Exploring Adolescent Vulnerability to Influencer Product Endorsement on Snack Intake Within a Live Streaming Context

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Live streaming is a rapidly growing source of digital entertainment that presents a unique opportunity for food brands to reach young audiences. Streamers, or content creators, use influencer-based marketing strategies to promote food brands and model eating behaviors. Adolescents are vulnerable to these types of marketing practices due to increased saliency of social influence, which presents health implications as most of the marketed food products are high in fat, salt, and sugar. In a randomized crossover design, a sample of 72 adolescents, 12–19 years of age, viewed two simulated live stream videos with imbedded marketing for a food and nonfood product. A bowl of chips was offered during the viewing, and the amount consumed was measured. Using a mixed effects model, no main effect of marketing condition was found on snack intake. A significant effect of External Food Cue Responsiveness scores on snack intake was found, with higher scores showing greater intake in both conditions. Significant interactions between condition and age, the Three Factor Eating Questionnaire—cognitive restraint subscale, and the TFEQ—emotional eating subscale were found. These results demonstrate possible individual differences that determine food intake outcomes in response to food marketing exposure.

Keywords: live streaming, eating behavior, adolescent, social media, food marketing

Adolescent obesity is on the rise due in part to environmental factors such as exposure to food marketing (Fryar et al., 2020; J. L. Harris et al., 2021). Food marketing on traditional media outlets, such as television, has been shown repeatedly to influence food choice, preferences, and food intake (Boylan et al., 2011, 2016; J. L. Harris, Bargh, & Brownell, 2009). Marketing dollars are following consumers to digital media platforms, such as social media sites, that are now serving as the predominate spaces for entertainment and social interaction (Chester et al., 2021; Rummo et al., 2020; Twenge et al., 2019). This transition of marketing to digital media presents an opportunity for brands promoting unhealthy products, such as gambling, alcohol, and ultraprocessed foods, to reach adolescent consumers in a landscape that is less regulated than television and print advertising (Bite Back, 2023; Campbell & Grimm, 2019; Montgomery & Chester, 2009; Twenge et al., 2019). This is concerning as adolescents report near constant use of digital media and have reported high exposure and engagement with food marketing on these platforms (Anderson & Jiang, 2018; Ares et al., 2022;
Fleming-Milici & Harris, 2020). Youth are spending extensive amounts of time in a digital environment that promotes the purchase and consumption of energy-dense, nutrient-poor foods. Understanding how adolescents engage and respond to food marketing within digital media is essential for designing interventions and policies to improve the online food environment targeting adolescents.

Live streaming is an emerging form of both digital entertainment and social media that presents the opportunity for extended viewing and live reciprocal communication between the viewer and the content creators. This contrasts with other social media platforms that rely mainly on asynchronous content delivery. Live streaming is a rapidly growing industry with billions of hours watched, accounting for 29% of internet users worldwide (Ceci, 2023). The top live streaming platforms, Twitch, YouTube Live, and Facebook Gaming, have primarily focused on video game streaming content (Stream Hatchet, 2023). The content creators, or “streamers,” on these platforms typically play video games, while viewers are able to interact with the streamer and other viewers through a chat box. The viewership of this type of content is predominantly young, less than 24 years old, and male (Mansoor, 2023). Similar to other digital media, food marketing is pervasive within live stream platforms (Edwards et al., 2021). Top food and drink brands not only advertise on live streams but also invest in sponsorships of streamers and host special events. When targeted campaigns are run, users heavily engage with brands. Viewers of live streams have reported a desire to engage with this marketing to support their favorite streamers and watch live streams for a sense of community (Ceci, 2018; Pollack et al., 2021). Live stream viewers have also reported craving and purchasing foods they have seen marketed on the platforms (Evans et al., 2023; Pollack et al., 2022).

In comparison to other mediums, live streaming allows for enhanced integration and engagement with food brands. For example, the most popular live streaming platform, Twitch, allows for brands to insert text, logos, and static advertisements in several locations on the screen (Edwards et al., 2021). This is all occurring around the streamer’s actual content, where streamers routinely place products on stream, wear branded products, or consume advertised products. In addition to these visual cues, the audience is also able to participate in discussion with the streamer about the brand and even share their own experiences with the brand (Haushalter et al., 2023). However, the most potent of these marketing cues is likely to be the promotion of products by the streamers themselves.

Streamers use influencer marketing techniques to promote brands that provide financial sponsorship. Influencer marketing capitalizes on the parasocial relationships between the viewer and the content creator, in this case, the streamer (Chen, 2021; Yuan & Lou, 2020). Influencer marketing of food brands has been found to impact eating behavior in children (Coates et al., 2019a). While extensive food-based content is aimed at adolescents, a direct relationship between influencer food marketing and adolescent eating behaviors has not been well explored.

The focus in food marketing literature has been on young children due to the perception that adolescents are more aware and therefore resilient against marketing. However, recent research has found that adolescents may be more vulnerable to digital marketing due to the degree of exposure and saliency of social influence during this developmental period (J. L. Harris et al., 2014, 2021; Potvin Kent et al., 2019; Quattein et al., 2022; World Health Organization, 2016). Although the ability to recognize persuasive intent develops by age 12, the critical evaluation of messaging continues to mature throughout adolescence (J. L. Harris et al., 2014). Adolescents recall more advertising compared to adults and may be more likely to believe messaging claims unless additional prompting is provided (Dubow, 1995; Linn et al., 1982). Self-reported exposure to food images and branded marketing on social media has been associated with increased awareness of food brands, increased reported unhealthy food intake, and positive attitudes toward commonly marketed foods (Evans et al., 2023; Quattein et al., 2022). However, less is known about the direct effects of digital food marketing exposure on adolescent snack food intake.

The transition from childhood to adolescence introduces additional factors that influence and motivate eating behaviors and impact susceptibility to food marketing (Albert et al., 2013; Story et al., 2002). The reactivity to embedded food cues in advertising model hypothesizes that food marketing integrated into media acts as a food cue, inducing both psychological and physiological drives to consume food (Folkvord et al., 2016). This model also considers the role of individual susceptibility in determining the degree of responsiveness to the food cues and the power of food marketing to influence eating behavior and ultimately weight and health outcomes. Specifically, factors such as impulsivity and attentional bias to cues may impact how marketing messages are processed and valued by the viewer (Folkvord et al., 2016). Reactivity to food cues has previously been associated with greater responsiveness to food marketing (Masterson, Gilbert-Diamond, et al., 2019; Pollack et al., 2022). Additionally, the cue-influencer-reactivity-outcome model theorizes more broadly the effects of eating behavior characteristics and environmental factors that impact responsiveness to food cues within an environment (Hayashi et al., 2023). Emotional regulation and state act as both constant and transient influencers of food cue reactivity. Individual variability in the propensity to consume food in response to negative emotions has been linked to the risk of overconsumption and obesity (Jalo et al., 2019). Responsiveness to food cues may also be moderated by restraint behaviors, such as active avoidance of the cue. Previous work has shown that cognitive restraint has been associated with decreased consumption of energy-dense foods in teenagers, while young adults with higher emotional eating have reported higher food cravings and greater intake of snack foods (Fahrenkamp et al., 2019; de Lauzon et al., 2004). Similar responses were also found with adolescent self-report of snack intake while viewing television (Snoek et al., 2006). Heterogeneity in responses to food marketing as related to food intake presents a research gap in the areas of adolescents and digital food marketing.

There is a wealth of literature on the direct effects of food marketing exposure on food intake (Boyland et al., 2016). However, this work has primarily examined the effect on children and television-based exposures. The primary aim of this study is to replicate the effect of acute food marketing exposure on snack intake in adolescents using influencer marketing, which includes both product promotion and behavior modeling, on a digital platform. The second aim was to explore how age and eating behavior characteristics may modify the effect of marketing exposure on snack intake. To accomplish these aims, we utilized a simulated live stream with influencer marketing imbedded into the entertainment content. We hypothesized that exposure to food-based influencer marketing would increase intake of a snack food compared to nonfood influencer marketing. Additionally, we hypothesized that higher scores on the External Food Cue Responsiveness (EFCR), Three Factor Eating Questionnaire–emotional eating (TFEQ-EE), and TFEQ–uncontrolled eating
calculated (kg/m²) from the measured height and weight. Body mass index (BMI) was instructed to remove shoes, heavy clothing, and items from pockets North America, Chino, California, United States). Participants were instructed not to eat or drink, except for water, for at least 2 hr prior to the study visit time. Levels of hunger, fullness, and desire to eat were assessed before and after watching the live stream using a 0–100-point visual analog scale with anchors of not at all to extremely for each (Stratton et al., 1998). Prior to viewing the live stream, participants were asked to taste one Pringles chip and rate their liking ratings given on a 0–100 point visual analog scale with anchors of extremely dislike to extremely like. Participants were provided the snack food to consume while watching the prerecorded live stream, which lasted 20 min. After viewing the live stream, participants were also asked to complete a streamer evaluation.

The second study visit followed the same procedures, with the addition of the revised 18-question TFEQ, EFCR questionnaire, and usual snacking behavior inventory at the end of the visit. At the end of the second laboratory visit, height (cm) and weight measurements (lbs) were performed by a trained research assistant. Height was measured using a stadiometer and weight using a digital scale (Seca North America, Chino, California, United States). Participants were instructed to remove shoes, heavy clothing, and items from pockets before measurements were performed. Body mass index (BMI) was calculated (kg/m²) from the measured height and weight.

Sample

A power analysis using G-power with 80% power and an α .05 was conducted based on available meta-analysis data (Quatina et al., 2019). An effect size of 0.2 was expected for the within-person difference in snack intake between conditions. Assuming a 10% dropout rate, the required sample size was estimated to be approximately 80 participants. Participants ranged in age from 12 to 19 years. This age range was chosen as it reflects the World Health Organization definition of adolescence as well as the typical National Health and Nutrition Examination Survey age category for adolescents and captures early through late adolescent developmental periods (Norris et al., 2022; Tripicchio et al., 2019). Participants were recruited from local middle and high schools, college campuses, and community locations near the Pennsylvania State University.

The study protocol was approved by the university’s institutional review board (STUDY00019242). Informed consent was obtained prior to the first study visit. Parental consent was obtained for participants under 18 years. Participants were required to meet the age requirement of 12–19 years, be fluent in English, not have a food allergy to the test food, and have no medical conditions that would impair completing study activities. Other food allergies that would not prevent consumption of the study food were not considered exclusionary. Participants who did not complete both study visits were excluded from analysis.

Study Food

A snack was chosen as the focus of this study as snack intake may be more vulnerable to external influences compared to meals, and snack food brands have a large presence on digital platforms (Edwards et al., 2021, 2021; Masterson, Bermudez, et al., 2019). A single food item was chosen as the marketed food is likely to be the most influenced (Emond et al., 2016; J. L. Harris, Bargh, & Brownell, 2009). A serving of 230 g (1,219 kcal) of Pringles in a bowl was then provided for participant consumption while watching a simulated live stream at both study visits. The serving size was initially set at 100 g (530 kcal) to reflect a reasonable snack size for this age group and provide an amount that would not be consumed in its entirety (Tripicchio et al., 2019). However, it was determined after the initial study procedure testing that a greater serving size was needed as the whole portion was consumed multiple times. The serving size was incrementally increased until “plate cleaning” no longer occurred. The eaten chips were weighed in the serving bowl to the nearest 0.1 g. The amount eaten was calculated by subtracting the amount of chips served from what was left after consumption.

Simulated Live streams

Two simulated live stream videos were created using the live stream platform Twitch as a model. The target marketing manipulation was the streamer promotion of a food product (Pringles) or a nonfood product (Zippo gaining handwarmer). Participants viewed both live streams 1 week apart. The order in which they were viewed was randomized. In both live streams, the pseudostreamer played Fortnite, which is a popular game among adolescents (Statista, 2018). Product promotion was modeled after influencer marketing techniques that aimed to integrate the product promotion into the entertainment content of the live stream. Other forms of marketing, including the interactive chat functions, were not included in the videos. The streamer discussed each product, highlighting why each one is preferred and how it is used or consumed by the streamer. The streamer also interacted with both products, either using the Zippo handwarmer or consuming the Pringles, during the stream, as shown in Figure 1. The streaming title and chat were excluded to not confound the targeted experimental manipulation. Consistency between the two live stream videos was achieved by creating a script that timed out the length of video game play and product promotion. In addition to screen formatting, typical slang words and behavior of Twitch streamers were used in creating the scripts to provide a realistic viewing experience.
Questionnaires

Prior to scheduling laboratory study visits, participants completed the demographic and use of live stream questionnaires. Demographic information included age, biological sex, race/ethnicity, education, and household income. Information related to usual live stream platform habits, including the specific platforms used to watch live streams, time spent daily watching live streams, and categories of live streams that are enjoyed, was also collected.

Streamer Ratings

After watching the live stream video at both study visits, participants were asked to provide feedback on the streamer and enjoyment of viewing the live stream. The question “Was this streamer entertaining to watch?” with the option to answer on a 5-point Likert scale from not at all to extremely was used as the measure of streamer liking for data analysis purposes. Finally, an open-ended text box was provided to allow for additional feedback on the live stream video and streamer.

Eating Behavior Questionnaires

Participants completed the EFCR scale at the end of their second visit. The EFCR questionnaire measures individual responses to food cues in varying contexts (Masterson, Gilbert-Diamond, et al., 2019). Questions related to the desire to eat in response to the sight and smell of food or recognition of food in the environment, such as restaurant logos. The original questionnaire was designed to be answered by parents of young children. The version used here has been previously adapted for use in adolescents and young adults by changing the language from “my child” to “I” statements and found to be reliable with Cronbach’s $\alpha$ of .83 (Pollack et al., 2022). The final score is an average of all responses.

Additionally, participants completed the revised 18-question TFEQ (Anglè et al., 2009; Karlsson et al., 2000). The TFEQ measures three eating behavior domains: cognitive restraint, emotional eating, and uncontrolled eating, with Cronbach’s $\alpha$ of .75 for cognitive restraint, .85 for uncontrolled eating, and .87 for emotional eating (Anglè et al., 2009). The subscales are calculated based on an adjusted score accounting for an unequal number of questions assigned to each subscale. This questionnaire has been validated for use in adolescents (Anglè et al., 2009). The cognitive restraint subscale asks questions related to conscious behaviors to control food intake for the purpose of controlling weight, including the questions “I do not eat some foods because they make me fat.” and “How likely are you to consciously eat less than you want?” The emotional eating subscale includes questions about eating in response to negative emotions as a method for self-soothing. The uncontrolled eating subscale measures loss of control overeating in response to the presence of food cues, such as the availability of palatable foods.

Usual Snacking Behavior

A brief, adapted snacking questionnaire was administered to capture both the frequency of snacking and the types of foods usually consumed as snacks (De Cock et al., 2017; Tripicchio et al., 2019). This questionnaire was administered due to the potential influence of usual eating habits on food intake during the experiment. Frequency of snacking was measured as the number of snacking occasions per week. Types of snacks consumed were presented as a choice list in which participants could select all that apply, including an option for “other.”
Data Analysis

A linear mixed effect model including intake of Pringles (g) as the dependent variable, study condition (Pringles or Zippo handwarmer product promotion) as the independent variable, and participant as the random effect was used to assess the unadjusted main effect of viewing a live stream with and without exposure to food marketing on the intake of Pringles chips. Degrees of freedom were calculated by the Satterthwaite method. A subsequent adjusted model was then employed that included age, sex, liking of the Pringles, hunger, usual consumption of chips for snacks, streamer rating, and BMI to account for potential influences or confounders. Previous research has found hunger, habitual eating behaviors, and liking of experimental food to be important factors in determining the quantity of food intake (Coates et al., 2019a; Gearhardt et al., 2020). Additionally, perceptions of an influencer, both positive and negative, have been shown to impact the effect of the marketing messages, with positive attitudes blunting negative perceptions of the marketing content (Yuan & Lou, 2020). Streamer rating was added to the adjusted model to account for the effect of viewers attitudes toward the streamer. Condition order and time of study visit, either a.m. or p.m., were added to the model to check for effects of these factors on the main outcome.

We again used linear mixed effects regression to examine the main effects of EFCR and TFEQ subscales and age on chip intake, each included in separate models. We further tested if each of those measures modified the main effect of study condition separately. Specifically, an interaction term between each of those measures and study condition was included in the adjusted regression model predicting chip intake. A threshold of $p < .05$ was used to define a statistically significant effect modification. Variables found to significantly predict chip intake in the main adjusted model were also included in all models.

All models used an a priori $p$ value of $\leq .5$ for significance. Analysis was conducted using R (Version 4.2.3; R Core Team, 2023). Data will be made available on the Open Science Framework data repository (https://osf.io/qexyd; Maksi et al., 2023). Data will be made available on the Open Science Framework (https://osf.io/qexyd; Maksi et al., 2023). Data were analyzed using R (Version 4.2.3; R Core Team, 2023). Analysis was conducted using R (Version 4.2.3; R Core Team, 2023). Data will be made available on the Open Science Framework (https://osf.io/qexyd; Maksi et al., 2023). Data were analyzed using R (Version 4.2.3; R Core Team, 2023).

Table 1

Sample Characteristics

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<thead>
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<th>Characteristic</th>
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<tr>
<td>Age</td>
<td>17.6 (±1.89)</td>
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<tr>
<td>BMI</td>
<td>0.3659 (±0.87)</td>
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<tr>
<td>BMI %</td>
<td>61.6 (±26.4)</td>
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<tr>
<td>Chip intake</td>
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<tr>
<td>kcal</td>
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Results

Demographics

A total of 79 participants were enrolled and completed at least one study visit. Participants were removed from analysis due to dropout before the second study visit ($n = 1$), study procedure error ($n = 2$), and not eating at least 2 g of the study food at both visits ($n = 4$). The final sample included 72 participants. The sample included a small percentage of regular live stream users, with 82% watching less than 30 min per day. The primary platforms reported for viewing live streams were YouTube, Instagram, and Twitch. A summary of the participant characteristics is shown in Table 1.

Main Effect Model and Adjusted Model

There was no significant effect of condition on chip intake ($p = .30$). The adjusted model remained insignificant for the effect of condition on chip intake ($p = .59$). In the adjusted model, age, sex, hunger, liking of Pringles, usual intake of chips for snacks, and BMI were significant predictors of chip intake regardless of condition. Results of both models are summarized in Table 2. There was no effect of condition order or time of visit, $p = .2$ and $p = .7$, respectively.

Interaction Models

In the models assessing for effect modification of the main effect of study condition on chip intake, a significant main effect was found for EFCR ($p < .01$), but there was no interaction with condition ($p = .1$). A significant interaction with condition was found for TFEQ-EE ($p = .03$), TFEQ-CR ($p = .01$), and age ($p = .001$), as shown in...
Figures 2A, 2B, and 2C, respectively. See Table 3 for a summary of these results.

Qualitative Streamer Rating

Participants were able to note additional comments related to the streamer, and 50 individuals left a comment, or 69% of the total sample. In total, 80 comments were made, and of those, 66% were negative, 18% were positive, and 16% were neutral. There were 48 comments made specifically about the frequency and style of the product promotion, with the majority noting that it was disruptive and not natural. Participants over 18 years old represented 71% of the comments recognizing the product promotion.

Discussion

In this study, simulated live streams that incorporated influencer marketing for Pringles chips or Zippo gaming handwarmer were used to explore the effects of food marketing within a live stream in a sample of adolescents (12–19 years old). The live stream featuring a food brand was hypothesized to produce a greater intake of the Pringles chips compared to the live stream with a nonfood brand. This hypothesis was not generally supported, as chip intake was not significantly different between conditions in the overall sample. However, we hypothesized that eating behavior traits and age may modify responsiveness to the food marketing exposures. This hypothesis was supported as age, emotional eating, and cognitive restraint significantly interacted with the live stream marketing exposure of Pringles or Zippo Handwarmer to decrease chip. These results demonstrate how characteristics of the study sample influence the acute effect of exposure to food marketing and provide several areas of consideration for future study design in the area of digital food marketing.

The finding that marketing exposure did not directly impact chip intake in this study is in contrast with other consistent findings of a relationship between exposure to food marketing and intake of branded foods in children (Boyland et al., 2016; Coates et al., 2019a). However, there are some important distinctions between this study and previous work. This study sampled early through late adolescence in contrast to younger children, who may have less awareness of marketing or experimental intent (Wright et al., 2005). The use of a pseudostreamer in the live stream videos may have further enhanced the awareness of marketing intent in this adolescent sample. A recent meta-analysis of the available studies in adolescents found a small effect size for exposure to food marketing on unhealthy eating outcomes (Qutteina et al., 2019). There may be age-related differences in response to marketing that warrant further exploration. Additionally, previous research on adolescents and digital food marketing has relied on self-reported measures for exposure and food intake, whereas this study used a direct measure of intake (Qutteina et al., 2022; Sharps et al., 2019). Using actual intake as the main outcome may have reduced the power of this study to detect an effect, as a variety of variables could

Table 2
Within-Subject Chip Intake Differences Between Live Stream Video Conditions

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>3.57</td>
<td>3.44</td>
<td>[−3.22, 10.37]</td>
<td>.30</td>
</tr>
<tr>
<td>Adjusted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>1.82</td>
<td>3.44</td>
<td>[−4.95, 8.53]</td>
<td>.59</td>
</tr>
<tr>
<td>Hunger</td>
<td>0.42</td>
<td>0.15</td>
<td>[0.11, 0.72]</td>
<td>.008</td>
</tr>
<tr>
<td>Liking</td>
<td>0.49</td>
<td>0.18</td>
<td>[0.15, 0.85]</td>
<td>.007</td>
</tr>
<tr>
<td>Sex</td>
<td>−28.94</td>
<td>7.10</td>
<td>[−42.39, −15.50]</td>
<td>.001</td>
</tr>
<tr>
<td>Age</td>
<td>−4.13</td>
<td>1.95</td>
<td>[−7.80, −0.44]</td>
<td>.03</td>
</tr>
<tr>
<td>BMI</td>
<td>2.67</td>
<td>0.97</td>
<td>[0.83, 4.52]</td>
<td>.007</td>
</tr>
<tr>
<td>Streamer rating</td>
<td>2.77</td>
<td>3.58</td>
<td>[−4.47, 9.63]</td>
<td>.43</td>
</tr>
<tr>
<td>Eat chips for snacks</td>
<td>16.62</td>
<td>7.52</td>
<td>[2.37, 30.84]</td>
<td>.03</td>
</tr>
</tbody>
</table>

Note. The reference group is the nonfood marketing condition (Zippo). In the model, males were coded as 1 and females as 0. Bold values indicate significance at p < .05. SE = standard error; BMI = body mass index.

Figures 2A, 2B, and 2C, respectively. See Table 3 for a summary of these results.

Figure 2
Interactions Between Marketing Exposure and (A) Emotional Eating, (B) Cognitive Restraint, and (C) Age

Note. TFEQ-EE = Three Factor Eating Questionnaire–emotional eating; TFEQ-CR = TFEQ–cognitive restraint.
Previous studies have demonstrated that food marketing exposure behaviors such as purchase and consumption (Kelly et al., 2015) can have an effect on food intake. The process that begins with increased brand awareness and the complex environment of digital media is important to consider when attempting to experimentally manipulate eating behaviors of adolescents. The few studies that have attempted to use social media to experimentally influence eating behaviors of adolescents also found no effect (Folkvord & de Reijmersdal, 2020; Sharps et al., 2019). This may be due to the challenge of creating experimental manipulations from the nuanced and complex environment of digital media.

The qualitative streamer rating data support this idea that familiarity with the streamer may be needed to reduce negative attitudes towards the presence of product promotion. However, awareness of the presence of product promotion is found to be acceptable or an irritant (Boerman & van Reijmersdal, 2020; Du et al., 2023). In this case, a pseudostreamer was used, and as such, viewers would not be familiar with the streamer. Additionally, the length of exposure to an unfamiliar streamer likely played a role in the lack of effect of marketing exposure on food intake. The lack of familiarity and, therefore, trust in the streamer may have altered the perceptions around the promotion of the products. The qualitative streamer ratings support this idea that familiarity with the streamer may be needed to reduce negative attitudes towards the presence of product promotion. An existing strong parasocial relationship with an influencer may be needed to reduce negative attitudes towards the presence of product promotion. However, the difference in chip intake between those who are more responsive to emotional state was more pronounced in the nonfood marketing exposure compared to the food marketing exposure. The reduced effect of marketing on chip intake could be a result of greater susceptibility to overall consumption, as emotional eating has been associated with overconsumption and relates to obesity risk (Gallant et al., 2010; van Strien et al., 2012; Wallis & Hetherington, 2009). Both live stream conditions could have elicited similar emotional responses from viewers, independent of the type of product promoted. Emotional appeal has been shown to be an effective strategy when targeting children and adolescents (J. L. Harris et al., 2021). A sample of adolescents from the United Kingdom reported on the emotional responses to digital food marketing, finding both positive and negative responses (Bite Back, 2023). One teen reported feeling bad for craving the food shown in the ads. Positive emotional responses included happiness and curiosity (Bite Back, 2023). Future research should include engagement and emotional responsiveness to the experimental media to determine if emotional eating presents a vulnerability specifically to food marketing or marketing in general.

Our findings related to cognitive restraint were in line with our hypothesis. Participants with less restraint behaviors consumed more chips when exposed to food marketing compared to those who reported restrained eating behavior. This effect was not observed in the nonfood marketing condition, suggesting that the presence of food cues is needed for restraint behaviors to impact food intake. The relationship of restraint behaviors related to weight status is unclear and likely context-dependent (De Castro, 1995; Polivy & Stellar, 2014).

### Table 3

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EFCR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>2.02</td>
<td>3.50</td>
<td>[−4.69, 8.94]</td>
<td>.56</td>
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<tr>
<td>EFCR score</td>
<td>22.66</td>
<td>7.06</td>
<td>[7.78, 34.19]</td>
<td>.002</td>
</tr>
<tr>
<td>EFCR × Condition</td>
<td>−11.73</td>
<td>7.13</td>
<td>[−20.1, 25.57]</td>
<td>.10</td>
</tr>
<tr>
<td><strong>TFEQ-EE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>1.91</td>
<td>3.47</td>
<td>[−4.91, 8.69]</td>
<td>.58</td>
</tr>
<tr>
<td>TFEQ-EE</td>
<td>0.28</td>
<td>0.14</td>
<td>[0.009, 0.56]</td>
<td>.05</td>
</tr>
<tr>
<td>TFEQ-EE × Condition</td>
<td>−0.323</td>
<td>0.13</td>
<td>[−0.59, −0.05]</td>
<td>.02</td>
</tr>
<tr>
<td><strong>TFEQ-CR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>1.74</td>
<td>3.48</td>
<td>[−5.17, 8.26]</td>
<td>.61</td>
</tr>
<tr>
<td>TFEQ-CR</td>
<td>0.05</td>
<td>0.17</td>
<td>[−0.21, 0.45]</td>
<td>.76</td>
</tr>
<tr>
<td>TFEQ-CR × Condition</td>
<td>−0.41</td>
<td>0.16</td>
<td>[−0.73, −0.10]</td>
<td>.01</td>
</tr>
<tr>
<td><strong>TFEQ-UE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>1.86</td>
<td>3.49</td>
<td>[−8.37, 5.09]</td>
<td>.59</td>
</tr>
<tr>
<td>TFEQ-UE</td>
<td>0.41</td>
<td>0.25</td>
<td>[0.08, 1.00]</td>
<td>.10</td>
</tr>
<tr>
<td>TFEQ-UE × Condition</td>
<td>−0.32</td>
<td>0.24</td>
<td>[−0.14, 0.78]</td>
<td>.18</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>−1.82</td>
<td>3.44</td>
<td>[−4.95, 8.53]</td>
<td>.53</td>
</tr>
<tr>
<td>Age</td>
<td>−4.13</td>
<td>1.95</td>
<td>[−7.80, −0.44]</td>
<td>.03</td>
</tr>
<tr>
<td>Age × Condition</td>
<td>−5.84</td>
<td>1.70</td>
<td>[−9.16, −2.55]</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Note. Bold values indicate significance at p < .05. SE = standard error; EFCR = External Food Cue Reactivity; TFEQ-EE = Three Factor Eating Questionnaire—emotional eating; TFEQ-CR = TFEQ—cognitive restraint; TFEQ-UE = TFEQ—uncontrolled eating.*

This study found that older adolescents (18–19 years) were less responsive to the food marketing condition compared to younger participants. These results should be interpreted with caution as the sample was skewed toward older adolescents, with 52% of the sample being between the age of 18 and 19 years. The reduced marketing effect may be due to greater skepticism toward persuasive messaging in older adolescents (Buijzen et al., 2010; van Reijmersdal & van Dam, 2020). The qualitative streamer rating data supports this idea, as the older adolescents most often commented on the presence of the product promotion. However, awareness of advertising intent is not always protective, especially in the case of influencer marketing (Coates et al., 2019b; van Reijmersdal et al., 2017). Another consideration is that younger adolescents may be more susceptible to social marketing due to greater influence of social pressures in early to late adolescents due to maturing cognitive control (Albert et al., 2013). Future studies should consider the effects of digital marketing across the span of adolescence.

Previous theoretical models related to food marketing effects include individual differences as an important component that may alter responsiveness to marketing messages (Folkvord et al., 2016; Kelly et al., 2015). Our findings of significant interactions between self-reported eating behavior and food marketing exposure support those theories. Specifically, those who were more likely to consume food in response to emotional state consumed more chips overall. However, the difference in chip intake between those who are more responsive to emotional state was more pronounced in the nonfood marketing exposure compared to the food marketing exposure. The reduced effect of marketing on chip intake could be a result of greater susceptibility to overall consumption, as emotional eating has been associated with overconsumption and relates to obesity risk (Gallant et al., 2010; van Strien et al., 2012; Wallis & Hetherington, 2009). Both live stream conditions could have elicited similar emotional responses from viewers, independent of the type of product promoted. Emotional appeal has been shown to be an effective strategy when targeting children and adolescents (J. L. Harris et al., 2021). A sample of adolescents from the United Kingdom reported on the emotional responses to digital food marketing, finding both positive and negative responses (Bite Back, 2023). One teen reported feeling bad for craving the food shown in the ads. Positive emotional responses included happiness and curiosity (Bite Back, 2023). Future research should include engagement and emotional responsiveness to the experimental media to determine if emotional eating presents a vulnerability specifically to food marketing or marketing in general.
Herman, 2020). Some studies have found that restraint increases the risk of binge eating and has been associated with overweight and obesity (Gallant et al., 2010; Mason et al., 2018). However, the food marketing defense model theorizes that motivation is needed to resist the marketing messages, along with awareness and cognitive ability to evaluate the messages (J. L. Harris, Brownell, & Bargh, 2009). The overt promotion of the Pringles chip may have induced restraint behaviors in those with higher levels of cognitive restraint. Food marketing within digital media, including live streaming, can be more subtle and integrated into entertainment content. The protective effect of cognitive restraint is an area to explore in future studies, with more subtle marketing techniques including known influencers that are better able to mask marketing intent due to preexisting parasocial relationships.

In contrast to a previous study that found higher reactivity to food cues was associated with greater purchasing and craving of marketed foods, this study found that reactivity was not related to marketing vulnerability (Pollack et al., 2022). High responsiveness to food cues did relate to overall greater chip intake, independent of the marketing exposure. This may be due to the choice of having participants consume the chips while watching the live streams. A bowl of chips would act as a strong cue to consume in both live stream conditions. Eating while watching a live stream is likely a common behavior and is modeled by top streamers. The act of watching video entertainment may influence food consumption by the habitual pairing of the two activities as well as distraction from appetite signals (Chartrand, 2005; Marsh et al., 2013). Just playing a video game has also been found to increase caloric intake of snack foods in adolescents (Chaput et al., 2011). Additional research is needed to explore the relationship between food cue reactivity and vulnerability to food marketing on digital platforms.

This study set out to test the ability of a simulated live stream with imbedded food marketing to influence adolescent eating behavior, and there are some limitations that should be taken into consideration for future studies. First, the choice of study food and presentation conditions (i.e., one with no marketing). However, future studies are needed to explore these relationships in greater depth and identify potential underlying mechanisms. The generalizability of these findings is limited by the lack of diversity in the study sample. Further research is warranted to explore whether these characteristics serve to protect or enhance vulnerability to food marketing.

Conclusions

This study found no main effect of live streamer promotion of a food product in the absence of other marketing cues on adolescent intake of a snack food while watching the live stream. However, the study identified several potential subpopulations of adolescents that may be particularly susceptible to this type of food marketing. Overall, there are factors that appear to affect the degree of influence the exposure to food marketing had on snack intake. Specifically, younger age, lower emotional eating, and lower cognitive restraint were associated with increased susceptibility to the snack intake promoting effects of the food marketing versus nonfood marketing condition. However, future studies are needed to explore these relationships in greater depth and identify potential underlying mechanisms. The generalizability of these findings is limited by the lack of diversity in the study sample. Further research is warranted to explore whether these characteristics serve to protect or enhance vulnerability to food marketing.

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