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ABSTRACT

Previous research established that children with poorer taxonomic knowledge in the food domain display increased levels of food rejection. However, the food domain heavily lends itself to script and thematic conceptual knowledge (e.g., pancakes at breakfast), to which young children already attend. This series of studies investigated the development of conceptual knowledge, specifically in the food domain, and the link with food rejection. Study 1 used a nonconflicting triad task testing children's knowledge of four subtypes of script and thematic associations (food–food pairs, food–utensil pairs, event scripts, and meal scripts) with children aged 3–6 years living in the United States (18 males and 14 females). Study 2 employed the same design along with a measure of food rejection in 3- to 6-year-olds living in France (67 males and 62 females). There was significant conceptual development in both groups, but thematic food concepts are acquired earlier than meal script concepts. Study 3 investigated the link between thematic and script cross-classification and food rejection in 39 females and 33 males living in France (4- to 7-year-olds). Results demonstrate that children as young as 3 years old are already attending to thematic and script structures to inform food-based decision making. Even more critically, Study 3 showed that increased food rejection tendencies are negatively related to script and thematic understanding in the food domain. Such seminal studies illustrate

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the importance of conceptual knowledge in children's interpretation and acceptance of food, highlighting promising avenues for knowledge-based interventions to foster dietary variety.

Introduction

Concepts are the mental representation of entities (e.g., a tomato is round, red, and juicy), and conceptual relations are the interrelations between concepts (e.g., a tomato is related to cheese in that they both are foods but also are commonly paired together) (Gelman, 2003; Murphy, 2002). There are many prevalent associations when thinking about eating situations because food rarely appears in isolation, is frequently accompanied by other items and foods, and is consumed in certain spatiotemporal contexts (Thibaut et al., 2016). Pioneering studies show that children and adults regularly rely on diverse concepts and categories to organize, store, and retrieve information about eating situations (Nguyen & Murphy, 2003; Rioux et al., 2016; Ross & Murphy, 1999; Thibaut et al., 2016). Adults have been witnessed spontaneously referring to taxonomic knowledge (e.g., vegetables), script-based knowledge (e.g., breakfast foods), thematic knowledge (e.g., cereal and bowl), and even ad hoc or goal-derived knowledge (e.g., things to eat in a hurry) when confronted with foods (Barsalou, 1983; Lin & Murphy, 2001; Ross & Murphy, 1999). Script relations are formed through categorizing objects based on a shared event script or schema representation such as a party hat and a cake representing a birthday party (Estes et al., 2011). Some script relations may further be considered as slot-fillers in that they play the same role in an event or a routine such as foods eaten at breakfast or a birthday party (Lucariello et al., 1992; Nelson, 1993). Thematic relations are complementary or conventional relations among objects, events, people, and other entities that co-occur or interact in space and time (Denney, 1975; Denney & Moulton, 1976; Markman, 1989; Markman et al., 1981). Research demonstrates that such conceptual knowledge influences our food decisions and allows us to form expectations of eating situations (Bian & Markman, 2020b; Ross & Murphy, 1999). For example, although a tomato belongs to the taxonomic category of fruits, we may be less accepting of a tomato prepared in a fruit salad or served as a dessert.

Decades of developmental literature demonstrate that young children are particularly attentive to thematic and script knowledge and spontaneously form collections of items that belong together or form a scene (Denney & Moulton, 1976; Keil, 1989; Markman, 1989; Markman et al., 1981). This is true in the eating situations and meal script appropriateness that already appears to be salient in preschool children. American children aged 3 and 4 years already impose contextual constraints on certain foods for specific mealtimes such as deeming chicken inappropriate for breakfast (Bian & Markman, 2020a; Birch et al., 1984; Nguyen, 2012; Nguyen & Murphy, 2003; Zeinstra et al., 2007). Recent work has examined children's knowledge of breakfast scripts in 4- and 5-year-old children living in the United States and China (Bian & Markman, 2020a). Children in the United States had more rigid notions of foods that belong in the script of breakfast foods, believing that fewer foods were appropriate at certain mealtimes (Bian & Markman, 2020a).

Children's judgment about the script associations of foods does not rest solely at the level of the food itself, with children also extending that judgment to people eating unconventional food associations (DeJesus et al., 2019). In a task where 5-year-olds were asked to judge individuals based on what they ate, children evaluated anyone who ate unconventional food associations (e.g., hot dog with chocolate sauce) more negatively than people who ate what they considered to be conventional associations (DeJesus et al., 2019). Together, these findings demonstrate that children are not only attending to conventional thematic and script knowledge to guide food acceptance but also evaluating others' food choices. In other words, children from a young age hold strong opinions about what and how to eat foods and generalize these beliefs in the judgments of others. Consequently, it is crucial in a domain such as food to investigate how children come to acquire and appreciate the more

culturally dependent thematic and script relations. In addition to gaining insights into the development of these relations in children, it is also important to examine whether thematic and script knowledge in the food domain is linked with food rejection tendencies in children.

There are three main lines of argument for our subsequent investigation into whether food rejection is linked with thematic and script knowledge in the food domain. First, as aforementioned, our expectations and acceptance of food are heavily guided by contextual cues based on existing thematic and script knowledge. Food is much more likely to be accepted if it conforms to our existing notions of thematic and script associations (e.g., chocolate and strawberries as opposed to chocolate and salmon). Second, developmental studies show that such thematic and script structures are particularly salient to young children who frequently rely on such conceptual knowledge to interpret their surroundings (e.g., expecting cereal at breakfast). However, the most crucial argument is that thematic and script associations are reliant on experience (Gelman, 2003; Murphy, 2002; Oakes & Madole, 2003). As such, younger children will have a limited conceptual representation of foods, including important thematic and script associations (Shutts et al., 2009). Having reduced script and thematic knowledge is problematic because it increases the probability that a young child is presented with foods or eating scenarios that are unfamiliar. When faced with an unfamiliar object or situation, we are much more likely to avoid the situation because humans, like other species, are biologically driven to avoid risky or adverse scenarios (Crane et al., 2020). Equally, having less conceptual understanding to draw on appropriate conceptual relations may also lead to a child forming incorrect conclusions, for example, believing that cereals and milk are the only acceptable instances of breakfast food (Bian & Markman, 2020a). Such uncertainty or incorrect conclusions frequently result in food rejection tendencies (i.e., food neophobia) and food pickiness, which are commonly witnessed in children aged 2–7 years.

Food neophobia is the reluctance to eat or even try novel food items, believed to be a protective function to prevent the ingestion of potentially harmful substances (Fallon et al., 1984; Milton, 1993; Rozin et al., 1985). Heavily interlinked to food neophobia, yet distinct, is picky/fussy eating (Dovey et al., 2008; Rioux et al., 2017b). Picky eating is defined as a substantial rejection of familiar food, certain food textures, or a lack of particular foods or food groups (Birch et al., 1991; Taylor et al., 2015). With only 18% of children eating five standard portions of fruit and vegetables per day (Conolly et al., 2019), it is imperative to address the factors influencing children's eating behaviors. Dietary variety is of paramount importance not only for physical health but also for forming healthy eating attitudes and behaviors in later life (Evans et al., 2018; Jirout et al., 2019; Maratos & Sharpe, 2018). Food neophobia has been linked to a significant reduction in vegetable consumption, decreased dietary variety, and lower liking for all food groups (Dovey et al., 2008; Galloway et al., 2003). Both food neophobia and food pickiness heavily reduce dietary variety, particularly in fruit and vegetable consumption (Fletcher et al., 2017; Perry et al., 2015). A study showed that children aged 2–5 years were twice as likely to be underweight if they were picky eaters (Dubois et al., 2007). Therefore, from a public health perspective, it is crucial to address how children's conceptual knowledge guides their acceptance or rejection of foods (Lafraire et al., 2016).

Seminal studies have indeed determined that impoverished taxonomic knowledge of foods (e.g., a banana is a fruit) is linked to food rejection in young children (Rioux et al., 2016, 2018). Furthermore, recent evidence supports the theory that children with high levels of food rejection are executing increased caution when determining whether items are edible. Foinant et al. (2021) demonstrated with a sample of 137 4- to 6-year-olds that children with high levels of food rejection displayed a more conservative strategy in that they incorrectly categorized food items as inedible more than children with lower food rejection. The studies that have investigated how gaps in conceptual knowledge underpin food neophobia have focused almost exclusively on taxonomic knowledge. However, script and thematic associations are intuitively predictive of food acceptance (e.g., expecting cereal at breakfast) and have been surprisingly disregarded until now.

Furthermore, given that children are attentive to thematic and script knowledge of their environment, it is important to think of how these two types of conceptual knowledge influence children's food rejection. To the authors' knowledge, these are the first studies to investigate the distinct developmental trajectories of thematic and script knowledge structures in the food domain and their relations with food rejection tendencies. Even though the research is exploratory, the results will be of

interest to the fields of both cognitive/development science (children's conceptual knowledge) and behavioral science (eating behavior) and will contribute to bridging these fields. Take, for example, knowing that eggs can be served at breakfast with toast. If children do not have sufficient knowledge of foods belonging to scripts (i.e., eggs for breakfast) and thematically associated foods (i.e., eggs with slices of toast), we predict that they will be left feeling uncertain about the appropriateness of the food scene. When an item or a situation holds a potential risk, it is safer to reject such an instance. This is especially true in a domain such as food in which ingesting a novel substance may lead to disgust, illness, or even toxicity (Crane et al., 2020). Therefore, our main prediction was that a lack of thematic and script knowledge of food was expected to be related to increased food rejection.

However, the relation between food rejection and conceptual development is far from simple because conceptual knowledge is heavily dependent on lived experience (Contento, 1981). Evidence shows that food-to-mealtime scripts (e.g., oatmeal at breakfast) form, through frequent consumption of food at a specific mealtime in the past or through the perceived appropriateness of consuming food at a given mealtime, learned implicitly through social cues (McLeod et al., 2020). Considering that a common disposition of picky eating and food neophobia is this rejection of food across eating periods and contexts, the opportunity to learn about script and thematic relations is mired and the cycle of food rejection is perpetuated. Therefore, it was equally expected that food rejection tendencies would hinder children's potential to experience and learn about conceptual knowledge in the food domain. Both directional theories support the idea that poor conceptual knowledge of food will be significantly negatively correlated with increased levels of food rejection in young children.

The three studies presented in this article focused on the developmental acquisition of thematic and script knowledge of foods and how conceptual development is linked with food rejection tendencies in children aged 3–7 years. Study 1 investigated the distinct developmental trajectories of thematic and script knowledge structures in the food domain. Study 2 expanded to investigate whether specific conceptual knowledge is linked to food rejection tendencies. The third and final study investigated thematic and script knowledge in a conflicting triad design that demanded the most appropriate relation in response to the situational demands. All three studies were preregistered, and the protocols, stimuli, anonymized datasets, and statistical scripts can be accessed at OSF project.

All three studies received institutional review board (IRB) approval from the Stanford IRB and the Lyon II IRB.

Study 1

Lucariello et al.'s (1992) word association task indicated eight distinct conceptual structures available to children as young as 4 years. However, for the conciseness of the research, the following studies examined the four most referenced conceptual relations (Lucariello et al., 1992). The definitions of the four association types were adapted from Lucariello et al. (1992, p. 996) but are interpreted to align with the conceptual relations relevant to food and eating situations. These are as follows:

- *Event scripts:* Foods that belong to a spatiotemporal concept denoting a place, a time, or an event in which the target food typically occurs (e.g., cake–celebration). These associates are referred to as event scripts.
- *Food–food associates:* Conventional associations, in which two objects form a part–whole (e.g., ice cream–cone) or mere association (e.g., fish–lemon). These relations are referred to as food–food pairs.
- *Food–utensil associates:* Functional associates denoting a characteristic functional association between food and an object (e.g., knife-to-cut bread; spoon-to-scoop ice cream). These functional associates are referred to as food–utensil pairs.
- *Meal scripts:* Slot-filler concepts of foods that are exemplars of specific meals and can be substituted for one another in a spatiotemporal context (e.g., cereal–toast "breakfast foods"). These associates are referred to as meal scripts.

The first study applied a match-to-sample task to determine whether the heterogeneous script and thematic relations outlined above show distinct developmental trajectories. The preregistered hypothesis for the first study was that children's knowledge in the food domain would be predicted by association type and age. In Lucariello et al.'s (1992) qualitative investigation, both 4- and 7-year-olds evoked script relations when establishing matches in several domains (food, clothing, animals, furniture, and tools), but thematic associates remained the most prevalent response in both age groups. Consequently, it was expected that food–food and food–utensil associates would develop earlier than event and meal script concepts in children aged 3–6 years.

Method

Participants

No previous research directly compared the development of the four conceptual relations with linear modeling, so power analysis estimates needed to be determined based on the work of Nguyen and Murphy (2003, Experiment 1). Nguyen and Murphy conducted a nonconflicting triad task for meal script knowledge and witnessed a significant effect of age for 4-year-olds, 7-year-olds, and adults. Following their results, a sample of 12 participants in each age group would be needed to obtain a similar effect size to Nguyen and Murphy (d = 1.54) with a power of 90 and an alpha level of 05. A slight overrecruitment was achieved due to interest from children to participate in the task.

Participants were 16 children aged 34.5–47 months (M = 42.9 months, SD = 3.9; 9 male and 7 female) and 16 children aged 55–68 months (M = 61.9, SD = 4.3; 9 male and 7 female). The children were recruited from a preschool affiliated with Stanford University and were drawn from middle to high socioeconomic populations. All legal caregivers provided written consent, and the children provided oral assent. The study received ethical approval from the Stanford IRB and complied with international regulations for research on human participants. The study took place prior to the COVID19 pandemic.

Design and materials

Study 1 used a forced-choice triad task, pitting a match against a distractor, with six trials for each of the respective conceptual relations outlined above: (A) event scripts (e.g., cake–celebration), (B) food–food (e.g., wafer cone–ice cream), (C) food–utensils (e.g., soup–spoon), and (D) meal scripts (e.g., bread–cereal). Each child was consecutively tested across all four association types, and an example triad always preceded each association to explain the association sought. To determine possible order effects, half the participants received the trials in one order (Association Types A-B-C-D), and the remaining half received the trials in the reverse order (Association Types D-C-B-A) (see Fig. 1). To determine whether a child showed a preference for specific stimuli, the distractor for one triad was a correct match for another triad. Post hoc analyses revealed that there were no triads in which the distractor was the most salient choice.

The stimuli were color photographs featuring foods, food utensils, and objects representing events or scenes. Child-directed literature and research articles studying food categorization in U.S. preschoolers (e.g., Nguyen & Murphy, 2003) were consulted to establish the food associations with which children were familiar. Parents of children aged 3 to 6 years and preschool staff were informally interviewed about children's experiences and knowledge of particular foods (e.g., "Does your child know what chicken tenders are?", "Does your child eat peanut butter with jelly?"'). The list of the items used in the first study can be found in the OSF directory. Some of the items appeared multiple times because they shared different association types salient to the children (e.g., pasta was commonly associated with meatballs but was also associated with a dinner script).

Procedure

A pilot of the procedure was conducted on 5 children aged 3–6 years to establish that the test was comprehensible for young children. The procedure was identical to the intended study but with the addition of asking children after each choice why they had selected that item to determine whether any nonintentional associates were salient to the children. Due to time limits, children were not asked

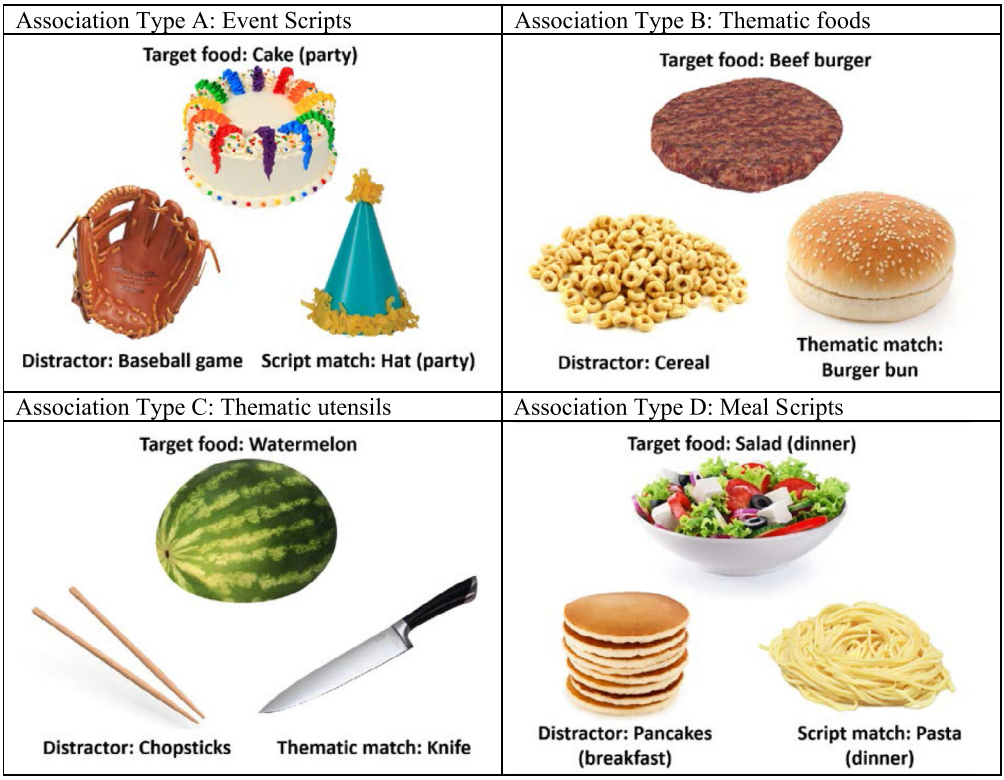

Fig. 1. Design and association type examples for Study 1.

to justify their selection in the test phase; research has also shown that if children expect the need to provide response justification, they may change their response to an option offering an easier explanation (Keil, 1989). The pilot study was appropriate, and no changes to the procedure or stimuli set needed to be made.

The preschoolers were tested individually in a quiet area of the school for approximately 10 min. The experimenter presented a puppet named Feppe: "This is Feppe. Feppe comes from a faraway place, so he needs your help. Feppe has many different things to choose from and needs your help to decide which things go together. Can you help Feppe decide?" An unknown character from an unknown place was used to avoid biasing children's response to both individual preferences and reflections on other cultures and characters. The researchers' instructions emphasized that the puppet needed to know the most "normal" or commonly typical food situations among the majority of people.

The experimenter showed a picture of the example target item (e.g., popcorn) and subsequently showed a picture of an associative match (e.g., a movie ticket representing the movies) and a distractor item (e.g., a Christmas tree representing Christmas) placed on a flat surface in a pre-counterbalanced placement. The experimenter then explained, "Look, Feppe has popcorn [experimenter pointing at popcorn picture], and he must choose whether it's more normal to eat popcorn at the movies [pointing at movie ticket] or at Christmas [pointing at Christmas tree]. Feppe should choose the movies because this is what people eat at the movies. Now it's your turn to help Feppe choose what food he should eat." Children then completed the six subsequent test trials. For Association Type B (food–food), the question was phrased as "Would it be more normal for Feppe to eat the burger with the bread or the cereal?" For Association Type C (food–utensils), the question was phrased similarly: "Would it be more normal for Feppe to use the chopsticks or the knife with the watermelon?" The explanation

for the meal script associations deviated slightly because it needed to be phrased so that children understood they must choose a possible substitute for a meal, not a complementary choice. As such, the experimenter said, "Feppe wanted oatmeal for breakfast, but there was no oatmeal left. Would he have a bagel for breakfast or pizza for breakfast instead?".

In each of the triads, the experimenter labeled the pictures to clarify what the items were. When providing the specific label would bias children's response, such as "cheese grater" as a match for "cheese," the experimenter provided a generic label for the object, such as "grater." The experimenter repeated the question if a child did not make a clear choice or did not respond. Except for the example trials, the experimenter never provided children with feedback on the test trials. Once children had completed the six triads of the association type, they moved on to the subsequent type of associations after the experimenter said, "We are now going to look at some different things that go together in a different way." The experimenter then demonstrated the example relationship, so children were informed that the type of association had changed.

Statistical analyses

Data sets for the three studies and the respective scripts are openly available in the OSF directory. The significance level was set at $p < .05$. Age was calculated in months and then coded as a binary variable, with children aged 34–48 months coded as younger and those aged 54–68 months coded as older.

For each trial, a 1 was assigned to children's selection of the associated choice and a 0 was assigned to children's selection of the distractor choice; a composite score was calculated for each association type. Descriptive statistics were run for all variables, and independent-samples t testing was conducted to determine whether children performed above chance level ($M > .50$) in each association. For hypothesis testing, mixed-model regression models were used to determine how age (independent variable) affects conceptual knowledge (dependent variable). Participants served as a random variable given that scores across the four association types were collinear within participants.

Results

The performance of 3- and 4-year-old children did not differ from chance (50%) in both the event script and meal script associations, $t(15) = 1.838$, $p = .086$, and $t(15) = 0.545$, $p = .594$, respectively. However, they performed significantly above chance in the food–food and food–utensil associations, $t(15) = 4.226$, $p < .001$, and $t(15) = 4.743$, $p < .001$, respectively. Children aged 4.5–5.5 years performed significantly above chance across all associations (Fig. 2).

Based on the procedure of decreasing the Akaike information criterion (AIC; Hu, 2007), the model of best fit included fixed effects of age group and association but no random effects or intercepts (see statistical outputs for model criteria). The tests of fixed effects show that age ($F = 25.602$, $p < .001$) and association ($F = 6.269$, $p = .001$) have a significant effect on children's performance in the thematic and script categorization tasks. There were no significant random or interaction effects.

The older children ($n = 16$) scored significantly better than the younger children ($n = 16$) across all associations and total performance (see Table 1). The estimated increase in task performance for 4.5- to 5.5-year-olds compared with 3- and 4-year-olds was 0.219 (95% confidence interval = [0.130, 0.307]). Post hoc analyses of the main effects of association type show that scores differed significantly for the food–food ($\beta = .12$, $p = .003$) and food–utensils ($\beta = .156$, $p < .001$) associates compared with the meal scripts. Scores for event scripts were not significantly better than scores for meal scripts (see Table 2 for estimates).

Discussion

In line with the literature, there was a significant yet steady development in the proficiency of all four conceptual relations from 3 to 6 years of age (Nguyen & Murphy, 2003). As the first study to directly compare the development of distinct conceptual relations, the results demonstrate that the heterogeneous nature of thematic relations renders them developmentally different. The main effects of association type show that the script and thematic subtypes (meal scripts, food–food, and food–

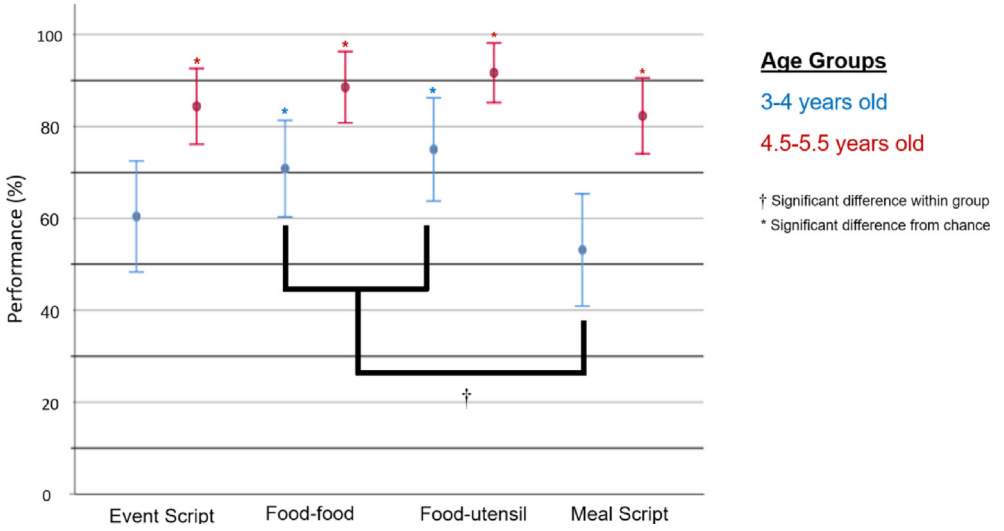

Fig. 2. Graph demonstrating mean score comparisons between age groups for each association type. Error bars show 95% confidence intervals.

Table 1
Mean scores for each association type for younger and older children with *t*-test comparisons of significant differences between age groups and significant differences from chance.

	3–4 Years (n = 16)		4.5–5.5 Years (n = 16)		Comparison of groups	
Conceptual relation type	Mean	*SD*	Mean	*SD*	*t* Value	Glass's delta effect size
Event scripts	60.4%	22.7	84.4%**	15.5	−3.491††	1.06
Food–food	70.8%**	19.7	90.6%**	13.6	−3.307††	1.00
Food–utensils	75%**	21.1	90.6%**	12.1	−2.57†	0.74
Meal scripts	53.1%	22.9	80.2%**	19.5	−3.601††	1.18
Total score	64.8%	15.7	86.5%	7.8	−4.919**	1.38

*Significantly different from chance at p <.05.
** p <. 01.
† Significant difference between age groups at p <.05.
†† p <. 01.

utensils) differ significantly. For children aged 34 to 47 months, knowledge of functional relations and food–food relations was significantly better than knowledge of meal script relations. Furthermore, knowledge of meal scripts was at chance level for the younger children. From 55 to 68 months of age, there were no significant differences in knowledge across the four conceptual relations tested, demonstrating that children appear to have relatively proficient knowledge of all four forms of conceptual relations in the food domain. One possible interpretation for witnessing that script knowledge developed later than thematic understanding is that, given the added complexity of finding a substitute as opposed to an associate, one example was not sufficient to prepare children for the script associations. Analyses were conducted to determine whether scores on individual trials differed according to order. The results of these analyses are provided in the online repository (••••). The trial-by-trial analyses for Study 1 did not indicate that children had greater difficulty in the first trials compared with the later trials. In addition, there were no effects of starting with the meal script associates compared with beginning with the thematic associates, indicating that the task demands did not influence children's performance.

Table 2
Estimates of fixed effects predicting performance: Study 1.

Parameter	Estimate	*SE*	*t*	Significance	95% Confidence interval	
					Lower	Upper
Intercept	.786	.039	20.116	.000	.709	.864
Event scripts	.047	.040	1.178	.242	−.032	.126
Food–food	.120	.040	3.010	.003	.041	.199
Food–utensils	.156	.040	3.926	.000	.077	.235
Meal scripts	0[a]	0				
Age = younger	−.219	.043	−5.060	.000	−.307	−.130
Age = older	0[a]	0				

[a] Reference variable.

Study 2

Whereas age accounts for a substantial part of the variance in conceptual development in the food domain, the interindividual differences observed warrant investigation of other explanatory variables. As detailed in the Introduction, recent research has shown that food rejection may partly account for differences in conceptual development in the food domain. Having established the developmental trajectories of these distinct conceptual relations, the second study aimed to investigate how food rejection may influence conceptual knowledge.

Previous studies have shown evidence that a lack of taxonomic knowledge has been linked to increased food rejection in young children (Rioux et al., 2016, 2017b). Later research has also shown that increased food rejection is linked to poorer thematic performance in a food analogy task (Pickard et al., 2021). The researchers investigated food rejection only with co-occurring thematic associates. Given that the results from Study 1 demonstrate the discriminability of conceptual knowledge acquisition, it begs the question of how such subtypes of conceptual knowledge are linked with food rejection. Study 2 expanded on the developmental inquiry by investigating whether food rejection is related to the specific subtypes of conceptual knowledge investigated in Study 1. The hypothesis for Study 2 was that food rejection negatively predicted conceptual knowledge across all four conceptual relations. An additional aim of Study 2 was to replicate Study 1 in a different culture to verify whether developmental trajectories of conceptual food knowledge are stable cross-culturally.

Method

Participants

Although the effect sizes and results obtained in Study 1 were robust, the expected effect sizes of food rejection on conceptual knowledge are much smaller, requiring a more substantial sample size. No mixed-model analyses have been conducted on conceptual knowledge and food rejection in young children, but an analogy task incorporating thematic knowledge and food rejection detected an effect size of 247 (Pickard et al., 2021). To expect the same effect size, 126 children would be needed to obtain a power of 80 at an alpha level of 05.

Participants were 129 children (67 boys and 62 girls) aged 36.5 to 72.25 months (M = 55.72 months, SD = 10.35). The children were recruited from a public preschool in France with low to middle socioeconomic backgrounds. Due to national ethical regulations, individual demographic data, including ethnicity and race, were not authorized to be collected. All legal guardians provided written consent, and the children provided oral assent. Both Studies 2 and 3 received ethical approval from Lyon II IRB and complied with national regulations for research on human participants.

Materials

Thematic and script associations, particularly in the food domain, are culturally dependent and heavily tied to individual experiences and exposure (Estes et al., 2011). For example, rice may be

considered a perfectly appropriate breakfast meal by children in China but might not be considered appropriate by children in the United States (Bian & Markman, 2020a).

Thus, the stimuli set from Study 1 with the American children were recalibrated to accommodate the food culture most familiar to children in France. Child-directed literature, research articles about typically consumed foods in France (e.g., Poquet et al., 2019), and online local school menus were consulted, and parents of children aged 3–6 years were interviewed. This resulted in an initial stimuli list (n = 62 pairs of food-related associations). In a second phase, this list was used to create an online survey, which was then sent to 40 parents of preschool-aged children living in the same geographical location as where the study was conducted. The parents were asked to indicate their children's knowledge (yes or no) of particular foods, food utensils, typical events, and food combinations (e.g., "Does your child know what noodles are?", "Does your child know a pancake pan", "Does your child know Easter", "Does your child know that fries go with ketchup?"). Only the items indicated as well known by the majority of parents (>80%) were retained from the list. Once the finalized stimuli images were sourced, a naming test with a sample of 6 children (age range = 3–5 years) was conducted to verify their knowledge and recognition of the selected stimuli represented in the pictures. Items identified by at least 5 of the 6 children were retained, resulting in the final 28 stimuli sets (consult the OSF directory for the complete stimuli set).

Procedure

The procedure of Study 2 was identical to that of Study 1—a forced-choice triad task testing for knowledge of event scripts, meal scripts, food–food associates, and food–utensil associates.

To measure food rejection tendencies, caregivers of each child filled out the Child Food Rejection Scale (CFRS; Rioux et al., 2017a) prior to the test phase at the school. The CFRS includes two subscales measuring the two main food dispositions, five items for food pickiness (e.g., "My child rejects some foods after tasting them") and six items for food neophobia (e.g., "My child is suspicious of new foods"). Caregivers were asked to rate their agreement with each item on a 5-point Likert scale (*strongly disagree, disagree, neither agree nor disagree, agree,* or *strongly agree*) according to their children's eating behavior. Total scores could range from 5 to 25 for food pickiness and from 6 to 30 for neophobia. Higher scores indicate higher levels of pickiness and neophobia. A global food rejection score was calculated, combining the scores of both subscales (with scores ranging from 11 to 55).

Statistical analyses

A mixed-effects linear model was performed to explain children's conceptual knowledge in the food domain (Baayen et al., 2008). The models were constructed by iteratively adding predictive variables to the null model (M0 = the intercept and no predictor), using the AIC (Hu, 2007) as a basis for model selection. Age and participant were included in all models as a fixed effect and a random effect, respectively. Additional separate models included fixed effects of food pickiness, food neophobia, and global food rejection (CFRS) as well as all possible interaction terms. Due to the collinearity of food pickiness and food neophobia, the subscales were never entered simultaneously into the same models.

Results

Average scores for pickiness, neophobia, and CFRS were 18.34 (SD = 3.93), 17.13 (SD = 5.31), and 35.47 (SD = 8.48), respectively. As in previous research, the distribution of food pickiness was negatively skewed and food neophobia was platykurtic (see OSF for data visualization).

Global conceptual knowledge scores ranged from 38% to 100% (M = 80.65%, SD = 14.93). Scores in each association type ranged from 38% to 100%: event script (M = 76.87%, SD = 22.27), food–food (M = 84.88%, SD = 20.76), food–utensils (M = 88.24%, SD = 17.23), and meal script (M = 72.61%, SD = 22.61) scores.

Although the stimuli set differed across Study 1 and Study 2, participants in Study 2 were divided into the two age groups predefined in Study 1 to observe the broader developmental effects. There was a significant improvement between the younger children and the older children in all four associations except meal script knowledge (see OSF for data visualization).

Confirmatory hypothesis testing

As witnessed in Study 1, the model of best fit included fixed effects of age and association type; there were no significant random or interaction effects. The tests of fixed effects show that age ($F = 88.574$, $p < .001$) and association type ($F = 21.736$, $p < .001$) each have a significant effect on children's performance. As witnessed with the U.S. participants, scores for food–food and food–utensil concepts were significantly better than scores for meal scripts within participants ($\beta = .123$, $p < .001$, and $\beta = .156$, $p < .001$, respectively). Scores for event scripts were not significantly better than scores for meal scripts (see Table 3). Food pickiness and food neophobia did not improve the fit of the model and were omitted from the model predicting performance.

Discussion

In conjunction with the results from Study 1, Study 2 showed that both association type and age were predictive of knowledge of conceptual relations in the food domain. Again, there were significant differences in children's performance between scripts and thematic associates. Scores for event and meal scripts were significantly lower than scores for food–food and food–utensil associates within participants. This speaks in favor that although the material was recalibrated to a different sample, the design and stimuli sets provide robust cross-cultural findings.

Food pickiness and food neophobia did not improve the fit of the model predicting performance on the food knowledge task. Equally, there was a lack of significant interaction terms in the best fitting model, indicating that children's food rejection was not associated with specific trial types.

This result seems surprising considering the previous research by Pickard et al. (2021), who concluded that increased levels of food rejection were linked to poorer thematic knowledge in the food domain. The results of the current experiment call for reinterpreting the results of Pickard et al., who used an analogical reasoning task in which children were required to pick the most appropriate response from a taxonomic or thematic match. Children with higher food rejection were perhaps capable of identifying both thematic and taxonomic relations but could not select the most appropriate in line with the task demands. This line of reasoning suggests that children with higher food rejection can identify common food associates and scripts when there is no strong contender, as shown by the high percentage of correct answers. However, they perhaps cannot contextualize and cross-classify this knowledge appropriately when a more diverse perspective is requested from the task. For example, children may know that cereal belongs to the category of breakfast food, but they may fail to retrieve this information when required to pick an appropriate substitute for breakfast when presented with a more salient associate such as milk. For the cognitive system to use categories effectively, such concepts must work in concert at the appropriate moment they are required (Markman & Stilwell, 2001). Food scenarios sometimes call on script categories, such as finding an appropriate slot-filler, or on thematic categories, selecting an associated food. Therefore, the final study aimed to disentangle children's knowledge of categories from cross-classification ability in response to task demand.

Table 3
Estimates of fixed effects predicting performance: Study 2.

Parameter	Estimate	*SE*	*t*	Significance	95% Confidence interval	
					Lower	Upper
Intercept	.227385	.056337	4.036	.000	.116065	.338706
Event scripts	.042636	.023510	1.814	.072	−.003883	.089154
Food–food	.122739	.021195	5.791	.000	.080801	.164677
Food–utensils	.156331	.021684	7.209	.000	.113425	.199237
Meal scripts	0[a]	0				
Age	.008950	.000951	9.411	.000	.007068	.010832

[a] Reference variable.

Study 3

The results from Study 2 appear to contradict the findings of Pickard et al. (2021), who witnessed that children with higher food rejection showed poorer knowledge of co-occurring food associates. However, their study pitted taxonomic and thematic associates in an analogy task, which does not allow the conclusion that children failed to identify the thematic relation. Children with increased food rejection may have been biased toward taxonomic relations pitted against thematic relations. Alternatively, the authors noted that food rejection may be linked to other abilities such as analogical reasoning, inhibition of preferred relations, and flexible switching between association types (Pickard et al., 2021). This limitation and the results of Study 2 present compelling reasons to conduct the subsequent investigation examining the relation between food rejection and children's conceptual understanding when given a more demanding task design.

The final study used a repeated match-to-sample task, this time with two competing options (a meal script match and a food–food match) framed across two scenarios. The first set of trials required a thematic associate response (requiring a co-occurring associate), and the second set of trials required a script associate response (requiring an alternative substitute). In other words, children were required to interpret the contextual cues to select the most appropriate choice. Meal scripts and thematic foods were the two conceptual relations retained for the final study because they showed significantly different development in both Studies 1 and 2.

It was determined a priori that, per Rioux et al. (2018) and Pickard et al. (2021), children with higher levels of food rejection would fail to appropriately select the correct conceptual relation in response to the contextual cues. The developmental hypothesis, based on literature and Studies 1 and 2, was that age and association type would be a significant predictors of cross-classification. More specifically, children would be better in the thematic associates than in the script associates.

Method

Participants

The previous analogy task incorporating thematic knowledge and food rejection detected an effect size of 247 (Pickard et al., 2021), which would require 126 children to obtain 80 power at the standard 05 alpha error probability. Given that the task design for Study 3 was less demanding than the analogy task by Pickard et al. (2021), a larger effect was expected, requiring a smaller sample size. Children were recruited from a preschool different from that in Study 2 in a middle socioeconomic area of France. National ethical regulations do not permit the collection of individual demographic data collection.

In total, 39 girls and 33 boys aged 48.95 to 84.04 months, with a mean age of 66 months (SD = 10.9), provided oral assent to participate in the task. Of this sample, 34 children completed the script associations followed by the thematic associations, and the remaining 38 children completed the thematic associations and then the script associations. As in Study 2, parents or legal guardians at a preschool in •••• were informed of the study and provided consent for their children to participate by completing the food rejection measure. Of the original sample, 3 children did not complete the task, 3 children failed to understand the script associations, and 1 child failed the thematic training associates (having scored <50% on the script or thematic training trials). These 7 children were not included in any further analyses, as established in the preregistration of the study.

Materials

The stimuli were color photographs featuring foods presented on a laptop screen. The target food appeared centered at the top of the screen, and the script match, thematic match, and distractor were displayed on the row below in a randomized left-to-right configuration. The basic label was written below each image as well as being labeled aloud by the researcher at the beginning of each stimulus set (the complete list of the stimuli sets can be found by visiting OSF).

A pilot of the procedure with the finalized stimuli sets was conducted with 15 adults and 8 children. The pretest with the adults was used as a baseline measure to establish that all trials had

a ubiquitous response across the two framed scenarios. There was 100% convergence on all trials across both script and thematic framed scenarios; thus, all stimuli were retained. The pretest with the 8 children aged 4–6 years was to determine whether the procedure was comprehensible for the children but sensitive enough to capture individual differences.

Procedure

The asagneolers were tested individually in a quiet area of the school for approximately 10 min. The researchers introduced two novel characters, Feppe and Cronus, and explained that they were from a faraway planet. Therefore, they needed the children's help to understand objects and foods normally found in specific situations.

Children completed 24 test trials in one of two counterbalanced sequences. Four non-food training trials were used at the beginning of both scenarios to explain the task to the children and determine whether they had understood the need to identify an associate or a replacement (see Fig. 3). The data for children who did not correctly respond to 75% or more of the training trials were excluded from the analyses. The script scenario was framed in that the character had a specific meal, and because there was no more of one food left, he needed to select a suitable substitute for that meal script ("Feppe was having lunch, but there was no fish left. Should Feppe have asagne, chocolate, or a lemon for lunch instead?"). The other scenario, requiring a thematic associate, was worded "Cronus has some fish for lunch. Could Cronus have the asagne, the chocolate, or the lemon with the fish?" Children needed to select among a meal script match, a thematic food match, and a distractor (Fig. 4).

To calculate contextual understanding in the food task, a score of 0 was assigned if participants selected the divergent choice for each trial (e.g., thematic scenario: script associate; script scenario: thematic associate). A score of 0 was assigned to a distractor selection. In contrast, a score of 1 was assigned to each trial if participants selected the corresponding choice (e.g., thematic scenario: thematic choice; script scenario: script associate). Scores were then averaged for both thematic and script scenarios.

The task included four training trials with non-food stimuli to determine whether children understood the script and thematic scenarios. Testing was suspended for children who failed on at least three of the four training trials to identify the convergent match to the scenario.

Statistical analyses

As well as descriptive statistics for the participants, descriptive analyses for the stimuli and trials were run to determine the saliency and preference for certain foods in each stimuli set. None of the trials found any significant bias toward any food in particular, but the full reporting of the stimuli results can be found online in the OSF repository.

As in the previous studies, a mixed-effects linear regression was performed on children's score in each scenario type. The models were constructed by iteratively adding predictive variables to the null model (M0 = the intercept and no predictor), using the AIC (Hu, 2007) as a basis for model selection. Age and participant were included in all models as a fixed effect and a random effect, respectively.

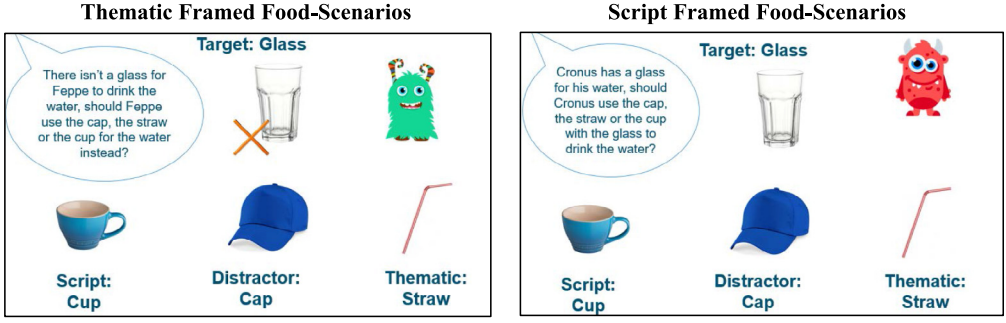

Fig. 3. Example of the training trials for Study 3.

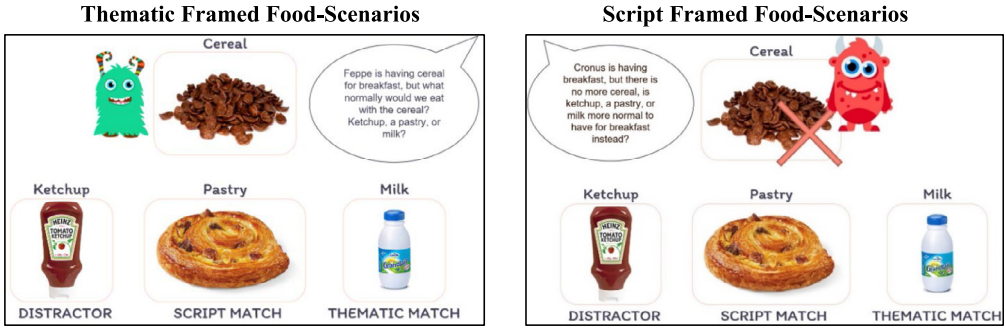

Fig. 4. Example of the task design for Study 3.

Table 4
Estimates of fixed effects predicting performance: Study 3.

Parameter	Estimate	*SE*	*t*	Significance	95% Confidence interval	
					Lower	Upper
Intercept	5.867	1.104559	5.312	.000	3.664	8.071
Scenario (script)	−1.176	0.406272	−2.896	.005	−1.987	−0.366
Neophobia	−0.092	0.031243	−2.934	.005	−0.154	−0.029
Age	0.056	0.014560	3.850	.000	0.027	0.085
Script Scenario * Thematic → Script	1.460	0.505394	2.889	.005	0.452	2.468
Thematic Scenario * Thematic → Script	0.336	0.362	0.930	.356	−0.385	1.058

Order was included as a fixed effect, as were food pickiness, food neophobia, and global food rejection (CFRS) as well as all possible interaction terms.

Results

Descriptives

Average scores for pickiness, neophobia, and CFRS were 17.22 (*SD* = 4.54), 14.63 (*SD* = 5.16), and 29.80 (*SD* = 8.69), respectively. Global performance across all children ranged from 37.5% to 95.8% (*M* = 71.3%, *SD* = 14.3). Scores ranged from 25% to 91.6% (*M* = 65.2%, *SD* = 18.8) in the script scenarios and from 33.3% to 91.6% (*M* = 70.0%, *SD* = 14.2) for the thematic scenarios.

Confirmatory hypothesis testing

Based on the procedure of decreasing the AIC (Hu, 2007), the best fitting model contained fixed effects of age, scenario, and neophobia as well as an interaction effect of scenario and order (see Table 4 for model reporting). The main effect of age shows an improvement of 0.056 in overall task performance for each unit increase in age. The main effect of the scenario demonstrates that children performed significantly worse in the script scenarios than in the thematic scenarios ($F = 4.83$, $p = .031$), from 0.061 to 1.184 less for the script associates compared with the thematic associates. A main effect of neophobia was also witnessed; for every unit increase in food neophobia, there was a decrease in task performance of 0.092.

There was also an interaction effect between scenario and order included in the final model. Children who completed the thematic scenarios followed by the script scenarios found the script context easier than children who were asked to complete the script scenarios first. The estimated increase in script performance for the children who completed the script scenarios last was 1.46 (95% confidence interval = [0.452, 2.468]) (see Table 4).

Discussion

The final study investigated children's ability to respond to contextual task demands and select the appropriate conceptual relation when given a conflicting choice between a meal script and a thematic associate. As expected, age significantly improved children's performance for the task in both thematic and script scenarios. Reiterating the findings of Studies 1 and 2, children performed significantly better in the thematic trials than in the script trials. In addition, performance in the script scenarios was better for children who had completed the task with the thematic scenarios first followed by the script scenarios. Crucially, food neophobia was determined to reduce the selection of the most appropriate relation for both meal scripts and thematic associates in the food domain. A possible explanation is that children with higher food neophobia levels have decreased inhibitory control to suppress a salient, albeit inappropriate, associate. In other words, highly neophobic children may be aware that one conceptual relation is more appropriate in response to situational demands, but when presented with such items in competition, they are unable to inhibit the immediate saliency or preference for a less appropriate associate. An alternative explanation for both Studies 2 and 3 could be that children with higher food neophobia fail to flexibly apply the correct conceptual relation in response to contextual demands. This suggests that a food neophobic child lacks the appropriate interpretation of situational cues and the ability to infer the most appropriate conceptual relation.

General discussion

The food domain lends itself to multiple conceptual relations such as thematic and script-based associates (Nguyen & Murphy, 2003; Ross & Murphy, 1999). In addition, young children have been found to depend on their notions of script and thematic associates to interpret and interact with their surroundings (Denney & Moulton, 1976; Markman et al., 1981). However, few studies have addressed children's script and thematic understanding of foods, and none has investigated how thematic and script knowledge influences food acceptance or rejection. The aims of the current research were twofold: first, to investigate at what age children have sufficient script and thematic knowledge in the food domain; second, to determine whether poorer knowledge of such conceptual relations is linked with food rejection tendencies.

In response to the first line of inquiry, Studies 1 and 2 investigated children's knowledge of four distinct thematic and script relations; these were defined as follows:

- *Event scripts:* Foods that belong to a spatiotemporal concept denoting a place, time, or event in which the target food typically occurs (e.g., cake–celebration).
- *Food–food associates:* Conventional associations in which two objects form a part–whole (e.g., ice cream–cone) or mere association (e.g., fish–lemon).
- *Food–utensil associates:* Functional associates denoting a characteristic function between food and an object (e.g., knife-to-cut bread, spoon-to-scoop ice cream).
- *Meal scripts:* Slot-filler concepts of foods that are exemplars of specific meals and can be substituted for one another in a spatiotemporal context (e.g., cereal–toast "breakfast foods").

Different developmental trajectories for thematic and script knowledge

Both Studies 1 and 2 support previous developmental evidence that children's thematic and script knowledge improves significantly from 34 to 55 months of age (Gelman, 2003; Markman, 1989; Murphy; 2002). When presented in a nonconflicting triad, by 55 months of age, children were selecting the correct relation above chance across all four association types. Such conceptual development is believed to be in large part due to experience and education, which broaden "the features (both conceptual and perceptual) that enable categorization and more sophisticated mental representations of objects, people, and situations" (Oakes & Madole, 2003, p. 143).

In addition to replicating previous developmental work, our research details differences in the developmental acquisition of specific thematic and script associations. The post hoc analyses reveal

that functional thematic associates (food–utensils) are mastered earliest, followed by knowledge of conventional food pairs (food–food) and event scripts. Knowledge of slot-filler associates (meal scripts) developed significantly later but still showed a significant developmental improvement. Once again, this finding not only replicates previous research but also aligns with the argument that the computation of script associates is more cognitively demanding than the computation of thematic associates (Berger & Donnadieu, 2006). Thematic associates must satisfy the requirement of complementarity, convention, or functional affordance (Estes et al., 2011). Whereas finding two appropriate meal script associates (e.g., oatmeal and pancakes at breakfast) requires inhibiting an initial salient script associate (e.g., the oatmeal) to identify a possible substitute script associate (e.g., the pancakes), the results from our three studies illustrate that the cognitive manipulation needed for identifying script associates is more cognitively demanding than identifying a thematic associate based on co-occurrence. This interpretation is further supported in the results viewed in our final task where children performed better in the script scenarios when they were presented with the thematic scenarios first, whereas children who completed the script scenarios first did not perform as well for the script scenarios. This is possibly due to the children already having eliminated the thematic associate as a potential choice in the first part of the task, indicating that the thematic associate appears to be more salient or accessible to younger children.

Although there appears to be a preference or saliency of thematic over script relations, by 5 years of age children are attending to both thematic and script relations in the food domain. Such evidence is groundbreaking in revealing the conceptual knowledge children attend to when making food-based decisions. Such findings imply that early childhood could be a critical period for instilling dietary variety and a diverse range of foods at mealtimes to avoid children forming overly restrictive or rigid notions of thematic and script food knowledge.

Food neophobia linked to global deficits in conceptual knowledge

Having established young children's developmental acquisition of script and thematic food knowledge, this research ultimately aimed to determine whether lacking such script and thematic knowledge was linked with food rejection. On the one hand, having a very limited repertoire of thematic and script associates is likely to lead to many food instances that children fail to interpret as appropriate. For example, not knowing that eggs are commonly served for breakfast in certain cultures may lead children to reject such an instance of eggs for breakfast. Inversely, having a very rigid script or thematic representations of foods (e.g., only pancakes are an acceptable instance of breakfast food) could lead children to interpret the food as inappropriate, limiting children's acceptance of other foods that deviate from their breakfast script. Therefore, this research hypothesized that food rejection tendencies, namely food pickiness and food neophobia, would be significantly linked with reduced knowledge of thematic and script associations in the food domain.

Somewhat surprisingly, Study 2 demonstrated that food rejection was not a significant predictor for conceptual knowledge in any of the four thematic and script relations examined. However, the null findings may have resulted from the simplicity of the task design, pitting the correct associate against an irrelevant distractor. This explanation seems plausible given that in the more demanding Study 3, where a script associate was pitted against a thematic associate, food neophobia was a significant predictor of poorer conceptual understanding. The main effects of the model demonstrate that higher levels of food neophobia predicted poorer ability to select the most appropriate conceptual relation in the conflicting triad design for both script and thematic associates. Taken together these results indicate that, rather than a lack of conceptual knowledge leading to increased uncertainty, food rejection is associated with children's appropriate use of conceptual knowledge.

An inability to flexibly refer to appropriate conceptual relations to guide understanding is problematic because food is situated in context and is liable to many simultaneous representations (e.g., soup shares functional associates [bowl and spoon], conventional associates [croutons], script associates [dinner], and temporal associates [starter]). With so many possible representations available simultaneously, children with increased food neophobia may face difficulty in referring to the most appropriate conceptual relations to guide appropriate acceptance. Not being able to draw on the most informative conceptual relation is likely to lead to incorrect interpretations or conclusions being

formed. With cognitive development, children with higher levels of food rejection should eventually be able to reason that those different conceptual relations are conducive to concluding different pieces of information (e.g., knowing that foods that are thematically associated might not necessarily share the same taste profiles). The pronounced advances in children's cognitive abilities and improved ability to refer to appropriate conceptual structures may explain why food rejection tendencies show a decrease around 6 or 7 years of age (Dovey et al., 2008). Improved ability to draw inferences and reason using appropriate conceptual relations thus will reduce feelings of uncertainty in food situations.

Limitations and future research

An important caveat to bear in mind is that the influence of food rejection on conceptual development in young children is far from simple because it is likely a cyclical process. Conceptual knowledge is heavily dependent on lived experience and is acquired through children's interaction with real-world events and objects (Chi et al., 1989; Contento, 1981; Fisher et al., 2015; Gelman & Markman, 1986). Thus, parents and caregivers are heavily responsible for children's conceptual acquisition in the food domain. If children present high food neophobia and picky-eating behaviors, caregivers may be discouraged from exposing their children to new foods and eating situations. For example, children may stay home from the cafeteria at lunch or take their own food and snacks when visiting relatives on the holidays. Consequently, the learning opportunities about foods and eating situations may be greatly reduced, and the opportunity to learn about common conceptual relations is mired. One possible explanatory mechanism for food rejection is that the behavior itself leads to decreased learning opportunities, resulting in impoverished conceptual knowledge in the food domain. Having provided concrete evidence that there is a link between thematic and script understanding and food neophobia, future work must investigate the cause and effect of this relation. Longitudinal or interventional research could indeed determine whether food rejection tendencies lead to poorer conceptual knowledge in the food domain or whether poorer conceptual knowledge in the food domain leads to food rejecting behaviors.

Our results strongly suggest that knowledge-based interventions appear to be promising in facilitating children's understanding of food situations and subsequently boosting dietary variety (Gripshover & Markman, 2013; Nguyen, McCullough, & Noble, 2011; Pliner, 2008). Based on the evidence generated by our studies and the existing literature, the objective of this knowledge-based intervention appears to be twofold: (a) improving children's ability to draw on the right conceptual relation according to the context demands and (b) rendering their view about these relations more flexible, for instance, broadening the extension of the breakfast food category (Bian & Markman, 2020a). Children may be perfectly able to switch from taxonomic to thematic to script according to the contextual demands but have a narrowed repertoire of accepted food by the rigidity of their script representations.

Future research would also benefit from investigating confounding variables such as socioeconomic status and genetic dispositions that influence the relation witnessed in this research. Studies have witnessed that both socioeconomic status and educational level also appear to modulate the expression of the disposition to reject fruits and vegetables (Flight et al., 2003; Giskes et al., 2002; Lien et al., 2002). Furthermore, as indicated from the stimuli sets in Studies 1 and 2, there is notable cultural diversity in script and thematic concepts in the food domain. Given apparent differences in French and American approaches to food, it would have been interesting to investigate differences in how French and American children conceive food associations or reject food. The literature appears to demonstrate that in older children and adults the rigidity and variety of food scripts varies significantly across cultures, with Americans holding a reduced number of breakfast exemplars compared with Chinese adults (Bian & Markman, 2020b). It was beyond the scope of this investigation to determine the effects of culture and socioeconomic status on children's conceptual knowledge in the food domain, but future evidence should consider such potential.

A novel limitation that must be considered in future research is the impact of the COVID-19 pandemic on children's food representations and conceptual knowledge. Studies 1 and 2 were conducted pre-pandemic, whereas Study 3 was conducted post-pandemic restrictions. During the national lockdown period in France, the majority of the students participating in our study would have spent

prolonged periods eating at home. This may have affected the children's exposure to meals, with most children normally attending the school cafeteria at lunchtime. It would be of great insight into understanding how exposure to different meals shapes children's knowledge of food scripts and thematic associations by investigating their eating habits during the pandemic versus post-pandemic.

Conclusion

Previous research on thematic and taxonomic knowledge in the food domain indicates that impoverished conceptual knowledge in young children is linked with greater food rejection tendencies. However, food is a domain susceptible to many conceptual relations and categories across different contexts and situations. These three studies examined the developmental acquisition of distinct thematic and script food relations in children aged 3–7 years. The results indicate that knowledge of event and meal scripts develops slightly later than knowledge of thematic associations based on co-occurrence and functional affordance. These findings are fundamental in understanding that at younger ages children may place greater importance on what foods and objects belong together, whereas at older ages children may place more emphasis on what context is appropriate for food.

This research also addressed whether food rejection tendencies (food neophobia and food pickiness) are linked with poorer conceptual knowledge of script and thematic associates. Food neophobia and food pickiness were not predictive of children's performance when a thematic or script associate appeared in a nonconflicting triad. However, Study 3 demonstrated that food neophobia was predictive of children's performance when a thematic associate and a script associate were competing associates. The results suggest that children with higher levels of food neophobia have conceptual knowledge in the food domain but struggle to draw on the most appropriate conceptual knowledge when making food-based decisions.

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Data availability

All three studies were preregistered, and the protocols, stimuli, anonymized datasets, and statistical scripts can be accessed at OSF.

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