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Food texture preferences in early childhood: Insights from 3–6 years old children and parents

Ching Yue Chow\textsuperscript{a,b}, Anne C. Bech\textsuperscript{b}, Helle Sørensen\textsuperscript{c}, Annemarie Olsen\textsuperscript{a}, Wender L.P. Bredie\textsuperscript{a,*}

\textsuperscript{a} Section for Food Design and Consumer Behaviour, Department of Food Science, University of Copenhagen, Frederiksberg C 1958, Denmark
\textsuperscript{b} Arla Innovation Centre, Arla Foods amba, Aarhus N 8200, Denmark
\textsuperscript{c} Data Science Lab, Department of Mathematical Sciences, University of Copenhagen, Copenhagen Ø 2100, Denmark

**Abstract**

Rejection of specific food textures in young children can be a significant barrier to establishing healthy eating habits. However, the literature on texture preferences in children under seven is sparse, partially due to a lack of suitable test tools for this age range. This study aims to investigate texture preferences in 3 to 6-year-old children and their parents and identify factors that could influence children’s preferences. Children (n = 235) completed a forced-choice questionnaire based on pictographic drawings of 14 pairs of foods differing in hardness (hard versus soft) or particle content (with-particle versus no-particle). Parents completed the same questionnaire and provided information on their feeding practices and children’s eating behaviors. To assess the questionnaire’s validity, children performed a paired preference test using actual food stimuli corresponding to 6 food pairs in the questionnaire. Results showed that children preferred foods without particles, and such preference was associated with food neophobia. Children did not show distinct preferences for foods differing in hardness, but older children preferred soft foods more than younger children. Texture preferences significantly differed between parents and children, with a low concordance between parent-child dyads (49–55 %). Parental restrictive feeding was associated with children’s rejection of particles in foods, whereas children’s experience with different textures was associated with preferences for foods containing particles. Moreover, the questionnaire showed agreement with children’s preferences measured using actual foods, and the validity increased with age. This study demonstrated that young children’s texture preferences follow developmental trends and depend on the eating environment.

1. Introduction

Texture, as a fundamental sensory property of foods, has an important role in the development of food preferences and eating patterns in early childhood, which could potentially impact a child’s ability to establish healthy eating habits later in life. Younger children might have a higher degree of texture awareness than older children, as evidence showed that they regarded texture as a more important sensory attribute than taste or flavor in governing food choices (Rose et al., 2004; Zeinstra et al., 2007). Despite a growing amount of research on texture preferences in young populations (Appiani et al., 2020; Cappellotto & Olsen, 2021; Laureati et al., 2020; Lukasewycz & Mennella, 2012; Ross et al., 2021; Skouw et al., 2023), literature focusing on children under seven years of age is sparse (Chow et al., 2022).

Early childhood (3 to 6 years) may represent a special period for the development of food texture preferences. Known factors that could affect preference development include a child’s orofacial growth and food rejection tendencies (Chow et al., 2022; Tournier & Forde, 2023). Szczesniak (1972) suggested that physiological development is dominant in shaping children’s attitudes to texture. Changes from deciduous (“milk teeth”) to permanent adult dentition, which start around five or six years of age, contributed largely to children’s advances in chewing (Gisel, 1988; Le Reverend et al., 2014; Tournier & Forde, 2023). Moreover, children preferring simple and homogenous textures tended to be more food neophobic or picky in eating (Boquin et al., 2014; Laureati et al., 2020; Lukasewycz & Mennella, 2012; Ross et al., 2021; Skouw et al., 2023). This is particularly relevant for young children because food rejection behaviors often increase from a low baseline at weaning, and these behaviors are known barriers to children adopting a healthy diet (Dovey et al., 2008). Studies also suggested that sensory

\textsuperscript{*} Corresponding author.
E-mail address: wb@food.ku.dk (W.L.P. Bredie).

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over-sensitivity negatively affected individuals’ appreciation of food texture (Nederkoorn et al., 2015, Nederkoorn et al., 2019). In both clinical and nonclinical populations, children who were more dismissive towards oral tactile stimulation were more selective in their eating, particularly regarding food textures (Nederkoorn et al., 2015; Smith et al., 2005).

Parents or caregivers play an important role in shaping their children’s food preferences and eating behaviors (Birch, 1999); this can be through the foods they offer and the feeding practices they use during mealtimes. A timely introduction of diverse food textures to children during weaning could facilitate texture acceptance at later developmental stages (Blossfeld et al., 2007; Coulthard et al., 2009; Tournier et al., 2021). Furthermore, evidence showed that parental feeding practices were associated with children’s food intake. It may further contribute to the development of children’s oral processing behaviors (Fogel et al., 2019), encouraging the selection of specific textures.

Investigating the inter-individual differences and factors influencing young children’s preferences for textures in foods could facilitate product development that meets their needs and expectations. The public health domain might also exploit these results to develop interventions to promote food texture acceptance in young children.

Forced-choice questionnaires are a useful method to assess texture preferences in children. However, most studies were conducted on schoolchildren aged above seven years (Appiani et al., 2020; Laureati et al., 2020; Lukasewycz & Mennella, 2012; Skouw et al., 2023), and there are limited measurement tools available for the younger age range (Chow et al., 2022). Recently, Skouw et al. (2023) developed and validated the use of a forced-choice pictographic questionnaire in schoolchildren (7 to 10 years). The questionnaire consisted of drawings of food pairs differing in hardness or particle content (i.e., hard versus soft or with-particle versus no-particle), and children had to indicate their preferred food within each pair. In the study, children demonstrated consistency in their preferences measured between the questionnaire and using actual food stimuli. The questionnaire also showed high test–retest reliability. The pictographic method can be applied to the younger age range by adjusting the protocols to meet young children’s cognitive abilities and attention spans (Guinard, 2000; Popper & Kroll, 2005). Previous research has suggested that younger children are less reliable in their preferences measured across testing methods or occasions (Guthrie et al., 2000; Léon et al., 1999). Therefore, it is important to assess the robustness of the measurement tool.

The present study aims to use the forced-choice questionnaire to investigate food texture preferences in 3–6-year-old children and their parents and identify child and parental characteristics that could influence young children’s texture preferences. Furthermore, the validity of the questionnaire was examined by agreement with texture preference assessments in children using actual food stimuli.

2. Method and materials

2.1. Participants

Children aged 3 to 6 years were invited to participate in the study at home with their parents. They were recruited through the University of Copenhagen and Arla Foods consumer databases and an advertisement about the project on social media. The inclusion criteria were that participants lived in the Copenhagen or Aarhus area in Denmark and were willing to participate in the whole study, including picking up food samples. Children who had allergies to dairy and cereal products were excluded from participation. Parents were thoroughly informed about the research and gave written consent to the study participation and use of data for research. The study protocol was submitted to the Capital Region’s Committee on Health Research Ethics for review. It was concluded that formal ethical approval of the study was not required (reference no. 21014653). The children received a board game (€30) as a gift for their study participation.

2.2. Study design

The study consisted of two sessions conducted approximately a week apart. In the first session, children completed a forced-choice pictographic questionnaire on texture preferences. Parents also completed the texture preference questionnaire and reported on their children’s demographics and food behaviors. In the second session, children performed a paired preference test using actual food stimuli.

2.3. Procedure

2.3.1. Home testing and ‘The magic squirrel and the Chef’ story

The study was developed as home testing in response to the COVID-19 pandemic. Tests were set up online, and participants answered through tablet or laptop. Children completed the two sessions with their parents’ help. Test procedures for each session were explained to parents through demonstration videos, which they had to watch before conducting the sensory tests. The procedures were also given on the introductory page of each online questionnaire. Parents could run the sessions at their own time of choice. They were advised to conduct the tests as fun activities with their children individually in a quiet place and were instructed to avoid giving suggestions, mentioning brand names, or indicating their own preferences to the child.

When conducting sensory tests with young children, the procedures needed to match the child’s limited attention span (Guinard, 2000; Popper & Kroll, 2005). Visual and story-based approaches could motivate children and keep them engaged across the two sessions (Ervina et al., 2020). Therefore, a picture story was used to narrate the study, which told a squirrel and a chef visiting the child’s home twice and asking the children for help to win a cooking competition. On the first visit, they asked the children about their texture preferences; on the second visit, they prepared foods for the children to taste.

Parents picked up the food samples for the paired-preference test between the two sessions. The samples were prepared at the University of Copenhagen (Copenhagen) or Arla Innovation Centre (Aarhus) on the pick-up day and kept in a cooler bag at 5°C.

2.3.2. Forced-choice pictographic questionnaire on texture preferences

The pictographic questionnaire assessed children’s texture preferences for hardness and particle content of foods. It consisted of drawings of pairs of foods that varied in texture (hard vs. soft or with-particle vs. no-particle), and children chose their preferred foods between the two. The two dimensions aligned with the common textural descriptor classes – mechanical and geometrical properties of foods (Szczesiak, 1963). The validity of the pictographic method was previously assessed in schoolchildren, which showed predictability to children’s texture preferences measured using actual food stimuli and test–retest repeatability (Skouw et al., 2023).

In this study, the questionnaire was updated from the original version of 12 food pairs to 14, consisting of 8 food pairs in the hardness dimension and 6 in the particle dimension (Table 1). Changes were made to food pairs differing in hardness since the original questionnaire did not identify patterns of preference in children (Skouw et al., 2023). The changes included adding three new food pairs to the questionnaire: apple 1 (whole vs. sliced), cornflakes (crispy vs. softened), and potato (boiled vs. mashed) while removing the broccoli (raw vs. boiled; drawings not shown) from the original version. In addition, two food pairs (carrot and cheese) were modified from the original version to reduce non-texture-related differences between items by updating ‘sliced cheese vs. cream cheese’ to ‘cheese block vs. sliced cheese’ and ‘raw carrot vs. cooked carrot’ to ‘raw carrot vs. grated carrot.’

In the questionnaire, children were first provided a definition of food texture as “how the food feels in the mouth: it can for example be hard or soft, and with or without pieces.” Then, drawings and descriptions of a food pair were shown on the screen side-by-side. Following a forced-choice procedure, children were asked to select their preferred food.
within the pair: “Which one do you prefer?” The procedure was repeated until the children answered all food pairs. The presentation of the 14 food pairs and the pair members were randomized between children.

2.3.3. Parental survey

Parents answered a survey to provide complementary information about their children and themselves. The survey was divided into three parts. In the first part, parents reported their own age and gender. They completed the forced-choice texture preferences questionnaire (without

<table>
<thead>
<tr>
<th>(A) Hardness</th>
<th>Food pair</th>
<th>Hard</th>
<th>Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple 1*</td>
<td>Half apple (whole)</td>
<td>Half apple in slices</td>
<td></td>
</tr>
<tr>
<td>Apple 2</td>
<td>Raw apple</td>
<td>Apple puree</td>
<td></td>
</tr>
<tr>
<td>Bread (hardness)</td>
<td>Crispbread</td>
<td>Toast bread</td>
<td></td>
</tr>
<tr>
<td>Cake</td>
<td>Chocolate biscuit</td>
<td>Chocolate cake</td>
<td></td>
</tr>
<tr>
<td>Carrot*</td>
<td>Raw carrot pieces</td>
<td>Grated carrot</td>
<td></td>
</tr>
<tr>
<td>Cheese*</td>
<td>Cheese in pieces</td>
<td>Cheese in slices</td>
<td></td>
</tr>
<tr>
<td>Cornflakes*</td>
<td>Crispy cornflakes</td>
<td>Soften cornflakes</td>
<td></td>
</tr>
<tr>
<td>Potato*</td>
<td>Boiled potatoes</td>
<td>Mashed potatoes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(B) Particle content</th>
<th>Food pair</th>
<th>With-particle</th>
<th>No-particle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread (particle)</td>
<td>Bread with grains</td>
<td>Bread without grains</td>
<td></td>
</tr>
<tr>
<td>Orange juice</td>
<td>Orange juice with pulp</td>
<td>Orange juice without pulp</td>
<td></td>
</tr>
<tr>
<td>Peanut butter</td>
<td>Chunky peanut butter</td>
<td>Smooth peanut butter</td>
<td></td>
</tr>
<tr>
<td>Strawberry jam</td>
<td>Strawberry jam with pieces</td>
<td>Strawberry jam without pieces</td>
<td></td>
</tr>
<tr>
<td>Strawberry yogurt</td>
<td>Strawberry yogurt with pieces</td>
<td>Strawberry yogurt without pieces</td>
<td></td>
</tr>
<tr>
<td>Tomato soup</td>
<td>Tomato soup with pieces</td>
<td>Tomato soup without pieces</td>
<td></td>
</tr>
</tbody>
</table>

Note. The food pairs in bold were used in the paired preference test with real foods for method validation (see Section 2.3.4 for details).
drawings shown) themselves, which was equivalent to the child-friendly version. The second part asked questions about the child’s demographics and eating behaviors. Parents reported their child’s age, gender, height, and weight. They described their child’s early feeding patterns (breastfeeding and the time of introducing solid foods) and dental status (loss of primary teeth); details of the response options are given in Appendix A. Then, parents reported their child’s consumption frequency of the 28 food items in the pictographic questionnaire (see Table 1) with five response options: never, less than once per month, 1 to 3 times per month, 1 to 4 times per week, every day or almost every day. The response was assigned a five-point score (1 = never to 5 = every day or almost every day), and children’s food consumption frequency was calculated as a composite score per texture dimension. In addition, they answered seven questions on their child’s food texture acceptance, which included the liking of 1) hard food, 2) soft food, 3) food that requires a lot of chewing, 4) foods containing pieces, 5) food without pieces, 6) having a variety of textures on the plate, and 7) having a limited variety of textures on the plate. Each question was scored on a five-point hedonic scale. In the third part, parents were asked to complete questionnaires on their child’s food neophobia, sensory responsivity, and their own feeding practices. Appendix A contains details of the scoring and internal reliability (Cronbach’s alpha) of each questionnaire.

1. Child Food Neophobia Scale (CFNS; Pliner, 1994). The CFNS is a 6-item questionnaire measuring children’s reluctance to eat new foods, scoring on a scale from strongly disagree (1) to strongly agree (5).

2. Short Sensory Profile (Dunn, 1999). The Short Sensory Profile is a 38-item questionnaire assessing children’s responsivity to sensory stimuli in different domains. Three subscales of the questionnaire were used in the present study: taste/smell sensitivity (e.g., ‘avoids tastes or food smells that are typically part of a child’s diet’), tactile sensitivity (e.g., ‘avoids going barefoot, especially in sand or grass’), and visual/auditory sensitivity (e.g., ‘responds negatively to unexpected or loud noises’), giving 16 items in total. Parents rated the frequency of behaviors occurring on a scale from never (1) to always (5).

3. Child Feeding Questionnaire (CFQ; Birch et al., 2001). The CFQ is widely used to assess parenting feeding styles. The present study used the restriction and pressure to eat subscales to measure parental coercive feeding practices. The restriction subscale measures the extent to which parents restrict their child’s access to foods (e.g., ‘I have to be sure that my child does not eat too much of her favorite foods’), whereas the pressure to eat subscale measures parent’s tendency to pressure their child to eat more food they want them to eat (e.g., ‘If my child says ‘I’m not hungry’, I try to get her to eat anyway’). The questionnaires included 12 items, scoring on a scale from disagree (1) to agree (5).

2.3.4. Assessment of texture preferences with actual food stimuli

In the second session of the study, children’s texture preferences were assessed through a paired preference test with actual foods that represented food pairs selected from the pictographic questionnaire. The test examined the predictability of the questionnaire to children’s preferences made after tasting. Six food pairs were selected for method validation (carrot, cornflakes, cheese, orange juice, strawberry jam, and yogurt) (see Table 1). Details of the food samples and preparations are given in Appendix B. Tasting was voluntary, and children were asked to drink water between tastings for palate cleansing.

At the start of the test, children were asked to rate their hunger (not hungry, a little hungry, very hungry). Next, parents served the food pair to their child according to the description shown on the screen. Samples were labeled with descriptions identical to the pictographic questionnaire. As a forced-choice task, children tasted the two samples within a pair and indicated their preferred one: “Which one do you prefer?”. The presentation of the food pairs and the pair samples’ position were randomized between children.

2.4. Data analysis

Statistical analyses were conducted using R version 4.3.1 (R Core Team, 2023) and latent class analysis using Latent Gold 6.0 (Statistical Innovation, Belmont, USA), with a significance level set at p < 0.05. Regression models were tested for multicollinearity by calculating the variance inflation factor, and no collinearity was detected. Effects of categorical variables were reported in estimated marginal means (EMM’s) unless otherwise indicated.

2.4.1. Food texture preferences

The questionnaire responses were coded as 1 for preferring the harder and with-particle food and 0 for preferring the soft and no-particle food of each pair. All findings were reported separately for each texture dimension (hardness and particle content).

Generalized linear mixed model (GLMM) logistic regression was used to examine potential demographic variables and child and parental characteristics that might influence children’s texture preferences. For each texture dimension, the model considered preference (1 or 0) as the outcome, fixed effects of children’s age (as a covariate), gender, food pair, composite scores for food neophobia, sensory responsivity, food consumption frequency, CFQ subscales on restriction and pressure to eat, and random effect of the child. Results were expressed as the probability of preferring the hard or with-particle foods, ranging from 0 to 1. Post hoc analysis compared the estimated probabilities with the halfway point of 0.5 using the Holm method for multiple testing (Holm, 1979). Moreover, the effects of composite scores were reported per an interquartile change in the score (see Appendix C).

Latent class analysis (LCA) was used to identify subgroups of children with similar response patterns in the questionnaire. LCA with two classes was performed per texture dimension. Wald tests assessed the differences between the two clusters in questionnaire responses. Differences between the two identified clusters in relation to child characteristics (i.e., age, gender, and food neophobia) were further determined.

The concordance of children’s texture preferences with their parents was calculated as the percent agreement for each food pair in the questionnaire. Parent-child differences in preferences were examined by GLMM logistic regression. The model considered preference as the outcome, fixed effects of food pair and participant group (children or parent), and the random effect of the parent-child dyad. Differences in preferences for individual food pairs were compared in post hoc analysis. The GLMM procedure was also used to examine the influence of parental preferences on their children. The model considered children’s preference as the outcome, the fixed effect of parental preferences (total number of hard/with-particle foods preferred, as a covariate), and the random effect of food pair and child. Moreover, parental perceptions of children’s texture acceptance were compared between two LCA-identified preference clusters using t-tests and adjusted with Holm’s correction.

2.4.2. Questionnaire validity

The predictive validity of the pictographic questionnaire was assessed in terms of the consistency between children’s responses in the questionnaire and the paired preference test using actual foods. For each food pair, a child preferring the same texture version across the two tests was coded as 1 (agreement), and inconsistency was coded as 0 (disagreement). GLMM logistic regression was used to examine potential child characteristics that might affect the agreement. The model included fixed effects of food pairs, children’s age (as a covariate), gender, hunger level (not little vs. very), food neophobia score, and random effects of the child. To have better insights into the effect of age
on the agreement, a second model was run using age group (categorical variable: 3-year-old, n = 79; 4-year-old, n = 50; 5-year-old, n = 65; 6-year-old, n = 41) as a fixed effect. Thus, results were expressed as the probability of agreement (range: 0–1) per food pair or age group. Post hoc analysis compared the estimated probabilities with the change level of 0.5 using the Holm method for multiple testing.

3. Results

The final sample of the study consisted of 235 children (mean age of 4.7 years), including 53 sibling pairs and their parents (n = 193). Table 2 shows the child’s demographics and early feeding patterns. There were slightly more boys (n = 134, 57 %) than girls (n = 101, 43 %). Most children were breastfed after birth (96.2 %) and introduced to solid foods between 4 and 6 months (76.6 %), which reflected the country-level estimates of Denmark (Kronborg et al., 2015). The parents were between 26 and 54 years of age (mean age: 36.3 ± 2.1), and 90 % of them were mothers.

3.1. Children’s texture preferences in the questionnaire

3.1.1. Factors influencing child texture preferences

Table 3 shows the probability of children preferring the hard over soft food or the with-particle over no-particle food of a pair in the pictographic questionnaire. Details of the logistic regression models fitted for each texture dimension are provided in Appendix C.

Children showed significant differences in preferences for foods differing in hardness (p < 0.0001). The estimated probabilities of preferring the hard food of a pair ranged from 0.30 to 0.65 (Table 3). The average probability of preferring the hard versions of foods was 0.5 (95 % CI: 0.48–0.53). The results suggested that children did not show distinct preferences for hard and soft foods.

At the individual level, there was a significant effect of age on preferences (p < 0.0001). From 3 to 6 years, the odds of children preferring hard foods decreased by 17 % per year, indicating that children developed preferences for soft textures with age. The effect of food neophobia was also statistically significant (p = 0.005). The odds of preferring hard foods increased by 29 % per one interquartile increase in food neophobia scores. There were no effects of gender, sensory sensitivity, food consumption frequency, or parental feeding styles on preferences (p > 0.05).

Children’s texture preferences significantly differed between food pairs in the particle dimension (p < 0.0001). The average probability of preferring the with-particle versions of foods was 0.22 (95 % CI: 0.19–0.25). Post-hoc tests confirmed that children consistently preferred foods without particles, as the estimated probabilities for all pairs were significantly below 0.5 (Table 3).

At the individual level, food neophobia significantly influenced children’s preferences for particles in foods (p < 0.0001). The odds of children preferring with-particles foods were reduced by 55 % per one interquartile increase in food neophobia scores, indicating that children’s preferences for particle-containing foods decreased with increasing food neophobia.

The effect of age was significant that the odds of children preferring with-particle foods decreased by 16 % per year (p = 0.014). The analysis also showed a gender difference in preferences (p = 0.029), in which girls were less likely to prefer particle-containing foods than boys (OR = 0.69).

Finally, parental use of restrictive feeding practices significantly influenced children’s preferences for particles in foods (p = 0.021). The odds of children preferring with-particle foods decreased by 27 % per one interquartile increase in restriction feeding (measured by CFQ). Children with higher consumption frequency of differing food textures were significantly more likely to prefer foods containing particles (p = 0.024). The odds of preferring with-particle foods increased by 29 % per one interquartile increase in scores for food consumption frequency.

3.1.2. Preference segmentation

Latent class analysis was used to identify subgroups of children with specific texture preferences assessed by the questionnaire. For the

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### Table 2
Child’s demographics and early feeding patterns (n = 235).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (boy:girl)</td>
<td>134:101</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>4.7 ± 1.2</td>
</tr>
<tr>
<td>BMI (mean ± SD)</td>
<td>15.1 ± 2.1</td>
</tr>
<tr>
<td>Breastfeeding initiated after birth (%)</td>
<td>Yes: 96.2, No: 3.8</td>
</tr>
<tr>
<td>Time for introduction of solid food (%)</td>
<td>Before 4 months: 3.8, 4 to 6 months: 76.6, 7 to 9 months: 18.7, Later than 9 months: 0.9</td>
</tr>
</tbody>
</table>

---

### Table 3
Estimated probability of preschooler preferring the hard (A) or with-particle (B) food of each pair in the pictographic questionnaire.

<table>
<thead>
<tr>
<th>Food pair</th>
<th>Hard / With-particles variant</th>
<th>Soft / No-particles variant</th>
<th>Probability of preferring the hard or with-particles food of a pair (95 % CI)</th>
<th>P&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Preferred texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Hardness dimension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple 1</td>
<td>Whole</td>
<td>In slices</td>
<td>0.30 [0.25, 0.37]</td>
<td>&lt; 0.0001</td>
<td>Soft</td>
</tr>
<tr>
<td>Apple 2</td>
<td>Raw</td>
<td>Puree</td>
<td>0.61 [0.55, 0.67]</td>
<td>0.0050</td>
<td>Hard</td>
</tr>
<tr>
<td>Bread</td>
<td>Crispbread</td>
<td>Toast bread</td>
<td>0.38 [0.32, 0.45]</td>
<td>0.0030</td>
<td>Soft</td>
</tr>
<tr>
<td>Carrot</td>
<td>Raw (in pieces)</td>
<td>Grated</td>
<td>0.65 [0.58, 0.71]</td>
<td>&lt; 0.0001</td>
<td>Hard</td>
</tr>
<tr>
<td>Cheese</td>
<td>In pieces</td>
<td>In slices</td>
<td>0.51 [0.44, 0.57]</td>
<td>0.035</td>
<td>None</td>
</tr>
<tr>
<td>Chocolate</td>
<td>Biscuit</td>
<td>Cake</td>
<td>0.41 [0.35, 0.47]</td>
<td>0.066</td>
<td>None</td>
</tr>
<tr>
<td>Cornflakes</td>
<td>Crispy</td>
<td>Soften</td>
<td>0.58 [0.52, 0.65]</td>
<td>0.0001</td>
<td>No-particle</td>
</tr>
<tr>
<td>Potato</td>
<td>Boiled</td>
<td>Mashed</td>
<td>0.57 [0.51, 0.63]</td>
<td>0.066</td>
<td>None</td>
</tr>
<tr>
<td>B. Particle dimension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bread</td>
<td>With grains</td>
<td>Plain</td>
<td>0.17 [0.12, 0.22]</td>
<td>&lt; 0.0001</td>
<td>No-particle</td>
</tr>
<tr>
<td>Orange juice</td>
<td>With pulp</td>
<td>Plain</td>
<td>0.16 [0.11, 0.21]</td>
<td>&lt; 0.0001</td>
<td>No-particle</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>Chunky</td>
<td>Smooth</td>
<td>0.22 [0.17, 0.28]</td>
<td>&lt; 0.0001</td>
<td>No-particle</td>
</tr>
<tr>
<td>Strawberry jam</td>
<td>With fruit pieces</td>
<td>Plain</td>
<td>0.35 [0.28, 0.42]</td>
<td>0.00015</td>
<td>No-particle</td>
</tr>
<tr>
<td>Strawberry</td>
<td>With fruit pieces</td>
<td>Plain</td>
<td>0.37 [0.30, 0.44]</td>
<td>0.00057</td>
<td>No-particle</td>
</tr>
<tr>
<td>Tomato soup</td>
<td>With tomato pieces</td>
<td>Plain</td>
<td>0.12 [0.09, 0.17]</td>
<td>&lt; 0.0001</td>
<td>No-particle</td>
</tr>
</tbody>
</table>

Note. Post hoc test comparing the estimated probability to the halfway point 0.5. A value significantly above 0.5 indicated a preference for the harder or with-particle food of each pair. For example, the probability of preferring ‘raw carrot pieces’ was 0.65, and ‘grated carrot’ was 0.35.

<sup>a</sup> P value adjusted based on the Holm method.
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hardness dimension, results did not show differences in preference patterns between the two identified clusters. In contrast, for the particle dimension, the two identified clusters showed clear differences in preference patterns (Appendix D). The first cluster included 155 children (64 %), and the second included 80 children (34 %).

Children in the first cluster (‘no particles’) preferred foods without particles in general. Conversely, children in the second cluster (‘with or without particles’) showed specific preferences for strawberry jam and yogurt with fruit pieces; they also preferred the no-particle foods in other pairs but to a lesser extent than in the first cluster. Fig. 1 shows the preference patterns for all food pairs (percentage of children in the two clusters preferring the with-particle food of each pair). The two clusters showed significant differences in preference patterns for all food pairs (p < 0.01) except for orange juice (Appendix E).

Comparison between clusters showed that children in the ‘no particles’ cluster were significantly older (mean age: 4.9 vs. 4.5; p = 0.019) and more food neophobic (mean CFNS: 17.8 vs. 14.7; p = 0.0001) than the others in the ‘with or without particles’ cluster, consistent with the results obtained from the logistic regression analysis. There was no significant association between the cluster and gender (p = 0.79).

3.2. Parental and child texture preferences

3.2.1. Concordance between parent–child dyads

The percentage of parents and children preferring the harder or with-particle food of each pair in the questionnaire is shown in Fig. 2. The overall concordance in texture preferences between parent–child dyads was 55 % for hardness and 49 % for particle content of foods. Consistent with the low concordance rates, analysis of the impact of parental texture preferences on their children’s preferences showed that the effect was not significant for both hardness (p = 0.72) and particle content (p = 0.10).

Comparison between the two groups showed that parents were significantly more likely than children to prefer hard and with-particle foods (p < 0.0001). The average probability for preferring hard foods was higher for the parents than children (0.58 vs. 0.50, respectively), and likewise for preferring with-particle foods (0.61 vs. 0.23, respectively). There was a significant difference between parent and children in their preferred texture types in four hardness food pairs (apple 2, bread, cake, cornflakes) and all particle food pairs except yogurt (see Fig. 2). The discrepancy between parental and child preferences for foods with particles was notably larger than preferences for harder foods.

3.2.2. Parental perceptions of children’s texture acceptance

Parental perceptions of children’s texture acceptance were compared between the two LCA-identified preference clusters (Table 4). Children’s liking of particle-containing textures differed significantly between the two clusters (p < 0.0001). The parents rated children in the ‘no particles’ cluster lower for liking food containing pieces (mean scores 3.1 vs. 3.7, respectively) than those in the ‘with or without particles’ cluster.

3.3. Validity of the pictographic questionnaire

The predictive validity of the questionnaire was examined by comparing the results to data from the paired preference test using actual food stimuli in terms of the level of agreement (i.e., for each food pair, children indicated the same preference across the two test methods). The logistic regression fitted with food pairs and children’s demographic variables showed that the overall probability of agreement was 0.62 (95 % CI: 0.60–0.65). Post-hoc tests confirmed that the agreement level was significantly above chance (compared to 0.5; p < 0.0001). There was no difference in agreement between food pairs (p = 0.15; Table 5).

There were no effects of gender, children’s hunger, or food neophobia levels on agreement (p > 0.05). However, there were significant

![Fig. 1. Percentage of children in the two LCA-identified clusters (cluster 1: ‘no particles’ and cluster 2: ‘with or without particles’) preferring the with-particle versions of foods in the questionnaire. Differences in preference patterns between the two clusters were significant for all food pairs (p < 0.01) except for orange juice (p = 0.063). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)](image-url)
differences in agreement by age ($p = 0.007$). The odds of children choosing consistently across two tests increased by 15% (95% CI: 3.8–27.1) per year, suggesting that the predictive validity of the questionnaire increased with age.

In addition, Table 5 shows the percentage of children who gave different responses between the pictographic questionnaire and the paired preference test (i.e., inconsistency between methods). These children tended to indicate preferences for the soft or no-particle foods in the questionnaire but preferred the hard or with-particle version in food tasting. This phenomenon was observed in all age groups and food pairs differing in particle content.

### 4. Discussion

The present study used the pictographic forced-choice method to study food texture preferences in 3 to 6-year-old children. Texture preferences in young children have been understudied partially due to a lack of suitable test tools. A key strength of this study was adapting the forced-choice questionnaire for this young age range, using an adequate sample of children with demographic variables that reflected the population estimates (e.g., the early feeding pattern in Denmark (Kronborg et al., 2015)).

A main finding of this study is the similarity of young children’s texture preferences with schoolchildren, demonstrated in our earlier study that children did not show distinct preferences for hard or soft
foods but a preference for foods without particles. Moreover, there was a strong relation between food neophobia and children’s rejection of particles in foods. Consistent across two stages of child development (preschool: 3 to 6 years and school-age: 7 to 10 years), children with higher levels of food neophobia were less likely to prefer foods with particles. Previous studies have also linked children’s lower preferences for particulate textures to food neophobia (Appiani et al., 2020; Laureati et al., 2020; Lukasewycz & Mennella, 2012; Sandvik et al., 2021).

With increasing food neophobia, children’s preferences for foods without particles were more pronounced. The recent survey study by Jaeger et al. (2023) demonstrated that (negative) arousal underlies the rejection of novel and familiar foods in food neophobia. While food novelty is a main source of unpleasantly high arousal, the complexity, intensity, and perceived danger in food stimuli can also evoke negative arousal (Berlyne, 1970; Jaeger et al., 2023; Spinelli et al., 2023). Previous research has indicated that children dislike foods with ‘things in it’; double textures with pieces inside the foods not only reflect higher complexity but also require a greater effort for oral processing, thus posing a higher risk of gagging/choking to children (Chow et al., 2022; Seo, 2015; Szczesniak, 1972). It is possible that double textures in foods are more arousing-inducing than homogenous textures, and such high arousal may mediate the association between food neophobia and children’s lower preferences for foods with particles.

Selective/picky eating in children has been previously linked to anxiety and sensory responsivity (Farrow & Coulthard, 2012). Although the present findings did not suggest correlations between a child’s sensory responsivity and texture preferences, further research may explore the role of high arousal in food neophobia and their lower preferences for foods with particles.

In addition to food neophobia, the questionnaire data showed age- and gender-related differences in children’s preferences for particles in foods. Children were less likely to prefer foods with particles with increasing age. A plausible explanation for this preference change is the development of food neophobia. In this sample, children’s food neophobia was not associated with age; similar results have been reported elsewhere among children of the same age range (Cooke et al., 2003; Russell & Worsley, 2008). Nevertheless, a recent study exploring the trajectory of food neophobia across the life course (1–87 years) showed that the trait peaks at around 6 or 7 years (Hazley et al., 2022). The preference shift (from particle-containing to homogenous textures) may reflect increasing neophobic tendencies in young children.

Moreover, the finding that girls were more likely to prefer foods without particles than boys confirmed the gender effect reported in our earlier study with schoolchildren (Skouw et al., 2023). The dislike of texture was identified as a more important reason for food rejection in school-age girls than boys (Sick et al., 2019). This gender effect can also be seen in adults. Women showed a higher awareness of food textures than men (Luckett & Geo, 2015; Szczesniak & Kahn, 1971).

In this study, food pairs differing in hardness (hard vs. soft texture) were updated from our earlier study to improve the questionnaire discrimination (see Section 2.3.2). The likelihood of children preferring hard foods remained at 50 %, as in the data from Skouw et al. (2023), but children showed specific preferences for hard or soft textures for each food pair individually (see Table 3). Also, the latent class analysis did not identify specific groups of children with similar preference patterns within the groups. These results suggested a lack of generic preferences for hard or soft foods in children. Conversely, the preference appears specific to individual products or food pairs.

The data also showed age-related differences in preferences for hard foods, which was not observed in previous studies with schoolchildren (Laureati et al., 2020; Lukasewycz & Mennella, 2012; Skouw et al., 2023). From three to six years of age, children were less likely to prefer hard foods with increasing age. This preference shift might relate to changes in children’s dentition. A child’s deciduous dentition remains stable throughout preschool until six years and progressively transits to permanent adult dentition. During this stage, children’s masticatory efficiency continuously improves with dental eruption and orofacial growth (Almotairy et al., 2018). However, children may experience

| Table 4 |

Comparison of parental perceptions of children’s texture acceptance between the two LCA-identified preference clusters.

<table>
<thead>
<tr>
<th>Children’s texture acceptance</th>
<th>Cluster 1: ‘no particles’ (n = 155, 66 %)</th>
<th>Cluster 2 ‘with or without particles’ (n = 80, 34 %)</th>
<th>p (^{a})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard food</td>
<td>3.6</td>
<td>3.7</td>
<td>0.76</td>
</tr>
<tr>
<td>Soft food</td>
<td>3.8</td>
<td>3.9</td>
<td>0.76</td>
</tr>
<tr>
<td>Food that requires heavy chewing</td>
<td>3.3</td>
<td>3.4</td>
<td>0.75</td>
</tr>
<tr>
<td>Food containing pieces</td>
<td>3.1</td>
<td>3.7</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Food without pieces</td>
<td>4.0</td>
<td>3.7</td>
<td>0.066</td>
</tr>
<tr>
<td>Having a variety of textures on the plate</td>
<td>3.4</td>
<td>3.7</td>
<td>0.067</td>
</tr>
<tr>
<td>Having a limited variety of textures on the plate</td>
<td>3.4</td>
<td>3.7</td>
<td>0.067</td>
</tr>
</tbody>
</table>

\(^{a}\) P value adjusted based on the Holm method.

| Table 5 |

Estimated probability of agreement and percentage of preference changes between children’s responses measured in the pictographic questionnaire and the paired preference test with actual food stimuli, grouped by food pair (A) and age group (B).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Probability of agreement [95 % CI]</th>
<th>p (^{a})</th>
<th>Preference change to hard / with-particle food</th>
<th>Preference change to soft / no-particle food</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Food pair</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrot</td>
<td>0.68 [0.61, 0.74]</td>
<td>&lt; 0.0001</td>
<td>0.23</td>
<td>0.09</td>
</tr>
<tr>
<td>Cheese</td>
<td>0.59 [0.52, 0.66]</td>
<td>0.023</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>Cornflakes</td>
<td>0.65 [0.58, 0.71]</td>
<td>&lt; 0.0001</td>
<td>0.13</td>
<td>0.23</td>
</tr>
<tr>
<td>Orange juice</td>
<td>0.66 [0.59, 0.72]</td>
<td>&lt; 0.0001</td>
<td>0.22</td>
<td>0.12</td>
</tr>
<tr>
<td>Strawberry jam</td>
<td>0.59 [0.53, 0.66]</td>
<td>0.017</td>
<td>0.23</td>
<td>0.17</td>
</tr>
<tr>
<td>Strawberry yogurt</td>
<td>0.58 [0.51, 0.64]</td>
<td>0.026</td>
<td>0.27</td>
<td>0.15</td>
</tr>
<tr>
<td>B. Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-year-old (n = 79)</td>
<td>0.58 [0.53, 0.63]</td>
<td>0.0029</td>
<td>0.24</td>
<td>0.19</td>
</tr>
<tr>
<td>4-year-old (n = 50)</td>
<td>0.63 [0.57, 0.69]</td>
<td>&lt; 0.0001</td>
<td>0.21</td>
<td>0.16</td>
</tr>
<tr>
<td>5-year-old (n = 65)</td>
<td>0.63 [0.58, 0.68]</td>
<td>&lt; 0.0001</td>
<td>0.20</td>
<td>0.16</td>
</tr>
<tr>
<td>6-year-old (n = 41)</td>
<td>0.69 [0.62, 0.74]</td>
<td>&lt; 0.0001</td>
<td>0.21</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Note. Post hoc test comparing the estimated probability of agreement to the chance level 0.5. A value significantly below 0.5 indicated no agreement between the two preference measurements. Preference change referred to children changing responses from the pictographic questionnaire to the paired preference test.  

\(^{a}\) P value adjusted based on the Holm method.
discomforts, such as loose teeth and tendered gum. A temporal shift of preferences for softer textures could be a coping strategy to overcome difficulties or discomfort due to changing dentition. It was observed among healthy children and children presenting early childhood caries that chewing difficulties can negatively impact their masticatory performance or preferences for hard foods, such as raw apples and carrots (Linas et al., 2019; Schwartz et al., 2021; Tournier & Forde, 2023).

The literature has been consistent in reporting that children were less likely to prefer hard foods and foods with particles than their parents, which suggested a progressive shift of texture preferences from early childhood to adulthood (Cappelotto & Olsen, 2021; Laureati et al., 2020; Łukasewycz & Mennella, 2012; Szczeniak, 1972). In particular, parents’ preferences for foods with particles were considerably higher than their children’s. Along with data from our earlier study, which reported a generally low preference for foods with particles among 7- to 10-year-old children (Skouw et al., 2022), these results suggested that preferences for particles in foods may develop after the school-age period.

This study also assessed the texture preferences of the parents and revealed low concordances (49–55 %) of preferences between parent-child dyads. Consistent with previous findings (Cappelotto & Olsen, 2021; Łukasewycz & Mennella, 2012), parents’ preferences had little direct relation to their children’s. Parents make food choices for their children, which may differ from what they prefer. For example, parents were aware of their child’s rejection of particles in foods (see Table 4). Moreover, the parent practice of offering diverse food textures, particularly double textures, to children when they are developmentally ready could facilitate texture acceptance in their later ages (Blossfeld et al., 2007; Lundby et al., 1998; Tournier et al., 2021). In agreement with these findings, children’s higher preferences for foods containing particles were related to frequent consumption of foods with different textures (e.g., homogeneous and particle-containing). The result indicates the importance of allowing children to experience different textures to foster more diverse food preferences.

Interestingly, children experiencing higher levels of parental feeding restriction were less likely to prefer foods with particles. Restriction in feeding has previously been reported to negatively affect children’s eating and weight status, such as overeating and preferences for energy-dense foods (Faith et al., 2004; Fisher & Birch, 1999). Recent studies further suggested that parental feeding practices may influence children’s oral processing during mealtimes. Children who ate fast for long, and consumed higher energy experienced more parental restrictions during meals (Fogel et al., 2019; Fries et al., 2019). Alternatively, parental restrictions may stress the child and be a factor in conditioning them to eat faster. Given that adding particles to homogeneous products could greatly increase the number of chews and consumption time and reduce eating rates (Aguayo-Mendoza et al., 2020), a possible explanation for this finding may be that these children tend to eat faster or consume larger portions during meals, which encourage the selection of foods without particles that can be consumed at a faster rate.

The present study used protocols similar to those of Skouw et al. (2023) to examine the validity of the pictographic questionnaire for young children by using actual food stimuli for preference assessment and thus comparing the experimental results with the questionnaire data. In this study, children aged 3 to 6 years showed an average agreement level in preferences of 63 %, which was marginally lower than our earlier findings in 7- to 10-year-old children, showing 67 % agreement.

The current data demonstrated that the questionnaire validity was influenced by the child’s age. The 3-year-old child group was most likely to respond inconsistently in the questionnaire and the preference assessment using actual food stimuli, as reflected by an agreement level closest to chance (see Table 5). Apparently, the pictographic questionnaire provided a close to random measure of texture preferences in this age group, which corroborated with other studies showing less reliable measures of food preferences for younger children (Guthrie et al., 2000; Köster et al., 2003; Léon et al., 1999). The 3-year-old may have greater difficulty understanding the tasks (Guinard, 2000; Issanchou, 2015), more random answering behaviors in a forced-choice experimental setting, or more explorative food choice behaviors.

The use of home settings in the present study might have improved the ecological validity, as young children could feel familiar and comfortable with the test condition. For instance, children interviewed by mums were more at ease expressing their dislike of food (Popper & Kroll, 2005). Parents also described their participation as fun and engaging for their children, and they could learn more about their children’s food preferences. However, the fact that experimenters were not present in the sessions (i.e., through online supervision) could be a limitation of the study, as parents might have conducted the sensory tests differently from the suggested protocols.

While forced-choice questionnaires are convenient tools for studying texture preferences in children (Chow et al., 2022), the questionnaire drawings were presented as a proxy of foods to help children set up expectations for actual sensory perception (Sildegaard et al., 2011). It is acknowledged that the questionnaire produced only fair to moderate predictive validity to children’s texture preferences measured using actual foods and that young children at three years were less reliable in completing the questionnaire. Children tended to exaggerate their preferences for soft and no-particle foods but preferred the hard and with-particle foods during tasting. Thus, the questionnaire results may show higher preferences for soft and particle-containing foods in children. However, irrespective of this methodological limitation, there is a need to understand further the causes of food texture rejection in young children.

5. Conclusion

This study identified child and parental characteristics that could influence young children’s food texture preferences, measured using the pictographic forced-choice questionnaire. The results demonstrated a predisposition for children to prefer foods without particles and that children’s rejection of particles in foods was strongly related to increased food neophobia. On the other hand, although children did not show distinct preferences for food differing in hardness, preferences appeared to be specific to the product itself. Comparing texture preferences in parent–child dyads revealed significant differences between the two age groups. Parents’ feeding practices, but not their own texture preferences, may affect their children’s texture preferences. These results can be useful for developing new products or interventions to expand food texture acceptance at young ages. Finally, the validity of the pictographic questionnaire was confirmed by agreement with texture preference assessments using actual food stimuli, in which children gave moderately consistent results across the two methods. Further application of the questionnaire to consumers of different age groups (schoolchildren, teenagers, and young adults) will increase the understanding of the developmental trajectory of texture preferences across lifespans.

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CRediT authorship contribution statement

Ching Yue Chow: Conceptualization, Methodology, Investigation, Visualization, Formal analysis, Writing – original draft. Anne C. Bech: Conceptualization, Methodology, Investigation, Formal analysis, Supervision, Writing – review & editing. Helle Sørensen: Visualization, Formal analysis, Writing – review & editing. Annemarie Olsen: Conceptualization, Methodology, Supervision, Writing – review &
editing. Wender L.P. Bredie: Conceptualization, Methodology, Supervision, Writing – review & editing, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ching Yue Chow reports financial support was provided by Arla Foods amba. Anne C. Bech reports a relationship with Arla Foods amba that may be considered as potential competing interests.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary information to this article can be found online at https://doi.org/10.1016/j.foodqual.2023.105063.

References


