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# Application and validation of the Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS) to assess liking and wanting in infants at the time of complementary feeding

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ABSTRACT

*Introduction:* The aim of this study was to validate a novel tool developed to measure liking and wanting in infants during the weaning period. The Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS; Hetherington et al., 2016) is an evidence based video coding tool, consisting of 13 items. There are 6 measures of avoidance/approach behaviours (turns head away, arches back, pushes spoon away, crying/fussy, leaning forward and rate of acceptance) to assess wanting and 7 facial expressions (brow lowered, inner brow raised, squinting, nose wrinkling, lip corners down, upper lip raised and gaping) to assess liking. Lower scores on the total scale indicated greater wanting and/or liking. The tool was applied to a recent randomized control trial (Hetherington et al., 2015).

*Method:* 36 mother–infant dyads took part in the study and were randomised to the intervention or the control group. Infants were filmed on two occasions whilst eating a generally liked vegetable (carrots) and less preferred vegetable (green bean). 72 video extracts were coded by 4 trained researchers with adequate certification scores, each video was coded by at least two coders. Items and scales were tested for discrimination ((1) intervention vs control; (2) liked vs disliked vegetable) and construct validity (correlation with intake and liking assessed by mother and researcher).

*Results:* Very good discrimination ($p < 0.001$) was obtained for carrots vs green bean for the total score and total negative facial expressions and rejection behaviours ($p = 0.003$). Discrimination for the intervention vs control groups was only obtained for the total rejections and the rate of acceptance ($p < 0.05$). The FIBFECS subscales had good construct validity as these were significantly correlated with intake and liking ratings ($p < 0.01$). Items such as crying/fussy and leaning forward were removed from the scale as well as inner brow raised, squinting and lip corners down, as these do not correlate with other variables. Their removal did not affect the integrity of the scale. The rate of acceptance parameter was found to have potential as a short method to measure wanting in infants.

*Conclusion:* The present study has demonstrated that the FIBFECS can be used to identify liking and wanting independent of subjective ratings from mothers and researchers, therefore, this tool can be used widely in the study of infant responses to novel foods at the time of weaning. There is potential to develop the tool for infants beyond the period of complementary feeding and to assist in identifying fussy eating in the early stages of development.



## 1. Introduction

Despite the known benefits of eating fruits and vegetables most children and adults do not meet their daily recommend intakes (Cobiac, Vos, & Veerman, 2010; Guenther, Dodd, Reedy, & Krebs-Smith, 2006; Wolf et al., 2005). A recent study by Fischer, Brug, Tak, Yngve, and te Velde (2011) found that the consumption of fruit in 11 year old schoolchildren improved between 2003–2009, but intake of vegetables had decreased. Low intakes of some vegetables may be due to their bitter taste, unfamiliar texture and low energy content (Krolner et al., 2011; Mennella & Ventura, 2011). However, since eating habits formed in the early years can

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shape eating behaviour later in life (Nicklaus, Boggio, Chabanet, & Issanchou, 2004; Savage, Fisher, & Birch, 2007; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002), it is important to expose infants to a variety of vegetables to promote acceptance. Complementary feeding is a sensitive period for developing taste preferences (Harris, 1993; Mennella & Ventura, 2011) therefore, increasing the consumption of vegetables during this time may have long term benefits (Barends, de Vries, Mojet, & de Graaf, 2014; Mennella & Trabulsi, 2012). Liking is strongly associated with intake, therefore, increasing liking for vegetables early on can help to enhance vegetable intake (Bere & Klepp, 2005; Gibson, Wardle, & Watts, 1998; Olsen, Ritz, Kraaij, & Møller, 2012). Infants are willing to accept new foods during complementary feeding (Lange, Visalli, Jacob, Schlich, & Nicklaus, 2011; Schwartz, Chabanet, Lange, Issanchou, & Nicklaus, 2011) but as children get older and food neophobia develops it becomes challenging to encourage children to accept new foods (Caton et al., 2014). Thus, the time to establish liking and wanting for vegetables is during weaning, since infants are willing to try new foods, food preferences are not yet fully established and neophobia has not yet emerged.

### 1.1. Liking and wanting in infants

According to the Incentive Sensitization Theory (Berridge, 1996; Berridge, Robinson, & Aldridge, 2009; Robinson & Berridge, 1993) food reward comprises of two components: food 'liking' and 'wanting'. Liking is the pleasantness derived from consuming a particular food and wanting is the appetitive motivation. In the context of eating behaviour these constructs are often related and are interdependent. Nevertheless liking and wanting can be measured independently (Berridge, 1996; Garbinsky, Morewedge, & Shiv, 2014; Havermans, 2011, 2012).

Research to date on liking and wanting in humans has largely focussed on adults (Finlayson, King, & Blundell, 2007; Goldstein et al., 2010; Havermans, Janssen, Giesen, Roefs, & Jansen, 2009; Ouwehand & de Ridder, 2008; Tibboel et al., 2011) and children (Finlayson, Hetherington, King, & Blundell, 2007; Jiang, Schaal, Boulanger, Kontar, & Soussignan, 2013; Kildegaard, Tønning, & Thybo, 2011; Liem & Zandstra, 2009). However tools to assess both liking and wanting in infancy have yet to be developed. This is because liking in infants may be difficult to judge due to their limited capacity to communicate verbally. It is generally assumed that infants will eat more of foods they like and will accept these readily when offered (Hetherington et al., 2016). Therefore, indirect measures of liking and wanting have been extrapolated from intake (weight), duration (Forestell & Mennella, 2007, 2012; Mennella & Beauchamp, 1997; Mennella, Forestell, Morgan, & Beauchamp, 2009; Mennella, Jagnow, & Beauchamp, 2001) and pace of eating (Forestell & Mennella, 2007; Mennella & Beauchamp, 1997; Mennella et al., 2009). These measures can be influenced by hunger, eating traits and situational context (Hetherington et al., 2016). A more direct measure of wanting could be revealed by behaviours such as leaning forward, readiness to accept the food and number of rejections.

Mothers are often asked to make judgments of how much a food is liked by their infant (Forestell & Mennella, 2007; Forestell & Mennella, 2012; Liem, Zandstra, & Thomas 2010; Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008; Mennella et al., 2001). To limit bias from maternal accounts, perceived liking can also be judged by an external observer (Maier et al., 2008). These judgements are made on the basis of the infant's immediate facial and behaviour responses to food taste or odour rather than relying on maternal ratings from prior experience with that food.

Indirect and subjective measures are useful but also challenging as it is difficult to make comparisons between infants or across studies. Therefore video coding methods have been developed to observe infant responses in detail (Forestell & Mennella, 2007, 2012; Mennella & Beauchamp, 1997; Mennella et al., 2001, 2009; Soussignan, Schaal, Marlier, & Jiang, 1997; Zeinstra, Koelen, Colindres, Kok, & de Graaf, 2009). Expressions of distaste are more obvious and numerous than expressions of liking, these can be examined in direct response to the odour and taste of foods consumed. Rejection behaviours are also quite clear in response to presentation (Forestell & Mennella, 2007; Pliner & Hobden, 1992; Rosenstein & Oster, 1988; Zeinstra et al., 2009). Therefore, the Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS) was developed from existing literature to capture certain facial expressions typical of distaste (e.g. Soussignan et al., 1997) and acceptance/rejection behaviours which may reflect wanting. In the FIBFECS, indicators of distaste include eye brow lowered, inner brow raised, gaping, squinting, lip corners down and upper lip raised. These expressions are assumed to reflect negatively valenced responses to food odours or tastes representing dislike (Soussignan et al., 1997). The coding system includes rejection behaviours such as turns the head away, arches back, crying/fussing, pushes the food away and slow rates of acceptance. Rejection behaviours are indicative of avoidance when the food is offered, whereas acceptance behaviours such as eagerness to accept the food, leaning forward to take the food are treated as indicators of approach (Hetherington et al., 2016). For the purposes of the validation exercise, it is assumed that facial expressions in response to the presence of food in the mouth represent "liking" whilst approach/avoidance behaviours before the food is tasted represent "wanting".

### 1.2. Measuring liking and wanting in infancy

To our knowledge video coding tools to characterise liking and wanting in infants are limited; studies have not reported their reliability or validity for wider use. Therefore, the Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS) was developed to assess different responses to food before the food is tasted and when the food is in the mouth. This temporal distinction allows the observer to note acceptance or rejection behaviours when the food is offered but not yet tasted indicative of "wanting" while facial reactions when the food is accepted and in the mouth is assumed to reflect "liking". This system has acceptable inter-rater reliability and test–retest reliability (see Hetherington et al., 2016). The present study set out to validate the coding tool by testing its applicability within a randomised control trial conducted at the time of complementary feeding in which infants were given a variety of vegetables in milk then cereal using a step-by-step gradual introduction over 24 days or were assigned to a control group receiving no prior exposure to vegetable flavours during the first 24 days of weaning (Hetherington et al., 2015).

To validate the tool infant feeding behaviours and facial expressions were coded using the FIBFECS in response to consuming a generally well liked vegetable (carrot) and less liked vegetable (green bean) during the early phase of complementary feeding. The carrot and green bean were unfamiliar to the control group and familiar to the intervention group through previous exposure (9 times in each case as part of a rota of vegetable exposures over 24 days). The tool was used to assess whether the two types of construct (acceptance/rejection behaviours and facial expressions) could discriminate between the two experimental conditions (intervention vs control) and the two vegetables (green bean vs carrot). It was predicted that acceptance behaviours (wanting) and indicators of liking should correspond to greater intake, whereas rejection behaviours and indicators of distaste should correspond to lower intakes. It was further predicted that if the acceptance/rejection behaviours represented "wanting" then these would be significantly greater for the intervention group compared

to the control group since intervention infants were familiar with these foods through prior exposure, and more likely to want these foods. It was predicted that if facial expressions represented "liking" then these would differ according to vegetable, with more expressions of "distaste" in response to green bean compared to carrot; and that facial expressions indicating liking should be more evident in the intervention compared to the control group. It was expected that both liking and wanting would be significantly correlated with objective measures of intake (amount eaten, rate of consumption, duration) and with subjective ratings of liking by mothers and researchers. It was hypothesised that the more wanted and liked the food was the greater the objective measures of intake and the higher the subjective ratings of liking; and that wanting and liking would be different as a function of prior exposure (intervention vs control). These predictions were generated to test the validity of the coding system to assess liking and wanting in infants during complementary feeding.

## 2. Methods

### 2.1. Participants

Participants were mother–infant dyads, recruited in September 2011 to May 2012, from the local community by a recruitment agency and advertising within mother and baby groups. Infants younger than 12 weeks, born prematurely before 37 weeks of gestation (Migraine et al., 2013), fed hydrolyzed-protein formula (Mennella & Beauchamp, 2002; Mennella, Kennedy, & Beauchamp, 2006; Mennella et al., 2009), suffering from a chronic health condition or with a known food allergy were not eligible to participate as these factors may influence their intake. 48 mothers were screened and 40 mother–infant dyads were eligible to participate. Four participants were excluded from the study due to missed appointments ($n = 2$), return to work ($n = 1$) and relocation ($n = 1$). A final sample of 36 mothers took part in the study. Infants were randomly assigned into the control ($n = 18$) or the intervention group ($n = 18$). Age of the mothers was 32.2 (±5.0) years and age of the infants on the first day of the experiment was 4.83 (±0.57) months. 16 infants were boys (42.9%) and mean BMI-*z* score was 0.23 (±1.16). Feeding method at birth was mostly or entirely breastfeeding ($n = 30$) and at the time of the intervention most infants were mostly or entirely formula-fed ($n = 23$). There were no significant differences in infants' characteristics or feeding methods between the two groups (Hetherington et al., 2015).

Mothers of the participating infants provided written informed consent. Participants were paid a small fee for their time and travel costs on completion of the study. This study was conducted according to the guidelines set in the Declaration of Helsinki. All procedures involving participants were approved by the Institute of Psychological Sciences (University of Leeds) ethics committee who adheres to the guidelines proposed by the British Psychological Society (Ref No: #11-0031).

### 2.2. Design

Briefly, the intervention consisted of a 35 day (30 days home; 5 days laboratory) exposure to vegetables gradually increasing the intensity of flavour over time (see Hetherington et al., 2015 for more detail). Infants were randomised to an intervention or control group. Infants in the intervention group were offered 12 daily exposures to vegetable puree added to milk (day 1–12), followed by 2 × 12 daily exposures to vegetables added to baby rice (days 13–24) in a rotation of pure vegetable purees (carrots, green bean, broccoli, spinach and parsnip). These vegetable flavours were novel at the time of offering, but became familiar with exposures. Participants in the control group received plain milk and then plain baby rice, therefore, carrot and green bean were unfamiliar to the infants. For the final 11 days (day 25–35) both groups were offered the rotation of target vegetables. The FIBFECS (Hetherington et al., 2016) was used to assess response to vegetables offered on day 25 (carrots) and day 26 (green bean). For the purpose of this study only the methods and findings related to day 25 and day 26 are discussed.

### 2.3. Measures

#### 2.3.1. Laboratory instructions

Prior to the laboratory session mothers were provided with guidance on how they should feed their infants in order to obtain standardised measures of their infants' interest and reaction towards the food. They were requested to minimise verbal interaction, use a neutral tone if speaking was necessary, avoid contacting the infant's lip with the spoon after the first few spoonfuls and feed to the infant's pace of eating. Mothers were also made aware that infants are able to self-regulate and know when they are full therefore to discontinue the feeding session after three consecutive refusals. Refusals were explained to mothers as infants pulling their body away, arching their back, crying, being fussy, pushing the spoon away, spitting food out, becoming playful or falling asleep. These signs for refusal were shown on a slide presentation. Whilst this may have ensured that mothers were similarly trained to researchers, this concern had to be balanced against the need for standard feeding sessions. Refusals were observed by both the mothers and the researcher to decide if the feeding session should discontinue.

#### 2.3.2. Laboratory setting and filming

Distractions were minimised in the area around the laboratory using notices and blinds were also pulled down to prevent external distractions. The laboratory was prepared with a specifically designed room setting including; camera angle, mirror (for researcher's observation) and position of the high chair/chair for the mother. This was done prior to the mother–infant arrival to allow infants to become familiar with the new setting. The researcher was seated behind the infant to minimise distractions and observed the infant in a strategically placed mirror. Each infant was filmed eating carrots (day 25) and green bean (day 26).

#### 2.3.3. Food intake and duration

Single vegetable purees were not available in the UK and therefore were transported from mainland Europe. Ingredients were suitable for infants aged 4–6 months and met baby food quality (European regulations, Directive 2006/125/CE). Vegetables chosen were based on evidence of common use in the UK taken from Ahern et al. (2013) representing a typically liked vegetable (carrot) and a generally disliked green vegetable (green bean). Intake of food was measured accurately before and after the feeding session using a digital scale (nearest to 0.1 g). Any vegetable remaining on the infant's face, hands, bib and/or chair was collected before final weighing of the food. The duration of the mealtime was measured in minutes and the mean rate of consumption was estimated by dividing the amount eaten by the duration of the mealtime.

#### 2.3.4. Ratings of liking

Mothers and researchers observed the infant during the mealtime and immediately after the feeding session independently recorded the infant's liking of the food using a 9-point scale (1 = dislikes extremely to 9 = likes extremely).

*2.3.5. Video recording analysis to assess liking and wanting*

Video recordings were coded using the Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS). The coding system has acceptable inter-item reliability, inter-rater reliability and test–retest reliability. The tool is divided into two sections with 6 acceptance/rejection behaviours (turns head away, arches back, crying/fussy, pushes spoon away, leans forward and rate of acceptance) and 7 facial expression items (brow lowered, inner brow raised, squinting, nose wrinkling, lip corners down, upper lip raised and gaping). Behaviours and facial expressions were assessed per spoonful and scored as yes/no (1/0) except the rate of acceptance which was assessed on a 4-point scale (early = 3/late = 2/enforced = 1/refused = 0). The coding system also included 3 non-visible options (for mouth movement, upper face and lower face) i.e. when the visibility was obscured or obstructed by mothers offering a spoon. When a spoon offer was rejected, the infant's behaviours were coded for the spoon offer; however facial expressions were not coded because the infant had not tasted the food for that particular spoon. Four independent trained raters blind to the infants' group condition (carrot or green bean) coded 72 video extracts (9 spoonfuls). Of these, 2 raters coded behaviours, 1 coded facial expressions and 1 coded both parts. It was important that the coders had not been told of the intervention nor the group assignment so that coding could be conducted without potential bias to the outcome.

*2.4. Procedures*

Mothers were introduced to the intervention procedures and they gave written consent for taking part in the study prior to the intervention. General information regarding infant's weight, height, birth date and feeding method was noted by the researcher. Mother–infant dyads visited the Infant Laboratory in the Human Appetite Research Unit during the laboratory days 25 and 26. Infants were fed by their mother and were offered 2 jars of food on each day (carrots/green bean). The mealtime duration was noted at the end of the feeding session and any remaining puree was placed back into the feeding bowl to ensure accurate measurement of vegetable intake. Ratings of liking were independently recorded by mothers and the researcher at the end of each session. Laboratory setting and instructions were kept the same for both days.

*2.5. Data analysis*

Four independent raters performed the certification test for the relevant part of the coding system and coded 72 video extracts. The video coding data across the raters were averaged and compared to the objective (intake, duration and mean rate of eating) and subjective measures (mothers and researchers liking scores).

For coding of facial expressions a minimum of 6 spoonfuls had to be coded for each infant. Data with <6 spoonfuls were removed from the analysis. Non-visible data were treated as missing data during the analysis. Only the spoonfuls that were coded by at least two coders were considered for further analysis. Thus, the coding of spoonfuls where there were fewer than two coders and where one of the coders remarked that the behaviour/facial expression was refused/non-visible was excluded. Corrections were applied to refused and non-visible spoons to get an overall measure for 9 spoonfuls.

Spearman rho correlations were performed to test associations between intake, duration, mean rate of consumption and liking ratings (overall). Spearman rho correlations were also performed to explore relationships between coded acceptance/rejection behaviours, facial expressions, intake, duration, mean rate of consumption and subjective liking ratings (separate analyses according to each vegetable and overall). Descriptive statistics and two-way analyses of variance (ANOVA) were performed to test the differences in frequencies of behaviours and expressions according to group assignment (intervention vs control) and the type of vegetable (carrots vs green bean). Sphericity was not assumed therefore Greenhouse-Geisser values were reported. Statistics were performed using IBM SPSS (v20, Chicago, USA).

## 3. Results

Details of the development and implementation of the tool including coders' certification test results, factor structure, internal consistency of the scale, internal-reliability and test retest reliability are documented in a companion paper (Hetherington et al., 2016). Mean intake of the vegetable purees, mean frequencies of facial expressions indicating liking and acceptance/rejection behaviours indicating wanting in response to these vegetables and group differences are presented in Table 1.

*3.1. Correlations between intake, duration, mean rate of consumption and liking ratings*

The correlation coefficients for intake, duration, mean rate of consumption, mothers' and researchers' liking ratings are presented in Fig. 1. There was a significant positive association in the direction expected for these variables ($R = 0.40–0.83$; $p < 0.01$). As predicted, intake of vegetable puree was associated with meal duration, pace of eating and liking according to mothers and researchers. The more a food is liked, the more is eaten, for longer and faster than foods which are less liked. The duration of the meal was strongly related to ratings of liking by researchers and moderately related to maternal ratings of liking. However, maternal and researcher ratings of liking were highly correlated, with a high 95% confidence interval range between $r = 0.70–0.89$.

*3.2. Association of FIBFECS with intake, duration, mean rate of consumption and liking ratings*

Correlations between acceptance/rejection behaviours, intake, duration, mean rate of consumption and liking ratings are presented in Table 2 (upper panel) and between facial expressions, intake, duration, mean rate of consumption and liking in the lower panel of Table 2. Overall rejection behaviours were inversely associated with intake, duration, mean rate of consumption and maternal/researcher liking ratings. Acceptance behaviours were positively correlated with intake measures. Some weak inverse correlations were observed between crying, intake and duration of eating. The item for pushes spoon away was inversely correlated with all other variables except duration within the green bean condition. Total negative behaviours were inversely associated with all intake and liking variables. Overall, this suggests that infants who expressed most avoidance behaviours had lower intake, a slower pace of eating and lower liking ratings according to both mother and researcher.

There were no significant correlations observed for leans forward. Rate of acceptance was positively associated with all intake and liking measures. This suggests that infants with an early rate of acceptance (higher wanting) had a higher intake, longer duration of eating, quicker pace of eating, and higher liking scores.

For facial expressions, inner brow raised was the only variable significant in the carrot condition and was only associated with the mean rate of consumption. Fewer negative facial expressions for carrot and only weak, non-significant correlations for carrot suggest that this vegetable produced more neutral responses and was better liked than green bean. Squinting did not correlate with any variables. All other facial expression items were significant in the green bean condition and/or overall. Brow lowered and gaping were inversely associated with intake, duration, mean rate of

**Table 1**
Providing a summary of descriptive statistics for the study variables including intake, ratings, infant behaviours before the food was tasted and facial expressions after the food was tasted. Significant main effects of group or vegetable are indicated in the right hand panel.

| Variable | Carrots (mean/SD) | | | | Green beans (mean/SD) | | | Sig *p* value | |
|---|---|---|---|---|---|---|---|---|---|
| | *N* | Control | Intervention | Total | Control | Intervention | Total | Group | Veg |
| Intake (g) | 33 | 44.09 ± 51.70 | 98.85 ± 64.74 | 72.30 ± 64.19 | 13.22 ± 11.65 | 54.97 ± 40.25 | 34.73 ± 36.37 | $p = .001$ | $p < .001$ |
| Duration (min) | 31 | 9.73 ± 8.11 | 16.19 ± 10.92 | 13.06 ± 10.05 | 4.47 ± 1.51 | 7.94 ± 4.02 | 6.26 ± 3.50 | $p = .011$ | $p = .001$ |
| MRC (g/min) | 31 | 3.81 ± 2.06 | 6.68 ± 2.46 | 5.29 ± 2.67 | 3.15 ± 2.15 | 6.18 ± 3.02 | 4.71 ± 3.01 | $p = .001$ | $p = .177$ |
| M rating (9 pt scale) | 31 | 6.35 ± 1.80 | 7.28 ± 1.93 | 6.83 ± 1.90 | 4.53 ± 1.81 | 5.28 ± 2.80 | 4.91 ± 2.37 | $p = .171$ | $p < .001$ |
| R rating (9 pt scale) | 33 | 5.94 ± 2.75 | 7.69 ± 0.87 | 6.79 ± 2.22 | 4.41 ± 2.12 | 5.63 ± 2.25 | 5.00 ± 2.24 | $p = .018$ | $p < .001$ |
| *Frequency (of occurrence) per spoon offered over the first 9 spoonfuls* | | | | | | | | | |
| THA | 34 | 1.92 ± 1.92 | 0.47 ± 0.73 | 1.20 ± 1.61 | 2.43 ± 1.92 | 1.77 ± 1.90 | 2.10 ± 1.91 | $p = .042$ | $p = .006$ |
| AB | 34 | 0.80 ± 0.80 | 0.25 ± 0.42 | 0.53 ± 0.69 | 0.92 ± 1.34 | 0.51 ± 0.73 | 0.72 ± 1.08 | $p = .046$ | $p = .355$ |
| CR | 34 | 0.16 ± 0.65 | 0.06 ± 0.24 | 0.11 ± 0.48 | 0.02 ± 0.08 | 0.34 ± 0.82 | 0.18 ± 0.60 | $p = .383$ | $p = .584$ |
| PSA | 34 | 0.35 ± 0.66 | 0.08 ± 0.15 | 0.22 ± 0.49 | 0.64 ± 1.06 | 0.35 ± 0.58 | 0.50 ± 0.86 | $p = .126$ | $p = .082$ |
| LF | 34 | 0.84 ± 1.20 | 2.08 ± 2.28 | 1.46 ± 1.90 | 1.42 ± 1.95 | 1.99 ± 2.31 | 1.71 ± 2.13 | $p = .134$ | $p = .492$ |
| ROA | 34 | 14.04 ± 6.62 | 18.63 ± 4.71 | 16.33 ± 6.12 | 12.06 ± 4.98 | 15.16 ± 6.25 | 13.61 ± 5.78 | $p = .037$ | $p = .003$ |
| Total rejection behaviours[a] | 34 | 3.24 ± 2.74 | 0.86 ± 1.09 | 2.05 ± 2.38 | 4.01 ± 3.43 | 2.97 ± 3.12 | 3.49 ± 3.27 | $p = .036$ | $p = .011$ |
| BL | 32 | 3.36 ± 2.17 | 2.28 ± 2.07 | 2.82 ± 2.15 | 5.24 ± 2.47 | 3.41 ± 2.61 | 4.32 ± 2.67 | $p = .055$ | $p = .001$ |
| IBR | 31 | 3.02 ± 2.05 | 1.91 ± 1.57 | 2.48 ± 1.89 | 2.74 ± 2.38 | 2.17 ± 2.07 | 2.46 ± 2.22 | $p = .190$ | $p = .974$ |
| Sq | 31 | 0.34 ± 0.87 | 0.34 ± 0.77 | 0.34 ± 0.81 | 0.39 ± 0.67 | 0.66 ± 0.63 | 0.52 ± 0.65 | $p = .530$ | $p = .251$ |
| NW | 30 | 2.07 ± 1.75 | 2.80 ± 1.98 | 2.44 ± 1.87 | 4.03 ± 2.81 | 3.97 ± 3.09 | 4.00 ± 2.90 | $p = .674$ | $p = .002$ |
| LCD | 30 | 1.12 ± 1.54 | 0.61 ± 0.93 | 0.87 ± 1.28 | 1.19 ± 1.50 | 1.04 ± 1.04 | 1.12 ± 1.27 | $p = .429$ | $p = .255$ |
| ULR | 30 | 2.92 ± 2.52 | 2.42 ± 2.43 | 2.67 ± 2.45 | 3.92 ± 2.49 | 4.09 ± 2.46 | 4.01 ± 2.43 | $p = .836$ | $p = .004$ |
| G | 30 | 0.21 ± 0.38 | 0.03 ± 0.13 | 0.12 ± 0.30 | 1.63 ± 2.31 | 0.62 ± 1.25 | 1.12 ± 1.89 | $p = .118$ | $p = .004$ |
| Total negative facial expressions | 30 | 13.16 ± 7.98 | 10.46 ± 7.39 | 11.81 ± 7.68 | 19.20 ± 9.91 | 15.95 ± 8.27 | 17.57 ± 9.12 | $p = .284$ | $p < .001$ |

Mean rate of consumption (MRC), mother's ratings for liking (M rating), researcher's ratings for liking (R rating).
Turns head away (THA), arches back (AB), cries/fussy (CR), pushes spoon away (PSA), leans forward (LF), Rate of acceptance (ROA).
Brow lowered (BL), inner brow raised (IBR), squinting (Sq), nose wrinkling (NW), lip corners down (LCD), upper lip raised (ULR), Gaping (G).
[a] Excluded positive behaviours leans forward and rate of acceptance.

consumption and liking ratings. Nose wrinkling was inversely associated with duration of eating in the green bean condition and with liking in the green bean condition and overall. Weak negative correlations were observed for lip corners down and overall researchers' ratings, however no other correlations were significant for this facial expression. Significant inverse correlations were observed overall for upper lip raised with intake, duration and liking ratings. Finally the total negative facial expressions score was inversely associated with intake, duration, and liking ratings in the green bean condition and overall. Taken together, this suggests that infants who showed more expressions of distaste had lower intakes, a shorter feeding duration and lower liking ratings as determined by both the mother and researcher.

### 3.3. Differences in coded behaviours and facial expressions by group and vegetable

Infants in the intervention group displayed fewer rejection behaviours such as turns head away [$F(1,32) = 4.51$, $p = 0.042$], arches back [$F(1,32) = 4.32$, $p = 0.046$] and total rejection behaviours[1] [$F(1,32) = 4.80$, $p = 0.036$] compared to the control group. Infants in the intervention group also accepted the spoon earlier during the feeding session as indicated by the rate of acceptance scores [$F(1,32) = 4.76$, $p = 0.037$].

Main effects for the type of vegetable were also found. Infants showed fewer rejection behaviours such as turns head away [$F(1,32) = 8.76$, $p = 0.006$], and total rejection behaviours [$F(1,32) = 7.38$, $p = 0.011$] for carrot compared to green bean. The rate of acceptance was also quicker for carrot compared to green bean [$F(1,32) = 10.41$, $p < 0.003$]. Pushes spoon away occurred less whilst infants were eating carrots but this only reached marginal significance [$F(1,32) = 3.23$, $p = 0.082$]. There were no interaction effects of group and vegetable for any of the acceptance/rejection behaviours or facial expressions (see Fig. 2). Therefore the main effect of group was an enhanced willingness to consume either vegetable, and the main effects of vegetable indicated that carrot was better liked and accepted than green bean.

For facial expressions, there were no significant differences by group. However, main effects of vegetable were observed for brow lowered [$F(1,30) = 14.62$, $p = 0.001$], nose wrinkling [$F(1,28) = 11.14$, $p = 0.002$], upper lip raised [$F(1,28) = 9.82$, $p = 0.004$], gaping [$F(1,28) = 9.99$, $p = 0.004$] and total negative facial expressions [$F(1,28) = 15.86$, $p < 0.001$]. Therefore, infants demonstrated more expressions of distaste whilst eating green bean compared to carrot. From this, it is proposed that green bean was less liked than carrot, but no differences in facial expressions by group assignment (prior vegetable exposure) were observed.

### 3.4. Removal of items and final recommended items

Factor analysis and reliability tests from the development paper (Hetherington et al., 2016) suggested that crying/fussy and leaning forward were not useful constructs in the present context therefore should be excluded. The findings from the present study also indicated that these two variables were only weakly associated with any of the direct measures of intake and did not differ according to the group or vegetable. The internal consistency of the behaviour scale is improved after these two variables were excluded, Cronbach's alpha increased from $\alpha = .70$ to $\alpha = .76$.

For the facial expression items the reliability analysis and findings from the present study indicated that inner brow raised, squinting and lip corners down were less reliable and therefore less useful as constructs for this type of coding. The Cronbach's alpha for internal consistency of the facial expressions scale is marginally raised from $\alpha = .76$ to $\alpha = .78$ when these three items are excluded.

The Cronbach's alpha for internal consistency of the overall scale is marginally raised from $\alpha = .77$ to $\alpha = .78$ when the above 5 variables are excluded (see Hetherington et al., 2016 and Table 3).

[1] Excluded acceptance behaviours leaning forward and rate of acceptance.

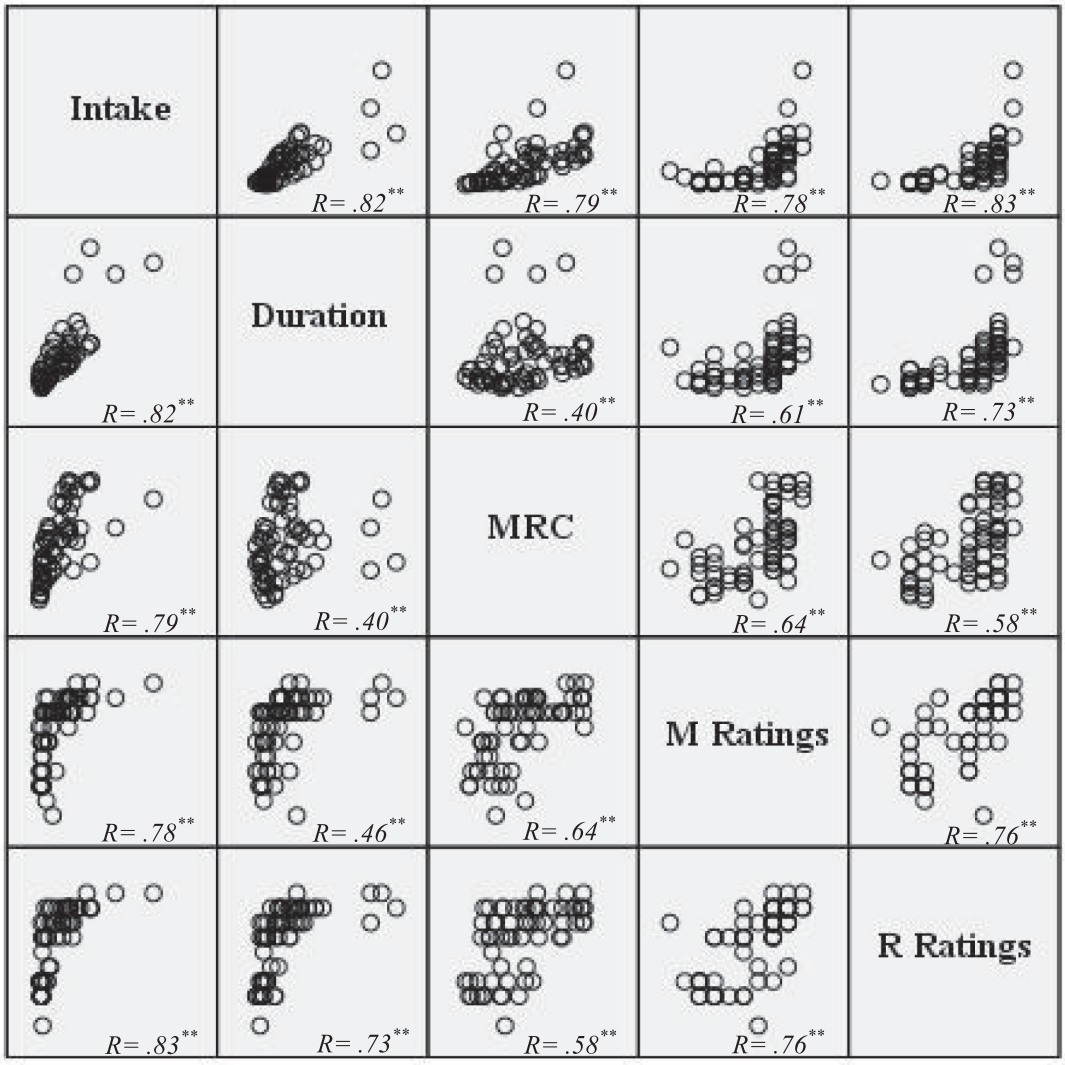


**Fig. 1.** Scatter plot matrix of intake, duration, mean rate of consumption, mothers' and researchers' liking ratings. Mean rate of consumption (MRC), mother's ratings for liking (M ratings), and researcher's ratings for liking (R ratings). $^{**}p < .01$ level (2-tailed).

## 4. Discussion

The aim of this study was to validate a coding system developed to measure "wanting" through acceptance/rejection behaviours during the offer of food by mothers to their infants and liking gauged by infant facial expressions in response to the taste of food. The coding system was applied to filmed meal episodes during the weaning period in response to pureed vegetables. The scale provided a means to identify infant responses to foods during complimentary feeding which are independent of maternal reports. The scale is based on specific acceptance and rejection behaviours which indicate wanting and facial expressions known to represent liking/disliking. Previous factor analysis confirmed construct integrity, good internal consistency and test–retest reliability of the scale and subscales. In this study an initial validation for the FIBFECS video coding tool tested whether these constructs could discriminate between a generally liked (carrot) and less liked vegetable (green bean) and between two groups depending on prior experience (intervention vs control). The present study found that the scale was sufficiently sensitive to distinguish responses between two different vegetables with significantly fewer indicators of distaste for carrot compared to green bean, (indicative of liking) and significantly fewer rejection and greater acceptance behaviours for carrot compared to green bean (indicative of wanting). The prediction that wanting would be greater in the group of infants who had prior exposure to the vegetable purees (intervention group) was fulfilled but was not met for the prediction that fewer distaste expressions would be evident in the intervention group compared to the control group. Only researcher ratings of liking distinguished between groups and not maternal ratings.

It is concluded that facial expressions provide a clear and valid means to determine liking. The work from pioneers such as Steiner (1977) and Rosenstein and Oster (1988) demonstrated a negative facial reaction (e.g. a nose wrinkle) to bitter and sour tastes which are initially rejected. It is suggested that fewer facial expressions is an indication of liking (Mennella et al., 2009) since it is dislike that is more strongly communicated by infants to their caregivers. This study found that the FIBFECS was able to discriminate between two different foods, namely carrot and green bean on the basis of facial expressions and these in turn corresponded with objective measures of intake (amount, rate of eating, duration) and subjective measures of liking.

**Table 2**
Correlations (Spearman rho) between coded behaviours, facial expressions, food intake, duration of the meal, mean rate of consumption and liking ratings.

| | | Intake | | | Duration | | | Mean rate of consumption | | | Mothers' ratings | | | Researchers' ratings | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carrots | GB | Overall | Carrots | GB | Overall | Carrots | GB | Overall | Carrots | GB | Overall | Carrots | GB | Overall |
| Behaviours | THA | −.65** | −.46** | −.60** | −.48** | −.33 | −.47** | −.38* | −.56** | −.51** | −.46** | −.37* | −.46** | −.60** | −.48** | −.57** |
| | AB | −.62** | −.36* | −.45** | −.40* | −.51** | −.39** | −.34 | −.36* | −.35** | −.36* | −.23 | −.28* | −.47** | −.34 | −.35** |
| | CR | −.29 | −.24 | −.27* | −.17 | −.47** | −.30* | −.25 | −.20 | −.23 | .05 | −.23 | −.15 | −.06 | −.29 | −.17 |
| | PSA | −.25 | −.51** | −.40** | −.10 | −.21 | −.21 | −.15 | −.52** | −.38** | −.34 | −.40* | −.42** | −.12 | −.46** | −.32** |
| | LF | .20 | .22 | .19 | .31 | .13 | .21 | −.14 | .27 | .10 | .13 | .32 | .19 | .08 | .32 | .15 |
| | ROA | .67** | .69** | .69** | .34 | .45* | .44** | .62** | .76** | .70** | .53** | .58** | .59** | .56** | .69** | .63** |
| | Total rejection behaviours[a] | −.72** | −.57** | −.66** | −.50** | −.42* | −.48** | −.43* | −.62** | −.57** | −.49** | −.44* | −.51** | −.59** | −.59** | −.59** |
| Facial expressions | BL | −.19 | −.30 | −.36** | −.10 | −.43* | −.33** | −.23 | −.28 | −.29* | −.19 | −.48** | −.43** | −.20 | −.37* | −.39** |
| | IBR | −.20 | −.12 | −.11 | −.08 | −.35 | −.16 | −.37* | .09 | −.09 | −.09 | −.05 | −.05 | −.22 | −.20 | −.17 |
| | Sq | .15 | .14 | .06 | .24 | −.03 | .01 | .02 | .20 | .09 | .01 | .09 | −.05 | .11 | .09 | .00 |
| | NW | .17 | −.33 | −.22 | .22 | −.44* | −.23 | .11 | −.26 | −.14 | .21 | −.43* | −.27 | .12 | −.47** | −.32* |
| | LCD | −.17 | .02 | −.08 | .03 | −.12 | −.06 | −.34 | .16 | −.07 | −.28 | −.01 | −.11 | −.32 | −.14 | −.26* |
| | ULR | −.22 | −.21 | −.31* | −.20 | −.32 | −.31* | .06 | −.12 | −.09 | −.31 | −.30 | −.37** | −.25 | −.27 | −.36** |
| | G | −.21 | −.40* | −.39** | −.31 | −.28 | −.38** | .05 | −.39* | −.23 | −.29 | −.46** | −.46** | −.28 | −.38* | −.41** |
| | Total negative facial expressions | −.13 | −.42* | −.38** | −.01 | −.56** | −.35** | −.16 | −.28 | −.25 | −.15 | −.50** | −.43** | −.21 | −.53** | −.47** |

Green bean (GB); turns head away (THA), arches back (AB), cries/fussy (CR), pushes spoon away (PSA), leans forward (LF), rate of acceptance (ROA), total negative behaviours (Total −ve B), brow lowered (BL), inner brow raised (IBR), squinting (Sq), nose wrinkling (NW), lip corners down (LCD), upper lip raised (ULR), gaping (G).

** $p \leqslant 0.01$.

* $p \leqslant 0.05$.

[a] Only rejection behaviours, i.e. the acceptance behaviours LF and ROA were excluded.

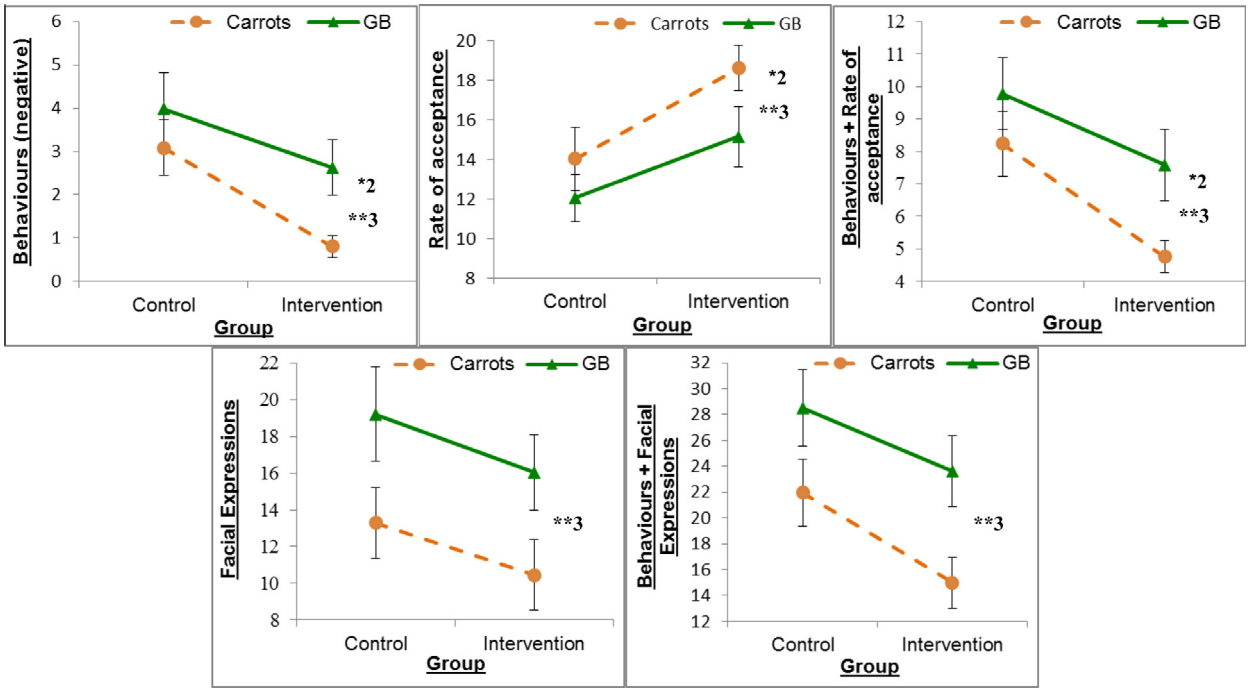


**Fig. 2.** Profile plots (SEM) for negative behaviours,[1] rate of acceptance (ROA), behaviour + ROA, facial expressions and behaviour + facial expressions. $^{*}p < 0.05$, $^{**}p < 0.01$. [1]Excluded negative behaviour crying/fussy. [2] significant difference for group. [3] significant difference for vegetable.

**Table 3**
Summary of psychometric parameters for all FIBFECS original items including coder certification tests factor loadings, Cronbach's alpha, inter-observer reliability, test–retest reliability, validity and the decision to retain or remove.

| | Scale | | | | Reliability | | Validity | | | Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| | Item | Certification test[a] | Loading in factor[b] | Cronbach's alpha[c] | Inter observer reliability[d] | Test–retest reliability[e] | Difference by group[f] | Difference by veg[g] | Associations with other variables[h] | Retain/ remove |
| Behaviours | THA | + | + | + | + | + | + | + | + | + |
| | AB | + | + | + | + | + | + | + | + | + |
| | CR | + | – | – | + | + | – | – | – | – |
| | PSA | + | + | + | + | + | – | – | + | + |
| | LF | + | – | – | + | + | – | – | – | – |
| | ROA | + | + | + | + | + | + | + | + | + |
| Facial expressions | BL | + | + | + | + | + | – | + | + | + |
| | IBR | – | + | – | + | + | – | – | – | + |
| | Sq | + | + | – | – | + | – | – | – | – |
| | NW | + | + | – | + | + | – | + | + | + |
| | ULR | + | + | + | + | + | – | + | + | – |
| | LCD | – | + | – | – | + | – | – | – | + |
| | G | + | + | – | + | + | – | + | + | + |

Turns head away (THA), arches back (AB), cries/fussy (CR), pushes spoon away (PSA), leans forward (LF), rate of acceptance (ROA), brow lowered (BL), Inner brow raised (IBR), squinting (Sq), nose wrinkling (NW), lip corners down (LCD), upper lip raised (ULR), gaping (G).

[a] Certification test: + = average Cohen's Kappa > 0.60.
[b] Loading in Factor + = >0.40.
[c] Cronbach's alpha: – = Cronbach's alpha > 0.70 if item was deleted.
[d] Inter observer reliability: + = intra class correlation > 0.60.
[e] Test–retest reliability: + = intra class correlation >0.60 or ⩾75% agreement (see Hetherington et al., 2016).
[f] Difference by group: + = significant difference observed between groups.
[g] Differences by veg: + = significant difference observed for generally liked vs generally less preferred vegetable.
[h] Association with other variables: + = significant associations with majority other liking/wanting variables (intake, duration, mean rate of consumption and liking ratings).

In addition, the scale was able to discriminate between two groups on acceptance/rejection behaviours but not facial expressions. In the present study, infants with prior exposure to both carrot and green bean showed fewer rejection behaviours (turns head away, arches back, total rejection behaviours) and had a faster rate of acceptance of both vegetables compared to the control group. However, no interaction effects were found therefore the main effect of group indicated that the scale revealed greater willingness to accept both vegetables in the group with prior experience suggesting a stronger "wanting" in this group compared to those with no prior experience (controls). Thus, infants in the intervention group displayed fewer negative behaviours in response to the foods compared to the control group at this early stage. This suggests that the intervention promoted acceptance of

both vegetables as a function of exposure, but longer term studies are needed to confirm the success and sustainability of the exposure intervention (see Hetherington et al. (2015) for more detail).

Analyses were also performed to determine if the scale constructs were related to subjective measures of liking and objective measures of intake, duration, mean rate of consumption. Overt acceptance and rejection behaviours indicating "wanting" were significantly associated with measures of liking. Thus faster acceptance and fewer rejections were significantly correlated with liking ratings. Facial expressions were also associated with intake, duration and ratings of liking by both mothers and researchers but not mean rate of consumption. Taken together, this suggests that fewer indicators of distaste correspond with higher intake and duration of eating, but not pace. The FIBFECS constructs relate to subjective measures of liking and objective measures of intake (reflecting wanting). These findings support previous research by Mennella and Beauchamp (1997) who reported that infants had greater preference for cereals/mother's milk mixture rather than cereal/water mixture. These infants also accepted the spoon at a distance and displayed fewer negative facial expressions. However the study only categorised facial expressions as positive, neutral or negative and did not report which specific expressions were observed. The present study also supports previous research by Mennella et al. (2001) where acceptance of a novel carrot-flavoured cereal was indicated by greater intake, longer feeding duration, higher maternal ratings of their infants' enjoyment of the cereal and fewer behaviour/negative facial responses (e.g. turns head away, nose wrinkling, brow lowered and upper lip raised). In this study, experience with carrot had been achieved indirectly either prenatally (through mothers drinking carrot juice in the last trimester of pregnancy) or postnatally (via mothers drinking carrot juice while breastfeeding). This experience has increased the likelihood of acceptance, intake and preference; a finding supported in the present study through direct experience during prior exposure for 24 days at weaning.

Forestell and Mennella (2007) found that squinting and overall facial expressions were inversely associated with the pace of eating. In the present study total rejection behaviours, brow lowering and gaping were inversely associated with mean rate of consumption. This indicates some support for previous research and further shows that pace of eating is indicative of both liking and wanting. The more the food is liked (such as carrot), indicated by fewer facial expressions of distaste and fewer rejections (indicating wanting), the faster the pace of eating, the greater the intake and the longer the duration.

Measuring the two constructs independently may provide a level of detail necessary to gain insight into the complex interactions and dissociations between liking and wanting in infancy. However, based on the present validation exercise, liking and wanting appear to be interlinked.

### 4.1. Evaluation of implementing the FIBFECS

The present study maintained good controls to ensure that mothers followed similar instructions, infants were fed in a controlled laboratory environment with the same foods and all distractions were minimised. The researcher remained in the room to ensure compliance with the procedure. Thus, it is assumed that the facial expressions which were recorded were in response to food and not to external stimuli such as maternal verbal exhortations or other distractions (Meltzoff & Moore, 1983). Another strength of the present study protocol is that infants' food intake prior to the study was standardised.

The video coding tool appears to be useful to assess liking and wanting in infants. The tool has been developed with an instruction pack and certification test. It can be developed further for older children and for recognising problems with food rejection, such as fussy eating. The liking and wanting constructs of this tool appeared to correlate with other subjective and indirect measures of liking/wanting. Coded facial responses provide a more direct measure of food liking and wanting than subjective ratings (Forestell & Mennella, 2012) and therefore provide the potential for investigating changes in food preference with exposure and to determine optimal strategies to promote liking of vegetables in infancy.

The present study indicates that crying/fussy and leaning forward could be removed from the scale without detriment to the scale's integrity. Furthermore, facial expressions which scored low on reliability measures, namely inner brow raised, squinting and lip corners down, were less useful constructs when discriminating between vegetables and may be removed for future use. The Cronbach's alpha indicated that the internal consistency of both subscales is improved after eliminating these variables.

The results of the discrimination and correlations analyses (Tables 1 and 2) suggest that the rate of acceptance parameter could be a very useful short method to measure wanting in infants. As it is a simple method, this parameter is potentially useful for use not only by experts, but also by parents.

The scale is valid and reliable but a limitation of the present study is that the analyses are based on the beginning of weaning only and on the intake of only two vegetables. The study is also limited in that the longer term effects of the intervention on infant responses were not examined beyond 35 days, but mothers did record intake of the vegetables in diaries between laboratory visits (Days 26–33) and at 6 months follow-up the group differences in liking remained but differences in intake had disappeared (see Hetherington et al., 2015). Another limitation of the design was that presentation of the vegetables (carrot and green bean) was not randomised. Future research should test the applicability of the present tool in a different context with older age groups, different foods over a longer time course and a randomised order of food presentation within sessions.

Studies examining the effect of repeated exposure may find this tool useful as research suggests that expression of distaste may decrease with experience (Forestell & Mennella, 2007; Mennella et al., 2001; Sullivan & Birch, 1994). Further work is also required to understand liking and wanting in infants, as differentiating between the two concepts may help to understand the difference between refusal cues (avoidance behaviours) and expression of distaste.

## 5. Conclusions

Assessing liking and wanting in infancy can be achieved using the FIBFECS. In combination with other subjective (liking) and objective (intake) measures this tool can be useful in identifying strategies to promote vegetable acceptance and healthy eating. In future, the FIBFECS may be used to identify problem eating, and may also be translated for use with mothers in promoting responsive feeding.

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