**Prospective associations between parental feeding practices and children’s oral processing behaviours: Results from the GUSTO cohort.**

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**Authors' contributions**

This study was conceived and designed by CGF, AF, MFFC and LRF. Analyses were performed and interpreted by AF, KM and CGF. ATG, JYT and MJC collected the data. AF, KMC and CGF prepared the draft manuscript with input from LRF and MFFC. YSC, KHT, FY, LPS, MJM, BFPB, YSL and KMG were responsible for conception and recruitment for the GUSTO cohort.

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**Abstract**

Previous research demonstrated that faster eating rates are linked with increased intake of energy during a meal. Here we examined whether within-meal parental feeding practices show cross-sectional and prospective associations with children’s oral processing behaviours, and whether the previously demonstrated association between faster eating rates and higher energy intakes varies by parental feeding practices. A subset (n=155) of children and their mothers from the Growing Up in Singapore Towards Healthy Outcomes cohort participated in an *Ad libitum* meal at age 4.5 years. Children’s oral processing behaviours (eating rate, bite size, chews per gram, oral exposure time, and meal duration) and parental feeding practices (autonomous and coercive prompts, restrictions, hurrying and slowing) were recorded during the meal. Subsequently, 94 of the children participated in a follow-up meal without their mothers at age 6 years. Parental feeding practices were not consistently associated with child oral processing behaviours overall. However, exploratory post-hoc analyses revealed some sex differences. The mothers of girls with faster eating rates, larger bite sizes and fewer chews were more likely to use hurrying, slowing and restrictions, but similar associations were not observed among boys. Children who had the most problematic eating style and were eating fast and for long, experienced more restrictions, instructions to slow down and prompts. Faster eating rates were linked with the highest energy intakes if children were additionally prompted to eat. Prospective analyses showed that children who were more often prompted using coercive techniques and less frequently hurried at age 4.5 years, had faster eating rates at 6 years and a larger increase in eating rates between ages 4.5 and 6 years, but did not consume more energy. Although the direction of these associations cannot be assumed, these exploratory analyses suggest sex differences in the associations between feeding practices and oral processing behaviours, and highlight the potential role of parents in the development of children’s oral processing behaviours.

**Keywords:** Feeding practices; eating behaviours; oral processing; eating rate; energy intake; childhood obesity

**Key messages:**

* Children’s oral processing behaviours are linked with parental practices that children experience during the meal and vary by child’s sex
* Mothers were more likely to use feeding practices when girls showed oral processing behaviours linked with greater intakes of energy, but not with boys
* Feeding practices predict children’s future eating rates and greater increases in eating rates from 4.5 to 6 years, but do not predict future intakes of energy
* Parental mealtime behaviours may contribute to development and consolidation of children’s oral processing behaviours
1. **Introduction**

Food preferences and dietary habits develop during early childhood and form the basis for food related behaviours that track into adulthood (Birch, 1999). Less is known about the factors that influence the development of food oral processing behaviours and in particular, a faster rate of eating, which has been identified as an important determinant of energy intake at a meal, both in adults and children (Llewellyn et al., 2008, Berkowitz et al., 2010, Robinson et al., 2014, Drabman et al., 1979, Fogel et al., 2017b). Using behavioural coding techniques, it was demonstrated that objectively measured faster eating rates in children are achieved through taking larger bites and taking fewer chews to process each bite of food (Fogel et al., 2017a). The same study also demonstrated that faster eating rates that co-occur with the longer eating duration are the most problematic, and linked with the highest intakes of energy. Though faster eating rates are more prevalent among children with overweight and greater whole-body and abdominal adiposity, faster eating still predicts greater energy intake at a meal, independent of a child’s body weight, sex or ethnicity (Fogel et al., 2017b, Llewellyn et al., 2008) and is an important predictor of future obesity risk (Berkowitz et al., 2010, Agras et al., 1987).

Evidence that children’s eating rates have a genetic component suggests that some children may be predisposed to faster eating (Llewellyn et al., 2008). Yet, children’s eating behaviours develop in the context of a range of mealtime interactions and parental feeding practices, where parents use a number of strategies to encourage or discourage food consumption during a meal, thus influencing children’s eating behaviours. Parental feeding practices have previously been linked to a range of child eating behaviours. In observational studies children tended to consume more energy if they were frequently prompted to eat (Drucker et al., 1999, Orrell-Valente et al., 2007), while coercive feeding practices, both self-reported and observed, have been linked with greater food refusal, aversion to foods to which children were coerced and increased reported intake of high energy foods (Bante et al., 2008, Sleddens et al., 2014, Blissett et al., 2015). Importantly, self-reported parental feeding practices have been linked with prospective weight gain and growth outcomes indicating that mealtime interactions with the parent can have a long-term impact on future dietary habits and body composition (Farrow and Blissett, 2006, Campbell et al., 2010, Gregory et al., 2010, Shloim et al., 2015).

The mechanisms that trigger parents to use certain feeding practices are complex and not well understood, but there is likely to be a bi-directional relationship between the child’s behaviour and child’s characteristics such as sex and/or weight, and parent’s motivation to achieve a desired feeding outcome. For example, caregivers are more likely to habitually use controlling feeding practices, such as restriction, with overweight children, particularly girls (Costanzo and Woody, 1985), and pressure to eat with children perceived to be picky eaters (Jansen et al., 2017). Conversely, in an acute observational setting children who showed fewer food refusals and readily accepted foods, were more likely to experience more positive feeding practices, such as autonomy supportive prompts (Tovar et al., 2016). Parent self-report of the use of controlling behaviours have been also linked with food disinhibition and overeating in girls, but not boys (Fisher and Birch, 1999, Johnson and Birch, 1994), suggesting that child’s sex may moderate the effects of certain feeding practices.

As is the case with other eating behaviours, it is possible that some features of children’s oral processing might be linked to parental feeding practices, although this has not been well documented to date. Preliminary evidence suggests that children who are more frequently prompted or encouraged to eat tend to have longer oral exposure times i.e. spend longer time actively eating during the meal (Klesges et al., 1983, Klesges et al., 1986) and eat at faster rates (Drucker et al., 1999), although the directionality of these associations has yet to be established. Conversely, parents who use more controlling feeding practices, such as restriction and pressure, report that their children have higher scores for slowness in eating, suggesting that controlling feeding practices are associated with slower eating rates (Webber et al., 2010, Haycraft and Blissett, 2012), though again the direction of this association cannot be assumed. These associations need to be confirmed using objective measures of parental feeding practices and child oral processing behaviours.

Although children’s oral processing behaviours are strongly associated with energy intakes during a meal, it is currently unknown whether this association is influenced by feeding practices that children experience during the meal, and whether parental feeding practices are linked with the development of oral processing behaviours over time. To address these gaps, parental feeding practices have been observed and quantified during a lunchtime meal using a method adapted after Fries et al. (2017), to investigate whether these strategies are linked with measured oral processing behaviours exhibited by children during the same meal. The first aim was to explore (1) whether children’s measured oral processing behaviours are linked with the parental feeding practices they experience during the meal. Previous work has demonstrated that faster eating rates lead to the highest intake of energy during the meal when they co-occur with longer meal duration. To investigate this further, we explored (2) whether children who eat at faster rates and for a longer duration differ in parental feeding practices that they experience, from children with other eating styles. We then considered (3) whether the association between children’s oral processing behaviours and energy intake is moderated by parental feeding practices. Finally, (4) we explored whether parental feeding practices observed during the meal at age 4.5 years predict children’s oral processing at age 6 years, change in eating rates from 4.5 to 6 years and energy intake during the meal at age 6 years.

1. **Methods**

2.1 Participants

The participants were a subset of 303 parent-child dyads from the Growing Up in Singapore Towards healthy Outcomes cohort (GUSTO; N=1247), who took part in a recorded lunch at age 4.5 years (±2 months). Further information on the cohort and participant eligibility criteria are described elsewhere (Soh et al., 2014). Children’s eating behaviours and mother’s feeding practices were video-coded separately. Videos were excluded for one or more of the following reasons: mothers spoke in a language other than English (n=62), the child was outside the camera view (n=23), poor video quality (n=20), mothers selected their food before the child (n=18), presence of family members other than the mother and the child in the room (n=15) or mothers served a food to the child that was not requested (n=10). The final sample considered in the analyses consisted of 155 mother-child dyads, whose eating behaviours and feeding practices were fully video-coded at 4.5 years. Mother-child dyads were of Chinese (n=108), Malay (n=25) and Indian ethnicity (n=21); one family did not report their ethnicity. The highest educational attainment reported by the mother at recruitment was primary education (5.2%), secondary education (58.8%) or university education (32.3%; 5.4% unreported). There were 75 boys and 80 girls in the final sample. Children who were excluded did not differ from those included in the study in BMI, sex, household monthly income or maternal education status. However, excluded children were more likely to be of Malay or Indian ethnicity (p<0.001), as these mothers were more likely to communicate with children in a language other than English.

The same children attended a follow-up study at age 6 years (n=94), where they were video-recorded while consuming a fried rice lunch served *Ad libitum* without the mothers present in the room. The follow-up sample consisted of 50 girls and 44 boys of Chinese (n=64), Malay (n=15) and Indian ethnicity (n=14). Children who attended the follow up did not differ from those who failed to attend the follow up in sex, ethnicity, BMI, household monthly income or maternal education status. The participant flowchart (Supplementary material) describes selection at all stages. Parents of all participants provided informed consent to participate in the study. The study was approved by the Institutional Review Boards of the hospitals involved (clinical trials registry: NCT01174875; Registered 01 July 2010).

2.2 *Ad libitum* lunch

At both time points lunch took place in the same testing room, which was furnished with child-friendly furniture and was equipped with inconspicuous closed-circuit TV cameras positioned in three corners of the room where lunch was served. The cameras captured all aspects of food choice and consumption in high resolution and provided a clear view of the child and parent, with the possibility of image magnification up to 400% while preserving resolution. Children consumed their normal breakfast at home and were requested to fast for a minimum of 3 hours before the lunch. Children were weighed and measured in light clothing on the same day.

At age 4.5 years, children were offered a standardised buffet lunch which consisted of nine commercially available foods and three beverages presented *Ad libitum*. The foods served for lunch were popular and well-liked products that were selected based on food frequency questionnaire records collected at an earlier time point. The foods and drinks served were: white bread (Gardenia; 2.63 kcal/g; 6 slices), Honey Stars cereal (Nestle; 3.8 kcal/g; 80g), pancakes (Aunty Jemima; 3 kcal/g; 70g), chocolate cake (Sara Lee; 4.3 kcal/g; 80g), cheese (Cowhead; 2.95 kcal/g; 66g), chicken cocktail sausage (Fairprice; 2.95 kcal/g; 192g), chicken nuggets (CP; 2.29 kcal/g; 216g), apple slices (0.44 kcal/g; 204g), canned corn (Hosen; 0.81 kcal/g; 160g), apple juice (Marigold; 0.5 kcal/ml; 6 boxes), full cream milk (Marigold; 0.65 kcal/ml; 6 boxes) and water. Additional portions of each item were also available should any single item have been fully consumed during the meal. Energy content of food items was derived from the food labels of the products. Mothers and children were left alone in the room during the meal and researchers observed the session via the cameras in an adjacent room. Mothers were instructed to select their own meal only after the child had chosen their own items. Mothers were asked not to override children’s food choices or portion selections, but to otherwise interact with children in the usual way. Children were told that they could eat as much or as little as they wished during the meal. Prior to the meal, mothers were informed that they would be given 20 minutes to eat, but additional extensions of 10 minutes were granted if they ran out of time.

At the 6 years session, the *Ad libitum* lunch consisted of fried rice (1.86 kcal/g), which is a common and accepted main meal item in this population based on the information from the same food frequency questionnaire. Children were asked to select their own portion from a large serving dish (800g) and were told that they could eat as much or as little as they wished within a similar time frame. At both time points the foods served were weighed before and after the meal, and intake of each food was recorded to estimate the energy consumed during lunch.

2.3 Behavioural Coding Analysis

Behaviours of interest were pre-defined in a coding scheme and coded directly from the video recordings using behavioural annotation software ELAN 4.9.1 (Max Planck Institute for Psycholinguistics, The Language Archive, Nijmegen, The Netherlands).

*Parental Feeding Practices:* An observational coding scheme was developed to measure mothers’ feeding practices based on the coding schemes previously used in literature (Hughes et al., 2007, Orrell-Valente et al., 2007, Fries et al., 2017). The coding scheme was adapted for the current study, based on preliminary coding, to account for the particular structure of the buffet task, as well as to identify parental feeding practices linked specifically to children’s oral processing behaviours, such as instructions focused on slowing or hurrying. A detailed description and examples of feeding practices recorded are presented in Table 1. As in the study by Fries (Fries et al., 2017), the current coding scheme included two categories of prompts to eat, following the classification system of Vaughn and colleagues (Vaughn et al., 2016). Incidences of all feeding practices used were summed to give a measure of total feeding practices observed during the meal.

*Child Oral Processing Behaviour:* The frequencies of children’s bites, chews and swallows were counted and used to derive food oral processing measures, based on a previously published approach (Fogel et al., 2017a, Forde et al., 2013). The derived measures are described in detail in Table 1, and include the total oral exposure time (min), total meal duration (min) and average eating rate (g/min), bite size (g/bite) and chews per gram.

For each coding scheme, the behaviours were video-coded by a single researcher and later validated by a second coder (10% of total videos), and achieved an acceptable level of total agreement (≥80%) in line with previous recommendations (Haidet et al., 2009), and excellent inter-rater reliability score (ICC; r>0.94).

2.4 Statistical analysis

There were no associations between the individual parental feeding practices or total feeding practices count and child BMIz (r<0.05, p>0.46), and there were no clear moderation effects of child BMIz on the findings of the current study. As a result, and also because BMIz scores were not available for all children in the sample (n=153), BMIz was not controlled for in the reported analyses to preserve power. All the reported findings were re-analysed after additionally controlling for BMI and the results remained virtually identical (unreported). Parental feeding practices did not show normal distributions, so bootstrapped (BtS) 95% CIs were computed and provided for all reported analyses (10000 samples, bias corrected accelerated 95% CI, with simple sampling procedure).

Non-parametric correlations (Spearman’s rho) were conducted to analyse the associations between parental feeding practices and children’s oral processing behaviours. For exploratory post-hoc comparisons, the same analyses were then stratified by child’s sex and revealed some sex differences in the measured associations. To further characterise these relationships among boys and girls, an additional variable was computed post-hoc, which comprised of CCP, food restrictions, hurrying and slowing and was described as a single measure of ‘controlling feeding practices’.

We previously demonstrated that the eating style characterised by eating faster and for a longer duration was linked with the higher intakes of energy (Fogel et al., 2017b). Therefore, we categorised children into four ‘eating style’ groups based on their median eating rate (Median 6.12 g/min) and median duration of oral exposure (Median 15.05 min): slower/shorter (n= 39), faster/shorter (n= 38), slower/longer (n= 39), faster/longer (n= 39). ANCOVA adjusted for sex, with post-hoc Bonferroni corrections was used to test if children with different eating styles differ in the frequency of parental feeding practices. Due to the sample size restrictions, this and the subsequent analyses were not further stratified by child’s sex.

To examine whether parental feeding practices moderated the link between children’s oral processing behaviours and their energy intake, four linear hierarchical regression models were tested, separately for each oral processing behaviour (eating rate, bite size, chews per gram and oral exposure time). Post-hoc simple slopes analyses were conducted to test the nature of these associations and to illustrate them. Oral exposure time and the total meal duration were highly correlated and showed identical findings (r=0.80, p<0.001). For clarity, only the results of the analysis involving oral exposure time were reported, as this was more relevant in the context of previous studies that linked it to the frequency of parental feeding practices (Klesges et al., 1983 ; Klesges et al. 1986). Child’s sex and oral processing behaviour were entered in the first step (Model 1), and five centred interaction terms (oral processing behaviour\*parental feeding practice) were entered in the step 2 (Model 2).

Three further hierarchical linear regressions were used to test prospective associations between parental feeding practices observed at age 4.5 years and children’s oral processing behaviours and energy intake at age 6 years. This was done separately for the three dependent variables considered: children’s eating rate at age 6 years, change in children’s eating rate from 4.5 (T1) to 6 (T2) years (calculated as T2-T1), and energy intake during the meal at age 6 years. Analyses of the prospective eating rates at 6 years were adjusted for child’s sex and the baseline eating rate at 4.5 years, and analyses of energy intakes were adjusted for child’s sex only. Covariates were entered in Model 1 and the parental feeding practices observed at age 4.5 years (ASP, CCP, restrictions, hurrying, slowing) were entered in Model 2. Due to high multicollinearity with other feeding practices variables two further regression analyses were conducted for total feeding practices and controlling feeding practices, using similar hierarchical modelling strategy. Criterion alpha used in all tests was 0.05. All analyses were conducted in SPSS version 23.0.

1. **Results**

**3.1 Are parental feeding practices associated with children’s oral processing behaviours?**

Counts of mothers’ feeding practices observed during the meal and children’s eating behaviours are summarised separately for boys and girls in Table 2. Boys experienced significantly more CCP and controlling feeding practices compared to girls. Boys also had faster eating rates, consumed more energy during the meal, and tended to have larger bite size, although this was not statistically significant. No other sex differences were found.

The relationships between oral processing behaviours and parental feeding practices are presented in Table 3. Overall, children’s eating rate was not related to the frequency of within-meal parental feeding practices. There were however some relationships with other oral processing behaviours. Children who had longer oral exposure and longer meals experienced more parental feeding practices overall. Larger bite size was associated with higher frequency of CCP and restrictions.

As an exploratory post-hoc analysis, the same analysis was then repeated separately for boys and girls, and highlighted some sex differences in the observed associations (Table 3). Relationships between parental feeding practices and children’s oral processing behaviours were consistently observed mainly among girls. For example, higher frequency of restrictions was significantly associated with faster eating rates among girls only. Also among girls, more frequent prompts to eat, restrictions and general controlling feeding practices were significantly related to larger bite size and fewer chews per bite. By contrast, among boys parental feeding practices were only linked to meal duration and oral exposure time, but not to specific oral processing parameters such as eating rate, bite size or chewing frequency. These results were supported by bootstrapped 95% CIs (Supplementary Table 1).

**3.2 Are parental feeding practices different among children with different eating styles?**

Parental feeding practices were compared for children who showed different eating styles, based on their eating rate and oral exposure time, and these are summarised in Figure 1. The groups differed significantly in the frequency of restrictions, slowing and ASP. Bootstrap corrected comparisons indicated that children who had slower eating rates and shorter oral exposure time received the fewest restrictions (p=0.002) and fewer slowing instructions (p=0.01), compared to children with faster eating rates and longer oral exposure. There was also a significant group difference in the frequency of ASP that children experienced during the meal. Children with a faster/longer eating style experienced ASP more frequently than children with a faster/shorter eating style (p=0.016). Groups did not differ in hurrying, CCP, or frequency of controlling or total feeding practices.

**3.3 Is the association between children’s oral processing behaviours and energy intake moderated by parental feeding practices?**

Children who had faster eating rates consumed more energy (β=0.62, p<0.001; B= 29.10, BtS 95%CI [21.74, 36.27]) and this association was moderated by the frequency of ASP (β=0.16, p=0.026; B=1.74, BtS 95%CI [0.07, 3.39]). Simple slopes analysis presented in Figure 2a, showed that children who ate at a faster rate and experienced more ASP consumed significantly more energy compared to children who ate faster, but experienced fewer ASP. Although oral exposure time was positively associated with energy intake (β=0.52, p<0.001; B=13.97, BtS 95%CI [9.63, 19.45]), this relationship was moderated by parental use of CCP (β=-0.19, p=0.036; B= -1.52, BtS 95%CI [-3.63, -0.13]), see Figure 2b. Children who ate for longer consumed less energy if they experienced higher frequency of CCP. At the same time, children who ate for shorter consumed more energy if they experienced a higher frequency of CCP. Children’s bite size (β=0.35, p<0.001) and chews per gram (β=-0.47, p<0.001) were associated with intake of energy, however these relationships were not moderated by any of the measured parental feeding practices (β<0.25, p>0.076).

**3.4 Do parental feeding practices at 4.5 years predict eating behaviours and energy intake at 6 years?**

The results of the linear regression models, adjusted for sex and the baseline eating rate, are summarised in Table 4. Children who experienced more CCP and fewer instructions to hurry up during the meal at age 4.5 years, had higher eating rates and a larger increase in eating rates from 4.5 to 6 years. Higher frequency of instructions to slow down also tended to be associated with faster eating rates and a larger increase in eating rates over time, although this was not statistically significant (p=0.091). These effects seem to be specific to these types of feeding practices, as higher frequency of feeding practices overall or controlling feeding practices were not linked to eating behaviours at 6 years.

**4.0 Discussion**

Earlier research showed that faster eating rates, larger bite size and lower chewing frequency are strongly associated with increased energy intake within the meal, particularly when children eat for a long time (Fogel et al., 2017a; Fogel et al., 2017b). The results of the current study present evidence that these oral processing behaviours are associated with parental feeding practices (1), and that some relationships may be stronger among girls than boys. Children who eat faster and for longer and are likely to consume the most energy experience different feeding practices than children with other eating styles (2). Furthermore, the relationship between faster eating rates and higher energy intakes may be to some extent moderated by the mealtime interactions with the parent (3). Importantly, parental feeding practices predict prospective eating rates and changes in child’s eating rates over time (4).

Overall, children’s eating rates showed weak associations with the individual parental feeding practices, which is contrary to previous findings showing that prompts to eat were linked to children’s eating rate (Drucker et al., 1999). In our study, the instructions to hurry up were linked with both the child’s oral exposure time and meal duration, suggesting that parents may indirectly encourage faster eating rates when children tend to have longer meals. When children were eating at faster rates parents were not necessarily instructing them to slow down, which raises the question of which behaviour(s) parents are responding to when using instructions focused specifically on eating speed. Though the exact eating behaviour cues that signal a child’s eating rate to a parent are not well understood, recent evidence suggests that parents probably take into consideration both the speed and duration of eating when defining the child as a slow eater (Fogel et al., 2018). This is also supported by the results of the current study, as parents were more frequently using the instructions to slow down when children were eating faster and for a longer duration, suggesting that parents perceived this eating style as the most problematic. In the current study longer oral exposure and meal duration were linked with higher total frequency of parental feeding practices, suggesting that excessive use of feeding practices may support longer mealtime and longer oral exposure. Conversely, children who eat for a longer duration create more opportunities for mothers to use feeding techniques and although the direction of this association cannot be established from the current data, this is likely a bi-directional association.

Exploratory post-hoc analysis revealed some sex differences in the observed associations. Mothers tended to respond differently to girls’ eating behaviours, using a higher frequency of ‘controlling feeding practices’ such as restrictions, slowing or CCP when girls had faster eating rates, larger bite size and took fewer chews, and this was not observed among boys. For girls, the strongest correlate of controlling feeding practices from the parent was when they were observed taking larger bites, which suggests that this was the specific feeding cue that was the most likely to result in a feeding instruction from the parent. The alternative explanation is that girls responded to parent instructions by taking larger bites and chewing food less, whereas boys may have been less responsive to these instructions resulting in no association between their oral processing behaviour and parental feeding practices. Past research on sex differences in parental use of feeding practices is limited, but suggests that mothers are more likely to use controlling feeding practices with girls rather than boys, particularly with heavier girls or girls perceived to be heavier (Francis et al., 2001, Johnson and Birch, 1994). There is evidence that starting in infancy and across the life course, there are sex differences in standards related to ideal body shapes, with parents in the Western and Asian populations showing preference for a thinner body shape for girls compared to boys (Rand and Wright, 2001, Pierce and Wardle, 1993, Holub and Dolan, 2012). This may explain the observed differences in the use of parental feeding practices between the sexes in the current study. Future studies should systematically examine and confirm whether associations between child oral processing behaviours and parental feeding practices are moderated by child sex and weight status.

Previous studies show strong links between faster eating rates, longer oral exposure times and higher energy intake within a meal (Fogel et al., 2017a,b). The results of the current study suggest that this association is to some extent moderated by the mealtime interactions with the parent. More specifically, children who had faster eating rates would consume more energy than the slower eating children, and these children showed the highest intakes when they were additionally prompted to eat using ASP. Parents who frequently use ASP may inadvertently encourage higher energy intakes among children who have faster eating rates and would be at risk for overeating.

Analysis of the prospective associations revealed that a higher frequency of CCP and lower frequency of hurrying instructions observed at age 4.5 years predicted higher eating rates among children at age 6 years and greater increases in eating rates over time, albeit with modest effect sizes. These results suggest that children who experienced fewer instructions to hurry up probably already had faster eating rates that their parents recognised and were therefore less hurried. These same children had the largest increases in eating rates over time suggesting that these patterns already occur at age 4.5 years, are recognised by the parents and are firmly established at age 6 years. This is further supported by the observed trends in the associations between instructions to slow down and larger increases in eating rates over time. Although not statistically significant, children who experienced more instructions to slow down tended to have higher eating rates at age 6 years, which could indicate that while parents recognise this eating style, this strategy may be ineffective at reducing this behaviour over time. Children who were prompted to eat using more coercive-controlling strategies also had larger increases in eating rates over time, suggesting that encouraging children to eat using controlling methods may inadvertently be contributing to the development of faster eating rates. Past research has demonstrated that parental feeding practices are predictive of future eating habits and food approach behaviours (Rodgers et al., 2013) and may mediate the associations between eating rates and future adiposity in children (Berkowitz et al., 2010). Our results suggest that parental feeding practices may, to some extent, also impact the development of stable oral processing behaviours. These associations were evident despite different foods being used at the two meals. Alternatively, parents may be responding to child’s eating behaviours and use coercive-controlling feeding techniques in attempt to reduce undesirable eating behaviours. Further research is needed to investigate the directionality of the associations between parental feeding practices and child oral processing behaviours, and to better understand the independent contribution of parental mealtime behaviours to the development of stable oral processing patterns, as well as their links to unhealthy weight gain in childhood in younger age groups.

A strength of the current study was the comprehensive measurement of observed maternal feeding practices and detailed measures of children’s eating behaviours collected at two time points. However, there are several limitations worth noting. Firstly, exploratory post-hoc analyses revealed potential sex differences in the observed associations. However, the sample size did not allow to methodically examine these as a potential moderator of the observed associations. Similarly, child weight (or perceived weight) might also be a potential moderator of these associations, although preliminary analyses showed that this was not the case in this sample. Secondly, the foods provided during the buffet lunch were all well liked and relatively popular products with similar energy densities. This may have increased the frequency of controlling feeding practices from certain mothers, with perhaps less opportunity for the use of supportive feeding practices to try new or healthier food items, or pressuring strategies to encourage consumption of the less liked products. As parents use different feeding practices when offering novel foods than familiar ones (Edelson et al., 2016), future studies should aim to explore the relationship between parental feeding practices and child eating behaviour using liked, less liked and novel foods, to establish how feeding practices adapt when faced with food refusal or when there is a challenge to consume a healthy or novel food. Nevertheless, parents generally tend to serve children foods that they like to reduce refusals (Bathgate and Begley, 2011) and to avoid food wastage (Johnson et al., 2015). Furthermore, this study limited the number of feeding practices coded to verbal statements, and non-verbal cues such as tone of voice or facial signals have not been coded, but may also impact a child’s behaviour. By focusing on objective verbal instructions we may have lost some of the sensitivity to the overall interaction between parents and children during the meal, but any relationships observed were regarded as robust and reliable. Another limitation was the fixed meal duration at age 4.5 years, which may have influenced some of the parental behaviours. However, during a real world setting children are also constrained by the amount of time dedicated to consuming a meal, both in the home setting and in kindergarten and/or school. Finally, lunch at age 6 years consisted of a single food item, and differed from the buffet lunch served at age 4.5 years, which may have contributed to differences in child’s oral processing characteristics across the two time points. Despite these limitations, the current study presents evidence that parental feeding practices are i) associated with child oral processing behaviours and ii)moderate the associations between faster eating rates and higher energy intakes, with preliminary evidence suggesting that this may be stronger among girls than boys.

**5.0 Conclusions**

The current study showed that children’s oral processing behaviours were correlated with parental feeding practices that they experienced during the meal. Children who ate faster and consumed more energy ate the most if they were additionally prompted to eat, suggesting that parental behaviours may further contribute to increased energy intakes. The eating style characterised by eating faster and for longer that was previously associated with the highest intakes of energy, was differentiated from other eating styles by higher frequency of restrictions, instructions to slow down and ASP, suggesting that parents recognise this problematic eating behaviour. Children who were more often prompted using coercive strategies and slowed down, and who were less frequently hurried, had the largest increases in eating rates over time, suggesting a potential role of parental behaviours in the development of stable oral processing patterns. Future studies should build on these findings to understand the role of parental feeding practices in the development of stable eating patterns and further examine how child characteristics such as sex, BMI or perceived BMI affect these relationships.

**Abbreviations: ASP- Autonomy supporting prompts; CCP- Coercive-controlling prompts**

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