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A treat for the eyes. An eye-tracking study on children's attention to unhealthy and healthy food cues in media content

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ABSTRACT

Based on cue reactivity theory, food cues embedded in media content can lead to physiological and psychological responses in children. Research suggests that unhealthy food cues are represented more extensively and interactively in children's media environments than healthy ones. However, it is not clear to this date whether children react differently to unhealthy compared to healthy food cues. In an experimental study with 56 children (55.4% girls; $M_{age} = 8.00$, $SD = 1.58$), we used eye-tracking to determine children's attention to unhealthy and healthy food cues embedded in a narrative cartoon movie. Besides varying the food type (i.e., healthy vs. unhealthy), we also manipulated the integration levels of food cues with characters (i.e., level of food integration; no interaction vs. handling vs. consumption), and we assessed children's individual susceptibility factors by measuring the impact of their hunger level. Our results indicated that unhealthy food cues attract children's visual attention to a larger extent than healthy cues. However, their initial visual interest did not differ between unhealthy and healthy food cues. Furthermore, an increase in the level of food integration led to an increase in visual attention. Our findings showed no moderating impact of hunger. We conclude that especially unhealthy food cues with an interactive connection trigger cue reactivity in children.

1. Introduction

Visual food cues within commercial (e.g., Keller & Schulz, 2011; Speers, Harris, & Schwartz, 2011) and editorial (e.g., Radnitz et al., 2009; Roseman, Poor, & Stephenson, 2014) media content targeted at children are omnipresent. As content analyses suggest, foods depicted in media targeted at children convey a rather skewed perspective on nutrition and reflect a "distorted food pyramid" (Keller & Schulz, 2011, p. 300); speaking to an overrepresentation of unhealthy foods (e.g., fast food, sweets, salty snacks) and simultaneously underrepresenting healthy foods (e.g., presentations of vegetables, fruits, and unsweetened beverages). Furthermore, researchers have continuously related the omnipresence of unhealthy foods on TV to children's food preferences (e.g., Auty & Lewis, 2004; Brown et al., 2017; Folkvord, Anschütz, Nederkoorn, Westerik, & Buijzen, 2014; Matthes & Naderer, 2015; Uribe & Fuentes-García, 2015) and, on a larger scale, to the increase in overweight and obese children worldwide (Jordan, 2007; WHO, 2016). So far, considerably less research has been conducted on the effects of healthy food cues. The findings of these pioneering studies yielded conflicting results (Charry, 2014; Dias & Agante, 2011; Folkvord, Anschütz, Buijzen, & Valkenburg, 2013; Harris, Speers, Schwartz, & Brownell, 2012). Thus, there is no consensus among researchers whether healthy food cues in media content serve as a positive agent to promote healthy eating behaviors for children.

To systematize how food cues in media content affect viewers, Folkvord, Anschütz, Boyland, Kelly, and Buijzen (2016) have developed the Reactivity to Embedded Food Cues in Advertising Model (REFCAM). According to the theoretical model, three factors have to be considered when investigating the possible effects of food cues in media content: (1) the type of food presented; (2) the level of integration of food cues; and (3) viewers' individual susceptibility factors. The authors propose that these three factors influence how viewers react toward the food cue. They describe this reaction as cue reactivity, which is categorized as physiological

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and psychological response toward food cues (Folkvord et al., 2016, p. 27). Cue reactivity theory (Jansen, 1998) states that food cues can prompt a series of physiological responses such as an increased heart rate, gastric activity, or salivation, (e.g., Castellanos et al., 2009; Nederkoorn, Smulders, & Jansen, 2000) and psychological responses, such as increased attention for food (e.g., Castellanos et al., 2009; Folkvord, Anschütz, Wiers, & Buijzen, 2015; Jansen, 1998). Folkvord et al. (2016), moreover, theorize that increased reactivity to food cues might be a strong predictor for subsequent food intake.

Although current research particularly focuses on how food advertising affects attention to food for adults (Kemps, Tiggemann, & Hollitt, 2014; Viacava, Weydmann, Tietze, Santolim, & Bizarro, 2016), this form of cue reactivity has rarely been investigated in children (Velazquez & Pasch, 2014), especially when it comes to food cues embedded in narrative media content (Folkvord et al., 2015). Against this background, the present study adds to the literature on cue reactivity with two major contributions. First, so far, research on children's cue reactivity as a dependent variable is missing (Folkvord et al., 2016). We aim to investigate children's cue reactivity to different food cues with regard to their visual attention by applying eye-tracking methodology. Presumably, children are not aware of the impact of different types of food cues on their gaze behavior. Thus, observational methods, such as eye-tracking, are clearly more suitable compared to self-report measures to investigate reactions to food cues. The duration of eye fixations indicates the depth of processing (e.g., Rayner, 1998). Hence, eye-tracking can afford an unbiased, straightforward measure of visual attention allocation in general and to food cues in particular.

Second, we investigate cue reactivity under consideration of all three factors named in the REFCAM (i.e., food type, level of food integration, and individual susceptibility factors; Folkvord et al., 2016), and therefore provide a comprehensive view on visual attention. In an innovative eye-tracking study with 56 children between the ages of 6–12 years, we aim to increase the understanding of how food cues affect children.

1.1. Food type

Following the literature on taste development, individuals are born with an inherent preference for unhealthy food products and as such, would always prefer the sweeter option given (e.g., Desor, Maller, & Turner, 1973). Beyond that, unhealthy food cues have become pervasive in the media environment and consequently, individuals are regularly confronted with the temptation of unhealthy food (e.g., Harris, Bargh, & Brownell, 2009).

Literature in the domain of self-regulation suggests that exposure to short-term temptations, such as unhealthy food cues, activates an eating enjoyment goal that triggers attentional bias (i.e., selective attention) for energy-dense food cues (Papies, Stroebe, & Aarts, 2008). Only exposing individuals to information that is congruent with their long-term goals (e.g., healthy eating behavior) seems to be effective in directly steering their attention away from goal-incongruent products (i.e., goal priming; Papies et al., 2008; van der Laan, Papies, Hooge, & Smeets, 2017). Compared to adults, children are generally less able to ignore the allure of short-term temptations to pursue long-term goals (e.g., Kerr & Zelazo, 2004), because of the immaturity of their attentional flexibility. Thus, children are less able to shift their attention away from affect-based persuasive messages such as unhealthy food cues within media content (Rozendaal, Lapierre, van Reijmersdal, & Buijzen, 2011).

Previous research generally lacks insights about the potential influence of diverse food types on visual attention (Hummel, Zerweck, Ehret, Salazar Winter, & Stroebele-Benschop, 2017). This research gap is particularly pressing in the context of food advertising as well as in the case of children as the target audience (Velazquez & Pasch, 2014). However, preliminary results indicate a relationship between visual attention and food preferences. For instance, in the study by Velazquez and Pasch (2014), children and adolescents viewed a total of 40 static food advertisements, of which more than two-thirds represented unhealthy food products. The authors tested the association between visual attention indicators and self-reported food preferences. Analyses showed that participants' visual attention to unhealthy food products was positively associated with their unhealthy food preferences. Similarly, Folkvord et al. (2015) investigated children's visual attention to unhealthy food cues in an advergame in association with their actual caloric intake. Results indicated that children with a longer gaze duration for the presented food cues were significantly more likely to eat more of the promoted snacks compared to children with a shorter gaze duration.

Yet, how children react to unhealthy compared to healthy food cues has not been sufficiently investigated (Ogle, Graham, Lucas-Thompson, & Roberto, 2017). Based on the literature of taste development which assumes a higher preference for unhealthy products (e.g., Desor et al., 1973) and children's lower levels of inhibitory control (Kerr & Zelazo, 2004), it can be argued that unhealthy food cues attract visual attention—defined by a) dwell time and b) first fixation duration—to a larger extent than healthy food cues (H1).

1.2. Level of food integration

Apart from the importance of food type (Folkvord et al., 2016), the level of food integration determines both children's processing and effectiveness of food placements (Buijzen, van Reijmersdal, & Owen, 2010). In the past the level of food integration was frequently connected to the interaction of food cues with characters (e.g., Naderer, Matthes, Marquart, & Mayrhofer, 2016). In our paper we thus operationalize *integration levels of food cues* as the interaction of characters with food products (in the following referred to as “level of food integration”).

According to the Social Learning Theory (Bandura, 1977), children's liking or admiration of a character increases the likelihood of children's imitation of the character's action. Thus, watching an admired media character handling or consuming a food product may lead to second-hand learning in young viewers (Kamleitner & Jyote, 2013). Recently, findings from food placement studies indicated that interactive placements are more effective in creating consumption behavior compared to non-interactive placements (Naderer et al., 2016). Furthermore, food that was actually consumed was even more effective compared to food that was only interacted with (Naderer, Matthes, & Zeller, 2017).

Yet, according to theoretical principles of observational learning, individuals do not automatically imitate the observed behavior. The reason is that cognitive processes occur between the observation of behavior and a potential imitation (Bandura & Jeffrey, 1973). These processes include, first and foremost, attentional factors. Hence, the extent of visual attention constitutes an important predictor for whether an observed behavior gets imitated. Thus, some researchers assume that children are influenced by media characters due to the amount of attention they pay to them (e.g., Neeley & Schumann, 2004). However, only one study so far measured children's visual attention to characters in traditional TV advertisements (Velazquez & Pasch, 2014), but no empirical work focuses on the influence of the level of food integration on children's attention in media content suitable for children.

Following existing studies (Naderer et al., 2016, 2017), we distinguish two different types of interaction, first, a character handling a product without consuming, and second, a character consuming a product. In line with the suggested impact of interactive food placements on children's attention (Naderer et al., 2016, 2017), food cues carried by a character (i.e., interaction without consumption) might be more effective in capturing children's visual attention—defined by a) dwell time and b) first fixation duration—compared to food cues with no character-product-interaction (H2). More specifically, visual attention—defined by a) dwell time and b) first fixation duration—to food cues increases when a character consumes the depicted food product (Naderer et al., 2017) compared to non-interactive food cues (H3) and food cues which are only carried by a character (H4). The reason is that the act of consuming showcases the purpose of the product and should thus generate more visual attention.

No research we are aware of has examined a possible interaction effect of food type and level of food integration when considering children's visual attention. A clarification is crucial, because compared to healthy edible products, unhealthy food cues are predominantly represented in active situations in children's media environment (e.g., Olafsdottir & Berg, 2016). Yet, how the interaction can turn out is not entirely clear. On the one hand, Buijzen et al. (2010) stress the power of interaction in the context of children's processing of embedded persuasive messages such as product placements. They propose that children allocate more cognitive resources toward more interactive (i.e., use by a character) than non-interactive (i.e., shown in the background) placements. This reasoning results in an acceptance of a stronger emphasis on level of food integration than food type when considering visual attention as a response.

On the other hand, when following literature on self-regulation, one might argue that the effects of food type outweigh the level of food integration: Once an eating enjoyment goal gets activated through environmental cues, it is very difficult to shift attention away from palatable unhealthy foods (Papies et al., 2008; van der Laan et al., 2017). In this context, it must be borne in mind that especially children are less able to ignore the allure of short-temptations (see e.g., Kerr & Zelazo, 2004). Based on the lack of research, we are interested in how the level of food integration impacts children's visual attention by different food types (RQ1).

1.3. Individual susceptibility factors such as hunger

Even though it is presumed that external cues such as attractive foods to which individuals are pre-exposed can lead to attentional bias for those foods (Papies et al., 2008), individual susceptibility factors must also be considered (Folkvord et al., 2016). Hunger as a powerful internal motivation for eating behavior is employed as the individual susceptibility factor in this study, as it may drive attention to visual food cues. For instance, findings of Piech, Pastorino, and Zald (2010) demonstrated that hunger of adult participants biased visual attention to food cues. Similarly, findings from other studies also showed a positive relationship between hunger and an attentional preference for food-related cues (Castellanos et al., 2009; Mogg, Bradley, Hyare, & Lee, 1998; Nijs, Muris, Euser, & Franken, 2010; Stockburger, Schmälzle, Flaisch, Bublatzky, & Schupp, 2009). Studies on the behavioral effects of food advertising commonly included children's hunger level as a control variable (Folkvord et al., 2014, 2015, 2013; Harris et al., 2009). Even though hungry children seem to be more vulnerable to food advertisements regarding the effects on eating behavior (Forman, Halford, Summe, Macdougall, & Keller, 2009; Halford, Gillespie, Brown, Pontin, & Dovey, 2004), no study so far has investigated the moderating impact of hunger.

Based on the outlined literature, the impact of food type (H1) as well as of level of food integration (H2-H4) on attention may be even more pronounced when children are hungry. Considering the current lack of research regarding visual attention measures and children (Folkvord et al., 2015), we are interested in how children's level of hunger moderates the visual attention regarding food type and level of food integration (RQ2). Fig. 1 visualizes all posed hypotheses and research questions.

2. Method

2.1. Design

We conducted a within-subject design eye-tracking study with children. We collected the data in a primary school in Austria in November 2016. The Regional Education Authority approved the study and we obtained parents' written consent prior to study

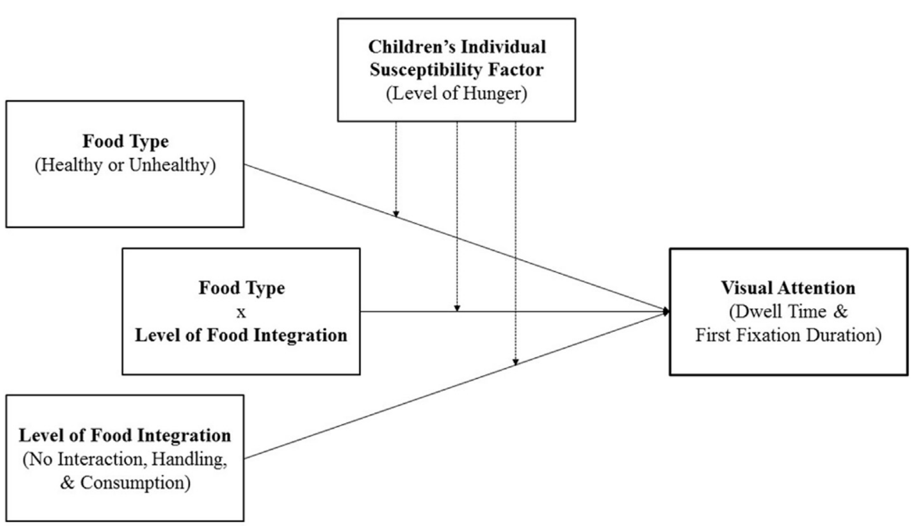

Fig. 1. Hypothesized model based on the REFCAM model (Folkvord et al., 2016, p. 27).

conduction. We exposed children to a self-created media stimulus suitable for young viewers in which 18 different food cues were embedded. Initially, a total of 61 children between the ages of 6 and 12 years took part in the study. We excluded five children because of extremely poor deviation results following final calibration. Hence, the final data set consisted of 56 children (55.4% girls; $M_{age} = 8.00$, $SD = 1.58$). It should be noted that within-subject designs need drastically smaller sample sizes than between-subjects designs. In fact, $N = 56$ is a typical sample size for eye-tracking studies using comparable within-designs (e.g., Karsay, Matthes, Platzer, & Plinke, 2018; Marquart, Matthes, & Rapp, 2016).

2.2. Procedure

One female experimenter (first author) conducted the eye-tracking study in individual sessions with the children. The experimenter seated the children in front of the eye-tracker, where each child saw the same stimulus material. First, the experimenter explained the plot of the subsequent stimulus to the children. Afterwards, the children saw the actual narrative stimulus accompanied by relaxing music. Participant's eye-movement was recorded during the reception with the SMI iView X™ RED eye-tracker. After the eye-tracking session, a second experimenter conducted a short interview with the children estimating their current hunger level.

2.3. Stimulus

The narrative stimulus composed out of 40 individual static pictures presented the traveling-adventures of two panda brothers. Each picture was shown for 5 s. We designed the stimulus by using the software PowToon. Eighteen out of 40 pictures showed food cues, whereof nine images depicted healthy food (e.g., apples, carrots), and nine images depicted unhealthy food (e.g., ice cream, a slice of pizza). For the healthy food cues, we chose products from the four bottom shelves of the food pyramid. Thus, they were more wholesome compared to the unhealthy food cues. Unhealthy food products were characterized by their classification at the top of the food pyramid. Therefore, they were high in fat, sugar, or salt (Department of Health, 2012). Differences in visual attention of the children should only depend on the presented food type. Thus, we took care to create food pairs of one healthy and one unhealthy product that were as similar as possible to each other (Castellanos et al., 2009). As visualized in appendix A healthy and unhealthy product pairs were very similar in regard to visual complexity, presentation, size, and coloring.

In a manipulation check, we tested ex post whether the embedded food cues were distinctively recognizable as healthy or unhealthy food products (i.e., all unhealthy and all healthy products were separately shown on cards with alternative food products that were not used as stimulus). Results indicate that the embedded unhealthy food cues were perceived as significantly more unhealthy ($M = 1.67$; $SD = 0.99$), compared to the healthy food cues ($M = 3.46$, $SD = 0.84$; $t(53) = -9.22$, $p < .001$); measured on a four-point scale from "1 = very unhealthy" to "4 = very healthy").

We also manipulated the level of food integration. We varied whether the character did not interact with the food at all (no interaction), was holding the food (handling), or was eating the food (consumption; Olafsdottir & Berg, 2016, for a visualization see appendix B). For each of the nine similar pairs of unhealthy and healthy products, we presented three pairs per level of food integration. Other items were inserted in the pictures to keep the 18 food cues inconspicuous (e.g., umbrella, picture frame).

In the story, the panda Peppino and his younger brother Rondo are going on a vacation together. On their travels, they visit different countries and meet new friends. When they come back home, the panda brothers realize that they forgot to get presents for their mom. Thus, they go back to the same countries they have already visited in reverse order and pick up a little present in every country. The reversed order was implemented so that the comprised food pairs of healthy and unhealthy products were always inserted in the same context, so the attention created by the food cue was dependent on the food type and not on different surroundings. To prevent order-effects, we randomized the presentation order of each food pair (i.e., the same food of a food pair was for some children presented in the beginning of the story and for some at the end). Level of food integration were kept identical within the story, only randomizing the order of the food pairs.

2.4. Pilot study

We conducted a pilot study with $N = 8$ children aged 6–12 years (62.5% female; $M_{age} = 8.63$, $SD = 2.07$) to test both the stimulus material and the functionality of the eye-tracker with children. The eye-tracking data proved to work perfectly with the children, and all quality criteria were in a reasonably good to perfect range. Regarding the stimulus material, qualitative interviews showed that children enjoyed the story of the two panda-brothers and they did not raise any concerns about the quality of the food cues embedded in the story. A few children, however, mentioned that one picture of the food product used (hotdog) looked strange to them, thus we replaced this picture for the main study.

2.5. Measures

We obtained the eye-tracking data with a remote eye-tracking system (SMI iView X™ RED) and we recorded the data with a sampling rate of 120 Hz. Viewing was binocular, but only the right eye's movements were monitored (for this procedure, see Henderson, Weeks, & Hollingworth, 1999). The experimenter conducted a five-point calibration test at the beginning of the experiment and a five-point validation test after the stimulus presentation.

We defined each food cue as an oval area of interest (AOI). The coverage of the AOIs varied between 2.7% and 7.4%. The coverage of each food pair was of similar size. For indicators of visual attention, we calculated dwell time and first fixation duration for each AOI. Dwell time makes a statement about total viewing time (i.e., fixations and saccades) of an AOI (measured in milliseconds ms.). First fixation duration provides information about the duration of the first visual contact with an AOI (i.e., duration of initial attention, again assessed in ms.).

To determine children's level of hunger, a hunger measurement was used by following Bennett and Blissett (2014). On a four-point scale, children could choose between the following degrees: *4 = really hungry*, *3 = quite hungry*, *2 = a little bit hungry*, and *1 = not hungry at all* ($M = 2.75$; $SD = 1.08$; see appendix C). This variable was later dummy coded to insert as a moderator in our analysis (really hungry and quite hungry = 1, $N = 20$; a little bit hungry and not hungry at all = 0, $N = 35$; 1 missing value).

2.6. Data analysis

We conducted two repeated measures general linear models

Table 1
Main and interaction effects explaining dwell time and first fixation duration for food cues.

	Dwell Time				First Fixation Duration			
	df	*F*	η_p^2	*p*	df	*F*	η_p^2	*p*
Within Subjects								
Food Type	**1.00**	**8.62**	**.140**	**.005**	1.00	0.73	.014	.398
Level of Food Integration	**1.00**	**154.43**	**.570**	**.001**	**1.57**	**19.62**	**.270**	**.001**
Food Type × Level of Food Integration	1.77	0.20	.004	.790	**1.74**	**3.60**	**.064**	**.037**
Between Subjects								
Hunger	1.00	0.63	.012	.431	1.00	0.30	.006	.589
Food Type × Hunger	1.00	0.22	.004	.639	1.00	0.08	.001	.781
Level of Food Integration × Hunger	1.00	0.04	.001	.961	1.00	0.37	.007	.641
Level of Food Integration × Food Type × Hunger	1.00	0.22	.004	.775	1.00	0.31	.006	.703

Note: Bold figures indicate significant effects; $N = 56$ children; 55.4% girls; $Mage = 8.00$, $SD = 1.58$.

with visual attention (i.e., either dwell time or first fixation duration) as the dependent variable. We inserted food type (healthy vs. unhealthy) and level of food integration (no interaction, handling, and consumption) as within-participant factors and hunger as an additional between-participant factor. In cases where Maulchy's test of sphericity indicated a violation, we applied Greenhouse–Geisser corrections (i.e., dwell time: interaction of food type and level of food integration; first fixation duration: level of food integration, interaction of food type and level of food integration).

3. Results

Effect of food type. We expected (H1) that unhealthy food cues would attract more visual attention—defined by a) dwell time and b) first fixation duration—compared to healthy food cues. Indeed, we found a main effect of food type on children's dwell time, $F(1, 53) = 8.62$, $p = .005$, $\eta_p^2 = .140$, indicating that children paid significantly more attention to unhealthy food stimuli ($M = 1753.45$, $SD = 420.31$) compared to healthy food stimuli ($M = 1609.90$, $SD = 354.59$). Regarding first fixation duration, we however found no main effects of food type, $F(1, 53) = 0.73$, $p = .398$, $\eta_p^2 = .014$ (see Table 1). Thus, H1a but not H1b was supported.

Effect of the level of food integration. H2, H3, and H4 predicted increased visual attention—defined by a) dwell time and b) first fixation duration—with a stronger character interaction with the embedded food cues. The level of food integration significantly increased children's dwell time, $F(1, 53) = 154.43$, $p < .001$, $\eta_p^2 = .570$. In line with H2a, the sole handling of food increased children's attention for the product ($M = 1786.01$, $SD = 444.51$) compared to no interaction ($M = 1222.88$, $SD = 405.97$), $F(1, 53) = 70.09$, $p < .001$, $\eta_p^2 = .569$. Also, in line with H3a and H4a, children paid most attention to products that were consumed by a character ($M = 2036.15$, $SD = 482.43$) compared to food products that were only carried or handled, $F(1, 53) = 10.65$, $p = .002$, $\eta_p^2 = .167$, or placements with no interaction, $F(1, 53) = 154.43$, $p < .001$, $\eta_p^2 = .744$.

Similarly, level of food integration also showed a main effect for first fixation duration, $F(1.57, 53) = 19.62$, $p < .001$, $\eta_p^2 = .270$. Consumed products ($M = 350.69$, $SD = 137.82$) were initially more interesting to children compared to food cues that were solely handled ($M = 273.98$, $SD = 86.87$), $F(1, 53) = 11.51$, $p = .001$, $\eta_p^2 = .178$, and food cues that were not interacted with ($M = 227.32$, $SD = 74.50$), $F(1, 53) = 32.12$, $p < .001$, $\eta_p^2 = .377$. Also, products that were interacted with received significantly more immediate attention than products that were not interacted with, $F(1, 53) = 10.92$, $p = .002$, $\eta_p^2 = .171$. This result confirms H2b, H3b and H4b.

Interaction effect of food type and the level of food integration.

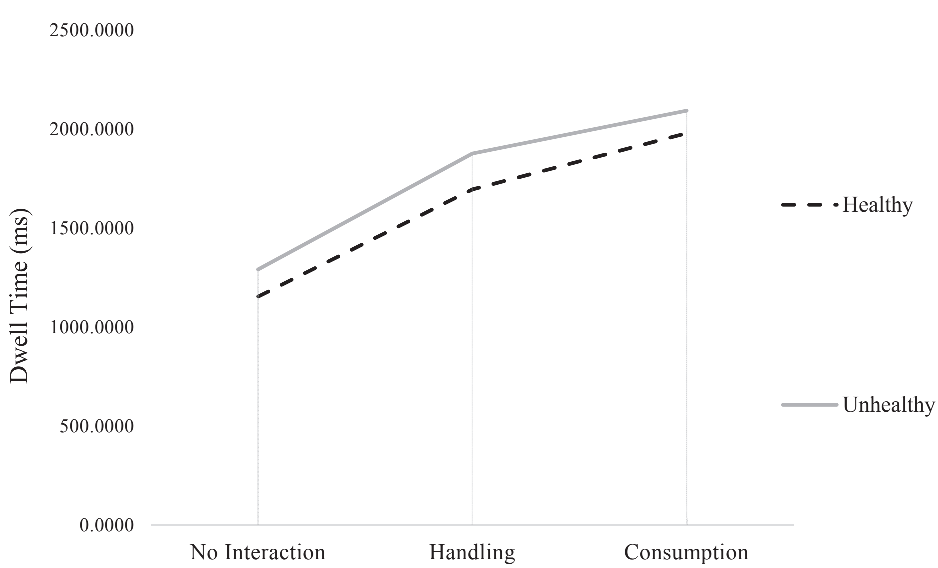

Fig. 2. Visualization of dwell time for food type*level of food integration.

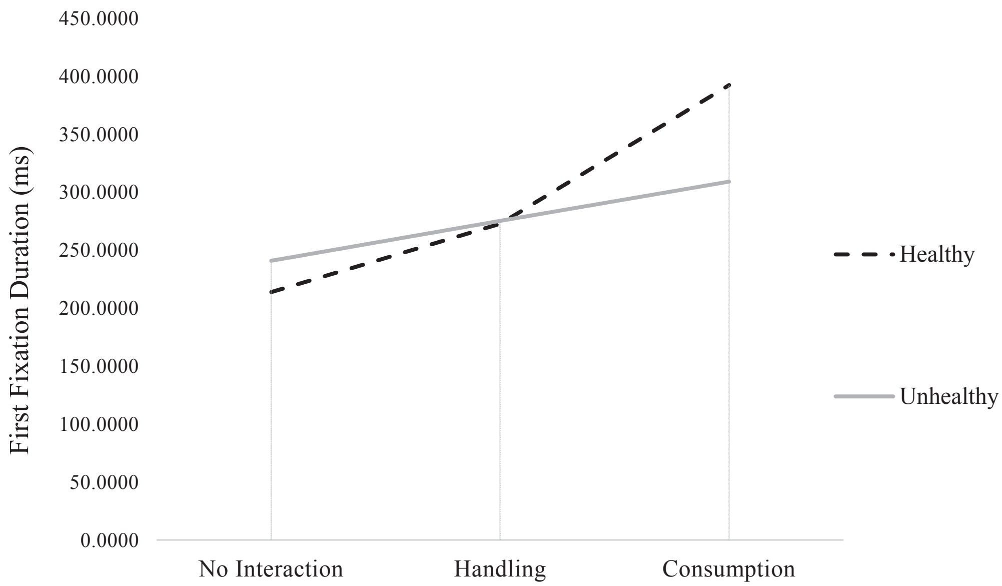

Fig. 3. Visualization of first fixation duration for food type*level of food integration.

RQ1 asked about the interaction effect of food type and level of food integration. We did not observe an interaction effect for dwell time, $F(1.77, 53) = 0.20$, $p = .790$, $\eta_p^2 = .004$ (for a visualization see Fig. 2). However, we found a significant interaction effect for first fixation duration, $F(1.74, 53) = 3.60$, $p = .037$, $\eta_p^2 = .064$ (for a visualization see Fig. 3). Children's initial fixation of unhealthy products that were consumed was significantly lower ($M = 309.95$, $SD = 125.25$) compared to healthy products that were consumed ($M = 381.63$, $SD = 229.16$). For the no interaction and for carried placements, this effect did not occur.

Moderating effect of hunger. Hunger (RQ2) did not have a main effect on children's dwell time for food cues, $F(1, 53) = 0.63$, $p = .431$, $\eta_p^2 = .012$, nor did it moderate the dwell time effects of food type, $F(1, 53) = 0.22$, $p = .639$, $\eta_p^2 = .004$, or level of food integration, $F(1, 53) = 0.04$, $p = .961$, $\eta_p^2 = .001$. Regarding first fixation duration, hunger did not directly impact $F(1, 53) = 0.30$, $p = .589$, $\eta_p^2 = .006$ nor moderate the observed effects for food type, $F(1, 53) = 0.08$, $p = .781$, $\eta_p^2 = .001$ nor for level of food integration, $F(1, 53) = 0.37$, $p = .641$, $\eta_p^2 = .007$. A three-way-interaction for food type, level of food integration, and hunger was not significant for dwell time, $F(1, 53) = 0.22$, $p = .775$, $\eta_p^2 = .004$, nor for first fixation duration, $F(1, 53) = 0.31$, $p = .703$, $\eta_p^2 = .006$.

4. Discussion

The results of our study indicate that unhealthy food cues receive overall more visual attention compared to healthy products. From an evolutionary point of view, tastiness and healthfulness are two attributes of foods that are needed for human survival (Breslin, 2013). Thus, both types of foods may capture individuals' automatic visual attention at first. However, research by Motoki, Saito, Nouchi, Kawashima, and Sugiura (2018) indicates that, compared to food stimuli high on the cognitive dimension (healthfulness; e.g., salad), foods with more hedonic components (tastiness; e.g., chocolate) especially capture individuals' long-term visual attention. These findings are in line with literature on taste development, which suggests a higher preference for unhealthy edible products (e.g., Desor et al., 1973). With respect to derivable food advertising effects, findings of the present study indicate that embedded unhealthy food cues promoted in media content appropriate for children capture visual attention of young viewers to a higher extent as opposed to healthier edible products. In other words, especially unhealthy food cues trigger cue reactivity in children (Folkvord et al., 2016), even though healthy food cues are integrated the same way.

This study additionally provides insights into how different integration levels of food cues with characters affect children's visual attention. In line with our expectations, we found that the level of food integration did significantly influence both attentional measurements, as the highest level of interaction with a media character (i.e., consumption) received the highest degree of visual attention compared to sole handling of food or no interaction at all. This result is of course also connected to the increasing closeness of the food to the depicted character. Yet, as the attention-increase between character handling and consumption is also significant, how the food is handled seems to be important. According to theoretical foundations of observational learning (Bandura & Jeffrey, 1973), increased attention represents one important predictor for an observed behavior being imitated. Moreover, children's liking of the main character Peppino was indeed very high (measured on a four-point scale; $M = 3.52$, $SD = 0.81$), which contributes to a higher likelihood of modeling behavior (Bandura, 1977).

We also observed the importance of level of interaction with a character in the interaction effect regarding children's duration of initial attention of food type and level of food integration. Children initially spent a longer time observing healthy food that is consumed, compared to unhealthy products that are consumed. This effect did not occur for other level of food integration. We can explain this interaction effect by the novelty of the food depiction. Children are evidently very used to seeing unhealthy food being consumed in their media environment (Radnitz et al., 2009). Yet, seeing healthy products like fruits or vegetables being consumed seems to be somewhat surprising to them, thus sparking their initial visual interest. Yet, this interest fades over the course of the observation as overall unhealthy food cues receive more visual attention. Children may therefore allocate their cognitive resources to attention-grabbing stimuli such as food cues in higher degrees of interaction with characters, but not process them further because their visual attention in particular to unhealthy food cues was maintained (Buijzen et al., 2010; Papies et al., 2008). This effect might be especially true for children due to the immaturity in their attentional flexibility (see e.g., Kerr & Zelazo, 2004). Findings of the present study thus underline children's susceptibility to affect-based persuasive messages (Rozendaal et al., 2011).

Interestingly, we did not find any effects of children's hunger on children's initial visual interest nor the duration children spend observing edible products. Independent of their own individual situation, food cues in media content can spark children's interest and attention. Considering this circumstance, it can be argued that children's feelings of hunger may not enhance persuasion effects of food cues in media content.

4.1. Limitations and future research

The presented results are limited in generalizability. First and foremost, the used stimulus material was self-created. Therefore, external validity could be enhanced in future research. We tried to adapt to the current media environment of children as closely as possible. However, there was a difference with the actual media integration of healthy food cues. Healthy food cues were also shown more interactively which does not, however, occur often in existing media content targeted at children (e.g., Olafsdottir & Berg, 2016).

Second, we did not control for children's individual food preferences (i.e., liking of sweets and snacks) and their prior experiences with foods (i.e., food neophobia). We were only able to concentrate on one of the most important individual predictors, children's hunger. Yet, as they may be important indicators (i.e., children's BMI, Folkvord et al., 2015), they should be accounted for in future studies. It must be moreover considered that not every level of food integration included food products from every used food category. However, we make no theoretical assumptions about the differences between several fast foods or several types of sweets. Yet we employed a rather complex design that allowed a simultaneous test about the roles of food integration and food types as randomized and internally valid as possible.

Third, eye-tracking data faces limitations regarding the interpretation of the results. For instance, higher degrees of visual attention might either indicate attentiveness to the investigated area of interest, or may signal a higher complexity of the stimulus (Henderson et al., 1999). Given the fact that it was the first study investigating children's cue reactivity regarding different food types and levels of food integration, replications and other methodological approaches are highly encouraged.

Lastly, this study solely tested children's reactivity to food cues promoted in media content. Thus, based on theoretical conceptions of REFCAM (Folkvord et al., 2016), further research should conduct a combined measurement of cue reactivity and the subsequent food activation in children (Folkvord et al., 2015).

5. Conclusion

As far as we know, this is the first study demonstrating that unhealthy food cues in media content impact children's visual attention to a higher extent than healthy cues. It is important to stress that healthy and unhealthy food cues were integrated the same way and participants' duration of initial attention between unhealthy and healthy food stimuli did not differ. Considering the potential influence on children's diet, the cue reactivity theory (Jansen, 1998) predicts that embedded food cues which signal food intake may act as conditioned stimulus that leads to cue reactivity or even conditioned responses such as actual eating behavior. In line with these theoretical considerations, an influence on subsequent palatable food intake in children participating in the present study can be assumed (Folkvord et al., 2016).

With regard to the findings of the level of food integration, a practical reference can be made. For a producer of children's movies, it would be necessary to show healthier edible products being handled or consumed by a character, because children pay more visual attention to food stimuli when they are integrated in a more active way. Therefore, if healthy foods would be shown in more interactive ways in media content and unhealthy food cues, in contrast, in more subtle ways, it might have a positive impact on children's health.

We hope that our present study paves the way for future research. Similar to other authors (Radnitz et al., 2009), we also voice concern about how food cues are presented in young viewer's media environments. We thus appeal for a reduction of unhealthy food cues in children's media content, or at least for placing healthy food products more prominently and showing them in more active patterns than has been the case in the past.

Declarations of interest

None.

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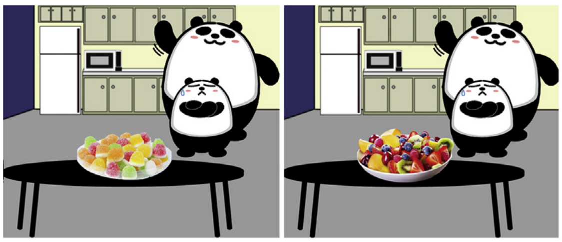
Appendix A

Embedded food pairs

Appendix B

Unhealthy vs. healthy food cues of one food pair displayed as no character-product-interaction



Unhealthy vs. healthy food cues of one food pair displayed as handled

Unhealthy vs. healthy food cues of one food pair displayed as consumed

Appendix C

Hunger Measurement: How hungry are you right now?

Really hungry Quite hungry A bit hungry Not hungry at all

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