

Title: Reaching consensus on a 'vegetables first' approach to complementary feeding
Running head: Vegetables and complementary feeding

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Abstract

On May 5th 2016, the British Nutrition Foundation (BNF) invited leading infant feeding experts to discuss and debate the strength of the evidence-base on a 'vegetables first' approach to complementary feeding. Consensus was reached on the translation of the science into practical messages for parents/carers. In particular, it is known that familiarising infants with a variety of vegetables from the start of complementary feeding increases the likelihood that vegetables will be accepted throughout childhood, though currently in the UK vegetables tend not to be prioritised as first foods. Infant feeding guidance could include recommendations to offer tastes of a variety of vegetables when complementary feeding begins, as a first step in the transition from milk to solid foods, so that liking and acceptance are established during this early window of opportunity. This report describes the main themes emerging from the discussions and the specific messaging recommendations which could be included within infant feeding guidance.

Keywords: weaning, complementary feeding, infants, food preferences, vegetables, fruit

The 'early years' of childhood lay the foundations for health, growth and development (BNF 2013) and, in terms of nutrition, the acquisition of eating behaviours that align with a healthy, varied diet are a critical feature of this period (Birch & Doub 2014). One of the most important eating behaviours to acquire during the early years is preference (liking) for foods that support good health. Consumers tend to eat those foods they like, so developing a preference for certain foods may produce health benefits. For example, diets high in fruit and vegetables are associated in adulthood with reduced risk of cardiovascular disease, obesity, hypertension, stroke and some cancers (Boeing *et al.* 2012; Wang *et al.* 2014).

Humans from birth tend to prefer sweet, salty and umami tastes over those that are bitter or sour (Beauchamp & Mennella 2009; Schwartz *et al.* 2009) and can quickly learn to like foods that are energy dense (Birch 1992); this can mean that some foods tend to be liked less than others from the outset, particularly those that are low in energy density and without a sweet, salty or umami flavour profile. This describes the characteristics of many vegetables and, indeed, it is well-known that vegetables are the type of food most commonly disliked by children and often the most difficult to encourage them to eat (Cooke & Wardle 2005). Food preferences are acquired through experience (Fildes *et al.* 2014) and these tend to 'track' into later childhood (Coulthard *et al.* 2010; Grimm *et al.* 2014). This means that, during the early years, there is potential for parents to provide their children with food experiences that can help them to accept and enjoy vegetables throughout childhood.

A recent narrative review of the scientific infant feeding literature highlighted that introducing 'vegetables first, frequently and in variety' during complementary feeding (*i.e.* when foods other than milk are first introduced - commonly referred to as weaning) can increase acceptance of vegetables during this period and into later childhood (Chambers 2016). On May 5th 2016, the British Nutrition Foundation (BNF) invited leading infant feeding experts to discuss and debate the strength of the evidence-base and to see if consensus could be reached on the translation of the science into practical messages for parents/carers. The event was chaired by Professor Marion Hetherington (University of Leeds, UK) and attendees provided expertise from several different disciplines, including psychology, dietetics, nutrition, policy development and paediatrics. The main themes emerging from the roundtable discussions are described below.

Complementary feeding as a sensitive period for food preference development

Attendees were in agreement that the complementary feeding period is a 'window of opportunity' for acclimatising infants to the taste of a wide variety of foods, because, during the first year of life, infants are receptive to all five basic tastes to differing extents, preferring those that are sweet and salty (Schwartz *et al.* 2009), but willing to consume most new foods (Schwartz *et al.* 2011). It was highlighted that, after the first year, infants typically become more neophobic or 'fussy' and tend to be more selective about what they will eat, and variety in the diet can decrease (Dovey *et al.* 2008). There was therefore consensus that

during the early complementary feeding period, it is imperative to capitalise on the willingness of infants to try new foods, such as vegetables, by exposing them to a wide variety of foods in order to 'educate the palate' (Schwartz *et al.* 2013). It was also noted that some infants are likely to accept some foods, particularly fruit and vegetables, more readily than others, due to genetic factors (Fildes *et al.* 2014). This is an important message to communicate to parents to alleviate anxiety during this transitional feeding period.

The Department of Health recommends that complementary feeding should start at around 6 months of age (DH 2010). Some organisations recommend that it is appropriate to start complementary feeding between 4-6 months of age, when the infant is showing signs they are ready for solid foods (such as the ability to stay sitting up and to coordinate hand and mouth movements) (*e.g.* EFSA 2009; Butte *et al.* 2004; Pac *et al.* 2004). The roundtable group considered potential issues with introducing solid foods after 6 months, including evidence suggesting that it might increase the risk of developing certain allergies (Perkin *et al.* 2016) and low iron levels (Agostoni *et al.* 2008), and that part of the 'window of opportunity' for acquiring a broad repertoire of food preferences may be missed (Coulthard *et al.* 2014). With a focus on food acclimatisation rather than nutrition *per se* (*i.e.* 'tiny tastes' of small quantities of food that do not compromise breastfeeding), it was agreed that the 4-6 month period can be an appropriate time to introduce *tastes* of solid foods, if the foods are of the appropriate type, texture and amount for the developmental age of the infant. However, while the majority of infants in the UK are weaned before 6 months of age (McAndrew *et al.* 2012), it was recognised that any advice should be consistent with the Department of Health recommendation to introduce solid foods at around 6 months. The group considered how the idea of early food acclimatisation aligns with French, Swedish and Dutch approaches to early complementary feeding, which is to provide infants with plenty of opportunity to experience different foods, including vegetables, with an emphasis on 'tiny tastes' and 'educating the palate' (Schwartz *et al.* 2013; Swedish National Food Agency 2012; Netherlands Nutrition Center 2016).

Food preferences developed in the early years track across the life-course

The experts agreed that food preferences acquired during the early years can 'track' into later childhood (*i.e.* food likes and dislikes developed in the early years predict food likes and dislikes in later years) but noted that this evidence-base is mostly observational (as is the case for most life-course research) and follow-up periods do not tend to cover later childhood (>7 years). The majority of this evidence comes from prospective cohort studies [as described by Chambers (2016)] and includes data from large cohorts such as the *Avon Longitudinal Study of Parents and Children (ALSPAC)* (Coulthard *et al.* 2010; Coulthard *et al.* 2009) and the *Infant Feeding Practices Study II* (Grimm *et al.* 2014), as well as smaller cohorts (Foterek *et al.* 2015; Gregory *et al.* 2011; Skinner *et al.* 2002b; Skinner *et al.* 2002a). The group also highlighted research indicating that early familiarisation with protein hydrolysate formulas, which have a particularly bitter taste, is associated with later

acceptance for bitter foods, including vegetables and fruit (Mennella & Beauchamp 2002). Recently Maier-Nöth and colleagues (2016) have published experimental data demonstrating a link between introducing a variety of vegetables at the onset of complementary feeding (Maier *et al.* 2008) with acceptance of these foods in early life and long term (up to 6 years of age). Overall, roundtable attendees agreed that messages based on the idea of food preference 'tracking' could be powerful, as establishing preferences for healthier foods early offers parents the opportunity to reduce the likelihood that their child will resist eating these foods in later childhood, which is a common concern amongst parents/carers.

Ways of introducing vegetables during complementary feeding

Roundtable discussions centred on the following ways of introducing vegetables during complementary feeding as there is both experimental and observational evidence that these can increase children's vegetable acceptance in the short and longer term: repeated exposure to vegetables, offering a wide variety of vegetables and introducing vegetables as first foods. The paper by Chambers (2016) described some of the studies in this evidence base but the roundtable participants agreed that a systematic research review is necessary to ensure that all relevant papers are captured and to assess the quality of the studies using standardised criteria.

It was agreed that there is good evidence that repeated exposure to the pure/distinct taste of a vegetable during complementary feeding (on at least eight occasions) can help infants learn to accept that vegetable, both immediately and in later childhood (*e.g.* Hetherington *et al.* 2015; Coulthard *et al.* 2014; Remy *et al.* 2013; Maier *et al.* 2007). Participants debated whether mixing or 'masking' vegetables alongside other foods, a common way of preparing infant meals, enhances or reduces the positive effects of exposure on the development of acceptance for the masked vegetable (*e.g.* Remy *et al.* 2013). Further research is required to explore whether specific combinations of foods and the prominence of the individual vegetable flavours (and visual characteristics) produce different outcomes for preference and intake. There is some evidence from a small sample of mothers that mixing vegetable flavours (purees of cooked vegetable) with milk or baby rice can increase infants' initial acceptance of vegetables and help bridge the transition from a diet of milk to the introduction of pure vegetable flavours (Hetherington *et al.* 2015).

Offering a variety of vegetables during the complementary feeding period was considered to be an effective way to increase acceptance of vegetables and other new foods in the short and longer term (in other words, this approach can make infants more 'versatile') (*e.g.* Coulthard *et al.* 2014; Maier *et al.* 2008; Gerrish & Mennella 2001; Maier-Nöth *et al.* 2016), though it was acknowledged that the evidence base is limited to small experimental studies. The group agreed that the most compelling evidence comes from a series of studies by Maier-Nöth (nee Maier) and colleagues (Maier *et al.* 2008; Maier-Nöth *et al.* 2016), the first of which showed that offering a high variety of vegetables, compared to no or low vegetable

variety, for 10 days at the beginning of complementary feeding increased acceptance of other new foods, including vegetables, immediately after the intervention. When this cohort was re-tested at 6 years of age in a laboratory setting, the group who had received a high variety of vegetables during early complementary feeding consumed more vegetables and reported liking them more than the no and low variety groups, although it was noted that there was a dip in vegetable acceptance during the notorious 'fussy' period (tested at 15 months and 3 years) and vegetable exposure at home during the 6-year study period was not controlled for in the study.

Studies that have specifically tested the benefits of introducing a variety of vegetable tastes exclusively for the first two weeks of complementary feeding were discussed and it was agreed that this approach can increase vegetable acceptance in the short and longer term (up to 12 months), though it was noted that this new area of research currently consists of only a handful of published, peer-reviewed papers (Fildes *et al.* 2015; Barends *et al.* 2014; Barends *et al.* 2013) (see Chambers 2016). Discussions at this point turned to the practical implications of recommending vegetable exclusivity at the initiation of complementary feeding. The group all agreed that it is imperative to provide context to this message as the appropriateness of this approach will be dependent on the infant's age and stage. This is because at 6 months of age infants' iron stores, accumulated during gestation, begin to deplete and consumption of iron-rich foods, such as red meat, eggs and pulses, is required as breast-milk is a poor source of iron (Fewtrell *et al.* 2007). Thus, introducing a variety of vegetable tastes exclusively for the first few weeks of complementary feeding is a suitable message for parents introducing solid foods between 4-6 months, but for those who adhere to the Department of Health's advice to start at around 6 months it should be advised that iron-rich foods are provided as well.

What about fruit?

The UK recommendation to eat '5 A DAY' does not distinguish between fruit and vegetables as studies demonstrating the health benefits of these foods have generally grouped them together; what appears to be most important to nutrient intakes is quantity and variety (Cooper *et al.* 2012; Bhupathiraju *et al.* 2013). In terms of food preference development, however, participants agreed that vegetables and fruit should not be 'lumped together' as fruits are typically well accepted from the start of complementary feeding, because of their sweet taste, while it is typically less easy to encourage vegetable consumption. Indeed, most of the research to date on infant food preference development has focussed on increasing acceptance of vegetables rather than fruit. The group noted that the distinction is not as simple as fruit or vegetable and that the flavour profile should be taken into account as some vegetables are sweet and usually well accepted from the outset (*e.g.* carrots) and some fruits are sour or astringent and less well accepted (*e.g.* plums). The focus should be, therefore, on the vegetables and fruits that are most difficult to encourage infants to accept, which are those without a predominant sweet flavour (*i.e.* many vegetables, some

fruits). At the start of complementary feeding, parents are known to serve infants sweet fruit and vegetables more often than less sweet varieties and commercial baby foods can be sweet in flavour (Garcia *et al.* 2015). Therefore, a focus on less sweet vegetables (and fruits) during early complementary feeding, when infants are likely to accept foods of all flavours, was considered sensible. It was stressed that for infants aged 6 months and older, any focus on bitter vegetable and sour fruits should be in the context of a healthy, varied diet to avoid unduly neglecting other important foods (*e.g.* those that are iron-rich).

Current messaging and practices in relation to complementary feeding.

The most comprehensive government resource for parents/carers on complementary feeding, the NHS/Start4life 'Introducing Solid Foods' booklet (Department of Health 2011), was discussed. It was noted that all fruit and vegetables recommended as appropriate first foods are sweet in flavour and no specific or detailed information is provided on ways to encourage infants to accept vegetables or on the importance of iron-rich foods. The Scientific Advisory Committee on Nutrition (SACN) Subgroup on Maternal and Child Nutrition (SMCN) is currently reviewing the literature on complementary feeding and it is expected that government guidance, including the 'Introducing Solid Foods' booklet, will be updated after the publication of their report.

A recent YouGov survey commissioned by Ella's Kitchen found that parents typically seek advice on complementary feeding from family, forums/websites, health visitors, NHS sources, friends and parenting groups (in that order of preference). The research also found that only 20% of babies are given vegetables as their first food and that most of the first foods offered are bland or sweet in flavour. Roundtable participants identified health visitors as professionals who play a particularly important role in providing guidance on complementary feeding because of the trust that parents place in their advice and the timeliness of their contact. The experts discussed what advice health visitors currently offer on complementary feeding and the information that is prioritised. It was recognised that health visitors invariably have so many other issues to discuss with parents that there tends to be little time to address the subject of complementary feeding. The group commented that health visitors can sometimes lack the confidence and knowledge to engage in conversations about complementary feeding and often have to rely on 'leaflets' because they may lack professional training on this topic. Without support for professional development in this area, health visitors can be 'modest' in their advice and focus of timing of weaning in terms of weight gain and growth, rather than discussing types and amounts of foods to provide. When advice is offered, baby rice/porridge are usually recommended as first foods, followed by fruit and vegetables, and the focus tends to be on the mechanics of eating and avoidance of allergenic foods rather than taste experiences and building the foundations of healthy eating. Participants were in strong agreement that involving health visitors in discussions about complementary feeding is a priority and that developing

training for health visitors could include evidence-based information about ways to help infants to establish preferences for vegetables and fruit.

Common parental concerns about complementary feeding were discussed to gain insight into the potential motives of UK parents who often prefer to offer baby rice and sweet fruits as first foods rather than vegetables. The experts highlighted that parents are likely to want their infant's first food experiences to be as positive as possible and that their own perceptions of 'tasty' foods will determine what foods are offered. Parents may also expect their child to dislike certain foods based on their own food preferences and so will not offer these foods from the outset. The misconceived idea that vegetables are difficult for infants to digest and can cause 'gassiness' or stomach pain sometimes also influences parents' decision making. Parents may avoid offering less sweet vegetables because infants tend to eat less of these foods than sweeter varieties, causing concerns about wastage or infants consuming 'enough' food and being 'full up' and more likely to sleep for longer. Cultural and traditional practices are also likely to influence the foods that are offered during complementary feeding.

Recommendations for messages for health professionals, parents and carers

Consensus was reached that there is enough evidence to communicate practical messages on how to encourage acceptance of vegetables from the start of complementary feeding, in order to increase the likelihood that these foods will be accepted throughout childhood. The core of the message is that vegetables are very important first foods. When infants are ready for complementary feeding, they should be familiarised with a wide variety of vegetables at the earliest opportunity, as a first step in the transition from milk to solid foods, bearing in mind that at 6 months of age iron-rich foods, such as pulses, meat and eggs, will need to be offered as well. Participants agreed that to capitalise on infants' willingness to try new foods at the start of complementary feeding, the focus in the early days should be on vegetables, but that fruits without a predominant sweet flavour could also be included in the messaging as it can be difficult to establish acceptance of these foods. As complementary feeding progresses, parents should be encouraged to offer their child a 'rainbow' of vegetables and fruit, emphasising less sweet vegetables and fruit but also offering those with sweet flavours intermittently to add variety to the diet (Ahern *et al.* 2013).

Understanding the importance of establishing liking and acceptance of vegetables and fruit early in complementary feeding is a first step to increasing the likelihood of children eating these foods later on. It is also important to recognise that it may be harder for some infants to learn to accept vegetables than others, but that all infants can learn to accept at least some vegetables. Frequently, infants are denied the opportunity to become familiarised with certain vegetables because their expression of interest or surprise in response to a food is misinterpreted as disgust and as a consequence parents cease to offer it (Barends *et al.* 2013); and so it is important to communicate that the focus should be on the infant's

willingness to continue eating rather than their facial expressions and that perseverance is key. It was suggested that the messaging could include terms such as 'first tastes', 'sensory education', 'taste journey', 'tiny tastes' and a 'variety of vegetables early' and the idea of the 'window of opportunity' for establishing food preferences should be built in the messaging. Participants emphasised the importance of 'joined up' advice on complementary feeding in order to avoid confusing health professionals, parents and carers.

Future activities

In light of the forthcoming SACN report on complementary feeding, a systematic review of the scientific literature, including quality assessment, on establishing acceptance of vegetables during the complementary feeding period was recommended, particularly if specific government recommendations are to be changed. However, it was acknowledged that the practical messages discussed at the roundtable are complementary to those already provided by the Department of Health and therefore might be considered as an extension, rather than amendment, to current weaning messages. The need for resources to communicate the message of establishing vegetable acceptance during complementary feeding either directly to parents or indirectly via health professionals was deemed an essential next step. Resources might include online training, seminars, leaflets, posters and 'apps'. Suggested communication channels included children's centres, supermarkets, pharmacies, online forums, the British Dietetic Association, the British Nutrition Foundation and the baby food industry. Commercial products to support the message might include small (~20g) 'taster' packs of a variety of vegetables and larger meal-sized vegetable-based products that are not sweet in taste. The need for more longitudinal randomised, controlled studies into effective ways to establish vegetable acceptance during weaning was also highlighted and it was suggested that the cohorts of previous trials in this area (*e.g.* Fildes *et al.* 2015) might be followed-up to examine the sustainability of the effects.

Conclusions

The acquisition of preferences for foods that comprise a healthy, varied diet is paramount during the early years. The complementary feeding period is a 'window of opportunity' to familiarise infants with a wide variety of foods because, at this stage, infants' openness to trying new foods is at its peak and familiar foods are likely to become preferred foods, with these acquired preferences 'tracking' into later childhood. The lack of sweet flavour and low energy density of many vegetables and some fruits means that these foods may be rejected by children and extra efforts may need to be put in place to help them accept these foods. The scientific literature indicates that repeated exposure to vegetables, offering a wide variety of vegetables and introducing vegetables as first foods during complementary feeding can increase vegetable acceptance in early life and in later childhood. Current infant feeding guidance and practices suggest that this type of approach is not typical in the UK and that there is scope to provide parents and healthcare professionals with practical advice on encouraging vegetable acceptance during complementary feeding. Participants

considered what these new messages should be and emphasised that they are dependent of the infant's age and stage and their immediate need for iron-rich foods. A systematic review of the scientific literature on establishing acceptance of vegetables during complementary feeding was recommended as were more longitudinal randomised, controlled trials, though the current evidence-base was considered sufficient to begin to update resources and communicate practical messages to healthcare professionals and parents about introducing vegetables during complementary feeding. Opportunities to disseminate the messages were identified, with health visitors considered to play an important role.

Acknowledgements

The British Nutrition Foundation would like to thank all participants for their expert contributions, with special thanks to Professor Marion Hetherington for chairing the event. Funding from Ella's Kitchen to support the running of the event was gratefully received.

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