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Parental Reward-Based Eating Drive Predicts Parents' Feeding Behaviors and Children's Ultra-Processed Food Intake

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Abstract

Reward-based eating drive is associated with individual consumption, but there has been a paucity of research on the relationships between parental reward-based eating, child feeding behaviors, and child food consumption. Child feeding behaviors likely to be associated with parental reward-based eating drive include the provision of ultra-processed foods, as they are designed to be hyperpalatable and are associated with disordered food intake. The present study uses a virtual reality (VR) buffet restaurant environment to examine parents' food choice behaviors for their children and a food frequency assessment to measure the children's reported consumption over the course of a week. Results found that parental reward-based eating drive significantly predicted ultra-processed calories chosen by parents for their children in the VR Buffet, as well as the amount of ultra-processed food children ate according to the food frequency assessment. Both of these effects were significantly mediated by the healthfulness of the home food environment. This study is among the first to demonstrate associations between parental reward-based eating drive and child-focused food behavior, and to elucidate a mediating effect of the home food environment on such relationships. These findings may be useful for the development of family-based interventions to improve child feeding and ultimately child health.

Keywords

eating behavior; child feeding practices; reward-based eating drive; ultra-processed foods; home food environment

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6. Author Contributions
AD and SP conceived and designed the analysis, AD performed the analysis, AD and SP wrote the paper.

Declarations of interest: none.

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1. Introduction

1.1. Reward-Based Eating Drive

Parents play a central role in choosing what their young children eat, and these choices lead to early eating habits which can shape the child's lifelong behaviors (Johannsen, Johannsen, & Specker, 2006). Because of the outsized influence of parental choices on their young children's future health and behavior, it is valuable to understand the antecedents of parents' feeding behaviors and the food environments they create for children. The present study tests how reward-based eating drive (RBED) of parents predicts their child feeding behaviors, specifically those behaviors regarding ultra-processed foods. Additionally, the present study explores (1) whether the family food environment mediates these relationships and (2) whether parental modeling of eating behavior moderates these relationships.

RBED, a set of eating tendencies including preoccupation with food, lack of control around food, and lack of satiation (Epel et al., 2014), is a powerful antecedent of individual eating behaviors. Recent research suggests a relationship between RBED, consumption, weight, and health. Mason et al. (2017) found that higher RBED is correlated with higher BMI, greater likelihood of having type 2 diabetes, and greater appetite for savory and sweet foods. Reward systems of the brain influence food intake and BMI (Volkow, Wang, & Baler, 2011; Alonso-Alonso et al., 2015; Romer, Kang, Nikolova, Gearhart, & Hariri, 2019). Disinhibition and uncontrolled eating, constructs closely related to RBED, are consistently correlated with increased food intake (Vainik, García-García, & Dagher, 2019). While present research supports the notion that RBED impacts individual food choices, it is not yet known whether reward-driven eating on the part of a parent may be similarly related to child feeding behaviors.

1.2. Patterns in Familial Eating Behaviors

Children tend to eat what parents eat (Wang, Beydoun, Li, Liu, & Moreno, 2011). This relationship may arise, in part, from the heritable nature of appetitive traits and eating behaviors and/or from parental influence on their children's eating behaviors (Carnell, Haworth, Plomin, & Wardle, 2008; Kral & Rauh, 2010; Wardle & Carnell, 2009).

Comprehensive models of child feeding posit that parental characteristics and behaviors also influence child feeding behavior (Larsen et al., 2015; Vaughn et al., 2016). Numerous studies have demonstrated a correlation between increased restrained eating in parents and increased restrictive feeding of their children (Birch & Fisher, 2000; Francis, Hofer, & Birch, 2001; Johannsen et al., 2006; Gray, Janicke, Wistedt, & Dumont-Driscoll, 2010; Tylka, Eneli, Kroon Van Diest, & Lumeng, 2013). Results such as these demonstrate the general principle that how parents eat influences how they feed their children and how those children eat.

Several studies have specifically examined reward in the context of parents' child feeding practices and familial eating behavior similarities. Parental food addiction is positively correlated with child food addiction (Burrows et al., 2017). Parents with subclinical eating disorder symptomatology are more likely to report using food as a reward for their children and pressuring them to eat (Blissett & Haycraft, 2011), and parents with uncontrolled eating, a concept closely related to RBED, more often try to regulate their children's emotions using food (De Lauzon-Guillain, Musher-Eizenman, Leporc, Holub, & Charles, 2009).

Based on these previous findings, we expect that a parent's own RBED will predict their food choices when creating a meal for their child; additionally, we expect that a parent's RBED will predict their child's consumption over a week-long period. Specifically, we expect that parents' reward-based eating tendencies will predict the amount of ultra-processed food they choose for their children in the lab as well as their children's consumption of ultra-processed food following the lab visit.

1.3. Ultra-processed foods

Ultra-processed foods are industrially manufactured food products that contain either ingredients rarely used in kitchens or cosmetic additives designed to increase the products' sensory appeal (Monteiro et al., 2019). These products are created through a series of industrial processes such as deriving substances such as sugars and fats from whole foods, chemically modifying these substances, combining them, and mixing in additives to increase the palatability of the final product. These processes are designed with maximal profit in mind: ultra-processed foods are generally long-lasting, created in bulk from low-cost ingredients, and specifically designed to be energy dense and thus hyper-palatable (Monteiro et al., 2019). The multinational corporations responsible for the production of the vast majority of these foods brand them and market them aggressively through a wide array of tactics to the extent that ultra-processed foods have ousted freshly prepared meals, whole foods, and minimally processed foods in the diets of many individuals and families around the world (Monteiro et al., 2019).

Nutrition research over the past decade has associated ultra-processed food consumption with numerous deleterious health and behavior outcomes (Monteiro et al., 2017). Hall et al. (2019) found that highly ultra-processed diets result in increased *ad libitum* food intake and increased consumption of carbohydrates and fats. Moubarac et al. (2012) discovered that consumption of ultra-processed food is correlated with failure to reach nutrient goals. Clinical diagnosis of food addiction and subclinical food addiction symptomatology are both associated with ultra-processed food intake (Filgueiras et al., 2019). Ultra-processed food consumption is positively associated with body fat and cholesterol in childhood and with weight gain and obesity in adulthood (Rauber, Campagnolo, Hoffman, & Vitolo, 2014; Juul & Hemmingsson, 2015; Costa, Del-Ponte, Assunção, & Santos, 2017; Hall et al., 2019). Individuals who consume more ultra-processed foods have an increased risk of developing hypertension, gastrointestinal disorders, and cancer, among other adverse outcomes (Mendonça et al., 2017; Schnabel et al., 2018; Fiolet et al., 2018).

Past research suggests that individuals with high RBED may be particularly vulnerable to overconsumption of ultra-processed food products due both to the availability and to the nature of such foods. Poti, Braga, and Qin (2017) reviewed the literature on mechanistic links between ultra-processed foods and obesity, finding that the marketing and convenience of these foods may lead to inattentive eating and overconsumption. Similarly, Rolls, Cunningham, and Diktas (2020) proposed a model in which the low cost and high convenience of these foods leads to higher energy intake and weight gain. High-fat and high-sugar hyperpalatable foods have increased energy density, and consumption of energy-dense foods is correlated with intake and BMI in adults and children (Kral & Rauh, 2010; Rolls et al., 2020). Epel and colleagues (2014) described highly palatable foods as particularly relevant to reward-based eating. Since ultra-processed food is increasingly common (Monteiro, Moubarac, Cannon, Ng, & Popkin, 2013), associated with a variety of negative health outcomes, and relevant to reward-based eating, it is used to operationalize unhealthy child feeding behaviors and child food consumption in this study.

1.4. Potential Mediator and Moderator

The healthfulness of the home food environment has the potential to mediate parental RBED's relationships with child feeding behavior and child food consumption. While no known research has examined the impact of parental RBED on which foods parents purchase for the home, food choice is well-known to be influenced by reward responses to food (Recio-Román, Recio-Menéndez, & Román-González, 2020). We then expect that parent reports of the healthfulness of the home food environment will predict child food consumption, since this comprises the foods available for a child to consume while at home. We furthermore expect that parent reports about the healthfulness of the home food environment will predict the healthfulness of child feeding behaviors within the lab, since the cognitive processes which underlie curation of foods for the child at a buffet meal likely mirror those in play during the creation of the home food environment. Larsen and colleagues (2015) similarly conceptualized a model in which the effect of parental dietary behavior on the dietary behavior of their child was mediated by the child's home food environment. Research testing this model, however, has been limited. Flórez et al. (2016) found that family nutrition and physical activity mediated the effect of improvements in parental eating behavior on improvements in child eating behavior; however, unhealthy foods in the home specifically did not explain this relationship. Apart from this paper, there is no known research examining the mediating effect of the home food environment on the relationship between parental dietary behavior and child dietary behavior. The current study is positioned to contribute to this gap in the literature by evaluating whether parent reports about the healthfulness of the home food environment mediate the relationships from parental RBED to parental feeding behaviors and their children's food consumption.

Parental modeling of healthy eating behavior is another key aspect of the home environment that has the capacity to influence the relationship between parental RBED and parental feeding behaviors and child food intake. Specifically, modeling might moderate these relationships such that parents who explicitly make efforts to model healthy eating behavior may diminish the extent to which their own food reward processes impact the way they feed their child. Multiple studies have established that parental modeling is associated with healthier child eating behaviors (Loth, MacLehose, Larson, Berge, & Neumark-Sztainer, 2016; Carbert, Brussoni, Geller, & Mâsse, 2019). As such, parents who actively model healthful eating may be less likely to feed their child in a manner consistent with their own reward-based eating.

1.5. The Present Study

The current study examines whether parents' RBED is associated with the amount of ultra-processed food they feed their children and the amount of ultra-processed food their children consume. Additionally, this study explores whether the healthfulness of the home food environment mediates the relationships between parental RBED and child feeding practices involving ultra-processed foods. Finally, this study explores whether parental modeling of healthy eating behavior moderates these relationships.

2. Methods

A virtual reality (VR) buffet restaurant environment called the VR Buffet (Figure 1) was used to test whether parental RBED was associated with child feeding behaviors; a detailed description of the VR Buffet is available in Persky et al. (2018). Parents selected a plate of food for their child in the VR Buffet and the content of the plate was assessed. Parent-reported food frequency assessments were used to measure the child's reported consumption for a week at follow-up via Smith et al.'s (2017) Food Frequency Assessment (FFA) (see 2.3 for a detailed procedure description).

2.1. Hypotheses

This study tested the following hypotheses:

1. Parental RBED will predict measures of parental food choice for their children, including: (a) the number of calories from ultra-processed foods chosen by parents in the VR Buffet, and (b) the number of unique ultra-processed foods chosen by parents in the VR Buffet, such that higher levels of RBED are associated with higher calorie counts and more servings of food.
2. Parental RBED will predict the amount of ultra-processed food consumed by children in a week according to the FFA such that higher levels of RBED are associated with more servings of food.

Additionally, this study conducted exploratory analyses to examine a potential mediator and moderator in the relationships between parental RBED and the dependent variables in the hypotheses above. Research questions for these analyses were as follows:

1. Does the healthfulness of the home food environment mediate the relationships in the hypotheses above?
2. Does parental modeling of healthy eating behavior moderate the relationships in the hypotheses above?

2.2. Participants

Data from this study came from a larger experimental trial (Persky et al., 2020). Trial participants were parents with a child aged 3 to 7 in the Washington, D.C., area. Participants were recruited via social media, flyers, word-of-mouth, and traditional media. The sample of participants included a roughly equal number of mothers and fathers. Participants were paid $90 for their completion of all parts of the study.

To be included in the trial, participants were required to be able to read and write in English and to self-report having overweight. Participants were excluded if they were pregnant, had uncorrected poor vision or hearing, had a past or current diagnosis of eating disorder, often felt motion sick, or had a vestibular or seizure disorder. Some of these exclusion criteria were required in order to ensure that all participants could use VR safely. Additionally, the child of the participant had to have no major food allergies related to items on the VR Buffet and no developmental delays, diet-related health conditions, or dietary restrictions that would limit their ability to eat most of the foods in the VR Buffet. Finally, participants had to be the only person in their household to participate in the study and the only biological parent of the child in question to participate in the study.

Power calculations for the larger experimental trial were based off McBride, Persky, Wagner, Faith, & Ward (2013) and resulted in a sample size of 187. The total number of participants in the experimental trial was 190.

In addition to the inclusion and exclusion criteria of the larger study, participants who did not regularly play a role in deciding the amount and quality of food eaten by their child were excluded from the current analyses. Participants self-reported the amount of responsibility they had in feeding their child via the perceived responsibility factor of the Child Feeding Questionnaire (Birch et al., 2001), which asked on 5-point scales how often they are responsible for deciding what their child's portion sizes are and how often they are responsible for deciding if their child has eaten the right kind of foods, where 1=never and 5=always. 13 participants who answered 1 or 2 on either of these questions were excluded. One additional participant was excluded due to missing parental RBED data. Finally, one outlier in parental BMI (5.5 SD outside the mean) was excluded, resulting in a sample size $N = 175$.

This study was approved by the IRB of the National Human Genome Research Institute.

2.3. Measures

The predictor variable parental RBED was operationalized using Mason et al.'s (2017) 13-item Reward-Based Eating Drive Scale (RED-13). RED-13 consists of 13 Likert type questions, where 5 indicates the most RBED and 1 the least. A reliability test of RED-13 in the current sample yielded a Cronbach's alpha of .92. We compiled RED-13 into a singular RBED variable by averaging all items.

Several of the outcome variables of this study examined the food choices of parents for their children in the VR Buffet. The VR Buffet included seventeen food options. Eight of those choices were classified as ultra-processed based on the example of Ares et al. (2016); see Table 1. The two specific outcome measures for this study related to the VR buffet were as follows:

(1) The number of calories from ultra-processed foods chosen by parents in the VR Buffet.—The VR buffet included two different types of 3D models for food items: amorphous (for foods normally taken by the spoonful, such as yogurt and mac and cheese) and object-based (for foods normally taken in discrete units, such as cookies and chicken nuggets). The Food and Nutrient Database from the Nutrition Data System for Research, software version 2015, was used to calculate the number of calories per cubic centimeter of each food item, then the number of calories for each unit of food in the VR buffet was calculated based on the cubic size of the 3D model of the food item. Participants could click on a food item in the buffet to put one unit of that food on their plate and increase the serving size by clicking multiple times. The number of calories from all units of ultra-processed food items chosen were totaled for this outcome measure. For example, one spoonful of boxed-style mac and cheese (associated with one "click" or selection on the VR controller) was calculated to have 9 calories, and one cookie was calculated to have 42 calories, so a participant who chose two spoonfuls of mac and cheese and one cookie would have chosen 60 calories of ultra-processed food. For information on the calories per unit of each ultra-processed food item in the VR buffet, see supplementary material.

(2) The number of unique ultra-processed foods chosen by parents in the VR Buffet.—The number of unique ultra-processed foods refers to how many different types of ultra-processed food items a participant chose; for example, if a participant put one cheeseburger slider, two pizza bagel bites, and three chicken nuggets on their plate, they would be scored as having chosen three unique ultra-processed foods.

(3) The amount of ultra-processed food consumed by children in the week following parents' VR trial.—The food that participants' children ate in the week following the lab visit was self-reported via the FFA (Smith et al., 2017). The FFA consisted of twenty items, each of which asked parents how often their child had consumed a certain category of food in the past seven days. Eleven food categories were classified as ultra-processed based on the example of Ares et al. (2016); see Table 1. The four-point response scale for each item ranged from "never" to "3 or more times per day."

The potential mediator (home food environment) and moderator (parental modeling of healthy eating) were operationalized using the Environment and Modeling subscales of Musher-Eizenman and Holub's (2007) Comprehensive Feeding Practices Questionnaire (CFPQ). The Environment subscale consists of four Likert-type items examining to what extent parents make healthy foods available in their homes; the Modeling subscale consists of four Likert-type questions examining to what extent parents demonstrate healthy eating for their child. Each scale allows responses for each item on a scale from 1 to 5, where higher numbers indicate a more healthful home food environment. Two items were reverse-coded, and responses from the four items were averaged to get a final score of the healthfulness of the home food environment ranging from 1 to 5.

2.4. Procedure

Participants were screened online or over the phone. Participants identified one of their children between the ages of 3 and 7 that fit the above inclusion criteria. The remainder of the experiment concerned only this child. Participants were consented online and then completed an online pre-test questionnaire, which included the RED-13 scale and the CFPQ subscales along with demographic characteristics and other self-report scales.

Upon arriving for the lab visit, participants were consented a second time. Participants did not bring their children with them to the lab visit. They completed a training session practicing the controls of the VR Buffet, which are described in detail in Persky et al. (2018). They were then provided information about their child's future risk for obesity; this was the focus of the larger trial. The content of the risk information provided was randomly assigned by condition in a 2x2 design: genetic obesity risk information (present vs. absent) X family environment obesity risk information (present vs. absent). While the larger experimental trial (Persky et al., 2020) primarily focused on the effects of these conditions on parental food choice behaviors for their child in the VR buffet and on child eating outcomes via the FFA, the current study did not make any hypotheses related to these experimental conditions. Experimental condition was controlled for in all analyses (see Section 2.4).

Participants then entered the VR Buffet and were asked to create a plate of food for their child. They were instructed to make a plate just as they would in real life for their child and were told to choose as much or as little food as they would usually choose for their child's lunch (see supplement of Persky et al., 2020, for full instructions). Participants had unlimited time to choose food items for their child from the buffet. Persky et al. (2018) describes procedures within the VR Buffet in detail. Following their VR Buffet experience, participants completed another online questionnaire before finishing their lab visit. One week after the lab visit, participants completed an online follow-up questionnaire which included the FFA, after which they were debriefed.

2.5. Statistical Analyses

Hypotheses and analyses for this study were specified before data were compiled for analysis, and all hypotheses were pre-registered (https://osf.io/bp9n6?view_only=826fe0b8b996416eb3897b4371404007)[1].

Parents' randomly assigned risk information condition from the larger experimental trial was controlled for using two variables. The first variable described whether the participant received genetic risk information for obesity, and the second described whether the participant received family environment risk information for obesity. Neither of these risk information condition variables were significantly correlated with outcome variables in the study. Demographic variables that were significantly correlated with outcome variables were controlled for as a covariate for all models that included that outcome variable. Child gender was significantly correlated with the number of calories from ultra-processed foods that parents chose in the VR Buffet ($r = -.17$, $p = .037$). Parent gender was significantly correlated with the amount of ultra-processed food children consumed at follow-up according to the FFA ($r = -.18$, $p = .033$).

[1]Among the preregistered hypotheses for this study were hypotheses about the influence of parental RBED on parental choice of desserts for their child in the virtual buffet and on the child's dessert consumption according to the FFA; these hypotheses were not included in analyses because the foods qualifying as desserts in the virtual buffet and the FFA were all ultra-processed.

A linear regression was conducted to test the primary hypothesis that parental RBED predicts number of calories chosen from ultra-processed foods by parents in the VR Buffet. Covariates in this model were child gender and the two risk information condition variables.

A linear regression was conducted to test the hypothesis that parental RBED predicts the number of unique ultra-processed food items chosen in the VR Buffet. The two risk information condition variables were the only covariates in this model.

Finally, a linear regression was conducted to test the hypotheses that parental RBED predicts the amount of ultra-processed food children ate over a week according to the FFA. The two risk information condition variables and parent gender were covariates in this model.

Mediation analyses were conducted to examine whether home food environment mediated the relationship between parental RBED and child feeding behaviors. Additionally, moderation analyses were conducted to examine whether parental modeling of healthy eating behavior moderated this relationship. These analyses were run using PROCESS (Hayes, 2017).

3. Results

Participant characteristics can be found in the table of demographics below (Table 2).

Participants, on the whole, reported moderate RBED ($M = 2.44$, $SD = 0.82$). On average, participants chose 180.3 calories ($SD = 144.0$) from ultra-processed foods and 3.0 unique ultra-processed foods ($SD = 1.7$) for their children in the VR Buffet. According to the FFA, children ate a relatively low amount of ultra-processed food in the week following parents' lab visit ($M = 0.76$, $SD = 0.35$).

Results of all regressions can be found in Table 3. Parents with higher RBED chose more ultra-processed calories for their children in the VR buffet ($R^2 = .08$). Children of parents with higher RBED consumed more ultra-processed food over a week at follow-up ($R^2 = .12$)[2]. The number of unique ultra-processed food items chosen in the VR Buffet was not significantly predicted by RBED ($R^2 = .04$).

The healthfulness of the home food environment mediated the effect of parental RBED on the number of ultra-processed calories parents chose for their children in the VR Buffet (Figure 2). In this full mediation model, each step higher on the RED-13 scale of parental RBED corresponded with a 0.18-point decrease on the CFPQ Environment subscale, and each step higher on the CFPQ Environment subscale corresponded with 85 fewer calories chosen in the VR Buffet.

The healthfulness of the home food environment also mediated the effect of parental RBED on the amount of ultra-processed food the child consumed in a week at follow-up according

[2]Analysis of only participants in the control condition (i.e. those who received no obesity risk information about genetics or family environment prior to the VR Buffet trial) showed no predictive link between parental RBED and ultra-processed food consumed by children at follow-up (B = 0.07, $p = .307$). It is possible that priming parents with obesity awareness may have changed the way they fed their children at follow-up. It is worth noting that for participants in the control condition, parental RBED still predicted the number of calories from ultra-processed food chosen for children in the VR Buffet trial (B = 33.62, $p = .024$).

to the FFA (Figure 3). In this partial mediation model, each step higher on the RED-13 scale of parental RBED corresponded with a 0.19-point decrease on the CFPQ Environment subscale, and each step higher on the CFPQ Environment subscale corresponded with a 0.29-point decrease on the FFA's self-report scale of ultra-processed foods.

Parental modeling of eating behavior did not moderate the effect of parental RBED on any of the child feeding outcome variables.

To ensure that our results did not simply reflect a relationship between parental RBED and overall number of calories chosen in the VR Buffet, we conducted an additional linear regression testing whether parental RBED predicted number of calories chosen from non-ultra-processed foods. No predictive effect was found ($B = -0.04$, $p = .59$), suggesting that parental RBED was only associated with ultra-processed calorie choice.

4. Discussion

Results of this study demonstrate for the first time a predictive link between parents' RBED at baseline and their child feeding behaviors on two follow-up occasions. Parents who self-reported a greater tendency toward reward-based eating chose more ultra-processed food for their children in a VR Buffet environment, and those parents reported that their children consumed a greater amount of ultra-processed food over the course of a week. The results of the present study constitute a first step toward integrating findings from past literature on reward-driven eating and ultra-processed food. Mason and colleagues (2017) found that higher RBED was associated with greater appetite for savory and sweet foods, and Epel et al. (2014) noted a conceptual link between palatable foods and reward-driven eating. Meanwhile, research on ultra-processed foods has found them to be intentionally hyperpalatable, designed with high sugar and fat contents to be extremely savory and sweet (Moodie et al., 2013; Rolls et al., 2020). The present findings demonstrate that individuals with higher RBED exhibit altered food choice behavior vis-à-vis ultra-processed food compared to individuals with lower RBED. In this case, specifically, adults with higher RBED are shown to choose more ultra-processed foods for their child. Future research should seek to replicate these results in different populations and situations, especially by conducting research examining adults' ultra-processed food choice for themselves.

Additionally, the results of the present study demonstrate another example of the relationship between parental eating behaviors, their child feeding practices, and their children's eating behaviors. Past research found parallel eating behaviors between parents and their children (Wang et al., 2011), and there is some evidence that reward-driven eating in parents may be associated with similar patterns in their children (Burrows et al., 2017). Furthermore, researchers have theorized that parents' eating behavior will predict the way they feed their children (Larsen et al., 2015; Vaughn et al., 2016). The present study builds upon this base to demonstrate these connections in that parental eating tendencies predict both parents' child feeding behavior and children's food consumption. Additionally, given the context of these results within the consumption of ultra-processed foods, this study provides evidence for specific familial patterns of unhealthy eating.

This study demonstrated that the home food environment is an important mechanism through which parents' RBED can predict child feeding practices and children's consumption. Indeed, mediation models were significant, and there was no significant direct effect of RBED on ultra-processed calories chosen in the VR Buffet when the home food environment was added into the model as a mediator. These results provide novel evidence in support of Larsen and colleagues' (2015) conceptual model in which the home food environment mediates the association between parents' eating behavior and their children's eating behavior. Furthermore, the findings of the current study add to a plethora of literature showing that aspects of the home food environment predict children's dietary behavior (Hearn et al., 1998; Cullen et al., 2003; Hendrie, Sohonpal, Lange, & Golley, 2013; Østbye et al., 2013; Nam, Kim, & Kim, 2015; Vepsäläinen et al., 2015; Loth et al., 2016, Vepsäläinen et al., 2018; Bassul, Corish, & Kearney, 2020; Gubbels, 2020), and specifically dietary behavior vis-à-vis consumption of ultra-processed foods (Onita, Azeredo, Jaime, Levy, & Rauber, 2021). The present results also suggest that parental RBED is related to the healthfulness of the home food environments parents create for their children, an apparently novel finding in the literature.

It is noteworthy that the home food environment explained the predictive effect of parental RBED not only on child food consumption according to the FFA but also on parental food choice for their child in the VR Buffet. While the FFA measures represent a week of the child's eating in the free-living environment, the VR Buffet measure of parental food choice takes place completely outside of the home food environment. The finding that the healthfulness of the home food environment predicts ultra-processed calories chosen by parents for their children in the VR Buffet lends credence to a conceptual model in which the cognitive processes underlying the creation of the home food environment and parents' perceptions of that environment also predict specific child feeding behaviors.

While the current study did not find that parental modeling of healthy eating behavior moderated the effects of parental RBED on child feeding and eating, future research should ask more questions about the impact of modeling on child eating behavior. Past research demonstrates that parental modeling behavior is associated with healthy eating behavior for both parents (Tibbs et al., 2001) and children (Loth et al., 2016; Carbert et al., 2019). Healthy parental modeling is associated with healthy child eating behavior even when parental diet is controlled for, and children of high-modeling parents demonstrate healthy eating behavior regardless of whether their parent eats healthily (Vaughn, Martin, & Ward, 2018). Therefore, although parental modeling did not have a moderating effect in the current study, there is some evidence that parents who actively model healthy eating behaviors for their children are less likely to carry their own reward-based eating behaviors into their child feeding tendencies.

Limitations include the fact that the sample of parents in this study self-reported having overweight. It is possible that the relationship between RBED and child feeding behaviors is different for lean parents. Additionally, excluding participants who did not self-report as overweight limits the range of parental BMI, which was controlled for as a covariate in this study due to its correlation with RBED. While the results of this study did not show a ceiling effect in parental RBED, future research should seek to replicate this result with a broader population of parents to ensure that the relationships between parental RBED, the home food environment, child feeding behaviors, and children's eating behaviors are replicated regardless of parental weight status.

The sample of participants included in this study was generally highly educated, which may further limit the extent to which the results of this study can be generalized to the whole population of parents. Maternal education level is related to a variety of child feeding practices (McPhie, Skouteris, Daniels, & Jansen, 2014), so it is possible that the relationships between parental RBED, the home food environment, and child feeding behaviors may be different for parents with lower education attainment.

This study was conducted with data originally collected for another trial. An additional shortcoming, therefore, is that some of the questionnaires used to measure outcome variables were not specifically geared towards testing the hypotheses of the current study. For example, the FFA is not specifically designed to test ultra-processed food consumption although it contains both ultra-processed and non-ultra-processed items.

Finally, this study was unable to examine any potential effect of child age on the relationships described in the hypotheses, as data on precise child age (other than the fact that they were in the inclusion age range) was not uniformly collected. It is possible that parental RBED may relate to child feeding practices differently for older children compared to younger children. Future studies on this topic should examine whether child age correlates with child feeding practices or influences the relationship between parental RBED and familial eating patterns.

Future research should expand upon these findings to determine whether other child feeding behaviors and child eating outcomes are associated with parental RBED. Understanding under what circumstances the patterns reported here hold should also be a priority of future studies, particularly by generalizing these findings to samples of lower SES and different ethnicities, cultures, and nationalities. Additionally, research should examine whether high parental RBED can predict child outcomes such as BMI, and whether any such effects are mediated by the home food environment, parental food choices, or child ultra-processed food intake. Interventions to promote healthy eating behavior in children could utilize these emerging connections by tailoring messages to parents about healthy child feeding behavior and healthful home food environments.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
A participant's view in the virtual reality (VR) Buffet.

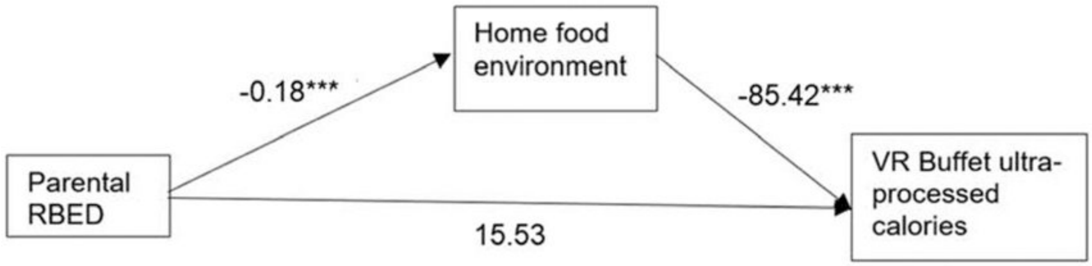

Figure 2.

The healthfulness of the home food environment mediates the effect between parental reward-based eating drive (RBED) and ultra-processed calories in the VR Buffet. All values reported are the unstandardized regression coefficient (B). ***p < *.001.*

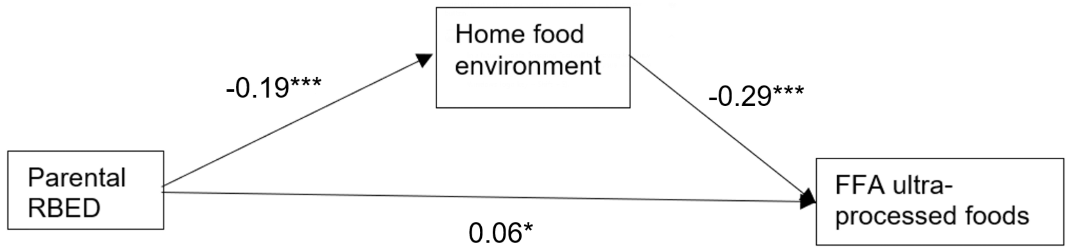

Figure 3.

The healthfulness of the home food environment mediates the effect between parental reward-based eating drive (RBED) and ultra-processed foods reported in the food frequency assessment (FFA). All values reported are the unstandardized regression coefficient (B). *p < *.05,* ***p < *.001.*

Table 1.

Ultra-processed food items in the Virtual Reality (VR) Buffet and ultra-processed food categories in the Food Frequency Assessment (FFA).

VR Buffet Ultra-Processed Foods	FFA Ultra-Processed Foods
Brownies	Fried Potatoes
Cookies	Heat and serve (e.g. mozzarella sticks)
Fries	Processed meat
Boxed-style mac and cheese	Burgers
Chicken nuggets	Fried chicken
Pizza bagel bites	Candy
Cheeseburger sliders	Baked goods (e.g. donuts)
Strawberry yogurt	Frozen dessert
	Chips
	Sugary cereal
	Non-sugary cereal

Table 2.

Demographics. Means (standard deviation) or frequency (%)

	***N* = 175**
Parent age	39.3 (6.3)
Parent gender: Female	96 (55%)
Parent gender: Male	79 (45%)
Parent race: Asian	14 (8%)
Parent race: Black/AA	29 (17%)
Parent race: White	114 (65%)
Parent race: Other/More than one	18 (10%)
Parent: Hispanic/Latino	15 (9%)
Parent BMI	30.4 (5.8)
Parent college graduate	145 (83%)
Child gender: Female	83 (47%)
Child gender: Male	92 (53%)
Child weight status: Overweight	21 (12%)
Child weight status: Not overweight	154 (88%)

Table 3.

Results of stepwise regressions. All coefficients reported are the unstandardized regression coefficient, B, and p-*values are in parentheses.*

	VR Buffet Ultra-Processed Calories	VR Buffet Ultra-Processed Food Items	FFA Ultra-Processed Foods
Parent RBED	31.17 (p=.019)	0.23 (p=.150)	0.12 (p<.0001)
Condition: Genetics	−0.34 (p=.987)	0.24 (p=.342)	0.00 (p=.962)
Condition: Family Environment	−32.79 (p=.124)	−0.40 (p=.115)	−0.09 (p=.079)
Child Gender	−49.34 (p=.023)	--	--
Parent Gender	--	--	−0.14 (p=.006)