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The effect of episodic future simulation and motivation on young children's induced-state episodic foresight

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ABSTRACT

Future simulation and motivation are two strategies that might help children improve their induced-state episodic foresight. In Study 1, 3- to 5-year-old children (N = 96) consumed pretzels (to induce thirst) and were asked what they would prefer the next day, pretzels or water. Children were randomly assigned to an experimental condition: (1) a standard thirsty condition, (2) an episodic simulation condition where they imagined being hungry the next day, (3) a motivation condition where children chose between a cupcake and water, or (4) a control condition (thirst was not induced). Future preferences did not differ by age and children were less likely to choose water (vs. a cupcake) in the motivation condition compared to the standard thirsty condition. Study 2 found that 3- to 5-year-old children (N = 22) were also less likely to choose water for *right now* versus a cupcake when thirst was induced.

1. Introduction

The ability to accurately anticipate future states is an important cognitive skill. This skill is relied upon heavily in our daily lives, whether it is taking an umbrella to work in anticipation of rain, bringing water on a hot afternoon jog in anticipation of thirst, or taking a snack with you to a long workshop in anticipation of later hunger. Episodic foresight (EpF), defined as the ability to imagine oneself at a specific time in the future (Atance & O'Neill, 2005), is an important ability as it allows individuals to plan for and best prepare for one's future. In the domain of food in particular, it is essential for individuals to be able to accurately anticipate future states of thirst or hunger when they are not currently being experienced (e.g., bringing a snack for later, despite being stuffed from an all-you-can-eat buffet breakfast) in order to satisfy future physiological needs.

Indeed, it has been argued that EpF surrounding physiological states in particular is a uniquely human ability that distinguishes us from non-human animals (e.g., Suddendorf, Addis, & Corballis, 2009; Suddendorf & Busby, 2003; Suddendorf & Corballis, 2007). The Bischof-Kohler hypothesis predicts that non-human animals cannot consider future states that are not being currently experienced (Bischof-Kohler, 1985). According to this hypothesis, only humans can anticipate future states such as hunger or thirst that are outside of their present experience (although see Clayton, Emery, & Dickinson, 2006; Correia, Dickinson, & Clayton, 2007; Raby, Alexis, Dickinson, & Clayton, 2007 for evidence that Western scrub-jays have basic prospective abilities and can act independently of their current motivation). Interestingly, there is also ample evidence to suggest that children and even adults struggle to accurately project themselves into the future, especially when it comes to physiological states (e.g., Atance & Meltzoff, 2006; Kramer, Goldfarb, Tashjian, & Lagattuta, 2017; Nisbett & Kanouse, 1969). In the social psychological literature, the presentism bias (Gilbert, Gill, &

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Wilson, 2002) is described as the "tendency to overestimate the extent to which their [adults'] future experience of an event will resemble their current experience of the same event" (p. 12). For example, in a classic study, hungry adults bought a larger quantity of food compared to non-hungry adults (Nisbett & Kanouse, 1969) demonstrating the effect of current physiological states on future decision making. This presentism bias has been studied in young children as well, showing that mispredictions often occur when children cannot escape a current state in order to reflect accurately on their future state (Atance & Meltzoff, 2006).

Two interesting and important questions then are: (1) how do children's current states affect their EpF surrounding food preferences, and (2) what (if anything) can be done to mitigate the effects of a current state on children's future food preferences? The current study examines these questions in the context of food preferences when one is or is not experiencing a relevant physiological state. Indeed, children's decisions about food are likely influenced by their current state and thus how and when the presentism bias operates is informative for understanding children's everyday food choices, eating behaviour, and nutrition.

1.1. The Early Development of Episodic Foresight

The body of literature on the development of EpF broadly suggests that the ability to think about the future emerges between the ages of 2- and 3-years (Suddendorf, 2017), when children begin to contribute their own plans and ideas to conversations about the future (Hudson, 2002). By 3-years of age children can prepare for future events as well as discuss the future (Atance & Meltzoff, 2005; Busby & Suddendorf, 2005) but still show some limitations in their EpF abilities. For example, 3-year-olds often perform at chance when selecting an item that would be useful in future scenarios to solve a problem or address a future physiological state when semantic distractors are present (Atance & Meltzoff, 2005; Suddendorf, Nielsen, & Von Gehlen, 2011). Three-year-olds' EpF seems to be limited by several underdeveloped cognitive abilities including: inhibiting semantically distracting items (Atance & Meltzoff, 2005), episodic and semantic memory (Atance & Sommerville, 2014; Martin-Ordas, Atance, & Louw, 2012), and language comprehension and production (Atance & Meltzoff, 2005; Ünal & Hohenberger, 2017). By the time children are 4- or 5-years-old, they show more advanced EpF and have the ability to select an item to satisfy a future need (Atance & Meltzoff, 2005; Suddendorf, 2017; Busby & Suddendorf, 2005). Although there is development beyond 5 years of age (see Suddendorf, 2017), many EpF tasks show that 5-year-olds' performance is well above chance (e.g., Atance & Jackson, 2009; Atance, Louw, & Clayton, 2015; Atance & Meltzoff, 2005; Bélanger, Atance, Varghese, Nguyen, & Vendetti, 2014; Martin-Ordas, 2017; Martin-Ordas, 2018; Russell, Alexis, & Clayton, 2010).

While research on children's EpF has provided insight into the emergence and age-related increases in this future-oriented cognitive ability, one limitation is that in most EpF tasks children's current state is not in direct conflict with their future state, so it is difficult to examine the influence of the presentism bias. Only a few EpF tasks have been developed that allow for the examination of the influence of children's current states on future states. For example, Bélanger et al. (2014) developed a task that involves children indicating their future preferences when they are all grown up, which often conflict with their current preferences (coffee vs. Kool-Aid). There were significant age-related increases on this task between 3- and 5-year-olds, although no age-related differences were found between 3- and 4-year-olds in another study that used the same task (Lee & Atance, 2016). In a resource allocation task developed by Martin-Ordas (2017), children's current desires were either met or unmet when they made decisions for the future (deciding how they should allocate rewards). Five year olds were better than 4-year-olds in allocating future rewards if their current needs were met (i.e., children had present access to the reward). However, within the physiological domain, one EpF task known as the Pretzel task (Atance & Meltzoff, 2006), manipulates children's current state of thirst in order to examine its effect on future reasoning. Interestingly, *no* developmental increases have been documented using this task from preschool to young adulthood (e.g., Atance & Meltzoff, 2006; Cheke & Clayton, 2019; Kramer et al., 2017; Mahy, Grass, Wagner., & Kliegel, 2014; Mahy, 2016).

Unlike the developmental increases found in children's food cognition during the preschool years (see DeJesus, Kinzler, & Shutts, 2018 for a review), including an emerging understanding of the impact of food on human physiology (Raman, 2014; Slaughter & Ting, 2010; Toyama, 2000), children's understanding of how physiology-generated desires change over time seems to develop more slowly. For example, Moses, Coon, and Wusinich (2000) found that 3- to 5-year-old children struggled with physiology-generated desires (e.g., wants to eat or drink) compared to perception (e.g., thinks there is a teddy bear in a box) or attitude-generated desires (e.g., wants to play with the dog). In a second study, they found that 4- and 5-year-olds had a better understanding of the quantity of experience (e.g., how much someone ate) compared to the timing of the experience (e.g., when someone ate) on physiological states and desires. Thus, these findings suggest that children have a limited understanding of how physiology-generated desires change over time and how the passage of time affects physiological states. Next, we review the literature that has examined EpF using the Pretzel task, a task in which children's thirst is induced and then they are asked to reason about the future.

1.2. Induced-state episodic foresight using the Pretzel Task

The Pretzel task, originally designed by Atance and Meltzoff (2006), requires children to indicate their preference between pretzels and water at baseline and then again for tomorrow after they have consumed pretzels (and thus induced thirst). The logic behind this task is that if children are influenced by their current state of thirst, then children who have consumed pretzels should indicate a future preference for water over pretzels more than children who have not consumed any pretzels in a control condition. Importantly, objective measures of thirst are taken by counting the number of pretzels children consume as well as how much water they drink when it is offered at the end of the task. Although the Pretzel task has minimal demands on episodic or semantic memory (unlike EpF tasks that do not induce a physiological state), it still seems to place some demands on language comprehension (such as the understanding of the concept of tomorrow) and inhibition to make an appropriate response between two choices.

In their original study, Atance and Meltzoff (2006) found that 3- to 5-year-old children who did not consume pretzels (and thus were not thirsty) preferred pretzels for the next day, whereas children who had consumed pretzels tended to prefer water for the next day. Interestingly, 5-year-olds did not perform any better than 3-year-olds. This lack of developmental increase on the Pretzel task was replicated and extended by Mahy and colleagues (2014) who showed no developmental increases between 3 and 7 years old (also see Mahy, 2016). Importantly, Mahy (2016) showed that the tendency to choose pretzels for the future could not be attributed to taste boredom for pretzels because children return to reporting a future preference for pretzels once they have an opportunity to quench their thirst. In sum, several studies with young children suggest that 3-to 7-year-old's future preferences are strongly influenced by their current state of thirst.

This lack of age effect in the Pretzel task has now been replicated across several studies with older children and adults (Mahy, 2016, Cheke & Clayton, 2019; Kramer et al., 2017; Mahy et al., 2014). One study showed that 8- to 13-year-old children and even young adults seem to fall prey to the presentism bias in the Pretzel task (Kramer et al., 2017). Thus, so-called induced-state EpF does not show the usual developmental progression compared to other EpF tasks where a current state does not conflict with a future state (e.g., Atance & Meltzoff, 2005; Suddendorf et al., 2011) and potentially where the current-future state conflict is outside the physiological domain (e.g., Bélanger et al., 2014; Martin-Ordas, 2017, although see Lee & Atance, 2016). Interestingly, it seems to be the case that older children and perhaps even adults perform similarly to 3-year-olds on this task. Notably, 3-year-olds perform below chance on the Pretzel task similar to many other EpF tasks.

Given that young children and adults alike struggle to escape the influence of a current state of thirst on their future states, are there any strategies that can be employed to help children overcome their presentism bias in the Pretzel task? Since episodic foresight relies on an individual projecting oneself into a future episode, one possible strategy would be to encourage children to more vividly imagine their future state and circumstances through episodic simulation. Perhaps having children whose thirst has been induced simulate and consider their future states might improve their ability to escape the influence of their current state and overcome the presentism bias. Another possibility is that having children choose between water (which would quench their thirst) and another highly motivating food might aid their reasoning in that the appealing food might allow them to momentarily escape from their current state of thirst in order to choose a highly valued food for the future. Thus, a highly motivating food reward might also help children to overcome the presentism bias. Both of these strategies seem promising in encouraging children to make more accurate food choices for the future. Next, we examine how episodic simulation and motivation might boost young children's EpF abilities.

1.3. Episodic Simulation

Vivid simulation of the future is one strategy that should aid in accurate future decision making. Research from several different areas supports the idea that episodic simulation increases performance. For example, adults who imagined helping another person using episodic simulation showed increased prosocial intentions (Gaesser & Schacter, 2014) and adults who envisioned a future event were more likely to fulfill their future intentions (Neroni, Gamboz, & Brandimonte, 2014). In children, Nigro, Brandimonte, Cicogna, and Cosenza (2014)) found that episodic future thinking was a significant predictor of 4- to 7-year-old's prospective memory ability suggesting that envisioning a future episode aids in fulfilling a future intention. Similarly, Chernyak, Leech, and Rowe (2017)) found that preschoolers (3- to 5-year-olds) who talked about the near future in an interaction with an adult went on to show better planning and prospective memory. However, little work has examined children's ability to simulate the future and its effect on EpF, and induced-state EpF more specifically. One study that did investigate this found that 4- and 5-year-old children who read books about their future self with an experimenter performed better on a battery of prospection assessments (prospective memory, EpF, and delay of gratification; Leech, Leimgruber, Warneken, & Rowe, 2019). Thus, there is reason to believe that thinking about one's future self and imagining the future might boost performance on an EpF task. In our current study, we encouraged children to consider that they might be hungry the next day before and during a state of thirst. Additionally, if children were successfully projecting themselves into the future with these instructions, then children might also take longer to make their choice for the future after episodic simulation compared to situations where they are not asked to simulate the future. This possibility is supported by the constructive episodic simulation hypothesis (Schacter & Addis, 2007) which states that in order to simulate the future, one must draw on past experiences and re-combine them to make future predictions. Thus, when children are asked to imagine a specific future state, they might take longer to make a future prediction than when they are not instructed to imagine a particular future state given the additional time it might take to bring to mind and then re-combine past experiences involving hunger and thirst.

1.4. Motivation

A second possible strategy to overcome the influence of a current state is to create an alternative option that is more motivating than the desire for water when thirsty. Instead of focusing on encouraging children to envision the future (as with episodic simulation), changing the desirability of the alternative future option might result in more accurate future reasoning. In the current study, we chose a highly valued food item (a cupcake) that we thought would appeal to preschoolers even more than pretzels. The rationale was that if children still indicated a future preference for water when the other option was a cupcake, then thirst exerts a powerful influence on future decision making that might overshadow children's motivation for a highly valued food item (cupcake). In contrast, if children choose a cupcake over water while thirsty, this suggests that children can overcome the presentism bias (and the influence of thirst) with sufficient motivation.

The main goals of the present research were to examine whether episodic simulation or motivation were effective strategies to help children overcome the presentism bias in the context of the Pretzel task. Thus, Study 1 examined if children were more able to overcome their current state of thirst when they were asked to episodically simulate the future or when they were presented with a motivating food item in the future. Study 2 was conducted to further explore the mechanism at play in the motivation condition, specifically, does a motivating item simply override a child's current state or does it allow them to better anticipate future hunger? This was tested in Study 2 by comparing children who were asked about their current preference for cupcakes or water after consuming pretzels (motivation-now condition) compared to children in the motivation condition of Study 1 who were asked about their future preference between cupcakes and water after consuming pretzels (motivation-future condition).

2. Study 1

Study 1 sought to address the question of whether we can improve children's performance on the Pretzel task using two distinct and novel strategies: encouraging children to simulate their future states prior to making a future choice (episodic simulation) and providing children with a desirable alternative in order to help them overcome the influence of their current state of thirst (motivation). To this end, children were randomly assigned to one of four experimental conditions: a standard thirsty condition (to provide a baseline for how thirst-induced children perform), episodic simulation condition, motivation condition, and a control condition (to provide a baseline for how non-thirsty children perform). Children completed the Pretzel task under one of these four conditions.

We predicted that: (1) there will be no age-related improvements in Pretzel task performance in line with past research (Atance & Meltzoff, 2005; Cheke & Clayton, 2019; Kramer et al., 2017; Mahy et al., 2014; Mahy, 2016; Mazachowsky, Koktavy, & Mahy, 2019), (2) children will perform better on the Pretzel task in the episodic simulation and motivation conditions (selecting water *less* often as their future preference) compared to the standard thirsty condition, and (3) children will take longer to make their future preference choice in the episodic simulation condition compared to all other conditions (potentially due to engagement in future simulation processes). We also examined children's explanations for their future choices in an exploratory manner by coding whether children's explanations focused on their present state, future state, their general preferences, or 'other' (if it did not fit into any of the first three categories, including no response). It is possible that explanations in the episodic simulation condition would be more future-oriented and explanations in the motivation condition would be more preference-oriented.

3. Method

3.1. Participants

One hundred and twenty-five 3- to 5-year-old children participated in the study. Twenty-nine children were not included in the final analysis: 28 children failed to eat at least 8 pretzels (criteria used by Mahy et al., 2014 for minimum to induce thirst) and one child drank water throughout the session and thus interfered with the thirst manipulation. The final sample consisted of 96 children: 32 3-year-olds (17 girls; M_{Age} = 42.34 months, SD = 2.65), 32 4-year-olds (16 girls; M_{Age} = 53.78 months, SD = 3.61), and 32 5-year-olds (21 girls; M_{Age} = 66.50 months, SD = 3.68). An a priori power analysis (G*Power 3.1; Faul, Erdfelder, Buchner, & Lang, 2009) revealed that a sample size of 61 children was necessary to detect a medium to large effect size (consistent with the large effect size, Phi = .67, found by Atance & Meltzoff, 2006) between the standard thirsty condition and the episodic simulation condition and between the standard thirsty condition and the motivation condition (Effect size w = 0.4, alpha = .05, power = .80), so we chose to round up our sample to 96 children. Children were mostly Caucasian (96%) and from a middle-class background (62% of families had an annual income above $75,000 per year). Participants were recruited from the X participant database maintained by five developmental psychology labs at X University.

3.2. Procedure

Upon arrival to the lab, parents gave their informed consent and children provided assent to participate. Children were randomly assigned within their age group to one of the four conditions of the Pretzel task (adapted from Atance & Meltzoff, 2006): standard thirsty condition (n = 24), episodic simulation condition (n = 25), motivation condition (n = 23), or control condition (n = 24).

3.2.1. Standard Thirsty Condition

This version of the Pretzel task was adapted from Atance and Meltzoff (2006). Children were first offered a 6 ounce apple juice box to quench any pre-existing thirst to ensure all children were beginning the experiment with a similar level of thirst (consistent with Mahy, 2016). The majority of children (81%) drank some of the juice. Children were then asked what they would like to have now: pretzels or water. These options were counterbalanced to control for any bias in response. After making their decisions, children were asked to explain why they would like their choice now. Following this question, children were offered 36 pretzels sticks to eat (to induce thirst) that were placed in a small bowl while they listened to a story read by the experimenter (The Perfect Picnic; Maestro, 1986). Following the story, children were told to pretend they were going to come back to the lab tomorrow to play a marble game. The researcher made it clear that they were not going to play with the marble game now, but they were going to play with it tomorrow. Then the children were asked what they would like to have for the marble game tomorrow: pretzels or water (counterbalanced order). Children were then asked to explain their choice in order to examine whether children made references to their present state, future states, general preferences or other considerations in their explanations and whether these future explanations differed from their baseline explanations. At the end of the task, children were offered 9 ounces of water to drink and the amount they drank was measured in ounces as an objective measure of their level of thirst.

3.2.2. Episodic Simulation Condition

This condition was identical to the standard thirsty condition with two important differences, before the children were offered pretzels to eat, they were told: "*Now, I want you to imagine how you are going to feel tomorrow. Close your eyes and imagine. You'll probably feel hungry like you are now*". After children had consumed pretzels, they were introduced to the marble game that they would play tomorrow, they were told: "*I want you to close your eyes for a minute and think about how you might be feeling tomorrow. Remember from before, you imagined how you might be hungry tomorrow*". The purpose of these instructions was to encourage children to simulate how they might feel in the future, specifically to encourage them to imagine that they might be hungry rather than thirsty the next day.

3.2.3. Motivation Condition

This last condition followed the same procedure as the standard thirsty condition with one important difference. Instead of asking children for their future preference between water and pretzels after thirst was induced, children were asked to make a future preference choice between water and a cupcake. The rationale in this condition was that if children's current state (thirst) was a powerful influence on future thinking then they should still choose water as their future preference. However, a motivating food item such as a cupcake might allow them to ignore their current state of thirst to select a preferred food for the future. At the end of the task after children received water to drink, children in this condition were asked to indicate their preference between pretzels and cupcakes (to ensure that a cupcake was a more appealing food item than pretzels). We asked about children's preferences between cupcakes and pretzels at the end of the session to ensure that: (1) this choice would not influence or bias any of their decision making about preferences between cupcakes and water, and (2) to keep this condition as similar as possible to the episodic simulation and standard thirsty conditions.

3.2.4. Control Condition

This condition was identical to the standard thirsty condition except that children were not given any pretzels to eat while they were read the story. Thus, children in this condition were not thirsty when they made the decision about their future preference between pretzels and water. This condition was included to have a baseline of how much children preferred pretzels versus water when not thirsty.

Upon completion, families and children were thanked for their participation and children received a small prize. All procedures were approved by the Research Ethics Board at X University.

3.2.5. Analytic Strategy

In preliminary analyses, we will examine: (1) the relation between the number of pretzels children ate and the amount of water they drank to ensure a positive correlation (an indication that pretzels effectively manipulated thirst), (2) children's preference between cupcakes and pretzels in the motivation condition to ensure children preferred cupcakes to pretzels, (3) children's performance at baseline compared to the other experimental conditions to ensure that children similarly preferred pretzels at baseline across conditions (to ensure random assignment to condition was effective), and (4) any effects of child sex on performance.

Our main analyses will examine the effect of age (age in months) on Pretzel task performance by performing a factorial logistic regression given that children's future preferences were dichotomous, categorical variables (pretzels/cupcake vs. water). In order to examine the impact of experimental conditions, both the episodic simulation and motivation condition will be compared with the standard thirsty condition using Chi-Square analyses (or Fisher's exact tests if any cell has less than five observations). Finally, children's response times will be examined using a one-way ANOVA to see whether response times differed by experimental condition. In an exploratory analysis, children's explanations will be coded (as present-oriented, future-oriented, preference-oriented, or other) and then will be analyzed with Chi-Square analyses to see if explanations differed by experimental condition.

Table 1
Descriptive Statistics by Experimental Conditions in Study 1 and 2.

	Study 1				Study 2
	Standard Thirsty Condition (N = 24)	Episodic Simulation Condition (N = 25)	Motivation- Future Condition (N = 23)	Control Condition (N = 24)	Motivation-Now Condition (N = 22)
Number of Pretzels eaten	16.21	17.64	13.57	0	17.64
Amount of Water drank (oz.)	1.07	1.19	0.78	0.38	0.90
Number of children preferring water at baseline (percentage)	6 (25%)	3 (12%)	4 (18%)	5 (21%)	22 (100%)
Number of children preferring water for tomorrow (percentage)	11 (46%)	13 (52%)	3 (13%)	5 (21%)	4 (18%)

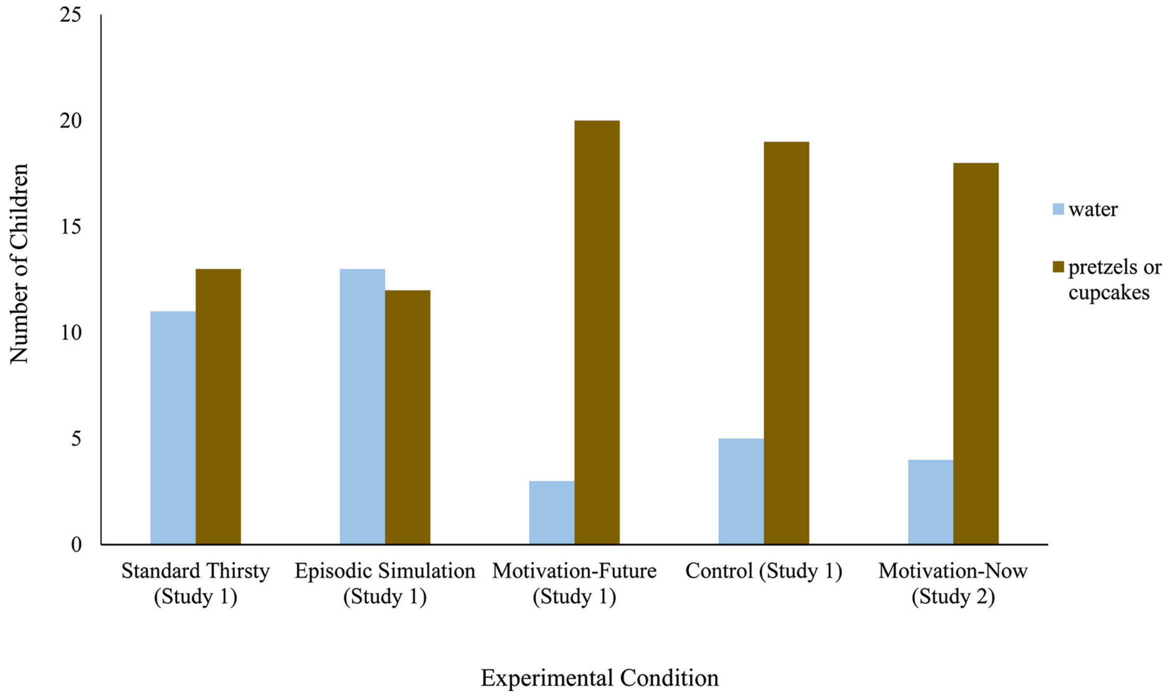

Fig. 1. Children's Performance on the Pretzel Task by Condition in Study 1 and Study 2.

4. Results & Discussion

4.1. Preliminary Analyses

Table 1 shows descriptive statistics and Fig. 1 shows the number of children who chose water versus pretzels (or cupcakes) by experimental condition. On average, children ate about 16 pretzels in the experimental conditions and consumed 0.86 ounces of water at the end of the task. The number of pretzels children ate was significantly positively related to the amount of water they consumed, $r(94) = .25$, $p = .02$, suggesting that our manipulation of thirst was effective. In the motivation condition, children reported preferring cupcakes (70%) marginally to pretzels (30%), $\chi^2(1) = 3.52$, $p = .06$, suggesting that a cupcake tended to be a higher value food compared to pretzels. Across all conditions, at baseline children preferred pretzels over water at a similar rate (approximately 80%), *Wald* $\chi^2(3) = 1.38$, $p = .71$. Finally, preliminary analysis found no significant effects of sex on children's performance, *Wald* $\chi^2(1) = 0.76$, $p = .38$, *Odds ratio* = 1.47, 95% CI [.62, 3.50], therefore sex was not included in subsequent analyses.

4.2. Pretzel Task Performance

Table 1 and Fig. 1 show children's performance on the Pretzel task by experimental condition. Children's future preferences were at chance in the standard thirsty condition ($t(23) = 0.40$, $p = .69$) and episodic simulation condition ($t(24) = -0.19$, $p = .85$), but they were significantly above chance in the motivation ($t(22) = 5.14$, $p < .001$) and control condition ($t(23) = 3.44$, $p = .002$), that is, children were more likely to prefer a cupcake or pretzels to water, respectively.

To test our first prediction that age would not significantly affect Pretzel task performance, a factorial logistic regression with age in months predicting children's future preference between pretzels and water was conducted. Results revealed that age was not a significant predictor of children's future preference, *Wald* $\chi^2(1) = 0.03$, $p = .87$, *Odds ratio* = 1.00, 95% CI [.963, 1.05], thus it was not included in later analyses. This lack of age effect on pretzel task performance is consistent with past research (e.g., Atance & Meltzoff, 2006; Kramer et al., 2017; Mahy, 2016; Mahy et al., 2014).

Given our prediction that children would be less likely to choose water for the next day in the episodic simulation condition and the motivation condition compared to the standard thirsty condition specifically, we computed a Chi-Square analysis comparing the episodic simulation condition to performance in the standard thirsty condition and performance in the motivation condition to performance in the standard thirsty condition. Results revealed that children's performance in the Pretzel task did not differ significantly between the episodic simulation condition and the standard thirsty condition, $\chi^2(1) = 0.19$, $p = .67$, *Odds ratio* = .78, 95% CI [.25, 2.4]. However, a two-sided Fisher's Exact test revealed that children chose water for the future significantly less in the motivation condition (13%) compared to the standard thirsty condition (46%), $p = .024$, *Odds Ratio* = 5.64, 95% CI [1.32, 24.17]. Children were 3.5 times less likely to prefer water in the future in the motivation condition compared to the standard thirsty

Table 2
Examples of Explanations from each of the four coded categories in Study 1.

Explanation Category	Baseline Preference Explanation	Future Preference Explanation
Present state	*"Because I am thirsty"* *"Because I am hungry"*	*"Because I am thirsty now"* *"To cool me off"* *"Because I already had juice"*
Future state	*None*	*"Because I'll be hungry tomorrow"* *"Because I'll be thirsty"* *"Because I'm going to be hungry"* *"Because I'll probably be hungry"*
General Preference	*"Because I like pretzels"* *"Because they are crunchy like carrots"* *"Water is healthy"*	*"Because they are yummy"* *"Because I like water"* *"Because I love cupcakes"*
Other	*"Because I'm feeling happy"* *"Because I'm just pretending"* *"I don't know"* *No response*	*"Because I am really strong, and I can open the lid"* *"I don't know"* *No response*

condition. Children were able to overcome their current state of thirst to choose a cupcake over water but imagining and simulating a future episode did not help children to overcome their current state.

4.3. Children's Explanations of their Future Preferences by Condition

Following Mahy (2016), we coded children's explanations at baseline and after they were asked to make a decision for the future. Children's explanations were coded as making reference to a: (1) future state, (2) present state, (3) general preference, or (4) 'other' category if they referred to something not covered by the first three categories. Table 2 shows examples of explanations that fell into each of these categories and Table 3 shows the number of explanations that fell into each of these categories by condition. Inter-rater agreement between two independent coders was excellent for baseline and future explanations (*Cohen's Kappa* = .93 and .95, respectively). Explanation codes did not differ across experimental condition for baseline explanations, $\chi^2(9) = 5.47$, $p = .49$, or explanations for the next day, $\chi^2(9) = 8.15$, $p = .51$. The majority of explanations fell into the 'general preferences' category appealing to children's liking of pretzels or water, followed by the 'other' category. It is worth noting that many children failed to provide an explanation or simply replied that they did not know why they had made their choice.

4.4. Response Times by Experimental Condition

A one-way ANOVA using bootstrapping (1000 samples, 95% CI) was conducted to examine the effect of experimental condition on children's response time on their future preference between pretzels (or cupcakes in the motivation condition) and water. The one-way ANOVA revealed no significant effect of condition on response times, $F(3, 88) = 0.90$, $p = .45$, *partial eta squared* = .03. Across conditions, children took just over 2 seconds (M = 2345.95 ms, SD = 2234.15 ms) to indicate their future preference. Thus, our prediction that children might take longer to respond in the episodic simulation condition was not supported.

5. Study 2

Based on the results of Study 1, it remains unknown whether children in the motivation condition chose a cupcake because: (1) it was a novel food item, or (2) because they were actually anticipating a future state of hunger. Thus, Study 2 involved a follow-up condition where children's thirst was induced and then they were asked what they wanted *right now*: a cupcake or water. The logic

Table 3
Number of explanations falling into each coded category by condition for baseline preference and future preference in Study 1.

Explanation Category	Standard Thirsty	Episodic Simulation	Motivation-Future	Control Condition
	Baseline Preferences			
Present State	4	4	6	5
Future State	0	0	0	0
General Preferences	10	15	8	10
Other	9	5	9	9
	Future Preferences			
Present State	2	3	1	1
Future State	2	5	0	2
General Preferences	12	12	13	12
Other	8	5	9	9

was as follows: if children chose water for the present after thirst-induction, this would suggest that a motivating food item improves future performance but that in the present, their current state of thirst influences their immediate decisions (suggesting that children in the original motivation condition were anticipating a future state of hunger). In contrast, if children chose a cupcake for the present after thirst-induction, then this suggests that their desire for the treat overrides their current state of thirst (both in the present and future, suggesting that the novelty of the cupcake is driving their decision making). Study 2 attempted to tease these two possibilities apart.

6. Method

6.1. Participants

Twenty-seven 3- to 5-year-old children participated in the study. None of these children had participated in Study 1. Five children (three 3-year-olds and two 5-year-olds) were not included in the final analysis due to failure to eat at least 8 pretzels (criteria used by Mahy et al., 2014 for minimum to induce thirst). The final sample consisted of 22 children: 7 3-year-olds (6 girls; M_{Age} = 41.86 months, SD = 3.02), 9 4-year-olds (6 girls; M_{Age} = 53.44 months, SD = 4.13), and 6 5-year-olds (2 girls; M_{Age} = 65.33 months, SD = 3.08). Since we planned to compare performance in Study 2 with children's performance in the motivation-future condition of Study 1, an a priori power analysis (G*Power 3.1; Faul et al., 2009) revealed that a total sample size of 50 children was necessary to detect a medium-large effect size (Effect size w = 0.4, alpha = .05, power = .80) between the motivation-future condition (Study 1) and the motivation-now condition in the current Study 2. Our current sample of 22 children fell just short of 25 children (given that we already had a sample of 23 children from the motivation-future condition in Study 1, the total sample size was 45) due to disruption to data collection by COVID-19. Children were mostly Caucasian (73%) and from a middle-class background (77% of families had an annual income above $75,000 per year). Participants were recruited from the X participant database maintained by five developmental psychology labs at X University.

6.2. Procedure

All children received a motivation-now condition which was identical to the motivation condition in Study 1 (which we will hence refer to as the motivation-future condition) except for one important difference: after children ate pretzels, they were asked to choose what they would like to have *now*: a cupcake or water (counterbalanced) rather than what they would like to have for the next day (motivation-future in Study 1).

7. Results & Discussion

On average, children ate about 18 pretzels in the motivation-now condition and consumed 0.90 ounces water at the end of the task. The majority of children indicated that they preferred cupcakes to pretzels (77%) in a follow-up question in line with Study 1 suggesting that cupcakes were a more desirable food than pretzels, $\chi^2(1) = 6.55$, $p = .01$.

Children's performance in the motivation-now condition is described in Table 1 and shown in Fig. 1. Similar to the motivation-future condition in Study 1, the minority of children (18%) preferred water to cupcakes when asked what they would like to have right now, immediately after consuming pretzels. A two-sided Fisher's exact test showed that this proportion did not significantly differ from children's preference for water over cupcakes in the motivation-future condition in Study 1 (13%), $p = .70$, *Odds ratio* = .68, 95% CI [.09, 4.64]. Thus, it seems that children selected cupcakes over water due to the novelty of the cupcake rather than the cupcake increasing children's ability to imagine a future state of hunger.

8. General Discussion

Taken together, these studies suggest that children whose thirst has been induced are able to ignore their state of thirst in the presence of a highly motivating food item such as a cupcake. This effect seems to be driven by the novelty of the item rather than a cupcake enhancing children's ability to anticipate their future state of hunger as children whose thirst has been induced select cupcakes when they are asked to make a decision between water and cupcakes immediately or for the next day. Nonetheless, a cupcake seems to be a tempting enough treat for children to ignore their current state of thirst and refrain from selecting the choice (water) that would quench their thirst. Interestingly, having children imagine their future states did not improve children's EpF in the Pretzel task and performance on the Pretzel task did not improve with age. Children's explanations for their food choices and food choice reaction times were similar across all experimental conditions.

8.1. Lack of Age Effect

Children's performance on the Pretzel task did not improve with age, consistent with previous literature (Atance & Meltzoff, 2006; Cheke & Clayton, 2019; Mahy et al., 2014; Mahy, 2016). This finding was not surprising as the lack of age effect is seen throughout childhood and even into adulthood (Kramer et al., 2017). The lack of improvement with age can be attributed to the presentism bias, as it appears that children are heavily weighting their decisions about the future on their current state (Gilbert et al., 2002) regardless of their age. This bias appears not to decrease with age perhaps because thirst is a powerful state that affects future reasoning regardless of one's age or developmental level. Interestingly, research has shown that hunger and thirst can impact individual's predictions of how other people might feel (Van Boven & Loewenstein, 2003) suggesting that one's current state might influence both decisions about the future self as well as decisions made for other people. Future work could examine how children's difficulty understanding how physiologically-generated desires change over time (Moses, Coon, & Wusinich, 2000) may contribute to the presentism bias in the context of thirst.

8.2. Episodic Future Simulation

Having the researcher encourage children to think about their future state (specifically hunger) did not boost their performance on the Pretzel task. This result contrasts with past work showing that conversations with a researcher about the future self generally improves prospective abilities (Chernyak et al., 2017; Leech et al., 2019). Our results might differ for several reasons. First, perhaps our manipulation was not powerful enough. Indeed, past work has had children engage in five minutes of conversation or reading stories about the future self with a researcher. Perhaps having a researcher suggest you might be hungry and encouraging children to imagine themselves in the future was not a strong enough manipulation to affect EpF. Future work could have researchers ask children questions about the quality of simulation of the future episode and have children provide an oral account of their imagined thoughts (which could offer further support that children were indeed engaged in episodic simulation). Second, it is possible that this type of manipulation would have worked in the absence of a current state that was in conflict with a future state. That is, perhaps thinking about your future self is effective when tasks do not involve a current state that makes it difficult to imagine one's future state. It is possible that simulating the future is especially difficult when a current physiological state, such as thirst, is so powerful that it interferes with projecting into future episodes (Mahy, 2016). This possibility is supported by the Bischof-Kohler hypothesis that describes non-human animals' difficulty with considering a future state that is not currently experienced (Bischof-Kohler, 1985). Our null findings surrounding response times suggest that children were not taking any more time to respond in the episodic simulation condition compared to the other conditions, so perhaps children were not projecting themselves into the future any more vividly than in the other conditions. Finally, even though children were encouraged to think about future hunger, this might have only been effective for children who were currently experiencing hunger (in line with the presentism bias). Thus, children who consumed many pretzels might have no longer felt hunger and this might have led to further difficulty imagining a current state of hunger that was not currently experienced.

Future work is needed to explore the role of episodic simulation of future events and its effect on children's EpF. One possibility is that vivid simulation of the self in the future relies on theory of mind abilities that are still developing during the preschool period. This could be explored in future work as theory of mind and prospection share a common neural basis (Spreng, Mar, & Kim, 2009); however, there is also evidence that theory of mind is unrelated to children and adults' EpF (e.g., Hanson, Atance, & Paluck, 2014; Jarvis & Miller, 2017). Thus, more research is needed to explore the cognitive abilities that contribute to children's episodic simulation of future events such as self-projection, planning, visualization, and perhaps theory of mind.

8.3. Motivation

Although simulation of a future episode did not increase children's performance in the Pretzel task relative to the standard thirsty condition, presenting a motivating food item as an alternative to water did. Thirst-induced children who were given a future choice between water or a cupcake managed to overcome the presentism bias to choose the cupcake and this seemed to be due to the fact that the cupcake was a motivating, novel food item, rather than due to the fact that the cupcake helped them better reason about their future state of hunger (as children whose thirst was induced in Study 2 also indicated they would prefer a cupcake vs. water in the present). Thus, presenting a highly desirable food item increased accuracy in future decision-making and seemed to mitigate the influence of children's current state of thirst on their future choice. We argue that children's reasoning is driven by the appealing aspects of a cupcake that override children's desire to quench their thirst. Research has shown that young children rate food as tastier and consume more of it when the food is described based on its appealing qualities rather than health-related information (e.g., Maimaran & Fishbach, 2014). We believe that the appealing qualities of cupcakes were salient enough for children to ignore their current state of thirst in their decision-making for both the present and the future.

Changing the motivational value of choices seems to be an effective way to overcome the presentism bias. Interestingly, however, children in this motivation condition did not take less time to make their choice as one might expect given the highly motivating cupcake option. It seems then that children were still considering their options between water and a cupcake, but ultimately the cupcake was motivating enough for children to ignore or at least downplay their current state of thirst when making their future decision. Future work could examine: (1) whether a less appealing, but novel food item (e.g., an apple) would be as effective in tempting children away from water, (2) whether an unappealing, novel food item (e.g., broccoli) would also be effective in tempting children away from water (this would be a strong test of the novelty vs. motivation question) or (3) manipulate the thirst-quenching aspects of different types of food to see if children choose foods that would quench thirst (e.g., juicy fruits) rather than novel foods that are salty and would increase thirst (e.g., chips, salty crackers) in the context of the Pretzel task. Importantly, because our power was somewhat limited in Study 2, it is important to replicate our findings in future research.

8.4. Children's Explanations by Condition

We examined children's explanations for their food choices across conditions in an exploratory manner. Interestingly, children's explanations did not differ between baseline (when choosing what they would like now) and when making a choice for the future. In both instances, children's explanations tended to appeal to their preferences rather than their current or future states, similar to past analysis of children's explanations of Pretzel task performance (Mahy, 2016). Many of children's explanations also fell into the 'other' category, suggesting that children's explanations were often absent, non-sensical, or did not include references to present states, future states, or their general preferences.

8.5. Limitations and Future Directions

As with all studies that have used the Pretzel task, it is difficult to know the extent to which these patterns of findings would apply to non-physiological states. However, part of the utility of the Pretzel task is that thirst is a powerful motivational state that impacts future choices. Nonetheless, EpF tasks that mimic the current-future state conflict that exists in the Pretzel task have been developed outside the physiological domain (see Belanger et al., 2014; Cheke & Clayton, 2019; Martin-Ordas, 2017). Future work should examine the extent to which manipulations surrounding episodic simulation and motivation might increase EpF in the non-physiological domains.

Another limitation of the Pretzel task more broadly is that children make a dichotomous choice between pretzels or water (or cupcakes vs. water in our motivation condition). Future work would do well to have children respond in a more continuous manner, for example, instead of choosing between pretzels and water for the future, they could indicate how many pretzels or how much water they wished to consume the next day. This more subtle measurement might reveal age-related changes in Pretzel task performance and condition effects that are not captured by the dichotomous choice between pretzels and water.

Future research could also explore other manipulations that might also improve children's EpF in tasks where there is current-future state conflict. For example, Mazachowsky et al. (2019) found that having children make decisions for an adult experimenter improved performance on Pretzel task performance (although children were at chance levels) compared to when they made a decision for themselves. Other manipulations, such as having children consider their own past experiences with hunger and thirst, might improve Pretzel task performance (in line with the constructive episodic simulation hypothesis; Schacter & Addis, 2007) and help to overcome presentism bias.

Finally, measuring children's baseline hunger level is an important control in future work. Just like we attempted to minimize thirst by providing children with juice to drink, researchers could attempt to equalize hunger in children across experimental conditions. Notably, in the current study we asked parents to refrain from feeding their child a meal before the study as we wanted children to be hungry when offered pretzels in order to ensure thirst was induced (i.e., children ate at least 8 pretzels which was an inclusion criteria for the present studies). Nonetheless, because we randomly assigned children to experimental conditions (in Study 1) this would have ensured that children's baseline level of hunger was similar across conditions.

9. Conclusion

The present study showed that unlike other areas of children's food cognition and the development of EpF more broadly (that shows significant improvement during the preschool years), young children struggle with predicting their future preference when a current state is in direct conflict with their usual preference. Importantly, children's motivation for a high value food item allowed them to overcome the presentism bias in the Pretzel task. Thus, a cupcake was a tempting enough food item for children to ignore their current state of thirst to make a more accurate future decision in line with their general preference. In contrast, episodic simulation that encouraged children to consider a future state of hunger was not effective. The current findings have important implications for improving children's EpF performance when a current state conflicts with a future state suggesting that a little motivation and novelty can go a long way. In everyday life, children's food choices might be strongly influenced by their current physiological states. Offering novel and appealing foods to young children might encourage them to eat a more diverse set of foods. For example, a child who is thirsty might not want to eat any more of their sandwich, but an apple or some yogurt might be novel and appealing enough to entice them to eat another type of healthy food contributing to better nutrition. In sum, the presentism bias in young children's predictions of future preferences is powerful but children's desire for a tasty, novel treat effectively mitigates the effect of this bias.

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