Children prefer natural food, too

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Abstract

Adults often prefer things that they believe are natural, including natural foods. This preference has serious implications, such as the rejection of cultured meat and other sustainable technologies. Here we explore whether children also prefer natural foods. We conducted two preregistered studies with 374 adults and children from the United States. In Study 1, children's (N = 120) ages ranged from 6-10 years, with 57% of the sample identifying as female identifying as White/European American, while adults (N = 120) had a mean age of 30 years and four months, with 48.7% identifying as female, and 69.2% identifying as White/European American. In Study 2 children's (N = 63) aged ranged from 5-7 years, with 57% identifying as female and 66% identifying as White/European American, while adults (N = 64) had a mean age of 29 years and 11 months, with 60.7% of the sample identifying as female and 59% of participants identifying as White/European American. We found that, like adults, children of these ages prefer natural over unnatural foods. This was found across two domains (fruit, juice) and a range of measures (tastiness, safety, unnaturalness, desire to consume). This preference was found in children as young as 5 years of age. Overall, we provide evidence that, at least in the United States, our tendency to prefer natural food is present in childhood.

Keywords: unnatural, development, child, social learning, preferences

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Many who are comfortable eating chicken nuggets would balk at the idea of eating meat grown in a lab. Often, people explain this intuition by referring to lab-grown meat as "unnatural" (Siegrist et al., 2018; Wilks & Phillips, 2017). In line with this, research has demonstrated our tendency to prefer natural things in a range of domains—food, water, and, to a lesser extent, medicine (Li & Chapman, 2012; Rozin, 2005, 2006; Rozin et al., 2004).

There is a growing body of research into our naturalness preferences, but virtually none which examines the emergence of these preferences in development. Several studies have identified factors that influence our intuitions about naturalness (e.g., Inbar et al., 2020; Li & Chapman, 2012; Román et al., 2017; Rozin, 2005, 2006). Rozin (2005) documents four principles. The first is the principle of contagion. For example, adding even a tiny amount of minerals to water can more than halve perceived naturalness. Second, chemical changes are seen as more potent than physical changes—adding or removing fat from milk reduces perceived naturalness but a physical intervention such as squeezing oranges to make juice does not. Third, the history of an object impacts perceived naturalness. For example, a free-range steak is considered more natural than a steak produced on a commercial farm (also see Rozin, 2006). And, finally, mixing similar natural entities does *not* influence perceived naturalness. For instance, mixing two different kinds of natural peanut butter does not have much impact on perceived naturalness.

Other research looks directly at preferences. Li and Chapman (2012) show that when presented with a natural and unnatural option (for example, a vitamin C pill made from natural extracts vs. one made in a lab) that are either implied or explicitly stated to be identical, people consistently prefer the natural over the unnatural option. And Inbar and colleages (2020) find that we prefer food technologies that have been used for some time, relative to more recent innovations. For example, people are more willing to eat a genetically modified sweet potato if the modification method has been in use for 100 years as opposed if the method was developed only recently.

These findings capture an intuition that natural things are, in some way, better than unnatural things (e.g., Scott & Rozin, 2020). This intuition has significant real-world consequences. Concerns about naturalness are associated with the rejection of novel food technologies, such as genetically modified (GM) food (Scott et al., 2016) and cultured meat (Michel & Siegrist, 2019; Siegrist et al., 2018; Siegrist & Sütterlin, 2017; Wilks et al., 2021). Concerns about these technologies are pervasive and widespread, with research suggesting it is difficult to shift perceptions (Bryant et al., 2019; Macdonald & Vivalt, 2017) (but see Chrispeels et al., 2019). Given that these technologies are argued to be a critical step in the adoption of a more sustainable global food system (Siegrist & Hartmann, 2020), understanding and addressing concerns about naturalness is of critical importance.

Psychological investigation of our naturalness preferences to date have focused mostly on adults—thus we have little understanding of the development of naturalness preferences. There is, however, a substantial body of literature examining children's understanding of food. For example, Girgis and Nguyen (2020) asked children to state whether they thought foods were grown in a garden or made in a factory. Children were better at identifying the origin of familiar than unfamiliar foods when they were processed (e.g., cake) but showed no differences for familiar vs. unfamiliar natural foods (e.g., apple). There is also data that informs children's food preferences more generally. For example, children generally tend towards familiar, rather than unfamiliar, foods (Birch, 1979; Wardle & Cooke, 2008). Foinant et al. (2021) finds that children from 3-6 years ascribe positive properties to familiar food above chance, but to unfamiliar food below chance. By contrast, they ascribe negative properties to unfamiliar food above chance and to familiar food below chance.

There is also a growing body of evidence that our general food preferences are shaped by social learning, for both infants (Elsner & Wertz, 2019; Wertz & Wynn, 2014, 2019; Włodarczyk et al., 2020) and young children (DeJesus et al., 2018, 2019; Shutts et al., 2013). For example, children as young as two years of age are more likely to eat a novel food if an adult eats a similar

food first (Addessi et al., 2005). There is also work exploring how very young children learn about the edibility of plants (see Wertz, 2019). Research finds that infants, at least in Western cultures (e.g., Germany, United States), typically avoid touching unfamiliar plants (Wertz & Wynn, 2014a) (but see McNamara & Wertz, 2021 who did not find this in Fijian children). However, if infants see an adult eat a plant food, or if there are cues that a plant has been touched (cut up), then the tendency to avoid is reduced—and, importantly, this occurs more for plants than other non-plant artifacts (Wertz & Wynn, 2014b, 2019). Similarly, infants look to parents more when confronted with novel plants than other items (Elsner & Wertz, 2019). Thus, our learning about plant foods seems to be hyper-social in motivation.

Perhaps, then, children are adopting the view that naturalness is good from those around them. They may absorb these ideas through advertisements or learn them either directly (through teaching about what to eat) or indirectly (through observing, overhearing) from parents, peers, and family members. To our knowledge, only one study has examined the role of the parent-child relationship in in the domain of food naturalness. Shtulman et al. (2020) found that children whose parents had better knowledge of the definitions of GM, organic, and gluten-free foods themselves tended to have better knowledge of these terms. However, while they found that adults tended to prefer organic and dislike GM foods, they did not explicitly measure children's preferences, nor ask about perceived naturalness.

In the current study we provide descriptive data of children's preferences for natural foods. We hope that this research can offer a first step towards understanding how these preferences are formed, including whether they are socially learned, and what drives our tendency to prefer natural things. Across two studies, we measured American children and adults' preferences for natural and unnatural foods in two domains (apples and orange juice) and across multiple judgements to provide the first exploration of whether these children, like adults, think of natural foods as better than their unnatural equivalents.

Study 1

In Study 1 we presented children (1a) and adults (1b) with a series of three apples—described as grown on a farm, made in a lab, and grown on a tree inside a lab. We included the tree-in-lab condition to explore whether naturalness is a binary judgement (natural vs. unnatural) or if there is a gradient of how natural something is. Specifically, we thought that participants might consider that the apple grown on a tree in a lab may be at risk of contamination from being in the lab, or perhaps was merely less natural from being grown inside a lab. We predicted that both children and adults would prefer the apple grown on a farm over the apple grown on a tree inside a lab, and both of these over the apple made in a lab. This study (The development of social and moral reasoning, protocol number #1302011578) received ethics approval from the Yale University Institutional Review Board.

Power analysis and preregistration

This research was preregistered on the Open Science Framework, https://osf.io/wqv2d (1a), https://osf.io/2jurm (1b). All data and code are also made available at https://osf.io/87xu6/?view_only=a145fb01f1b24cbabe793f7412a4edd7.

We planned to conduct a mixed ANOVA with condition as a within-subjects factor and age and gender as between-subject factors for each outcome variable. To obtain .80 power to detect a small to medium effect (f = .18) with an alpha .05, G*Power recommended 120 participants for each study.

1a – Children

Method

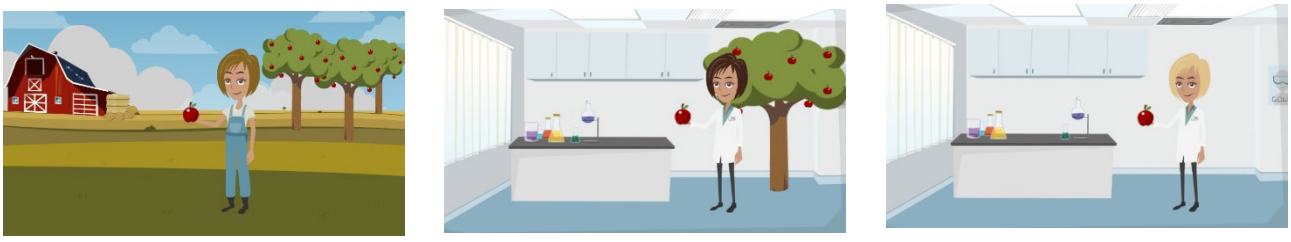
Participants. A total of 153 US-based children participated in the experiment. Sixteen children were excluded, twelve because of experimenter error and four for being the incorrect age, leaving a final sample of 137 children. Children's ages ranged from 6 years and 1 month to 10

years and 11 months, with 50.4 % identifying as female and 49.6% identifying as male. We chose this age range because, to our knowledge, the concept of naturalness has not yet been studied in children and we wanted to optimize the chance that participants would understand the manipulations, with the goal of testing younger children in the future. Demographic reporting was optional, thus not all parents responded to these questions. Of the 77 who did, their reported ethnicities were: 73% White/European American, 9% African American, 6% Asian, 1% Hispanic. Additionally, 10% reported being mixed or multiple ethnicities. Children were tested in a dedicated child-friendly testing laboratory at a local university (58), in local schools (48), museums (28), or in local parks/community events (3). Parental consent and child assent was attained for each participant.

Procedure. Using iPads, experimenters presented children with three stories about three different apples. One apple was grown on a tree on an apple farm (farm condition), one was made by a scientist in a laboratory (lab condition), and one was grown on a tree inside a science laboratory (tree in lab condition) (Figure 1). The latter condition acted as a control and allowed us to explore whether the predicted negative attitudes in the lab were due to how the apple was being made, or simply due to negative associations with a lab. All stories were presented to all participants in a randomized order.

Figure 1.

Images presented with each story: farm condition, tree in lab condition, lab condition



After hearing each story, children were asked a series of questions about the apple. Two questions asked about how tasty the apple was (tasty, neither, gross) and if the apple was safe to eat (yes, unsure, no) which were coded on a scale of 1-3. If children selected a non-neutral option they were asked to report how tasty/gross (a little bit tasty/gross, really tasty/gross) or how safe/unsafe (maybe safe/maybe not safe, definitely safe/definitely not safe) which were coded on a binary scale (1-2). Responses to these questions were combined to create a response scale from 1-5 (gross—tasty and unsafe—safe). In a third question children were asked about how much they wanted to eat the apple which was coded on a scale of 1-4 (not at all, a little bit, a medium amount, a lot). All questions were presented in a randomized order. After hearing all three stories and answering all questions, children were asked which apple they would choose to eat if all options were available to them. They could choose one of the three, or report that they didn't care. Finally, they were asked why they chose that apple.

Results

We conducted a mixed ANOVA for each of the three outcome variables. For each, condition (farm, lab, tree in lab) was the within subjects-factor and both age (in years) and gender were between-subjects' factors (see Figure 2 for all graphs).[1]

There was a significant effect of condition on children's ratings of how tasty the apples were, $F(2) = 109.35$, $p < .001$, $\eta^2 = .46$. There was no significant effect of gender or age, nor any significant interactions between any factors ps $> .067$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the farm apple ($M = 4.58$) as significantly tastier than the lab ($M = 2.69$) or tree in lab apples ($M = 3.70$) and the tree in lab apple as significantly tastier than the lab apple (all ps $< .001$).

[1] As per our pre-registration, we conducted these analyses with the full dataset and also with the first 28 children removed as their data had been collected prior to preregistration. The pattern of results was identical in both cases—thus we report only the full dataset.

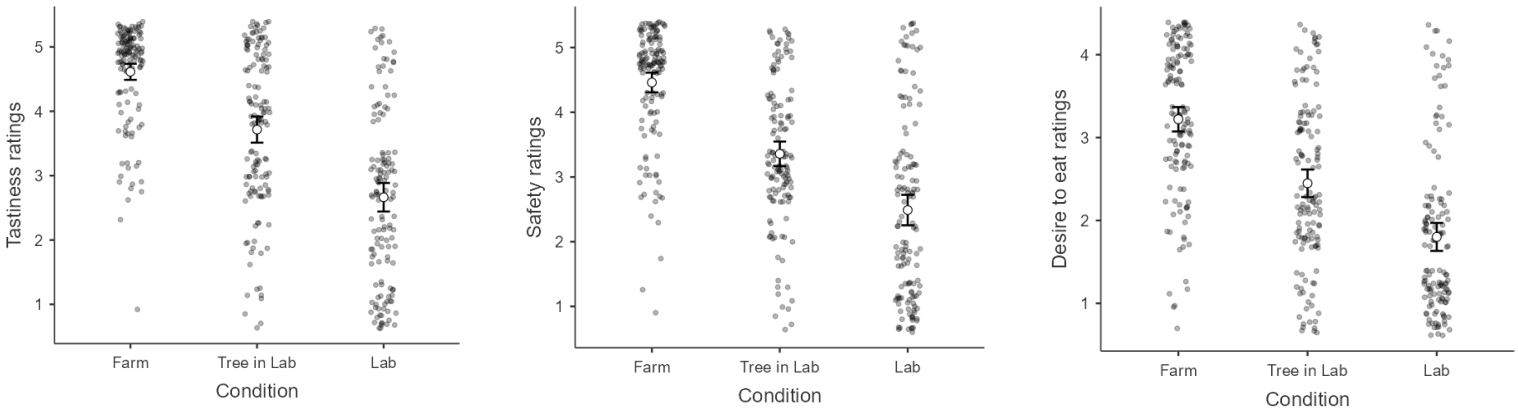
There was also a significant effect of condition on children's ratings of how safe the apples were, $F(1) = 75.83$, $p < .001$, $\eta^2 = .37$. There was no significant effect of gender or age, nor any significant interactions between any factors ps > .372. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the farm apple ($M = 4.47$) as significantly safer than the lab ($M = 2.50$) or tree in lab ($M = 3.39$) apples and the tree in lab apple as significantly safer than the lab apple (all ps < .001).

There was a significant effect of condition on children's ratings of how much they wanted to eat the apples, $F(1) = 58.12$, $p < .001$, $\eta^2 = .32$. There was no significant effect of gender or age, nor any significant interactions between any factors ps > .118. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated wanting to eat the farm apple ($M = 3.22$) significantly more than the lab ($M = 1.82$) or tree in lab apples ($M = 2.45$) and wanted to eat the tree in lab apple significantly more than the lab apple (all ps < .001).

We also report the number of children who chose each apple in the forced choice question. A total of 117 children chose the chose the farm apple (84.4%), while 4 each chose each the tree in lab and lab apples, respectively (2.9% per condition). Twelve children reported that they would not care which apple they chose (8.8%). We made a posthoc decision to conduct a chi-square goodness of fit test to examine whether children selected the farm apple above chance. If participants were selecting at chance, we would expect about 34 children to choose each of the four options. However, as noted above, 117 children chose the farm apple. The chi-square goodness of fit showed that children's choices were not random, $x^2(3) = 267.82$, $p < .001$.

Figure 2.

Children's responses for ratings of tastiness, safety and desire to eat the apples as a function of condition (error bars represent 95% CIs)



Finally, we report children's explanations of their choices. The authors developed a series of categories based on rough responses identified in the sample. An independent coder then coded each response and a second blind coded conducted reliability coding. Interrater reliability was high ($\alpha = .88$). Of the children who chose the farm apple, the most common explanation was to do with freshness, outside, or sunlight (27%), followed by safety (22%), naturalness e.g., referred to the word natural (12%), tradition (9%), health (7%), taste (6%), familiarity (4%), and exciting or novel (1%). Another 10% of participants who chose the farm apple gave other reasons. Too few participants chose the other apples to report percentages, but full responses and choices are made available on the Open Science Framework.

1b – Adults

We also conducted this study with a sample of adults. The motivations for this were twofold. First, if we had not found any naturalness preference in young children, it would have been unclear whether this represented a genuine lack of effect or was specific to the stimuli used, so the adult sample acted as a check. Second, it allowed us to make direct comparisons between children and adult naturalness preferences. The procedure was identical to Study 1a.

Method

We administered a survey to 120 adults via Prolific. All participants were required to be over 18 years of age and be living in the United States. All coding was identical to Study 1a.

Participants. Participants in the sample had an average age of 30 years 4 months, with 48.7% identifying as female, 48.7% identifying as male, and 2.5% reporting their gender as other. The sample was generally left leaning, with the average participant scoring 6.58/9 on a scale of 1 (conservative) to 9 (liberal). Participants were also generally well-educated, with 34.2% of participants having completed a bachelor's degree and 27.5% having completed some college. Finally, 69.2% of participants identified as White/European American, 12.5% as Asian/Asian American, 9.2% as Black/African American and 6.7% as Latino/Hispanic, while 1.7% identified as other and 0.8% identified as more than one category.

Results

We conducted a one way within-subjects ANOVA for each of the three outcome variables (see Figure 3 for all graphs). Unlike Study 1a, we did not include age or gender in the analyses as these were not variables of interest.

There was a significant effect of condition on adult's ratings of how tasty the apples were, $F(2) = 59.11$, $p < .001$, $\eta^2 = .33$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults rated the farm apple ($M = 4.53$) as significantly tastier than the lab ($M = 3.25$) or tree in lab ($M = 3.58$) apples ($ps < .001$) and the tree in lab apple as significantly tastier than the lab apple ($p = .023$).

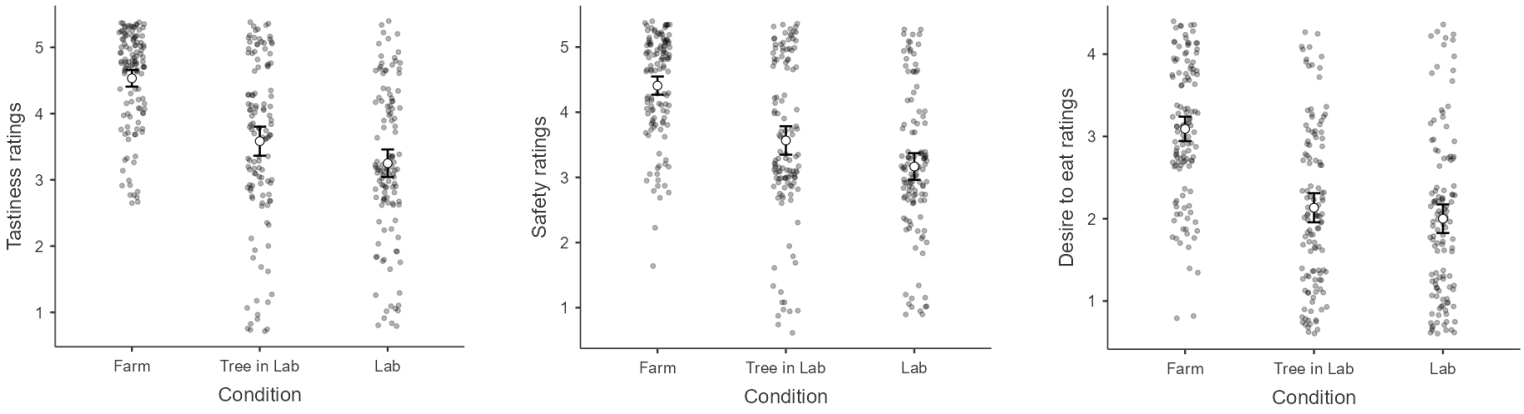
There was also significant effect of condition on adult's ratings of how safe the apples were, $F(2) = 61.37$, $p < .001$, $\eta^2 = .34$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults rated the farm apple ($M = 4.41$) as significantly safer than the lab ($M = 3.17$) or tree in lab ($M = 3.57$) apples ($ps < .001$) and the tree in lab apple as significantly safer than the lab apple ($p = .002$).

There was also a significant effect of condition on adult's ratings of how much they wanted to eat the apples, $F(2) = 77.39$, $p < .001$, $\eta^2 = .39$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults wanted to eat the farm apple ($M = 3.09$) significantly more than the lab ($M = 2.00$) or tree in lab ($M = 2.13$) apples ($ps < .001$). However, there was no significant difference between the how much adults wanted to eat the tree in lab and lab apples ($p = .414$).

We also report the number of adults who chose each apple in the forced choice question (Figure 3). A total of 91 adults chose the chose the farm apple (75.8%), while 12 chose the lab apple (10.0%) and 8 chose the tree in lab apple (6.7%). Nine adults reported that they would not care which apple they chose (7.5%). We again made a posthoc decision to conduct a chi-square goodness of fit test to examine whether adults selected the farm apple above chance. If participants were selecting at chance, we would expect 30 adults to choose each of the four options. However, as noted above, 91 adults chose the farm apple. The chi-square goodness of fit showed that adults were not choosing at random, $x^2(3) = 165.67$, $p < .001$.

Figure 3.

Adults' responses for ratings of tastiness, safety and desire to eat the apples as a function of condition (error bars represent 95% CIs)



Finally, we report adult's explanations of their choices. An independent coder coded each response using the same coding categories as Study 1a and a second blind coded conducted

reliability coding. Interrater reliability was high (α = .90). Of the participants who chose the farm apple, the most common explanation was to do with naturalness e.g., referred to the word natural (53%), followed by safety (17%), freshness, outside, or sunlight (8%), taste (6%), tradition (5%), health (4%), familiarity (2%) exciting or novel (2%), and another 1% gave other reasons. Too few participants chose the other apples to report percentages, but full responses and choices are made available on the Open Science Framework.

Child vs. adult comparisons

We also opted to directly compare children and adults' responses in posthoc analyses. We conducted a mixed ANOVA with group (adults vs. children) as the between subjects' factor and condition as the within-subjects factor for each outcome measure. Note that for the latter two analyses (perceived safety and willingness to eat) sphericity was violated so we employed Greenhouse-Geisser corrections in our analyses.

For perceived tastiness there was a significant main effect of condition ($p < .001$) but no main effect of group ($p = .159$). There was also a significant condition x group interaction $F(1) = 10.12$, $p < .001$, $\eta^2 = .04$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the lab apple ($M = 2.66$) as significantly less tasty than adults ($M = 3.25$), $p < .001$, while no other comparisons were significant $p > .376$. For perceived safety there was a significant main effect of condition ($p < .001$) and a main effect of group ($p = .004$). There was also a significant condition x group interaction, $F(1) = 8.96$, $p < .001$, $\eta^2 = .03$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the lab apple ($M = 3.16$) as significantly less safe than adults ($M = 2.48$), $p < .001$, while no other comparisons were significant $p > .152$. Finally, for desire to eat there was a significant main effect of condition ($p < .001$) but no main effect of group ($p = .339$). There was also significant condition x group interaction $F(1) = 6.99$, $p = .001$, $\eta^2 = .02$. Follow up Bonferroni adjusted pairwise comparisons revealed that children

reported wanting to eat the tree in lab apple (M = 2.13) significantly less than adults (M = 2.45), p = .011, while no other comparisons were significant p > .107.

Discussion

In Studies 1a and 1b, we show that both children and adults prefer apples grown on farms to those grown in a lab or grown on a tree inside a lab. They also preferred the apple grown on a tree inside a lab to an apple grown in a lab. In direct comparisons, children and adults were remarkably similar, with children tending to perceive the lab apple and tree-in-lab apple more negatively than adults on some measures. Importantly, the naturalness preferences found here persisted on all metrics tested: perceived tastiness, perceived safety, and desire to consume. Further, children's responses did not change as they aged—children as young as 6 years responded similarly to children as old as 10 years—suggesting that, by age 6, the view that "natural is better" is well established. When considering the motivation behind choosing the farm apple, children were most likely to refer to freshness, being outside, or sunlight, while adults were most likely to refer to naturalness.

Study 2

While the findings from Study 1 suggest a tendency to prefer natural things, we did not explicitly measure perceived unnaturalness. For Study 2, then, we wanted to measure children's beliefs about (un)naturalness explicitly. We also employed more subtle manipulation of naturalness and a different target food to ensure that the effect was not specific to apples. Given that we did not find any age effects in Study 1 and that even the youngest children showed a preference for natural foods, we opted to only test younger children in Study 2. Again, we replicated this study with an adult sample.

In Study 2 we presented children (2a) and adults (2b) with a four different kinds of orange juice. All was squeezed on a farm and then either was: left as is, had a box placed over it, had chemicals added and removed, or had chemicals added. We included the box condition to examine

whether perceived naturalness was affected by any action, even one that could not rationally change the content of the juice (placing a box over it). We included the two different chemical conditions (added vs. added and removed) to build off prior work showing that it is the history of the object rather than its current content that affects perceived naturalness (Rozin, 2005). That is, participants might think of the juice with chemicals added and removed as less natural, despite the content now being ostensibly the same as the farm juice (i.e., no chemicals).

We predicted that both children and adults would prefer the farm juice and the juice with a box placed over it over the juice with the chemicals added and chemicals added and removed. We did not make predictions about differences between the two chemical conditions. This study (The development of social and moral reasoning, protocol number #1302011578) received ethics approval from the Yale University Institutional Review Board.

Power analysis and preregistration

The experiments were preregistered on the Open Science Framework child https://osf.io/bq5u8 (2a), https://osf.io/2jurm (2b). All data and code are also made available at https://osf.io/87xu6/?view_only=a145fb01f1b24cbabe793f7412a4edd7.

We planned to conduct a within-subjects ANOVA for each outcome variable. To obtain .80 power to detect a small to medium effect (f = .18) with an alpha .05, G*Power recommended 64 participants.

2a – Children

Method

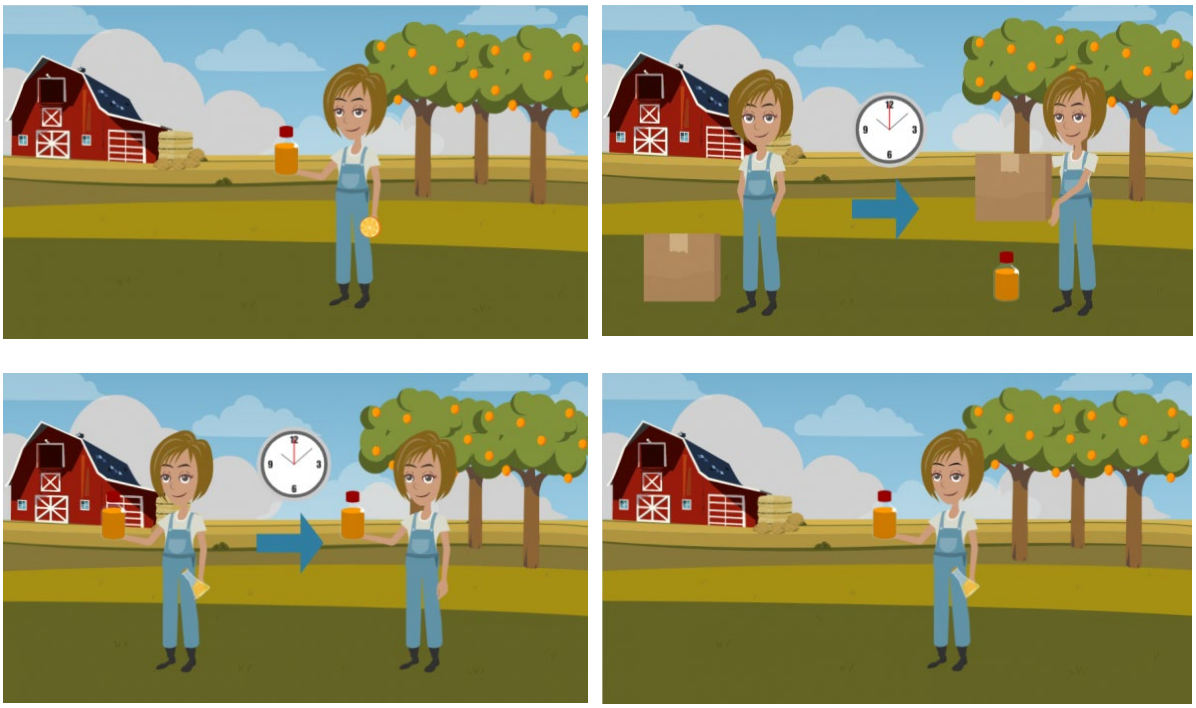
Participants. A total of 85 US-based children participated in the experiment. Twenty-two children were excluded, 16 for failing the manipulation check and six for being outside of the focal age range, leaving a final sample of 63 children. Children's ages ranged from 5-7 years (21 5-year-olds, 23 6-year-olds, and 19 7-year-olds), with 57.1% identifying as female and 42.9% identifying

as male. Demographic reporting was optional, thus not all parents responded to demographic questions. Of the 66 who did, their reported ethnicities were: 66% White/European American, 11% Asian, 6% Hispanic, 3% African American, and 1% Middle Eastern. Additionally, 9% reported being mixed or multiple ethnicities and 3% reported 'other'. All children were tested online via Zoom. Parental consent was attained for each participant.

Procedure. The procedure was similar to Study 1 except children heard about four different kinds of orange juice. For each, children were told that the juice was made fresh from the juice grown on the farm and that the farmer put the juice straight into the bottle. From here, children were either given no additional information (farm condition), told that the farmer placed a cardboard box over the juice for 2 minutes and then removed it (box condition), told that the farmer added 5 drops of chemicals and removed them after two minutes (add/remove condition), and told that the farmer added 5 drops of chemicals (add condition) (Figure 4). The box condition was included as a control; covering an item with a box should not affect naturalness. After hearing each story, children were asked how tasty, unnatural, and safe the orange juice was, as well as how much they wanted to drink it. Each of these questions was scored on a scale of 1—4, where a higher number represents a stronger belief (e.g., more safe, more unnatural). Finally, children were asked to report what natural means to them in an open-ended format.

Figure 4.

Images presented with each story: farm condition, box condition, chemicals added and removed condition, chemicals added condition (note the clocks represent the passing of two minutes)



Results

We conducted four one-way repeated measures ANOVAs, one for each outcome variable (See Figure 5 for all graphs). As we found no age or sex effects in Study 1, we opted not to include these variables in our analysis.

There was a significant effect of condition on children's ratings of how tasty the orange juices were, $F(3) = 4.23$, $p = .006$, $\eta^2 = .06$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the farm juice ($M = 3.14$) as significantly tastier than the juice with the chemicals added ($M = 2.59$) ($p = .013$). There were no differences between either of these and the

juice with the box placed over it (M = 2.86) or the juice with the chemicals added and removed (M = 2.79) (ps > .160)

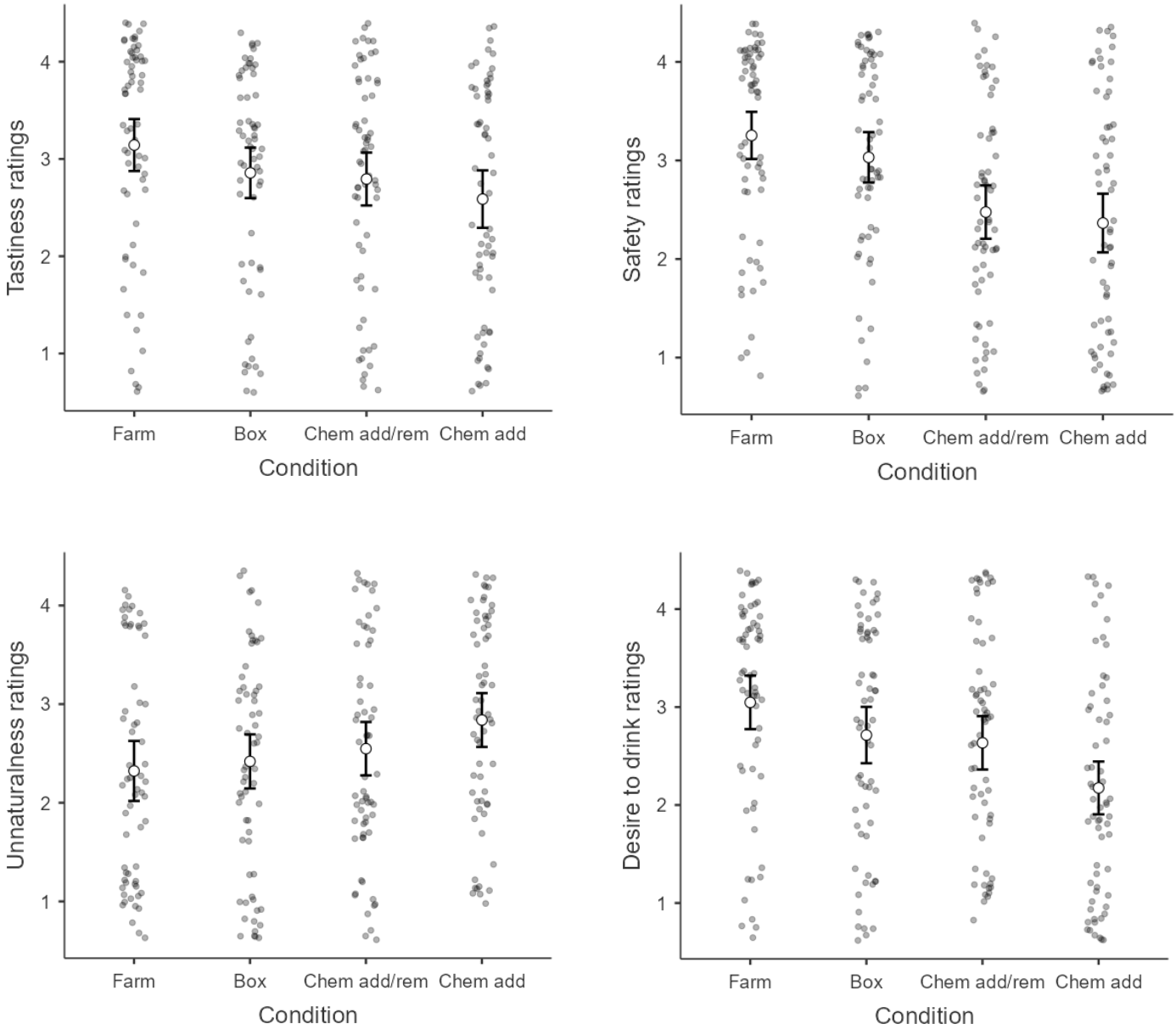
There was a significant effect of condition on children's ratings of how unnatural the orange juices were, $F(2.68) = 3.62$, $p = .018$, $\eta^2 = .06$. Note we applied a Greenhouse-Geisser correction for violations of Sphericity (Mauchley's W, $p = .045$). Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the juice with the chemicals added (M = 2.84) as significantly more unnatural than the farm juice (M = 2.32) ($p = .040$). There were no differences between either of these and the juice with the box placed over it (M = 2.42) or the chemicals added and removed (M = 2.54) (ps > .954).

There was a significant effect of condition on children's ratings of how safe the orange juices were, $F(3) = 11.27$, $p < .001$, $\eta^2 = .15$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the farm juice (M = 3.25) and the juice was a box placed over it (M = 3.03) as significantly safer than either the juice with the chemicals added and removed (M = 2.47) or the juice with the chemicals added (M = 2.36) (ps < .015). There were no differences between the farm juice and juice with a box placed over it ($p > .999$) or the juice with chemicals added or chemicals added and removed ($p > .999$).

Finally, there was a significant effect of condition on children's ratings of how much they wanted to drink the orange juice, $F(3) = 9.45$, $p < .001$, $\eta^2 = .13$. Follow up Bonferroni adjusted pairwise comparisons revealed that children wanted to drink the farm juice (M = 3.05) significantly more than the juice with the chemicals added (M = 2.18) ($p < .001$). There were no differences between either of these and the juice with the box placed over it (M = 2.71) or the juice with the chemicals added and removed (M = 2.63) (ps > .067)

Figure 5.

Children's responses for ratings of tastiness, safety, unnaturalness, and desire to drink the orange juice as a function of condition (error bars represent 95% CIs)



2b – Adults

We again decided to conduct this study with a sample of adults. The procedure was identical to Study 2a.

Method

We administered an identical survey to 64 adults via Prolific. All participants were required to be over 18 years of age and be living in the United States.

Participants. Participants in the sample had a mean age of 29 years and 11 months, with 60.7% identifying as female, 34.4% identifying as male, and 4.9% reporting their gender as other. The sample was generally left leaning, with the average participant scoring 6.38/9 on a scale of 1 (conservative) to 9 (liberal). Participants were also generally well-educated, with 27.9% of participants having completed a bachelor's degree and 31.1% having completed some college. Finally, 59% of participants identified as White/European American, 19.7% as Asian/Asian American, 6.6% as Black/African American and 6.6% as Latino/Hispanic, while 8.2% identified as more than one category.

Results

We conducted four one-way repeated measures ANOVAs, one for each of the four outcome variables (See Figure 6 for all graphs) There was a significant effect of condition on adult's ratings of how tasty the orange juice was, $F(3) = 40.07$, $p < .001$, $\eta^2 = .40$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults thought the farm orange juice was the tastiest (M = 3.25), followed by the orange juice with a box placed over it (M = 3.02), the orange juice with chemicals added and subtracted (M = 2.46) and, finally, the orange juice with chemicals added (M = 2.18). All differences were statistically significant (*p*s < .020).

There was a significantly effect of condition on adults ratings of how unnatural the orange juice was, $F(3) = 106.50$, $p < .001$, $\eta^2 = .64$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults thought that the farm juice (M = 1.12) and juice with a box placed over it (M = 1.20) were significantly less unnatural than the juice with chemicals added (M = 2.56) or the juice with chemicals added and removed (M = 2.62) (*p*s < .001). The farm juice and juice with a box placed over it were not significantly different from each other ($p > .999$) and the juice with the

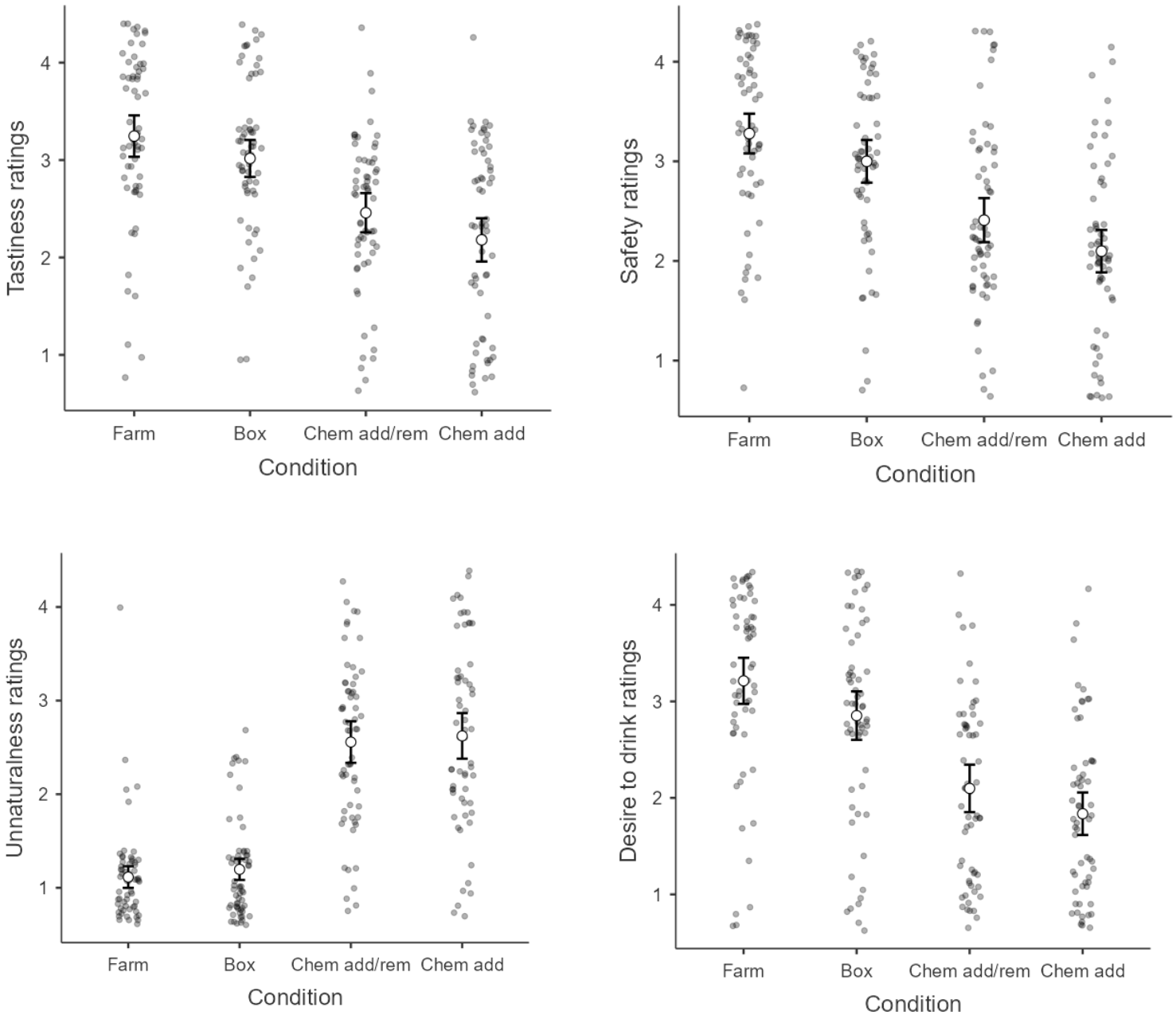
chemicals added and the juice with chemicals added and removed were not significantly different from each other ($p > .999$).

There was a significant effect of condition on adult's ratings of how safe the orange juice was, $F(3) = 39.42$, $p < .001$, $\eta^2 = .40$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults thought the farm orange juice was the safest (M = 3.28), followed by the orange juice with a box placed over it (M = 3.00), the orange juice with chemicals added and subtracted (M = 2.41) and, finally, the orange juice with chemicals added (M = 2.10). All differences were statistically significant (ps < .020).

Finally, there was a significant effect of condition on adult's ratings of how much they wanted to drink the orange juice, $F(3) = 57.45$, $p < .001$, $\eta^2 = .49$. Follow up Bonferroni adjusted pairwise comparisons revealed that adults most wanted to drink the farm orange juice (M = 3.21), followed by the orange juice with a box placed over it (M = 2.85), the orange juice with chemicals added and subtracted (M = 2.10) and, finally, the orange juice with chemicals added (M = 1.84). All differences were statistically significant (ps < .031).

Figure 6.

Adult's responses for ratings of tastiness, safety, unnaturalness, and desire to drink the orange juice as a function of condition (error bars represent 95% CIs)



Child vs. adult comparisons

We again directly compared children and adults' responses directly in posthoc analyses. For each outcome measure, we conducted a mixed ANOVA with group (adults vs. children) as the between subjects' factor and condition as the within-subjects factor. Note that sphericity was violated in each analysis, so we applied Greenhouse-Geisser corrections to all analyses.

For perceived tastiness we found a significant main effect of condition ($p < .001$) but no main effect of group ($p = .341$). We also found a significant group x condition interaction, $F(1) =$

4.57, $p = .004$, $\eta^2 = .04$. Follow up Bonferroni adjusted pairwise comparisons revealed that children ($M = 2.58$) perceived that the orange juice with the chemicals added and removed as tastier than adults ($M = 2.18$). No other comparisons were significant (ps > .051).

For perceived safety we found only a main effect of condition, $F(1) = 38.86$, $p < .001$, $\eta^2 = .24$ but no main effect of group, nor a group x condition interaction (ps > .425).

For perceived unnaturalness we found main effects of both condition and group (ps < .001) and a condition x group interaction $F(1) = 20.54$, $p < .001$, $\eta^2 = .15$. Follow up Bonferroni adjusted pairwise comparisons revealed that children rated the farm juice ($M = 2.32$) and the juice with a box placed over ($M = 2.42$) it as significantly more unnatural than adults ($M = 1.12$, 1.20, respectively). No other comparisons were significant (p > .241).

For desire to drink the juice we found a main effect of condition ($p < .001$) but no main effect of group ($p = .285$). We also found a significant group x condition interaction, interaction $F(1) = 5.81$, $p = .001$, $\eta^2 = .05$. Follow up Bonferroni adjusted pairwise comparisons revealed that children ($M = 2.64$) wanted to drink the orange juice with the chemicals added and removed significantly more than adults ($M = 2.10$). No other comparisons were significant (p > .055).

Finally, we report children and adult's responses to the question "What does unnatural mean to you?". After an initial examination of the responses prior to analyses, the authors produced a series of categories that captured the range of responses in the developmental sample. This same coding scheme was applied to the adult sample. An independent coder coded each response under these categories and a second blind coded conducted reliability coding (*Table 1*). Interrater reliability was high ($\alpha = .83$) for children and moderate for adults ($\alpha = .68$), so we recommend caution in interpreting the adult responses.

Table 1.

Children and adult's most common response categories to the question "What does unnatural mean to you?

Category	Children	Adults
Different from how it is supposed to be	8%	10%
Different from its original state	2%	10%
Different from nature or manmade	6%	31%
Things added/more than needed	2%	16%
Not normal	13%	3%
Chemicals in it	3%	26%
Unsafe/bad	11%	-
Positive	8%	-
How good it is	6%	-
Not natural	8%	3%
I don't know/I'm not sure	20%	-
Other	13%	-

Discussion

In Study 2, we again find that both children and adults prefer natural foods. However, children and adults' views diverged slightly more than in Study 1. Adults distinguished between all four conditions on a continuum for most outcome measures, with the exception of the naturalness judgement where they considered the juice with a box placed over it equivalently natural to the farm juice and the two chemical conditions equally unnatural. By contrast, children's judgements typically created a dichotomy between the farm and chemicals added condition (but not added and removed) with the exception of safety where children considered the two chemical conditions equally unsafe and less safe than the farm and box conditions, which were also equally safe. This is reflected in the direct comparisons, with adults generally rating the chemicals added and removed condition more negatively than children. Adults also rated the farm juice and juice with a box placed over it as less unnatural than did children, which likely reflects children general tendency to be less discerning on this measure. In their responses to "What does unnatural mean to you" adults gave more consistent responses and no participants reported being unsure or not knowing, while this was the most common response for children.

General Discussion

In the current study we examined children's tendency to prefer natural things, aiming to shed light on how these preferences emerge in development. Across two studies, we find that children prefer natural foods in two domains—apples and orange juice—and that these preferences are similar to those shown in adults. This was found across a range of measures: perceived tastiness, perceived safety, and desire to eat. Moreover, both children and adults showed a strong preference for natural foods when the options were presented in a forced choice manner. We found little evidence for an age effect in children—that is, children as young as 5 and as old as 10 years tended to respond similarly. This suggests that the belief that natural things are good is established by five years of age.

However, we also identified differences between adults and children. In Study 1, children rated the lab and tree in lab conditions more negatively than adults on some measures. But in Study 2 children rated the chemicals added and removed condition more positively than adults (and gave equivalent ratings for the chemicals added condition). Why would children's ratings be more negative than adults in Study 1 and more positive in Study 2? Past work has shown that adults do not always believe the premises stipulated in naturalness experiments (e.g., that natural and unnatural versions of the same food can be molecularly identical; see Li & Chapman, 2012). Perhaps children were more willing than adults to believe that the chemicals could be removed from the juice, thus explaining their more positive ratings in Study 2. If we focus only on the ratings from Study 1, then children seem to evaluate the unnatural foods similarly or more negatively than adults. Although we do not know what may drive the more negative views, it is worth noting that they seem to occur in in cases where the naturalness manipulation is quite extreme (e.g., for lab grown food).

Relatedly, it seems that children may have a less nuanced understanding of naturalness. When asked the question "What does unnatural mean to you?" children were more likely than adults to report that they were unsure or say, "I don't know". This reflects past work showing that

older children are better able to identify the origins of food items (and other items) than younger children (Girgis & Nguyen, 2020).

We also find evidence that perceived naturalness can be gradated. Both children and adults consistently reported that the apple grown on a tree in a lab was intermediate in value—better than the lab apple but worse than the farm apple. It is unclear why the lab apple was judged worse. Is this some form of perceived contamination (i.e., from lab chemicals), or it simply being associated with a lab can decrease positive perceptions? If it is the former, these findings may contradict past work which shows that children have less contamination sensitivity than adults (Rozin et al., 1986), Here, children seemed even more sensitive to this manipulation.

Finally, adults' perceptions of naturalness teased apart from other judgements in Study 2. That is, adults rated the juice with a box placed over it as equally natural to the farm juice, despite (surprisingly, for reasons we can't explain) rating it more negatively on all other measures. Perhaps the lack of context and detail provided lead people to believe that the farmer had changed the juice with the box. Alternatively, it may have been demand effects, where participants thought that they were meant to perceive this condition differently.

We note also that while both child and adult participants rated unnatural foods less positively than natural foods, the overall ratings were not negative—they were still above the midpoint of the scale. Thus, we might not explicitly dislike unnatural foods, and instead just think of them as less preferable than natural foods. To address this, future research could look at whether children and adults report disliking unnatural foods above chance. However, regardless of their intensity, naturalness preferences do seem to impact real-world behaviour—there is substantial evidence of the rejection of food technologies, such as genetically modified food and cultivated meat being tied to naturalness concerns (Scott et al., 2016; Siegrist & Hartmann, 2020).

There are, of course, limitations to the current studies. Data were collected between September 2019 and March 2021, and we are unable to tell how much how the global pandemic

may have affected participants' responses. Although there are no differences in responses for participants who completed Study 1 in person vs. online, it's unclear how concerns about Covid-19 may have impacted participants' intuitions about contamination and related constructs.

All participants were also from the United States. It is an open question whether a preference for natural things would also be found in children from other countries. There is little cross-cultural work exploring naturalness preferences (but see Rozin et al., 2012), thus we are hesitant to make strong predictions. However, market trends towards natural and organic foods appear to be particularly strong in Western countries like the United States (Nutrition Business Journal, 2020). Research also shows that children from the United States and Germany are less willing to touch plant food that children in Fiji, which may be due to their less frequent exposure to plants (McNamara & Wertz, 2021). Possibly, then, those from Western cultures may have more concerns about naturalness than people from other communities, particularly those who are more closely connected to food production.

We only tested two foods. It would be beneficial to further investigate naturalness preferences in a wider range of stimuli, including novel, exotic, and manmade foods (see Girgis & Nguyen, 2020), or even medicines (Rozin et al., 2004). Also, we used a salient naturalness manipulation (e.g., lab grown, chemicals) to offer the strongest possible opportunity to find children's naturalness preferences if they did exist. It would be interesting to explore the strength of these preferences with more subtle manipulations.

Finally, examining parent-child dyadic interactions and the role of parental attitudes in shaping children's naturalness preferences would be a fruitful area for future investigation (see Shtulman et al., 2020) and may offer some insight into the (possible) role of social learning. While the current data don't directly inform whether social learning is the mechanism through which children come to prefer natural things, they do suggest that, if it is the mechanism, this is well established by five years. Ideally, we would like to conduct research in places where there may be

a less strongly held belief that natural things are good. However, due to the limited scope of past naturalness research in adults (i.e., being primarily in Western countries) it is currently unclear which countries, if any, have weaker naturalness preferences, or if bias against unnatural foods is universal. We hope that this paper serves as a platform to motivate further cross-cultural and developmental research into naturalness.

To conclude, adults' tendency to prefer natural things is well documented, at least in Western cultures, and has real-world implications for the acceptance of novel technology (Siegrist & Hartmann, 2020). Here we demonstrate that, like adults, children also prefer natural foods—at least in the United States. This is consistent across domains (apples, orange juice) and a range of preferences (tastiness, safety, desire to consume). Although the nature and origins of these preferences remains unclear, this work represents a first step in demonstrating that these biases exist even in early and middle childhood.

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