



# Development of children's implicit and explicit attitudes toward healthy food: Personal and environmental factors

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## ABSTRACT

This cross-sectional study investigates the implicit and explicit food attitudes of 1,412 Croatian children (5–9 years old) and extends our knowledge regarding how those attitudes relate to food behavior, while accounting for the potential influence of age and environmental variables such as watching television and poverty. While our findings corroborate previous work to show that children's explicit attitudes tend to be more positive toward unhealthy than healthy foods, we also find that implicit attitudes are actually more positive toward healthy than unhealthy foods. Both implicit and explicit attitudes toward healthy foods were more positive at older ages. More positive attitudes were associated with (a) a stronger belief that healthy foods “make me strong” and (b) greater consumption of healthy foods. Watching television was associated with more favorable attitudes toward unhealthy foods. Our study demonstrates how accounting for both implicit and explicit attitudes across different age groups aids understanding of children's food-related beliefs and behaviors. These insights can help health policy makers and parents instill positive attitudes toward healthy food among children early on and increase their consumption of healthy foods during childhood.

## 1. Introduction

Do children have an aversion to healthy food? There is a lack of consensus in the literature regarding what children really think about healthy food. Some studies suggest that children mostly prefer unhealthy, energy-dense, sugary foods (Cooke & Wardle, 2005; Russell & Worsley, 2007) and are averse to fruits and vegetables (Russell & Worsley, 2007). However, the evidence is far from universal: in some cases, children report liking fruits more than unhealthy confectionery and donuts. Understanding such preferences can predict food choices in health-oriented social contexts (Marty, Nicklaus, Miguet, Chambaron, & Monnery-Patris, 2018). Whether children reject healthy foods, such as unprocessed vegetables, because of their intense taste or because of some innate sensory reaction or pre-learned association is unclear (Zeinstra, Koelen, Kok, & de Graaf, 2009). This raises the question: what are the correlates of children's attitudes toward healthy and unhealthy foods?

One stream of the literature regarding children's attitudes toward healthy food is based on the perspectives of parents and other caregivers. Caregivers often assume that children do not like vegetables, fruits, and other healthy foods, which influences their food purchases and meal planning (Nepper & Chai, 2016). As one parent remarked to Nepper and Chai (2017, p.4) “it is easy to say ‘since they are not going to eat it, I am not going to buy it’. I think that is the biggest problem.” Yet, given the mixed evidence regarding children's actual attitudes to healthy and unhealthy foods, there is a danger that caregivers create a false narrative that unnecessarily limits exposure to healthy food. Further research on the factors that foster (or undermine) children's internalization of healthy attitudes and behaviors is thus desirable (Moore, Wilkie, & Desrochers, 2016). Specifically, it is important to understand the correlates of children's attitudes toward healthy and unhealthy foods, especially given that childhood eating habits and attitudes typically persist into adulthood (Skinner, Carruth, Bounds, & Ziegler, 2002).

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These considerations have prompted another stream of research seeking to understand children's perspectives directly. However, understanding children's attitudes toward certain foods and their willingness to eat them can be tricky because children are difficult to reach in food research (van der Heijden, te Molder, de Graaf, & Jager, 2020) and are more likely to report what they believe their parents or investigators expect or prefer (DeJesus, Gelman, & Lumeng, 2020). Moreover, several studies regarding children's food attitudes and behaviors relied only on questions directed at parents (Carnell, Cooke, Cheng, Robbins, & Wardle, 2011). Consequently, we possess fewer insights from children than from parents, and insights from children are incomplete due to variability in the types of attitudes investigated (e.g., directly vs. indirectly measured), leading to a fragmented and incomplete picture. Therefore, we require a more complete investigation that accounts for both the directly measured (explicit, self-reported) attitudes and the indirectly measured (implicit) aspects of children's attitudes toward healthy food (e.g., Craeynest et al., 2005; DeJesus et al., 2020; Monnery-Patris, Marty, Bayer, Nicklaus, & Chambaron, 2016).

Explicit, self-reported attitudes correspond to *conscious evaluations* about the nutritional and health benefits of particular foods (Marty, Chambaron, Bournez, Nicklaus, & Monnery-Patris, 2017), while implicit attitudes involve more *automatic evaluations* pertaining to sensations and emotions experienced in response to foods, such as taste (Dubé & Cantin, 2000). Implicit attitudes are non-verbal and can be measured indirectly, most commonly through an Implicit Association Test (IAT; DeJesus et al., 2020; Greenwald, Nosek, & Banaji, 2003). Explicit and implicit attitudes can correlate substantially with each other in some cases (Hoeffling & Strack, 2008; Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005), but may be weakly correlated in others (Wilson, Lindsey, & Schooler, 2000), even in children (Cvencek, Brečić, Gaćeša, & Meltzoff, 2021). For example, a child may implicitly evaluate French fries very favorably, but express a slightly negative explicit attitude. Thus, studies that examine only implicit or explicit food attitudes may provide an incomplete, or even misleading, picture of how children's attitudes influence their food behavior.

Accounting for both implicit and explicit attitudes in the same study has proven fruitful for understanding beliefs and behaviors in adults (Greenwald & Banaji, 1995; Kahneman, 2011). Such an approach offers psychometric rigor and sensitivity to individual differences (Cvencek, Greenwald, & Meltzoff, 2016; Cvencek & Meltzoff, 2014). Child-friendly implicit and explicit methods are evidence-based, psychometrically sound, sensitive to individual differences, and predictive of children's behavioral outcomes, such as their play behaviors (Cvencek, Greenwald, & Meltzoff, 2011; Paz-Albo Prieto, Cvencek, Herranz Liácer, Hervás Escobar, & Meltzoff, 2017), school grades (Cvencek et al., 2021), and standardized test scores (Cvencek, Kapur, & Meltzoff, 2015). However, "few studies have used the IAT to examine children's thinking about topics outside of social stereotypes" (DeJesus et al., 2020, p. 2). Some early studies that applied the IAT relied on small samples, leading for calls to replicate the studies with larger samples to ensure sufficient statistical power and robustness (van der Heijden et al., 2020). Moreover, little is understood about how children's implicit and explicit attitudes toward food are related to personal (individual) factors such as age, watching television, beliefs about food, and food-related behavior. The combination of implicit and explicit measures of attitudes and understanding their relations to personal and environmental factors can provide a useful, standardized metric for assessing the efficacy of efforts to promote healthy eating. In the present study, we follow the United Nations definition of a healthy food as "one that provides beneficial nutrients (e.g. vitamins, minerals, essential amino acids, essential fatty acids, dietary fiber) and minimizes potentially harmful elements (e.g. anti-nutrients, quantities of sodium, saturated fats, sugars"; Neufeld, Hendriks, & Hugas, 2020, p. 5).

In this study we investigate children's attitudes toward healthy and unhealthy foods in a large sample of Croatian children spanning 5–9 years of age. This age range is interesting for several reasons. Firstly,

children of these ages are often difficult to reach and are largely underrepresented in food research (van der Heijden et al., 2020, p. 9; Langer et al., 2021.). Similarly, previous studies with this age range often depended on small and possibly unrepresentative samples (Desrochers & Holt, 2007), which could lead to erroneous conclusions. To adequately capture their implicit attitudes, we employ an IAT specifically designed for primary school-aged children (Cvencek, Meltzoff, & Greenwald, 2011; DeJesus et al., 2020). Secondly, this age group coincides with the start of formal schooling, which is critical for children to learn about food (Cashdan, 1994). Elementary school provides an important window of opportunity for understanding the malleability of children's attitudes toward foods, which can influence subsequent food behavior (DeCosta, Møller, Frøst, & Olsen, 2017).

## 2. Conceptualization, propositions, case selection, and study aims

### 2.1. Explicit and implicit attitudes

Two broad types of attitudes are theorized to influence behavior (Fazio & Olson, 2003). *Explicit attitudes* can involve the assessment of the costs and benefits of a specific behavior, as well as rational decision making (Calitri, Lowe, Eves, & Bennett, 2009). Explicit attitudes are easily accessible and thus can be measured through direct self-reports that permit cognitive reflection (Fazio & Olson, 2003). *Implicit attitudes*, in contrast, are relatively automatic and may shape behavior in a more spontaneous, affective way, without a rational consideration of costs and benefits (Craeynest et al., 2005). Consequently, implicit attitudes toward particular entities (e.g. brands, products) can translate automatically into behavioral tendencies without the need for reflection (Calitri et al., 2009).

Explicit and implicit attitudes can diverge or converge (Strack & Deutsch, 2004; van Tuijl, Bennik, Penninx, Spinhoven, & de Jong, 2020). So-called "dual-processing" models explain convergence by postulating that explicit and implicit attitudes are represented in memory structures, and that bonds develop between the two types of attitudes when they are repetitively activated (Greenwald & Farnham, 2000). In other words, explicit and implicit attitudes are "inter-connected" in the sense that they may strengthen or provoke each other to trigger behavior (van Tuijl et al., 2020). At the same time, there is robust evidence for a dissociation between explicit and implicit attitudes in socially sensitive domains (Greenwald, Poehlman, Uhlmann, & Banaji, 2009): in other words, deliberative, verbal responses on explicit measures may sometimes be associated with behavioral outcomes that are distinct from the outcomes informed by more automatic reactions assessed by implicit measures.

As researchers explore implicit attitudes from a developmental perspective, their work is revealing such dissociations even in young children (Cvencek et al., 2021; Dunham, Chen, & Banaji, 2013). In fact, such early emergence of dissociations may reflect the different developmental courses of implicit or explicit attitudes. Implicit attitudes may be established by early formative experiences, whereas explicitly endorsed attitudes may reflect more recent experiences (Baron & Banaji, 2006; Cvencek et al., 2016; DeHart, Pelham, & Tennen, 2006).

Few studies have attempted to measure both explicit and implicit attitudes toward food in children, or how those attitudes vary by age. Rather, most research in this area has been conducted on adults, and to what extent the work generalizes to children is unclear. Explicit and implicit evaluations certainly play an important role in guiding the choices of adults, and any divergence between the two may depend on the characteristics of foods, like palatability (Papies, Stroebe, & Aarts, 2007), as well as individual characteristics such as dietary habits (Houben, Roefs, & Jansen, 2010), hunger level (Hoeffling & Strack, 2008), body mass index (Craeynest et al., 2005), and personality (Nederkoorn, Van Eijs, & Jansen, 2004). In general, adults overconsume foods that they perceive as unhealthy, believing that such food is tastier.

For instance, Raghunathan, Naylor, and Hoyer (2006), as well as Mai and Hoffmann (2015) and van der Heijden et al. (2020), found that the less healthy subjects perceived a food, the better they inferred the taste, the more they enjoyed its consumption, and the more likely it was to be preferred in a choice task when a hedonic goal was primed.

## 2.2. Age variations in children's attitudes toward food

Age may have an important effect on children's explicit and implicit attitudes toward food. At a pre-school age (3–5.5 years), children can already associate a food that is presented as “healthy” as less tasty and consume less of it compared to when it is presented as “yummy” or presented in a neutral manner (Maimaran & Fishbach, 2014). Maimaran and Fishbach (2014) argue that this reflects inferential thinking: Children conclude that if a food is instrumental to achieving a certain goal (e.g., being strong), it cannot be instrumental to achieving a different goal (e.g., good taste). Among children aged 9–11 years, there is also some evidence that healthiness is associated with being less tasty: Wardle and Huon (2000) found that labelling a novel drink as “healthy” reduced children's liking of the drink and their willingness to ask their parents to buy it. This evidence suggests that campaigns using the terminology of “healthy” to improve children's diets may not be successful (Marty, Chambaron, Nicklaus, & Monnery-Patris, 2018).

However, the association between “healthy” and “less tasty” may not be consistent. Among children aged 4–9 years, Echelbarger, Maimaran, and Gelman (2020) found that children preferred diversity in their selections, so that their attitude toward healthy food and its appeal to them depends on what other choices are available and the timeframe for decision-making. DeJesus, Du, Shutts, and Kinzler (2019), studying 5- and 6-year-olds, found that what initially appeared as a favorable evaluation of “healthy” foods reflected a pattern of avoiding foods labelled as “unhealthy,” and this finding was replicated for 8- and 9-year-olds. Recently, DeJesus et al. (2020) applied implicit and explicit measures to assess food healthfulness (healthy vs. unhealthy) and palatability (yummy vs. yucky) for children aged 4–12 years, and they detected no clear variation by age. Similarly, no significant variation by age was apparent among children who possessed favorable implicit attitudes toward vegetables (Marty, Chambaron, et al., 2017). van der Heijden et al. (2020) found that primary school-aged children and parents from lower socioeconomic backgrounds associated healthy foods and tastiness more strongly with each other than they associated healthy foods with not being tasty, indicating a “*healthy = tasty* intuition.” This was most apparent at an implicit level, contrary to the expected *unhealthy = tasty* intuition (van der Heijden et al., 2020). This study, which involved a relatively small sample of 44 parent-child dyads, did not detect variations by age. However, Monnery-Patris et al. (2016), found that children aged 5–11 years possessed both negative implicit and explicit attitudes about healthy food, with older children showing more negative implicit attitudes, but less negative explicit attitudes, toward healthy food. The current literature fails to answer with certainty whether the explicit and implicit attitudes of children toward healthy and unhealthy food vary by age. Consequently, there is a need for a more detailed investigation of the effects of age on children's attitudes toward food, which the present study provides.

Education about healthy food can alter children's *healthy = tasty* associations (Monnery-Patris et al., 2016), suggesting that the onset of formal schooling may lead to differences in children's attitudes toward food with age. Nutrition education can be defined as “learning experiences designed to facilitate the voluntary adoption of eating and other nutrition-related behaviors conducive to health and well-being” (Washington State Department of Social and Health Services, 2021), and it seeks to increase students' nutritional knowledge so they are better able to distinguish between healthy and unhealthy diets (Gripshover & Markman, 2013). Compulsory nutritional education is typically embedded in the curriculum, and the complexity of material increases with children's age. Consequently, older students should possess

increasingly positive implicit and explicit attitudes toward healthy foods compared to younger students. There is evidence that education can significantly change implicit and explicit attitudes toward food, leading for instance to more favorable evaluations of vegetables (Mattavelli, Avishai, Perugini, Richetin, & Sheeran, 2017).

However, the degree to which implicit and explicit attitudes are changeable may depend on the nature of the educational strategy employed. Conventional, information-based education may lead to more favorable explicit attitudes to healthy food but be ineffective in changing implicit attitudes (Demartini et al., 2019; Mattavelli et al., 2017). For changing implicit attitudes, self-reflective, identity-based exercises appear to be more effective (Demartini et al., 2019; Mattavelli et al., 2017). Where nutritional education includes both informational and self-reflective exercises, more favorable explicit and implicit attitudes to healthy food should emerge. In our study, children (5–9 years) transition from kindergarten to formal schooling and it is expected that formal nutritional education will shape their attitudes. Therefore, we test the following:

**Proposition 1.** *Due to exposure to nutritional education, children's implicit and explicit attitudes toward healthy food become more favorable with age.*

## 2.3. Environmental factors and children's food attitudes: the role of television watching

Environmental factors corresponding to both intentional education and passive learning can shape children's implicit and explicit attitudes and their food behavior (Monnery-Patris et al., 2016). Though a sizeable literature already exists on children's food behavior, relatively little systematic knowledge is available on environmental factors that may affect explicit and implicit attitudes. Importantly, children are strongly influenced by others when developing their own attitudes toward healthy foods (Maimaran & Fishbach, 2014; Shutts, Kinzler, & DeJesus, 2013).

Watching television is an important environmental factor and there is considerable interest in the relation between children's television watching habits, attitudes toward food, and food behavior (Boyland, Harrold, Kirkham, & Halford, 2012; Powell, Szczypka, Chaloupka, & Braunschweig, 2007). In countries like Croatia, where television watching overwhelmingly involves channels operated by private broadcasters, viewers are inevitably exposed to advertisements. Television advertisements are skewed toward processed foods high in fat and sugar, with relatively few for fruits and vegetables (Whalen, Harrold, Child, Halford, & Boyland, 2017). Children's exposure to advertisements while watching television is expected to affect their explicit and implicit attitudes. Advertising associates a stimulus (i.e., brand) with other target stimuli, such as a desired mood and outcomes (Sweldens, Van Osselaer, & Janiszewski, 2010). These associations can be activated automatically in memory or through the application of deliberate thinking processes, suggesting that advertising can affect both implicit and explicit attitudes (Heath, 2012). Empirical studies confirm that exposure to advertising leads to more favorable overtly expressed judgments (explicit attitudes) and “gut reactions” (implicit attitudes) to the advertised stimulus (Matthes & Schmuck, 2015). These effects may occur incidentally, for example, through exposure to a sponsor's brand when watching sports on television (Zerhouni, Bègue, Duke, & Flaudias, 2016) and even when motivation to process information is low (Heath, 2012). Consequently, we test whether:

**Proposition 2.** *Time spent watching television increases the implicit and explicit appeal of unhealthy foods to children.*

## 2.4. Relations among food attitudes, food-related beliefs, and behavior

Food behavior is a function of both attitudes and beliefs about food (Greenwald et al., 2009; Kormos & Gifford, 2014; Rathje, 1989).



However, children's *evaluative* attitudes about food can be conceptually distinguished from their *non-evaluative* beliefs about food, and both can be differentiated from children's actual food behavior. For example, asking children to report how much they agree with the statement "I like fruit," which means measuring their *attitude*, is qualitatively different from asking them to report how much they agree with the statement "I believe that fruit is healthy," which means measuring their *belief*. Both are conceptually distinct from children's reports of how much fruit they actually consume. This distinction between (evaluative) attitudes and (non-evaluative) beliefs is particularly important in investigations of age-related differences, as evident in research on children's attitudes and beliefs about social groups. Children's evaluative attitudes about social groups form early and remain stable during development (Baron & Banaji, 2006; Cvencek, Greenwald, & Meltzoff, 2011; Dunham, Baron, & Banaji, 2008), whereas their non-evaluative beliefs about social groups become evident later during childhood and are less stable than their attitudes (Cvencek et al., 2015; Cvencek, Meltzoff, & Greenwald, 2011).

The theorized distinction between the different origins of explicit and implicit cognition is an important dimension that is relevant to the developmental order of emergence. Specifically, it bears on the question of whether implicit/unconscious attitudes develop before their explicit counterparts do. Implicit attitudes have been proposed to arise through formative experiences that occur prior to formal education, within families, and have even been theorized to contribute to the development of more explicit attitudes (Cvencek et al., 2021; DeHart et al., 2006). In addition, explicit beliefs are expressed through greater deliberation and are therefore prone to cognitive distortions and reporting biases due, for example, to children's increased understanding of socially desirable responding as they grow older (Shiffrin & Schneider, 1977). Against the backdrop of this empirical and theoretical background, we treat children's food-related beliefs as an outcome measure (because they are theorized to be later cognitive-developmental milestones), along with their food behaviors, both of which we assess with self-report. Due to their different origins and emergence, we expect implicit and explicit attitudes to have non-overlapping roles in predicting children's food-related beliefs and behaviors. Therefore, we test the following:

**Proposition 3.** *Children's positive attitudes toward healthy food are associated with (a) more positive food-related beliefs toward healthy food and (b) more positive food-related behaviors, with implicit and explicit measures capturing different aspects of food beliefs and behaviors.*

### 2.5. The case of Croatian schoolchildren

Our study took place in Croatia, a context that is well-suited for examining children's developing attitudes toward food for two main reasons. First, 21% of Croatian schoolchildren are overweight and 14% are obese, based on Body Mass Index calculations (Milanović, Morović, & Markelić, 2018). The rate of obesity among Croatian children is slightly above the average of 12.5% among children across the European Union (EU; OECD, 2018). Similarly, the rate of obesity among Croatian adults (18%) is higher than the EU average of 14.9% (Eurostat, 2021). By examining the development of food attitudes in a large cross-sectional sample of Croatian children, the present research has the potential to increase our understanding of the normative development of food attitudes in other EU countries.

Second, the Croatian government seeks to develop a national strategy for health promotion among schoolchildren. According to the Croatian National Curriculum Framework, nutritional education should be embedded throughout elementary school education (Milanović et al., 2018). The rationale behind these efforts is that children's attitudes toward healthy foods will improve with schooling, although strong evidence for this view is currently lacking. At present, nutritional education is missing from elementary school curricula in many countries, and questions remain about how effective it may be among very young

schoolchildren (Amahmid et al., 2019; DeCosta et al., 2017). The Croatian experience can shed light on whether such educational efforts can positively affect children's attitudes toward healthy foods.

### 2.6. Research objectives

The overarching goal of the study is to increase our understanding of the development of children's evaluative attitudes toward healthy foods and how such development may be related to age, watching television, and children's own non-evaluative beliefs about the foods they eat and their healthiness.

In examining these relations, this study seeks to make three novel contributions to the literature. First, through much larger sampling by age than in the previous literature, we examine the age-related differences in children's implicit and explicit attitude toward food, capturing the first years of formal schooling. Second, previous child studies have not examined relations between children's television watching habits and their explicit and implicit attitudes toward healthy food. This is an important gap, and this study allows us to assess whether any positive effects of formal schooling can be counteracted by excessively watching television. Third, we use a combination of implicit and explicit measures in the same children, allowing the two types of attitudes to be evaluated separately in terms of their independent relations with food-related beliefs and behavior.

## 3. Method

To test our propositions, we administered an adaptation of the Implicit Association Test (IAT) for children and a developmentally-appropriate self-report survey. This allowed us to measure implicit and explicit attitudes, as well as our proposed predictor variables (age and television watching).

### 3.1. Sample description

Participants between 5 and 9 years of age were randomly selected from schools in Zagreb, Croatia. The sample population represented all levels of socioeconomic background, and families of all children were contacted in September 2018. The study was approved by the Croatian Institute of Medical Research Ethics Committee. Written informed consent was obtained from parents before their children participated in the study. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were adhered to during this study.

The sample included 1,412 students (716 girls) recruited from 15 different schools in Zagreb. Children ranged in age from 5 to 9 years old ( $M = 7.45$  years,  $SD = 1.14$ ): 78 children (42 girls) were 5 years old, 194 (107 girls) were 6 years old, 457 (227 girls) were 7 years old, 374 (200 girls) were 8 years old, and 309 (140 girls) were 9 years old. Given the magnitude of the Cohen's effect size  $f$  (0.16),  $\alpha = 0.01$ , total sample size in two-way ANOVA of 1351,  $df_{\text{numerator}} = 1$ , number of groups = 10, the power  $\beta$  exceeds 0.95, indicating that the initial sample size of 1,412 children included in the research is sufficient. This age range was selected based on previous findings that children are capable of correctly categorizing foods according to their healthiness by the age of four (Nguyen, 2007).

### 3.2. Procedure

Participants were provided with a touch-screen tablet (25-cm diagonal screen). They were tested individually in a quiet room alone with an adult facilitator. Upon arrival, parents of participants signed a written informed consent form and children sat in front of a tablet at a distance of approximately 60 cm. Each test session began with a 3–5 min description of the study, during which children were told that they would "play a game on a tablet" and were familiarized with the test

apparatus. The actual experiment lasted approximately 15 min and children received a small prize for participating in the study. The study was comprised of three tasks: (a) an assessment of implicit evaluations using an IAT; (b) a categorization and rating task for explicit attitudes, and (c) a questionnaire evaluating television watching and capturing demographic variables of interest. The order of implicit and explicit tests was counterbalanced across participants.

### 3.3. Measures

All children completed implicit and explicit measures of food attitudes, as well as a self-reported measure of food beliefs and behavior.

#### 3.3.1. Implicit food attitudes

Children completed a child-friendly adaptation of the IAT, which has been validated for use with preschool children (Cvencek, Greenwald, & Meltzoff, 2011) and elementary school children (Cvencek, Meltzoff, & Greenwald, 2011). In this “Child IAT,” children sorted stimuli belonging to four different categories as quickly as possible using two response buttons. The Child IAT is based on the principle that it is easier to give the same response to items from categories that are mentally associated (or “congruent”) than to ones that are not (Cvencek, Greenwald, & Meltzoff, 2011). For example, the pairing of the category *games* with the attribute *fun* would be congruent, as would the pairing of *chores* with *boring*; whereas the pairing of *chores* with *fun* or *games* with *boring* would be incongruent. Participants would be expected to respond faster to congruent pairings. The faster the participants’ responses, the stronger the presumed underlying association between the two categories.

During the Child IAT, children responded to stimuli from four different categories: *healthy food*, *unhealthy food*, *tasty*, and *not tasty*. The *healthy* and *unhealthy food* categories were each represented by four pictures obtained from the study Raghunathan et al., 2006: salad, cooked fish, apple, and broccoli for *healthy food*; pizza, French fries, donuts, and potato chips for *unhealthy food*. The *tasty* and *not tasty* categories were each represented by five Croatian words presented as text with an accompanying audio recording of a female voice speaking each word. Pilot work with three translators and two teachers confirmed that all words were familiar to Croatian children in the age groups under study. English translations of the *tasty* words were “flavorful,” “appetizing,” “yummy,” “lip-smacking,” and “tasty,” and translations of the *not tasty* words were “stale/flavorless,” “unappetizing,” “unpalatable,” “yucky,” and “less tasty.” The individual stimuli for each of the four categories of stimuli were piloted in advance with children who were not involved in the study reported here. This pilot work revealed the Child IAT used here operated similarly to the standard IAT with adults, and in line with prior research showing that the IAT functions at the level of categories (Nosek, Greenwald, & Banaji, 2005, p. 17), and not individual stimuli (Lane, Banaji, Nosek, & Greenwald, 2007, p. 73).

Children completed the Child IAT on a tablet computer and responded to the stimuli by tapping one of two on-screen response buttons. All instructions were presented orally by an experimenter who sat with the child and ensured that the instructions were understood. These included a general description (e.g., “it’s going to be your job to tell the tablet what kind of words they are”) and general instructions (e.g., “the way you play this game is to always use both hands”). Before the sorting task began within each block, the experimenter identified the stimuli on the screen so the child would know how to sort them (e.g., “some of the pictures are going to be of healthy foods like these”) and gave specific instructions on how to respond to the stimuli (e.g., “if you see and hear a tasty word, tap this button”). The experimenter also alerted the child to anything different about the current block so the child would not become confused (e.g., “the words switched sides”) and to ensure that the child would respond rapidly and without conscious deliberation (e.g., “try to go as fast as you can this time”). To keep the child engaged, the experimenter provided positive feedback after each block regardless of

the child’s actual performance (e.g., “you’re doing great”). Experimenters also rehearsed answers to common questions from children (e.g., “yes you did go very fast”) and methods of getting children refocused (e.g., “remember to always use both hands like I showed you”).

Each trial presented exactly one stimulus on the screen and the child was tasked with categorizing the stimulus using the correct response button, after which the child was presented with the next trial. The stimulus presented in each trial was randomly selected by the software (Inquisit) from the categories involved in the present block. Visual reminders of which category was associated with each response button were present throughout each block. If an incorrect response was given (e.g., classifying donuts as *healthy*), a red question mark appeared and the child had to provide the correct response before continuing to the next trial. The software precisely recorded the response latency for every trial in milliseconds and whether the child’s response to each trial was correct or incorrect. Similarly to the standard IAT with adults, the Child IAT featured a built-in-error-penalty method, in which latency was recorded when the correct response was provided (Greenwald et al., 2003).

The Child IAT consisted of seven blocks. Blocks 1 and 2 (16 trials each) were single-task blocks in which children sorted stimuli from only two opposing categories per block (*healthy* and *unhealthy foods* in Block 1, *tasty* and *not tasty* words in Block 2) in order to gain familiarity with the stimuli and the rules of the game. Blocks 3 (16 trials) and 4 (24 trials) were the first combined-task blocks in which the children sorted stimuli from all four categories, and Blocks 6 (16 trials) and 7 (24 trials) were the second combined-task blocks which had the opposite pairings as Blocks 3–4. In one combined task, images of *healthy food* and the *tasty* words shared one response button, while images of *unhealthy food* and the *not tasty* words shared the other. The other combined task reversed the pairings, so that *unhealthy food* and *tasty* words shared one response button, and *healthy food* and *not tasty* words shared the other. Block 5 (between the two combined tasks) was a single-task block which reversed the orientation of the *tasty* and *not tasty* categories to allow children to practice with the new response button mapping before completing the second set of combined-task blocks. We expected that children with a positive attitude toward healthy foods (*healthy* = *tasty*) would find it easier to respond when images of *healthy food* and *tasty* words were paired together (*congruent task*) than when images of *unhealthy food* and *tasty* words were paired (*incongruent task*).

The Child IAT is a relative measure that relies on comparing two opposing associations of categories (e.g., *healthy food* = *tasty* vs. *unhealthy food* = *tasty*), hence only one score can be derived from the measure, and no sub-scores based solely on one association (e.g., *healthy food* = *tasty* only) or ratings of individual stimuli can be computed. The food attitude Child IAT score (*D*) was calculated by first (a) computing the difference between the mean response latencies of the *healthy food* = *tasty* and *unhealthy food* = *tasty* tasks for each participant, then (b) dividing that difference by the pooled standard deviation across all combined task blocks within each participant (Greenwald et al., 2003). Only trials from the combined-task blocks (Blocks 3–4 and 6–7) were included in the scoring procedure, following the standard scoring recommendations (Greenwald et al., 2003). The advantage of this scoring algorithm over unstandardized response times has been established by Greenwald et al. (2003), who demonstrated that the *D*-algorithm almost completely eliminates the artifact of spuriously extreme IAT scores for slow responders, which is especially useful in studies that compare IAT scores for groups, such as younger versus older children, who may differ in speed of responding. Positive *D* scores indicated a stronger association of *healthy food* with *tasty* (upper bound: +2), and negative *D* scores indicated a stronger association of *unhealthy food* with *tasty* (lower bound: -2). The food attitude Child IAT had a rational value of 0, indicating an equally strong association of both *healthy* and *unhealthy food* with *tasty*.

**Table 1**  
Means of implicit food attitude, explicit food attitude, and food-related beliefs and behaviors by age and gender.

Participants	Implicit Food Attitude		Explicit Food Attitude		Makes Me Strong		Eaten Recently	
	M	SD	M	SD	M	SD	M	SD
Overall	0.09***	0.47	-0.31***	0.80	4.58***	4.51	0.05***	0.42
Girls	0.06**	0.46	-0.25***	0.77	4.97***	4.40	0.07***	0.44
Boys	0.11***	0.48	-0.37***	0.83	4.18***	4.59	0.03*	0.41
Age 5	-0.17**	0.42	-0.64***	0.76	1.66**	4.56	-0.11*	0.40
Girls	-0.14***	0.46	-0.49	0.69	2.61*	4.77	-0.06	0.36
Boys	-0.20**	0.36	-0.82***	0.81	0.54	4.11	-0.16	0.44
Age 6	-0.002	0.44	-0.31***	0.84	3.84***	4.76	-0.01	0.40
Girls	0.004	0.44	-0.19*	0.86	4.24***	4.73	0.01	0.42
Boys	-0.01	0.44	-0.46***	0.80	3.35***	4.79	-0.04	0.36
Age 7	0.06*	0.46	-0.36***	0.75	4.55***	4.51	-0.01	0.40
Girls	0.004	0.47	-0.33***	0.71	4.86***	4.42	0.01	0.43
Boys	0.11***	0.45	-0.39***	0.78	4.24***	4.59	-0.02	0.37
Age 8	0.11***	0.44	-0.36***	0.75	4.96***	4.36	0.07**	0.42
Girls	0.08**	0.42	-0.31***	0.78	5.42***	4.30	0.11***	0.42
Boys	0.14***	0.47	-0.42***	0.71	4.43***	4.38	0.02	0.41
Age 9	0.21***	0.50	-0.12*	0.89	5.18***	4.28	0.17***	0.45
Girls	0.19***	0.48	-0.05	0.79	5.56***	3.98	0.17***	0.47
Boys	0.23***	0.52	-0.18*	0.96	4.87***	4.50	0.17***	0.43

Note. Asterisks indicate significant difference compared to 0. \*\*\**p* < .001. \*\**p* < .01. \**p* < .05.

### 3.3.2. Explicit food attitude

Measurement of explicit attitudes occurred based on a variant of the explicit forced-choice categorization task employed by Monnery-Patris et al. (2016) and Marty, Chambaron, et al. (2017), which was designed to fit with the cognitive abilities of primary school-aged children. Children viewed four pictures of healthy foods and four pictures of unhealthy foods, one at a time, and were asked to rate how much they liked the food. The pictures used in this measure were the same healthy and unhealthy food pictures that appeared during the Child IAT. Children’s responses were provided on a 3-point Likert scale with options of 1 (*I really dislike this food*), 2 (*I do not like or dislike this food*), and 3 (*I really like this food*). These options were accompanied by respective emojis: an unhappy (disgusted) face, a face with a neutral expression, or a happy (satisfied) face. Children also had the option of indicating that they had never tried the food in the picture. The explicit food attitude score was computed as the difference between the mean of the four healthy food ratings and the mean of the four unhealthy food ratings. Positive difference scores indicated a positive attitude toward healthy foods (upper bound: +3), and negative difference scores indicated a positive attitude toward unhealthy food (lower bound: -3). A score of 0 indicated equal attitudes toward healthy and unhealthy foods.

### 3.3.3. Television watching

Following the collection of information on explicit food attitudes, children also reported the average number of hours they spent watching television per day. This was coded in intervals: none (0), less than one hour (1), between one and two hours (2), between three and four hours (3), and more than four hours per day (4).

### 3.3.4. Food-related beliefs and behaviors

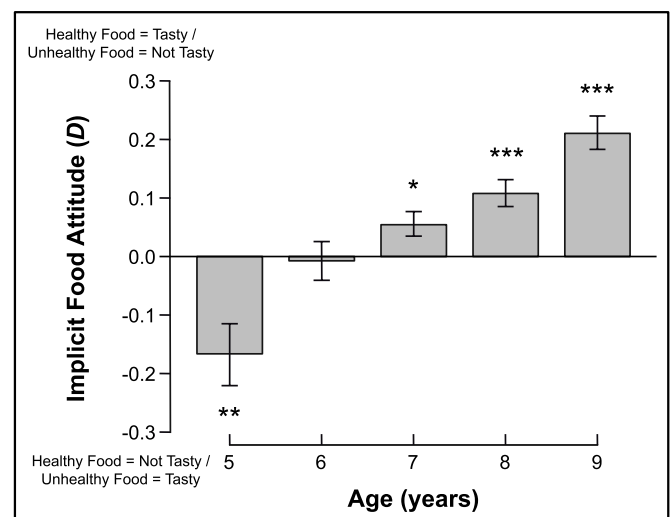
Children also self-reported (a) the extent to which they believed certain foods would make them strong and (b) the frequency of the foods they ate recently. Children were asked to report their beliefs and behaviors for each of the four images of healthy foods (salad, cooked fish, apple, and broccoli) and each of the four images of unhealthy foods (pizza, French fries, donuts, and potato chips).

For Makes Me Strong ratings, children answered the question “Does \_\_\_ make you strong” on a scale from 0 (*this food does not make me strong*) to 10 (*this food makes me strong*). For Eaten Recently ratings, children answered the question “Have you eaten \_\_\_ in the last couple of days” by responding with no (0) or yes (1). For both ratings, a

difference score was computed by subtracting the ratings for unhealthy foods from the ratings for the healthy foods. Positive scores on Makes Me Strong and Eaten Recently ratings indicated, respectively, stronger beliefs that healthy foods make one strong and more recent consumption of healthy foods.

### 3.4. Data reduction

The three standard exclusion criteria for Child IAT (Cvencek, Meltzoff, & Greenwald, 2011) were applied to the sample. Namely, data were excluded for participants who: (a) made too many fast responses (i.e., greater than 10% of responses under 300 ms), (b) had an error rate greater than 35%, or (c) had mean response latencies greater than three standard deviations from the sample mean. These criteria led us to exclude 51 participants (3.6%), leaving a final sample of *N* = 1,361 participants in the analyses.



**Fig. 1.** Mean food attitude Child IAT score for each age group. Positive scores indicate stronger *healthy food = tasty* association. Negative scores indicate stronger *unhealthy food = tasty* association. \*\*\**p* < .001. \*\**p* < .01. \**p* < .05. Error bars represent ±1 SE.

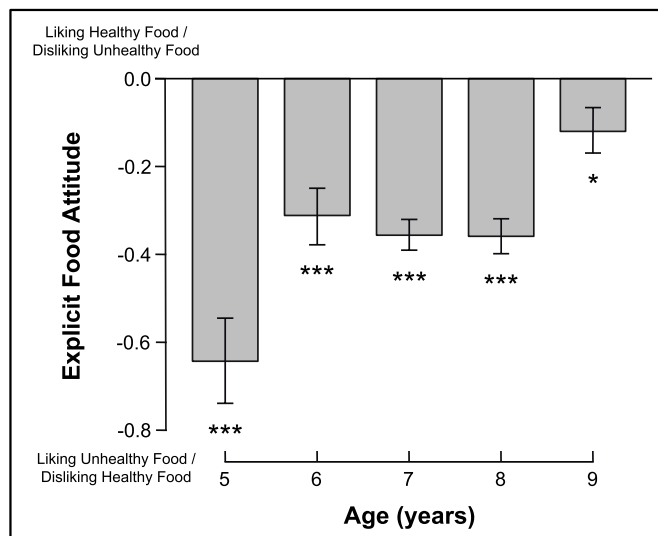


Fig. 2. Mean explicit food attitude scores for each age group. Positive scores indicate a more positive explicit attitude (“liking”) toward healthy foods. Negative scores indicate a more positive explicit attitude (“liking”) toward unhealthy foods. \*\*\* $p < .001$ . \* $p < .05$ . Error bars represent  $\pm 1$  SE.

## 4. Results

### 4.1. Implicit food attitudes

As the Child IAT had a rational value of 0—which indicated an equally strong association of both *healthy* and *unhealthy food* with *tasty*—we first conducted a one-sample *t*-test to examine whether children’s implicit attitudes toward foods were positive (*healthy = tasty*) or negative (*healthy = not tasty*). Overall, children associated *healthy food* with *tasty* [ $t(1360) = 6.86, p < .001, d = 0.19$ ; Table 1]. The same comparisons were conducted for each age group separately. Only the youngest group (5-year-olds) associated *unhealthy food* with *tasty* more than they associated *healthy food* with *tasty* [ $t(60) = -3.15, p = .003, d = -0.40$ ], which was significantly different from the means for all other age groups ( $|ts| > 2.55, ps < .02, ds > 0.37$ ). Children one year older (6 years of age) had a mean Child IAT score not significantly different from 0 ( $p = .94$ ). Children of 7–9 years old had significant *healthy food = tasty* associations ( $ts > 2.55, ps < .02, ds > 0.12$ ).

A 2 (gender: girl vs. boy)  $\times$  5 (age: 5 vs. 6 vs. 7 vs. 8 vs. 9) one-way ANOVA was conducted using Child IAT score as a dependent variable. No effect of gender was observed ( $p = .48$ ), which allowed us to collapse across gender in subsequent Child IAT analyses. Consistent with Proposition 1, ANOVA revealed an effect of age [ $F(1, 1351) = 12.57, p < .001$ ], suggesting that the association of *healthy food* with *tasty* was stronger in older children (Fig. 1). To follow-up on this age effect, independent-samples *t*-tests were used to compare the Child IAT scores of each age group to all the other age groups. These follow-up independent-samples *t*-tests showed that the *healthy food = tasty* association was stronger in 9-year-olds than at every other age, stronger in 8-year-olds than in 5- and 6-year-olds, stronger in 7-year-olds than in 5-year-olds, and stronger in 6-year-olds than in 5-year-olds (all  $ts > 2.71, ps < .007, ds > 0.24$ ). There was no significant interaction of age with gender ( $p = .49$ ).

### 4.2. Explicit food attitudes

The same analyses were undertaken for explicit food attitudes. Overall, children self-reported that they liked unhealthy foods more than healthy foods [ $t(1360) = -14.36, p < .001, d = 0.39$ ; Table 1]. For each of the five ages, children self-reported significant positive attitudes toward unhealthy foods (Fig. 2). Akin to the results of the Child IAT, 9-

Table 2

Correlations among implicit food attitude, explicit food attitude, and food-related beliefs and behavior.

Measure	1	2	3	4
1. Implicit Food Attitude	–			
2. Explicit Food Attitude	.27***	–		
3. Makes Me Strong	.23***	.35***	–	
4. Eaten Recently	.22***	.54***	.29***	–

Note. \*\*\* $p < .0001$ .

year-olds had a less positive attitude toward unhealthy foods and more positive attitude toward healthy foods than all the other ages ( $ts > 2.36, ps < .02, ds > 0.22$ ). Five-year-olds again had stronger positive attitude toward unhealthy foods than any other age ( $ts > 2.69, ps < .05, ds > 0.37$ ).

A one-way ANOVA similar to the one performed above with implicit attitudes indicated a main effect of gender on explicit food attitude [ $F(1, 1351) = 10.67, p = .001$ ]. Both boys and girls rated unhealthy foods as tasty significantly more than they rated healthy foods as tasty ( $ts > 8.60, ps < .001, ds > 0.32$ ). A follow-up independent-samples *t*-test showed that boys had a more positive attitude toward unhealthy foods than girls did [ $t(1359) = 2.72, p = .01, d = 0.15$ ]. Again consistent with Proposition 1, there was also a main effect of age on explicit food attitude [ $F(1, 1351) = 8.43, p < .001$ ], suggesting that the rating of unhealthy foods as tasty was lower in older children (Fig. 2). There was no significant interaction of age with gender ( $p = .55$ ).

### 4.3. Implicit–explicit correlations

The implicit and explicit measures of food attitudes correlated moderately with each other ( $r = 0.27, p < .0001$ ; Table 2). Explicit measures correlated moderately with Makes Me Strong ratings ( $r = 0.35, p < .0001$ ) and strongly with Eaten Recently ( $r = 0.54, p < .0001$ ). Implicit measures correlated moderately with Makes Me Strong ratings ( $r = 0.23, p < 0.0001$ ) and Eaten Recently ratings ( $r = 0.22, p < .0001$ ).

### 4.4. Environmental correlates of children’s food attitudes

This stage of the analysis considered the potential correlates of implicit and explicit food attitudes (Table 3). Scores for the dependent variables, implicit and explicit food attitudes, were bounded, so we estimated two Tobit regressions, with cluster adjustment of standard errors by school (Primo, Jacobsmeier, & Milyo, 2007). The independent variables in each model were gender, child’s age, hours spent watching television, whether the child attended a school with a kitchen garden with associated activities in their grade, and the poverty rate in the school’s locality. The latter two were included as control variables. School kitchen gardens may provide an environment for experiential learning about healthy foods (Somerset & Markwell, 2009). In the analysis, we also wanted to control for impoverishment, as children growing up in poverty may develop attitudes distinct from those who grow up in more affluent households (Chaplin, Hill, & John, 2014). However, estimates of household income were not solicited from children given that erroneous or missing data were likely to cause a major problem. Impoverishment was therefore operationalized according to the poverty rate in the locality of the school, following the approach of Chaplin et al. (2014). This rate varied significantly across districts: in the most affluent locality, 6.8% of households were officially classified as poor, while in the least affluent locality, the poverty rate was 2.5 times higher.

Consistent with Proposition 2, watching television was related significantly and negatively to implicit ( $\beta = -0.06, t = -4.93, p < .001$ ) and explicit ( $\beta = -0.46, t = -5.80, p < .001$ ) attitudes, indicating that the appeal of unhealthy food increased as children watched more television per day.



**Table 3**  
Tobit models to identify environmental correlates of implicit and explicit food attitudes.

Variable	Implicit Food Attitude <sup>a</sup>					Explicit Food Attitude <sup>b</sup>				
	$\beta$	SE	T	p	95% CI	$\beta$	SE	t	p	95% CI
Gender	.05	.02	1.92	.05	[.00, .09]	-.43	.17	-2.54	.01	[-.75, -.09]
Age	.67	.01	5.60	<.001	[.04, .08]	.27	.07	3.78	<.001	[.13, .41]
Poverty	-.02	.01	-1.62	.11	[-.04, .003]	-.003	.08	-0.04	.97	[-.15, .15]
Television Viewing	-.06	.01	-4.93	<.001	[-.08, -.03]	-.46	.08	-5.80	<.001	[-.62, -.30]
Kitchen Garden	-.03	.03	-0.90	.37	[-.09, .03]	.01	.21	0.04	.97	[-.41, .42]
Constant	-.27	.09	-2.88	<.001	[-.45, -.09]	-1.77	.64	-2.75	.006	[-3.03, -.51]

Note. CI = confidence interval.

<sup>a</sup> AIC = 1845.998, BIC = 1882.891.

<sup>b</sup> AIC = 3413.372, BIC = 3480.264.

Age was positively related to both implicit ( $\beta = 0.67$ ,  $t = 5.60$ ,  $p < .001$ ) and explicit ( $\beta = 0.27$ ,  $t = 3.78$ ,  $p < .001$ ) attitudes, which is consistent with the ANOVA results above. Regarding the control variables, schools possessing a school garden with use by a particular grade's students had no significant relation to either children's implicit ( $\beta = -0.03$ ,  $t = -0.90$ ,  $p = ns$ ) or explicit ( $\beta = -0.08$ ,  $t = -0.04$ ,  $p = ns$ ) attitude toward food. Similarly, impoverishment had no significant relation with implicit attitudes ( $\beta = -.02$ ,  $t = -1.62$ ,  $p = .11$ ) or explicit attitudes ( $\beta = 0.003$ ,  $t = 0.04$ ,  $p = ns$ ).<sup>2</sup> In contrast, gender was significant in explaining variations in both implicit ( $\beta = .05$ ,  $t = 1.92$ ,  $p = .05$ ) and explicit food attitudes ( $\beta = -0.43$ ,  $t = -2.54$ ,  $p = .01$ ). After controlling for other factors, there was an effect of gender on attitudes: Boys exhibited more positive implicit attitudes, but more negative explicit attitudes toward healthy food.

#### 4.6. Relations among children's attitudes, food-related beliefs, and behaviors

##### 4.6.1. Foods that make me strong

Overall, children believed that healthy, rather than unhealthy, foods would make them stronger [ $t(1361) = 37.43$ ,  $p < .001$ ,  $d = 1.01$ ]. A one-way ANOVA examining gender and age effects on children's beliefs about which foods make them strong revealed a main effect of gender [ $F(1, 1351) = 11.57$ ,  $p = .001$ ]. Both girls and boys believed that healthy, rather than unhealthy, foods would make them stronger ( $ts > 23.60$ ,  $ps < .001$ ,  $ds > 0.91$ ), and girls held this belief more strongly than boys [ $t(1359) = 3.22$ ,  $p = .001$ ,  $d = 0.17$ ]. There was also a main effect of age on children's beliefs about which foods make them strong [ $F(1, 1351) = 10.38$ ,  $p < .001$ ], suggesting that older children believed to a greater extent that healthy, rather than unhealthy, foods would make them stronger. Children of all ages believed that healthy foods would make them stronger ( $ts > 2.84$ ,  $ps < .007$ ,  $ds > 0.36$ ). This belief was stronger in 9-year-olds than in 5-, 6-, and 7-year-olds, stronger in 8-year-olds than in 5- and 6-year-olds, and stronger in 7- and 6-year-olds than in 5-year-olds (all  $ts > 1.93$ ,  $ps \leq .05$ ,  $ds > 0.14$ ). There was no significant interaction between age and gender ( $p = .80$ ).

##### 4.6.2. Foods eaten recently

Overall, children self-reported they had recently eaten more healthy foods than unhealthy foods [ $t(1361) = 4.20$ ,  $p < .001$ ,  $d = 0.11$ ]. A one-way ANOVA examining gender and age effects on children's reporting of the food they had eaten recently revealed no effect of gender ( $p = .07$ ), but a main effect of age [ $F(1, 1351) = 12.00$ ,  $p < .001$ ], suggesting that older children had eaten more healthy foods recently than younger children. Both 9- and 8-year-olds had eaten more healthy foods than

<sup>2</sup> Subsequent analysis indicated no significant correlation at the 0.05 level between poverty level and healthy or unhealthy foods eaten recently.

unhealthy foods recently ( $ts > 3.14$ ,  $ps < .002$ ,  $ds > 0.16$ ), and 5-year-olds had eaten more unhealthy foods than healthy foods recently [ $t(60) = -2.10$ ,  $p = .04$ ,  $d = 0.27$ ]. Means for 6- and 7-year-olds were not significantly different from 0 ( $ps > .63$ ). Follow-up independent-samples  $t$ -tests showed that 9-year-olds reported eating more healthy foods recently than all other ages, 8-year-olds had recently eaten more healthy foods than all younger ages, and 7-year-olds had recently eaten more healthy foods than 5-year-olds (all  $ts > 2.19$ ,  $ps < .03$ ,  $ds > 0.18$ ). There was no significant interaction of age with gender ( $p = .71$ ).

##### 4.6.3. Attitudes, beliefs, and behavior relations

To examine relations of implicit and explicit food attitudes with children's beliefs about food (i.e., "food makes me strong") and food-related behaviors (i.e., "foods eaten recently"), separate hierarchical regressions were conducted for the Makes Me Strong and Eaten Recently scores. In one regression model, gender was entered at Step 1, the implicit food attitude score was entered at Step 2, and the explicit food attitude score was entered at Step 3. In the other regression model, the order of the implicit and explicit predictors was reversed. Table 4 summarizes the results.

The effect of gender was significant for the Makes Me Strong ratings at Step 1 ( $R^2 = 0.01$ ,  $\beta = -0.09$ ,  $p = .001$ ), but not for the Eaten Recently ratings ( $p = .12$ ). For both sets of ratings, zero-order correlations were significant for the implicit ( $R^2s > 0.04$ ,  $\beta s > 0.21$ ,  $ps < .0001$ ) and explicit food attitude measures at Step 2 ( $R^2s > 0.12$ ,  $\beta s > 0.34$ ,  $ps < .0001$ ). Simultaneous regression at Step 3 showed significant effect of implicit [ $\Delta R^2s > 0.01$ ,  $ts(1385) > 3.27$ ,  $ps \leq .001$ ] and explicit measures [ $\Delta R^2s > 0.09$ ,  $ts(1385) > 11.75$ ,  $ps < .0001$ ], demonstrating that the two measures provided incremental prediction over and above any effects of gender at Step 1.

Taken together, the results indicated that the two measures were independently predicting different aspects of food-related beliefs and behaviors: each food attitude measure added value at Step 2 beyond the value already demonstrated by the other measure at Step 1.

## 5. Discussion

Researchers acknowledge the importance of understanding how children's food attitudes are associated with behavior, and they lament the lack of novel methods for assessing children's attitudes and beliefs across development (Goodnow, 1988). Nevertheless, the continuing reliance on self-reported assessments of attitudes leaves a critical gap in knowledge about the relations between children's food attitudes and their food-related beliefs and behavior. Bringing new light to this area of inquiry, the present study provides insights into children's attitudes toward healthy and unhealthy food by measuring implicit and explicit measures for the same children across multiple ages.

In terms of explicit attitudes, children self-reported liking unhealthy foods more than healthy ones. Child IAT scores indicated that children of all but the two youngest ages associated healthy food with being tasty. A



**Table 4**  
Linear regressions for food-related beliefs and behavior.

Regression Step	Predictor	Dependent Measure							
		Makes Me Strong				Eaten Recently			
		$\beta$	$t$	$\Delta R^2$	$p$	$\beta$	$t$	$\Delta R^2$	$p$
Step 1	Gender	-.09	-3.22	.01	.001	-.04	-1.54	.002	.12
Step 2	Exp. Food Attitude	.35	13.75	.12	<.001	.54	23.47	.29	<.001
Step 3	Imp. Food Attitude	.16	5.97	.02	<.001	.08	3.27	.01	.001
Step 1	Gender	-.09	-3.22	.01	.001	-.04	-1.54	.002	.12
Step 2	Imp. Food Attitude	.24	9.11	.06	<.001	.22	8.27	.05	<.001
Step 3	Exp. Food Attitude	.31	11.75	.09	<.001	.52	21.76	.25	<.001

Note. Exp. = Explicit. Imp. = Implicit.

steady developmental progression toward *healthy = tasty* was found on both implicit and explicit measures, consistent with Proposition 1. The study thus extends knowledge regarding the age-related boundaries on children's food attitudes and choices described by Echelbarger et al. (2020). Importantly, the present study provides novel evidence of positive progress in children's nutritional awareness during elementary school, with the favorable evaluation of healthy food and its association with "tasty" increasing with age. Adults often explicitly report that healthy food is good for them, yet their implicit attitude is that healthy food is less tasty. For example, Raghunathan et al. (2006) and Mai and Hoffmann (2015) found that when a food is portrayed as unhealthy, adults regard it as tastier. In contrast, in two studies with 5- to 6-year-olds, DeJesus et al. (2019) found that children ate more foods described as "healthy" compared with foods described as "unhealthy," and van der Heijden et al. (2020) found that children and parents implicitly associated healthy foods and tastiness more strongly with each other than healthy foods and being not tasty. The evidence of this study and others thus indicates that an *unhealthy = tasty* association is not inevitable.

Children self-reported a positive attitude toward unhealthy foods, but also demonstrated a *healthy = tasty* association at an implicit level. This suggests that self-reported attitudes might be more negative toward healthy food than indirectly measured attitudes. Advertising can affect both explicit and implicit attitudes (Matthes & Schmuck, 2015), and television commercials appear particularly effective at influencing the explicit attitudes of elementary school-age children, who may not have yet fully developed their critical reasoning abilities (D'Alessio, Laghi, & Baiocco, 2009). Moreover, children who watch television more often are more likely to believe television commercials (D'Alessio et al., 2009). Our data suggest that watching television is more strongly related to explicit than implicit attitudes (Table 3).

An additional novel finding of this study concerns an early and strong implicit-explicit dissociation: one would draw very different conclusions if one was shown only the implicit data (Fig. 1) vs. only the explicit data (Fig. 2). Specifically, if one were assessing children's attitudes towards food using *only* implicit measures, one would conclude that children's food attitudes are negative before children start formal schooling, but they *become positive with age* as children progress through primary school. In contrast, if one were assessing children's attitudes towards food using *only* explicit measures, one would conclude that children's food attitudes are negative before children start formal schooling, and although they become *less* negative with age, they *still stay negative as children progress through primary school*.

A substantial body of work has already been done on the dissociation between implicit and explicit measures in adults (Hofmann et al., 2005), and similar dissociations have been described in young children (Cvencek et al., 2021; Dunham et al., 2008). Importantly, while the results on both implicit and explicit measures trended in the *healthy = tasty* direction, the "switch" from average *unhealthy = tasty* attitudes to *healthy = tasty* attitudes was evident only for implicit measures. This is in line with theorizing about the differences between controlled and automatic cognitive processes. The experiences a person reports having

early in development play an important role in shaping "automatic" processing, whereas experiences acquired later in life influence more "controlled" processing (DeHart et al., 2006). Here, we demonstrate that attitudes trending in the *healthy = tasty* direction, as suggested by Proposition 1, are evident earlier and are detected more robustly by implicit measures than explicit ones. This is consistent with past research suggesting that implicit attitudes and beliefs in young children may precede explicit ones (Cvencek, Meltzoff, & Greenwald, 2011; Guardabassi & Tomasello, 2020; Steffens, Jelenec, & Noack, 2010).

The observed developmental change in implicit food attitudes is also relevant to the emerging debate about the developmental stability versus malleability of implicit social cognition. Past research with children demonstrated that children's implicit attitudes about social groups form early and remain strikingly stable over development (Baron & Banaji, 2006; Dunham et al., 2013). Such reports of stability in implicit attitudes and the current findings of developmental change are not necessarily at odds with each other. It is possible that children's affective evaluations pertaining to social groups from which one derives one's own group identity (e.g., implicit attitudes about prominent social categories such as race or gender) form quickly and remain stable, in part, due to the early emergence of in-group favoritism and stronger positive attitudes toward high-status groups in children (Rhodes & Baron, 2019). In contrast, positive affective evaluations of hedonically rewarding categories (e.g., implicit attitudes about food), may form more gradually and be more malleable because they are reinforced and adjusted over time in response to repeated consumption of a food item, and are not processed as highly relevant for the formation/maintenance of one's social identity. A fertile area of future research will be to systematically compare age-related changes in attitudes toward social groups that are identity-relevant (*my in-group = good*) versus attitudes toward socially relevant categories that are more identity-neutral, such as food (*fruit I like = good*).

When comparing attitudes from one age to another, we found that age was positively related to more favorable attitudes toward healthy food. It is useful to compare these results with those of Marty, Chamberon, et al. (2017) and of Marty, Miguet, et al. (2017) regarding the relations between children's attitudes and age. Marty, Miguet, et al. (2017) found that both implicit and explicit attitudes influence children's food choices, but they did not explicitly investigate age-related factors. Marty, Chamberon, et al. (2017) reported that implicit attitudes toward unhealthy food vary by age, although in the reverse direction to what we found here. This discrepancy may reflect that Marty, Chamberon, et al. (2017) examined a smaller sample (138 children) and compared quite different age groups, 6–9-years-old and 8–12-years-old. In addition, their focus was not so much on "the dynamics of attitude formation through children's development" (p. 152) but rather differences between normal- and overweight children, which has considerable resonance given increases in childhood obesity. Unfortunately, we could not measure children's anthropometrics as part of this study, limiting direct comparison of our results with theirs. Our work, nevertheless, may provide a statistically more powered and developmentally

more nuanced age investigation than previous studies by providing an analysis by age.

Regarding [Proposition 2](#), our results indicate that watching television has a significant and negative relation to both implicit and explicit measures, suggesting that unhealthy food becomes more appealing and healthy food becomes less appealing with increasing average daily time spent watching television. This result gives credence to fears regarding the effect of television on children's attitudes toward food ([Halford, Gillespie, Brown, Pontin, & Dovey, 2004](#)), particularly when advertisements for foods high in fat, salt, and sugar dominate ([Lewis & Hill, 1998](#)). However, further research is warranted to explore whether the relations between watching television and food attitudes are causal or correlational. While watching television may increase exposure to advertisements that are overwhelmingly biased toward less healthy foods ([Boyland et al., 2012](#)), it may also be that long hours watching television and high consumption of unhealthy foods are both characteristics of less structured households ([Brazendale et al., 2017](#)).

Finally, regarding [Proposition 3](#), implicit and explicit attitudes correlated with each other, and they were both associated with beliefs that healthy foods make one strong and with having recently eaten healthy foods. However, explicit attitudes exhibited stronger associations with these food-related beliefs and behaviors than implicit attitudes did ([Table 1](#)). In adults, explicit attitudes are better predictors of food consumption than implicit attitudes ([Karpinski & Hilton, 2001](#)). In order to detect relations between attitude and behavior, both must be measured appropriately and according to the same criteria ([Fishbein & Ajzen, 1974](#)). The explicit measures assessing food attitudes, Makes Me Strong beliefs, and Eaten Recently food behaviors are conceptually and methodologically more similar to each other than to the implicit food attitude measure. Nevertheless, implicit attitudes in our sample showed incremental validity for predicting actual food consumption: the results of our hierarchical regression ([Table 4](#)) underscore the importance of combining implicit and explicit measures when evaluating attitudes and understanding their relations to the development of food-related beliefs and behaviors in children.

### 5.1. Practical implications

The results here have two sets of implications for public policy practitioners and parents seeking to instill a positive attitude toward healthy food among children. First, schools, as educational facilities that support healthy physical and social development and environments where children spend much of their time, should be structured in a way that promotes healthy eating habits ([Brazendale et al., 2017](#); [Milanović et al., 2018](#)). In the Croatian context, the National Curriculum Framework provides guidelines for integrating nutrition into the elementary school curriculum. In fact, 93.9% of 154 surveyed elementary schools in Croatia offer some form of nutritional education to their students ([Milanović et al., 2018](#)), and this was the case with all the schools in the present study. This integration of nutritional education into the school curriculum may be one of the drivers of the age-related increase in *healthy = tasty* implicit attitude. Consistent with this, we found that the “switch” from *unhealthy = tasty* implicit attitudes to *healthy = tasty* implicit attitudes coincided with the onset of formal schooling ([Fig. 1](#)). The Croatian National Curriculum Framework provides a scalable framework that can be applied in other countries to foster more favorable attitudes toward healthy foods among children. Integrating such educational efforts into the core curriculum in elementary schools is likely beneficial.

Second, unhealthy food becomes more appealing, both implicitly and explicitly, as children spend more time each day watching television. A danger is that excessively watching television may counteract the positive effects of nutritional education in schools. While causality is difficult to establish, efforts to curtail screen time nonetheless appear sensible. Public health guidelines worldwide suggest that children 5–12 years old should spend no more than two hours a day watching

television ([Cox, Skouteris, Dell'Aquila, Hardy, & Rutherford, 2013](#)), but over a quarter of the sampled children in this study reported exceeding this threshold. Educators should work with parents to promote restrictions on screen time, communicating evidence that excessively watching television in early childhood is associated with adverse cognitive and behavioral outcomes. Removing televisions from children's bedrooms is one practical measure that gives parents greater control. While it is difficult to precisely assess exposure to commercials from the data, it is likely that the high prevalence of television advertisements promoting foods high in fat, salt, and sugar alters children's implicit and explicit attitudes toward food. Parents should prioritize children's television channels that do not carry advertisements, although their availability varies by country, depending on the nature of public sector broadcasting and commercial subscription packages.

### 5.2. Limitations and future directions

While providing important insights into patterns of implicit and explicit attitudes toward healthy foods, the present study is not without limitations. Specifically, four considerations should be addressed in future research. First, the analysis drew on cross-sectional data, so although we possessed information on children 5–9 years old, we could not trace the evolution of a *specific* child's implicit and explicit attitudes, nor whether attitudes precede or follow children's food-related beliefs. This limits the ability to understand causal mechanisms and the determinants of *unhealthy = tasty* associations. Presumably, food-related behaviors are a function of both evaluative attitudes and non-evaluative beliefs, which should be explored in longitudinal research investigating a wide range of potential correlates of children's attitudes and beliefs about food, including the influence of family food and leisure habits. Second, we rely on self-reported measures for watching television, food-related beliefs, and food consumption. While children understood that the study was anonymous with no right or wrong answers, self-reported measures may still be subject to social biases. An advantage of the IAT is that it captures automatic associative processes, making it less susceptible to self-presentation biases ([Greenwald & Farnham, 2000](#)), and our results emphasize the need for more detailed and precise study of the effect of watching television on children's attitudes by complementing explicit measures with implicit ones. Third, we did not obtain detailed information about children's households. It would be interesting to consider the degree of correlation between children's and parents' implicit and explicit attitudes toward food, and how these relations may be affected by purchasing behaviors at the household level. Finally, the present study identifies some important differences in explicit attitudes between boys and girls. Future research could consider the extent to which children associate meat with maleness, as found for adults by [Rozin, Hormes, Faith, and Wansink \(2012\)](#), and whether body consciousness may help explain gender differences in attitudes toward healthy food. Such research would fulfill calls for better understanding of the development of body dissatisfaction among children ([Knauss, Paxton, & Alsaker, 2008](#)) and how gender stereotypes relate to food attitudes and choice.

### 5.3. Conclusion

This study sheds light on both implicit and explicit aspects of children's food attitudes, finding an implicit attitude that “healthy foods are tasty,” which contrasts with a self-reported attitude that “unhealthy foods are tasty.” The findings thus reveal implicit–explicit dissociation, already observed in adults. In our sample, implicit and explicit attitudes toward healthy foods related positively to beliefs that healthy foods make one strong and to actual consumption of healthy foods. The present study provides mixed comfort to nutritional experts and educators. On the one hand, our work suggests that children possess positive implicit attitudes toward healthy foods, they associate healthy foods with tastiness, and this link strengthens during elementary school. On the

other hand, watching television, which is largely out of their control, is associated with more favorable attitudes toward unhealthy foods. Taken together, the results of this study underscore the importance of capturing children's implicit and explicit food attitudes to provide a more complete picture of how children's developing attitudes inform their food-related behavior.

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