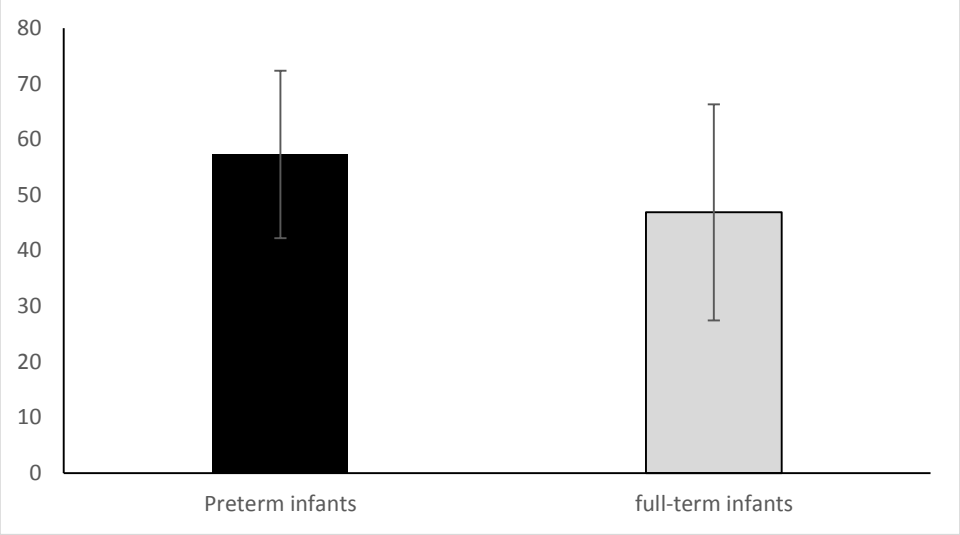

Figure 6. Pleasure (evaluated by judges in the range à to 100) according to the term of birth

Concordance between the evaluation by naïve judges and the expert evaluation by Baby FACS coding.

The intensity of the negative response is evaluated by scores inferior to 50 attributed by judges on the analogue scale going from 0 to 100. This score concerns the third spoonful of each of the four meals. The intensity evaluated by the Baby FACS coding is estimated by the sum of negative action units calculated for the six first spoonfuls of the four meals.

The results indicate that the evaluation by naïve adults of pleasure in eating the third spoonful of each video recording is highly correlated with the intensity of the negative response

(objective analysis by FACS) over the first six spoonfuls (r=-0.758 ; p<.001). This is valid both for the evaluations of images of infants born at term (r= -0.771 ; p<.001) as well as for prematurely born infants (r=-0.680 ; p<.001) (Figure 7).

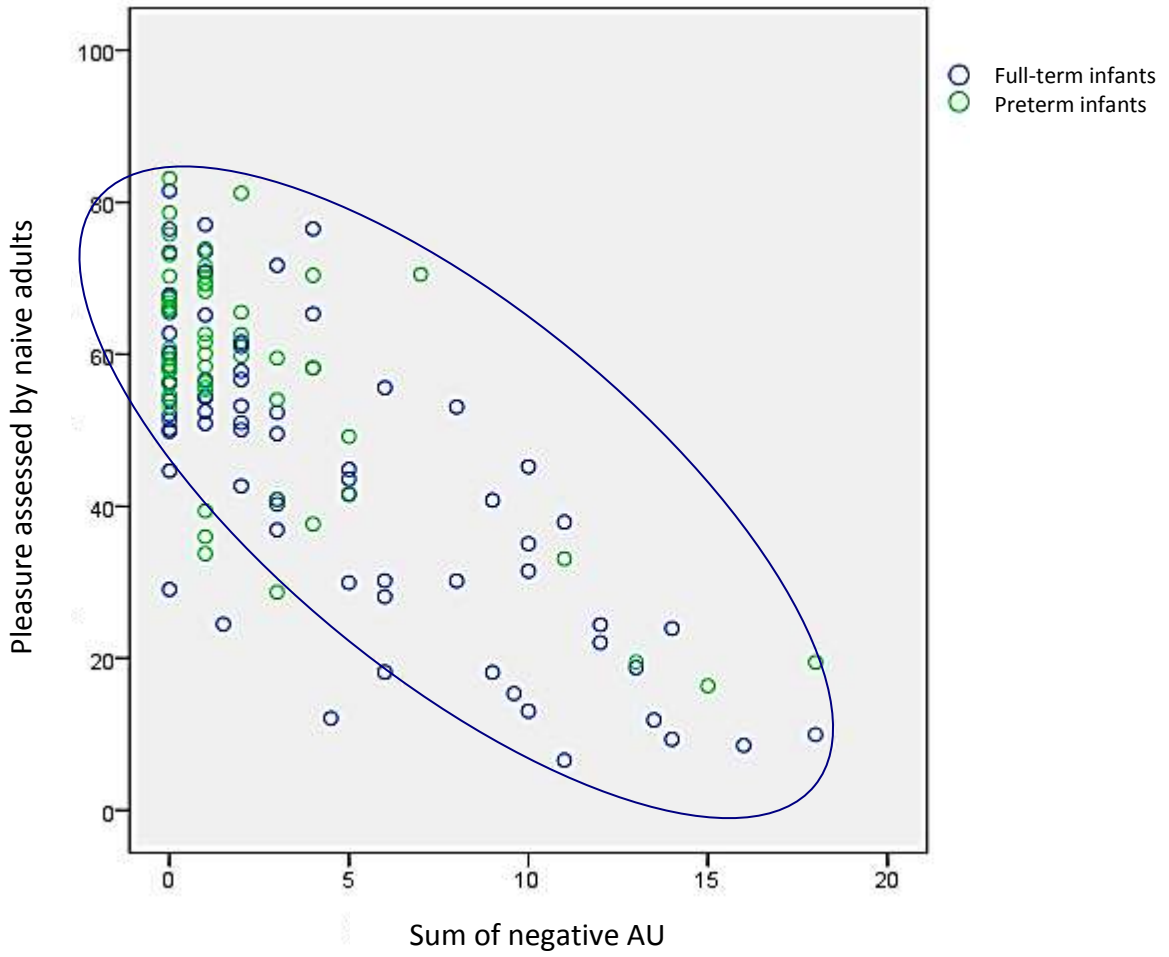

Figure 7. The degree of pleasure as evaluated by naïve judges, plotted as a function of the sum of negative expressions (FACS action units).

Temperamental dimensions and emotional responses

The Pearson correlation test indicates a moderate positive effect of the dimensions “laughs and smiles” and “consolability” on the acceptance of novel foodstuffs by infants born at term (laughs and smiles * UA neg : r= -0,352 ; p=0,004 ; n=65 ; laughs and smiles * pleasure : r=0,323 ; p=0,009 ; n=65 ; Consolability * UA neg : r= -0,346 ; p=0,005 ; n=65 ; Consolability * pleasure : r=0,345 ; p=0,005 ; n=65). For its part, a higher score on the dimension “frustration” is associated with less

pleasure on the part of infants born prematurely on the occasion of evaluation by naïve judges (Frustration * pleasure : r= -0,449 ; p=0,000 ; n=58).

Discussion

The results obtained by FACS coding or by the subjective evaluation of naïve judges do not confirm our hypothesis, according to which prematurely born infants should manifest more negative emotional responses than infants born at term. On the contrary, the analyses indicate that the number of negative responses is less for premature infants compared to the responses of infants born at term. Moreover, these analyses allow the conclusion that the emotional responses of premature infants are interpreted by naïve judges as manifesting more pleasure than those of infants born at term. The subjective evaluation by naïve judges thus goes in the same direction as the expert codings of Baby FACS. This confirms our second hypothesis concerning the concordance of objective and subjective evaluations, although it may be remarked that the subjective judges give a more positive interpretation of the infants than the expert coding. This suggests that when interpreting images, the subjective judges may have taken into account additional information beyond the mere emotional expression of the face, probably by including other features, for example posture and tonicity. The data on temperament reported by the parents one month before the onset of diversification do not indicate any differences according to term of birth; the interpretation of the responses of the infants is principally related to tasting new foods. We have nevertheless noted that the dimension of frustration is moderately linked to a lesser expression of pleasure in the case of premature infants. Two other dimensions, “laughs and smiles” and “consolability” are correlated with the emotional expressions of infants born at term. We have noted that the results are consistent whatever the nature of the foodstuff, sweet or salted, or whatever the order in which the foodstuffs are presented to the infant. Knowing that the order of presentation of the new foodstuffs goes with the period of the experience of the infants (the meals are filmed from weeks 1 to 4), it may be concluded that the responses to the various flavours and textures is not confounded with the effects of habits and practices of feeding. We may therefore consider that the emotional responses expressed at the time of diversification are differentiated according to the foodstuffs, whether these are tasted at the first observation or in the month that follows, both for premature infants and for those born at term.

The analysis of the emotional responses over the course of a meal has shown that the negative responses are more numerous and more manifest at the beginning of the meal, and in particular for the first two spoonfuls, whatever the nature of the foodstuff and independently of the order in which they are presented. The third spoonful opens the phase of familiarity with the foodstuff, when

399 the initial reactions to novelty as such are overcome. This finding does not differentiate the
400 emotional responses of premature infants and those born at term, with the exception that there is a
401 substantial decrease for the premature infants right from the first week, i.e. without any previous
402 experience of spoon-feeding, whereas this decrease only intervenes during the second week for
403 infants born at term. This clearly shows that the infants process the sensory information emanating
404 from the new foodstuffs, and that they rapidly become familiar with it, from the third spoonful
405 onwards, for all four flavours tested. It cannot be concluded that premature infants take any longer
406 to get used to new foodstuffs than infants born at term. If we rely on the criteria employed in this
407 study, this result confirms that the capacities for habituation in premature infants are fully effective.
408 Thus, the modality of taste, like the tactile modality (Lejeune et Gentaz, 2013) allows for an effective
409 perceptual treatment right from the perinatal period, whereas the discrimination of auditory stimuli
410 remains less effective than for infants born at term, up to an age of 6 months (Le Driant et
411 Vandromme, 1999). The perceptual treatment of the taste of foodstuffs suggests that the bio-
412 developmental order (Gottlieb, 2002) prevails so as to protect the formation of perceptual
413 knowledge for the modalities which are most ancient in phylogenetic terms, in spite of the particular
414 conditions of experience related to special care.
415 The method we have employed, which is rigorous and demanding for coders and judges, has made it
416 possible to evaluate the emotional dimension of pleasure/displeasure in reactions to diversification
417 of foodstuffs on the basis of the facial expressions of the infant. This enables us conclude, contrary to
418 what may be expected on the basis of studies by interviews or questionnaires, that premature
419 infants manifest fewer negative reactions than infants born at term, when they are confronted with
420 new foodstuffs at the moment of diversification. The premature infants show fewer negative
421 emotional responses, and their expressions are interpreted more positively than those of infants
422 born at term. This finding results in part from the method of study, which is based on evaluation of
423 the facial expression of the emotions. This evaluation does not take into account the rhythm of
424 ingestion, the total duration of the meal, the total quantity of food that is ingested, which are all
425 indications employed by the overall judgement of the parent as to whether the infant has “eaten
426 well”. We may also note that the evaluation employed here does not take into account the social
427 dimension of the meal. It analyses the sensory and hedonistic responses in close relation to the
428 sensori-motor experience of tasting, while neutralizing the modalities of interaction initiated by the
429 mothers. Another study could propose a wider angle of vision, or the deployment of two
430 synchronized cameras, in order to examine how the emotional expressions of the infant integrate the
431 communication with the mother and the strategies employed to negotiate the social interaction.
432 The results reported here come from an analysis that was carried out blind, where the coder or the
433 judge had no information as to the status of the infant or the nature of the foodstuff. An estimation

of the role played by the representations of adults and parents as to premature term of birth and the nature of the foodstuffs could thus be the object of complementary studies which would investigate the representations of "eating well" made by adults. In this case it would be appropriate to ask the naïve judges to evaluate the images with full knowledge of whether the infant in question was premature or born at term. It would also be appropriate to compare the evaluations made by the parents of premature infants, with the evaluations made by naïve judges and by the parents of infants born at term. A final aspect would be to know to what extent the evaluations of naïve judges are influenced by prejudices concerning foodstuffs. Here, they were presented with black-and-white images without any knowledge of the foodstuff brought to the mouth of the infant. The examination of evaluations made by naïve judges or parents, informed at each image of the birth status of the infant and the nature of the foodstuff being tasted, would make it possible to complete the analysis of the emotional responses of the infants by including those related to the expectations of adults in relation with their representation of prematurity and the taste quality of the foodstuffs.

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