

How much do preverbal children signal a wish to be fed? Nested case control study comparing weight faltering and healthy infants

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ABSTRACT

We aimed to 1/develop an observational tool to rate non-verbal cues infants give when being fed 2/test whether these differ between healthy children and those with weight faltering (WF) 3/describe how well these predict whether offered food is eaten.

Subjects: and methods: The study used videos of infants eating a standardised meal studied in a case control study nested within the Gateshead Millennium Study (GMS). Infants with weight faltering (WF) were each matched to 2 healthy controls. Half the control videos (N = 28) were used to develop the scale. Food offers were identified and the child's head, eyes, hands, and mouth position/activity rated as signalling a readiness to be fed (engaged), or not (disengaged) as well as whether food was accepted; 5 of these videos were used to assess inter-rater and test-re-test reliability. The scale was then applied to the videos of 28 WF infants (mean age 15.3 months) and 29 remaining controls (mean age 15.8 months) to identify and code all feeding events.

Results: test-re-test rates varied from 0.89 for events to 0.74 for head; inter-rater reliability varied from 0.78 for hands to 0.67 for mouth. From 2219 observed interactions, 48% showed at least one engaged element, and 73% at least one disengaged; 67% of interactions resulted in food eaten, with no difference between WF and control. Food was eaten after 73% interactions with any engagement, but also in 62% with disengagement.

Conclusions: Infants were commonly disengaged during meals, but a majority accepted food despite this. Those with weight faltering did not differ compared to healthy controls.

1. Introduction

Weight faltering is a common problem in early childhood which often defies clearcut explanation. Early accounts of “non-organic failure to thrive”, were usually of cases referred to hospital and tended to assume that they reflected a failure of maternal care (Fischhoff, Whitten, & Pettit, 1971). However, a series of population-based studies have shown a lack of association with most socio-economic factors and maternal mental health and point instead to a more multifactorial causation (NICE, 2017).

One of the many potential factors involved is that of disordered eating and feeding behaviour, but pinpointing the ways in which children with weight faltering, or their parents, may differ from their thriving peers has proved challenging. Early research in referred

children with weight faltering/failure to thrive suggested that parents (Ammaniti, Ambruzzi, Lucarelli, Cimino, & D'Olimpio, 2004; Black, Hutcheson, Dubowitz, & Berenson-Howard, 1994) and children (MacPhee & Schneider, 1996; Mathisen, Skuse, Wolke, & Reilly, 1989) behaved differently during meals, but when participants were identified by whole population screening, no differences were found (Skuse, Wolke, & Reilly, 1992).

In the late 1990s the Gateshead Millennium study (GMS) was set up with the aim of describing the natural history of weight faltering in a population based sample and the extent to which it related to maternal or intrinsic child characteristics. This found no association between weight faltering and various maternal characteristics (C.M. Wright, Parkinson, & Drewett, 2006b) but did show that weight faltering children were described by parents as having lower appetite and more food

Abbreviations: GMS, Gateshead Millennium study; WF, weight faltering; OR, Odds ratio R correlation coefficient.

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refusal (C.M. Wright, Parkinson, & Drewett, 2006a). The programme also included a nested case control study, where children within the cohort were recorded while eating two meals, allowing direct observation of the feeding and eating process. These videos were first studied using a previously validated all event coding scheme (Parkinson & Drewett, 2001) which found no difference between weight faltering cases and controls in the number of bites of food offered, eaten or refused, but still found that cases consumed less energy (Parkinson, Wright, & Drewett, 2004). This rating made no assessment of the quality of the parent-child interaction, so a subsequent researcher rated the videos again using the Mellow Parenting Observation System (Puckering, Roger, Mills, Cox, & Mattsson-Graff, 1994). Using this scheme, carers of weight faltering infants were found to interact significantly less with their infants than controls (Robertson, Puckering, Parkinson, Corlett, & Wright, 2011). However, we hypothesised that the lack of carer interaction might reflect a child who sought less interaction. We thus aimed in this study to complete the observation of the videos by formally studying the child's cueing behaviour during the same meals. At the time of the study there were no published scales specifically describing child actions during a meal except for very young infants (Sumner & Spietz, 1994) so we set out to develop our own system of coding the child's degree of engagement during mealtimes, with the hypothesis that engaged behaviours will be less common and disengaged behaviours more common in WF children compared to controls.

1.1. Objectives

1. Develop a rating scale which observed child behaviours immediately before an offer of food, with the hypothesis that engaged behaviours will be more likely to be followed by acceptance of offered food and disengaged behaviours by refusal.
2. Compare the proportion of interactions which are engaged or disengaged between children with weight faltering (WF) and healthy controls within the same data set,

2. Methods

2.1. GMS videos

The GMS comprised a birth cohort of 1029 infants recruited shortly after birth over a 12 month period in 1999–2000 in Gateshead UK. They were then followed prospectively via parental questionnaires at ages 6 weeks 4m, 8m, and 12m, routinely collected weights were forwarded by parents and health staff and a health check was performed at age 13 months (Parkinson et al., 2011). Within this cohort a nested case-control group was identified comprising all incident cases of weight faltering identified in the cohort (below the 5th percentile for weight gain) and a 10% systematic sample of the remaining GMS cohort as controls (all with weight gain >10th percentile); 30 cases and 57 controls agreed to be studied (Parkinson et al., 2004). Each parent-child dyad was filmed during two standardised mealtimes when children were aged between 13 and 24 months. Meals were supplied by the researcher, after consultation with the parent about their child's preferred foods. One meal consisted of food which required spoon feeding, while the other consisted of finger foods. For the finger meals children largely self-fed, so only the spoon-fed video could be used to assess the interaction between carer and child.

The control videos were randomly divided in half, with one half used in the initial development of the scale and the other half for the main study. All the videos for the weight faltering children were used for the main study.

2.2. Scale development

A measure of the child's interactive behaviour during mealtimes was developed based on our collective experience of observing infants and

via discussion. This was an all-events coding scheme applied by watching the video in real time to identify successive feeding events (the offer of food from the caregiver) and then describe the specific postures or actions of head, eyes, mouth and hands preceding the offer, that either suggested a readiness to eat (Engagement) or avoidance of eating (Disengagement). The actions of the child's head, eyes, mouth and hands were each coded as 0 where the child appeared disengaged, 1 where they were neutral and 2 where they suggested an active wish to be fed (see Table 1) The outcomes of feeding events were also recorded using Parkinson's methodology (Parkinson and Drewett, 2001) as: accepts, refuses, rejects (child spits the food), withdraw (parent withdraws food before child reacts to the offer), feeds self (child is not fed by parent), and miss (child fails to get food into their mouth after attempting to feed self). Table 1 gives details of the final definitions used for each code. The meal was coded from the first to the last offer of food and the time between these was defined as the meal duration. The total number of food offers and the number of feeding events that did not involve an interaction (where the child was self-feeding), were also recorded.

PH developed an initial coding scheme using half of the GMS control spoon fed videos (N = 28) as a development set. At this point the test-retest and inter-rater reliabilities were assessed and a revised version of the coding system developed, removing or combining low frequency codes. This system was then applied to 5 of the development set videos. PH then wrote a coding manual which LC used to learn the technique. LC then coded the same 5 videos to test concordance with PH and test-retest and definitive inter-rater reliabilities were calculated.

2.3. Analysis

The feeding event data was entered into IBM SPSS v28. For each feeding event engagement and disengagement scores were calculated by counting which of the 4 elements (head, eyes, mouth and hands) were engaged or disengaged respectively (range 0–4). In addition, the child's cuing behaviour in each interaction was classified overall as Engaged: 2–4 elements engaged and the remainder neutral; Disengaged: 2–4 elements disengaged and the remainder neutral; Neutral: 3–4 elements neutral; and Ambiguous: where there were both engaged and disengaged elements. Test re-test reliability was assessed using coefficient of variation. We compared the proportion of engaged or disengaged interactions in GMS controls compared to weight faltering and to clinical

Table 1
CIMB scale scoring of child actions and reliability.

Codes	Head	Eyes	Mouth	Hands
Engaged 2	Turning to face food; leaning towards food	Gaze fixed on food.	Mouth is wide open before food is brought to mouth	Reaching towards/ pointing at food; trying to feed self
Neutral 1	Not looking at food or turning back and forth	Not looking at food; glancing about.	Closed/ relaxed	Still
Disengaged 0	Facing away from food	Gaze fixed on something other than food; looking away	Busy talking/ crying/ chewing	Non-feeding actions: playing with food/toy; reaching towards mother; pushing food away etc
Coefficient of variation				
Concordance	0.70	0.72	0.85	0.80
Test re-test	0.74	0.81	0.78	0.83
Inter-rater	0.76	0.74	0.67	0.78

For feeding events: Concordance: 0.91; Test-retest 0.89; Inter-rater reliability 0.78.

videos using generalized linear mixed modelling to adjust for clustering of feeding events within subjects. We then described the proportion interactions resulting in food being eaten where there was any engaged or disengaged element, again using generalized linear mixed modelling adjusted for clustering within subjects.

3. Results

3.1. Test-retest and inter-rater reliabilities

Concordance rates varied from 91% for feeding to 70% for head position. Test-retest rates varied from 0.89 for feeding events to 0.74 for head, while inter-rater reliability varied from 0.78 for hands to 0.67 for mouth (Table 1).

There were 59 videos available for the final analysis. As described previously, these were all healthy White British children and generally representative of their community, with no differences between WF and controls (Parkinson et al., 2004) except for over-representation of ultra-orthodox Jewish children in the WF group (Robertson et al., 2011) whose high rates of weight faltering have already been discussed elsewhere (C. M. Wright, Stone, & Parkinson, 2010).

The videos yielded 2216 interactions (median 38 per child, range 0–132). One child (WF) only self-fed, so yielded no feeding interactions, leaving 29 children with weight faltering and 29 healthy controls. There was no difference in the number of interactions between WF and controls.

The children’s heads and eyes tended to be either looking directly at the food or actively turned away and these two elements were strongly correlated (Spearman’s $R = 0.82$). In contrast the hands and mouth were most commonly neutral (see Table 2). All elements showed significant ($p < 0.001$) intercorrelation; Hands were moderately correlated with Eyes ($R = 0.33$) and Head ($R = 0.32$), but mouth was only weakly correlated with the other elements (R Head = 0.10; Hands 0.13; Eyes 0.09). When considered together, children showed at least one (out of 4) engaged action or posture in only half the interactions, while three quarters had at least one that was disengaged (Table 2). The commonest overall rating for each event was disengaged (43%) followed by ambiguous (24%) and engaged (22%), with only 11% mainly neutral. After adjustment for clustering within subjects, there was no statistically significant difference between the WF and control group in the proportion of disengaged or engaged cues (Table 3).

Just over two thirds of all interactions resulted in food being eaten and there was no statistically significant difference in food acceptance between cases and controls. In all the individual elements there was a significant association ($p < 0.001$) between level of engagement and food acceptance (Fig. 1). A disengaged head (turned away) was least likely to result in food being eaten while an engaged mouth (open) was most likely to result in food being eaten, but was seen in only 4% children. For eyes and hands there was less difference in levels of acceptance between engaged and disengaged actions.

Interactions with any engagement were more likely to result in food being eaten (adjusted Odds ratio (OR) [95% Confidence interval] 1.6 [1.3–2.0]) while those with any disengagement were less likely (OR = 0.44 [0.34–0.6]). Generally engaged and neutral interactions more often resulted in food being eaten than disengaged or ambiguous, but even in these over 60% still led to acceptance (Table 4). There was no difference between WF and control interactions in the associations of food

Table 2
Proportion of actions for each element that were disengaged, neutral or engaged.

	Head		Eyes		Mouth		Hands		One or more element	
	Number	%	Number	%	Number	%	Number	%	Number	%
Engaged	976	44.0	831	37.4	82	3.7	275	12.4	1062	47.9
Neutral	437	19.7	330	14.9	1362	61.4	1146	51.6		
Disengaged	806	36.3	1058	47.7	775	34.9	798	36.0	1613	72.7

Table 3
Proportion of engaged or disengaged interactions in GMS controls compared to weight faltering and to clinical videos.

Overall cue type	GMS Controls		GMS WF		P^a
Engaged	271	23.7%	215	20.0%	
Neutral	142	12.4%	107	10.0%	
Disengaged	495	43.2%	453	42.2%	
Ambiguous	237	20.7%	299	27.8%	
Any engaged element	535	46.7%	527	49.1%	NS
Any disengaged element	804	70.2%	809	75.3%	NS

Values are number % interactions;

NS = non significant.

^a a wf vs GMS controls, generalized linear mixed model, adjusted for subject ID.

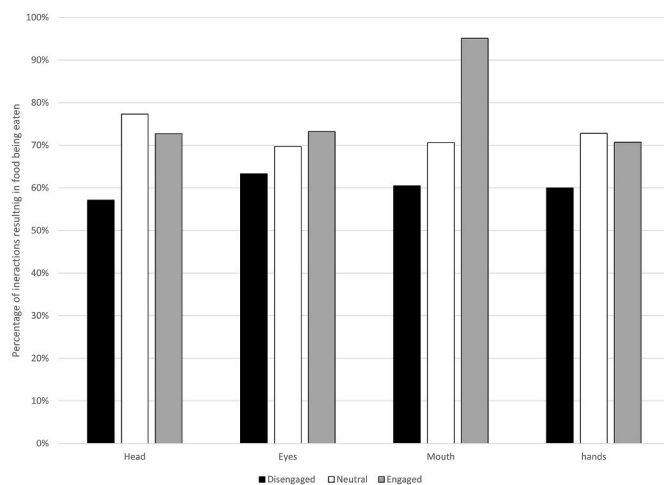


Fig. 1. Proportion of disengaged, neutral, or engaged actions for each element that resulted in food eaten.

Table 4
Proportion of engaged or disengaged interactions resulting in food being eaten in GMS participants and the adjusted odds of events with any disengaged or engaged element resulting in food eaten, compared to events with none.

Overall cue type	GMS ^a	Odds ratio (95% CI) ^b
Engaged 2-4	80.2%	1
Neutral 3-4	76.7%	
Disengaged 2-4	60.8%	
Ambiguous	65.4%	
No disengaged element	79.8%	1
Any disengaged element	63.5%	0.44 (0.34–0.6)
p		<0.001
No engaged element	63.6%	1
Any Engaged element	72.7%	1.59 (1.3–2.0)
p		<0.001

Values are number % where food was eaten.

^a No difference between WF and controls;

^b From generalized linear mixed model, adjusted for clustering by subject ID.

acceptance with engagement and disengagement.

There was no obvious relationship between time into the meal or age, with food acceptance or the type of interaction (results not shown).

4. Discussion

This is the third analysis of these videos collected in a nested case control study within the Gateshead Millennium cohort study. The first analysis (Parkinson et al., 2004) found no detectable differences between the groups in terms of the number of bites of food eaten or refused, but still found that the weight faltering children ate significantly less via before-and-after weighing of the food. A subsequent analysis examined the nature of the carers' interaction with the child, using the Mellow Parenting Observation System and here found significant differences, with parents of weight faltering children generally interacting less with the child compared to the controls (Robertson et al., 2011). However, the Mellow Parenting Observation System does not describe the child's specific contribution to the feeding interaction, and it seemed possible that the differences in maternal behaviour observed may have reflected children who themselves sought less or different attention during the meal. Thus, this final piece in the jigsaw set out to describe the child's non-verbal communication. To do this we developed a tool to specifically measure the child's behaviour during feeding interactions, as at that time there seemed to be no suitable existing measure. A scale developed to assess the effectiveness of breast feeding does include a rating of the infant's cues (Sumner & Spietz, 1994), but this has been used mainly in younger infants (Shloim, Shafiq, Blundell-Birtill, & Hetherington, 2018; Shloim, Vereijken, Blundell, & Hetherington, 2017; Ventura, Sheeper, & Levy, 2019).

Use of this scheme revealed that children showed relatively little active engagement with the food and, when they did, this was mainly turning towards or looking at the food. Disengagement was more common; in nearly half of all interactions the child was looking elsewhere and in around a third, respectively, had their head turned away, their mouth tightly shut, or their hands occupied with other activities. As hypothesised, the engaged behaviours were significantly associated with higher food acceptance and the disengaged with lower, but in fact three quarters of all interactions began while the child was at least partially disengaged, yet still a majority of children accepted a mouthful of food.

The previous two analyses of these videos used assessment methods that had already been used and validated elsewhere. In this case we devised the method ourselves, so the generalisability of the method also needed to be tested. At the same time as this analysis, LC also studied 12 children from a feeding clinic, described elsewhere (Corlett, 2010, p. 2185) This was a smaller sample, powered only to detect large differences, but the overall pattern of behaviour and their association with food acceptance was very similar to the GMS sample, suggesting that the CIMB is describing a real and reproducible behaviour pattern.

The hypothesised differences between weight faltering and control feeding cues were not found, so the reduced maternal interaction observed previously using the same videos (Robertson et al., 2011) cannot simply be explained by differing signalling by the child. This suggests that the way mothers engage with the child during meal may contribute to their weight faltering. This is in keeping with early research which suggested that parents of children with weight faltering or failure to thrive might be less sensitive to their child's feeding cues (Ammaniti et al., 2004; Black et al., 1994), although in a study where participants were identified by whole population screening, no such differences were found (Skuse et al., 1992). Other research has suggested that children with weight faltering show more difficult, oppositional, negative, or stubborn behaviours and fewer vocal cues indicating a desire to eat (MacPhee & Schneider, 1996; Mathisen et al., 1989) which was not born out by the current study. However, these studies were often quite small and studied only children who had been referred for treatment.

This is probably the first study to focus entirely on how pre-verbal

children behave during meals and to assess the child's actions objectively during feeding interactions. Recent research, focussed more on over-nutrition, has explored how parents recognise hunger and satiety (McNally, Hugh-Jones, & Hetherington, 2020) but has not actually assessed or quantified these behaviours by direct observation. Since this work was completed in 2010 a scale has been published which included recording of a range of hunger and fullness cues (Hodges et al., 2013). Hodges used the approach of rating whole behaviours, rather than movement of individual body parts, as in our study, and covers a wider age range. The relative commonness of these behaviours has been described at different ages, but not in relation to food eaten (Hodges, Wasser, Colgan, & Bentley, 2016). It is possible that Hodge's approach might detect child signalling that has been missed by the simple rating of different body parts, so future work could usefully compare both approaches. Another study (McNally et al., 2019) has described just the gaze behaviour of infants during complementary feeding, though this was related only to the stage of the meal and the type of food offered, not whether it was eaten. It is of note that in this study the commonest observed gaze pattern was 'gazes at other': neither at the caregiver or the food.

A strength of our analysis is that the participants in the main study were recruited from a population-based cohort study which identified all incident cases of mild to moderate weight faltering, without the need for referral, which has so often been a source of bias in earlier studies of weight faltering and FTT. Case control studies are generally felt to be methodologically weak, but in this case the use of a nested design avoided selection bias while permitting a labour-intensive methodology to be used. A further strength was that although the meals given to the child were preselected by parents, they were all of a standard type. This has the limitation that the experimental meals may not have been representative of the child's normal meals, but in the related clinical study where the meals were not standardised, little difference in child actions was found from the GMS sample (Corlett, 2010, p. 2185).

This study had other limitations. As these children were essentially preverbal, we could only address non-verbal cues. The study included only one main ethnic group, reflecting the make-up of the local community, where the largest religious minority were a small ultra-orthodox Jewish community. The CIMB scale focused solely on the child's behaviour just before each offer of food, so will not detect cues that the parent has missed and does not provide a more global overview of the mealtime interaction. The CIMB may thus only be useful when applied in addition to other measures of carer responsiveness - in this case the Mellow Parenting Observation System.

4.1. Conclusions

This first detailed description of preverbal child actions during meals suggests that preverbal children, are fairly passive in the feeding process, though still willing to eat, a picture of feeding somewhat at variance with the classic concept of a responsive feeding as a two way interaction. Children with weight faltering showed no behavioural differences in the extent to which they signalled interest in food compared to healthy infants, suggesting that a previously observed lack of maternal interaction in the same sample cannot be explained by differences in child behaviour. Further work would thus be worthwhile to replicate these findings in other populations and possibly explore the role of infant cues in relation to over-nutrition.

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Data

The source data used for this analysis could be made available on request.

Ethics

The GMS cases control study received ethical approval from the Gateshead Local Research Ethics committee (146/99). Ethical approval for use of the clinical videos was given by the West of Scotland Research Ethics Committee.

Declaration of competing interest

There is no conflict of interest.

PH developed the rating scale supervised by CW. LC coded all the videos, performed an initial literature search and analysis of the data, and wrote this up for her D Clin Psych thesis supervised by CP and CW. CW reanalysed the data, updated the literature review and drafted this paper. All the authors have seen and commented on an initial draft and approved the final draft.

Data availability

Data will be made available on request.

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