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Research report

Enhancing children's vegetable consumption using vegetable-promoting picture books. The impact of interactive shared reading and character–product congruence ☆

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ABSTRACT

The present study investigated whether and how a picture book promoting carrots can increase young children's carrot consumption. One hundred and four children (aged 4–6 years) participated in shared reading sessions using the book on five consecutive days in school. These children were assigned randomly to one of four experimental conditions. In a 2 × 2 between-subjects design, the reading style and character in the book were manipulated. The reading style was either passive (listening to the story) or interactive (also answering questions about the story). The character in the book fitted either conceptually well with carrots (a rabbit) or not (a turtle). Compared to a baseline group of 56 children who were not exposed to the book, the children in the experimental groups consumed almost twice as much carrots (in proportion to other foods consumed), $F(1, 159) = 7.08$, $p < .01$. Results suggest that picture books are particularly effective when children are actively involved, answering questions about the story. Young children seem to enjoy this interactive shared reading style, triggering positive feelings that increase children's liking and consumption of the healthy food promoted in the book.

Introduction

Many children do not eat enough fruit and vegetables (e.g., Geller & Dzewaltowski, 2009; Ocké et al., 2008). For two reasons, fruit and vegetable consumption is particularly important at a young age. First, it has been linked to a healthier weight in childhood (Lin & Morrison, 2002; Tohill, 2005) and adulthood (De Kroon, Renders, Van Wouwe, Van Buuren, & Hirasing, 2010). Second, food attitudes developed during the preschool years tend to persist into adulthood (Rasmussen et al., 2006; Zeinstra, Koelen, Kok, & De Graaf, 2007). An engaging way to stimulate children's fruit and vegetable consumption is via shared reading. Child nutrition programs, such as the American Alliance for a Healthier Generation (2011), are using picture books with characters modeling healthy food behaviors. However, whether and how such books stimulate children's healthy food consumption is currently unknown.

Therefore, the present study investigates whether picture books can stimulate young children's vegetable consumption. The first aim is to investigate whether exposure to a picture book promoting carrots can influence children's consumption of carrots and other (non-promoted) healthy and unhealthy foods. In an experimental study, we compare the consumption results of children exposed to the book with those of children not exposed. The second aim is to investigate how the impact of the picture book can be enhanced by asking children questions about the story during the reading session (i.e., *interactive shared reading*) or by using a book character that fits conceptually well with the vegetable promoted in the book (e.g., using a rabbit to promote carrots) (i.e., *character–product congruence*).

The impact of picture books on children's food consumption

Influencing children's healthy food consumption via picture books is generally referred to in the literature as Entertainment Education (EE). EE has two defining characteristics (Moyer-Gusé, 2008). First, EE-productions contain an *educational* message, for example that eating carrots makes you feel fit and strong. Second, the educational message is incorporated into an *entertaining* narrative, such as a story about the adventures of a rabbit. A growing body of research indicates that EE-productions can successfully influence the attitudes and behaviors of a number of different

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target groups (e.g., Moyer-Gusé & Nabi, 2010; Singhal, Cody, Rogers, & Sabido, 2004).

From an information-processing perspective, combining educational and entertaining content may be particularly effective among children aged 6 and under. Their limited information-processing abilities usually inhibit processing of purely educational messages (Buijzen, Van Reijmersdal, & Owen, 2010; Siegler, 1998). However, as we will explain in detail in the following sections, incorporating an educational message into an entertainment framework renders message processing less demanding for young children, consequently increasing their comprehension of and positive attitude toward the message (Buijzen et al., 2010; Fisch, 2000).

While the positive impact of EE-productions on children's academic and social skills has been well established (for overviews see: Fisch, 2000; Wilson, 2008), the impact on children's health behaviors has received little scientific attention. Preliminary research regarding healthy food messages used in various *Sesame Street* media outlets suggests that EE-productions may successfully enhance children's healthy food consumption (Ritchie, Whaley, Spector, Gomez, & Crawford, 2010). In addition, research regarding fruit and vegetable pictures in books suggests that repeated exposure to these books may enhance children's visual preference for and willingness to taste the exposed foods (Heath, Houston-Price, & Kennedy, 2010, 2011; Houston-Price, Butler, & Shiba, 2009). Based on these studies, we anticipate that exposure to the carrot-promoting picture book will increase children's consumption of carrots (H1a).

The picture book may also influence the consumption of non-promoted foods. First, we may expect a spill-over effect for other healthy foods. Research suggests that advertising a specific food may also stimulate the consumption of unadvertised foods from the same category (Buijzen, Schuurman, & Bomhof, 2008). In other words, promoting a specific vegetable may encourage the consumption of other vegetables. Second, we may expect a displacement-effect for unhealthy foods. Research suggests that the high fiber content of vegetables reduces the craving for high-calorie snacks (Lin & Morrison, 2002; Tohill, 2005). We thus anticipate that exposure to the carrot-promoting picture book will increase children's consumption of other (non-promoted) healthy foods (H1b), and decrease their consumption of unhealthy foods (H1c).

Enhancing the impact of picture books via cognitive and affective processing

To enhance the impact of picture books on children's healthy food consumption, we also need to understand how they work. Based on literature regarding young children's information processing, we put forward two perspectives: one proposing a *cognitive* route to processing picture book content, the other an *affective* route.

The cognitive route to processing picture book content

The cognitive perspective on the effectiveness of picture books explains how children process the educational content in EE-productions. EE-productions are generally easier processed by young children than purely educational messages, because new information can be linked to existing story and character schemas. Fisch's (2000) capacity model predicts that easier processing of the EE-production means that greater cognitive resources are available to deeply process the embedded educational message, resulting in increased message comprehension. The advantage of a more deeply processed and comprehended message is that children may develop strong beliefs, for example that eating carrots makes them strong (Zeinstra et al., 2007), which we refer to as a child's cognitive response. In turn, a strong belief about a food's benefits (e.g., providing strength), has shown to predict consumption of that food (Oram, 1994).

Cognitive processing of picture book content may be enhanced through interactive shared reading (Barrentine, 1996; Dickinson, 2001; Whitehurst et al., 1988). This reading style demands active participation of the child and is designed to assist children's processing and comprehension of picture book content. For example, during the reading session, children are asked questions about the characters, to make storyline predictions, and to make connections between story and real life events (McGee & Schickedanz, 2007; Whitehurst, 1992). Compared to passive reading (whereby children merely listen to the story), interactive reading has shown to be more effective, resulting in enhanced comprehension of the content and ultimately to the desired (behavioral) change (Barrentine, 1996; Dickinson, 2001; Whitehurst et al., 1988).

We thus anticipate that interactive shared reading of the carrot-promoting picture book will increase children's carrot consumption (H2a). Specifically, we initially expect interactive shared reading to enhance children's processing and comprehension of the picture book content, as measured in a stronger cognitive response toward carrots (H2b). In turn, this strong cognitive response will enhance children's carrot consumption (H2c). This hypothesized mediated path is presented in Fig. 1.

The affective route to processing picture book content

The affective perspective on the effectiveness of picture books explains how children process the entertaining content in EE-productions. According to persuasion models (e.g., Buijzen et al., 2010), the positive feelings evoked when processing entertaining content are easily transferred to the food promoted in the EE-production, resulting in a more positive response toward that food. In turn, positive responses toward foods have shown to predict consumption (Institute of Medicine, 2006).

Affective processing of picture book content may be enhanced using characters. In books the embedded message is often communicated via a character's behavior. For example, the character is able to rescue his friend after eating carrots to make him fit. Characters evoke strong positive emotions that children typically transfer to everything associated with that character, including the food it promotes (Acuff & Reiher, 1997; De Droog, Valkenburg, & Buijzen, 2011b; Roberto, Baik, Harris, & Brownell, 2010). Recent studies suggest that characters conceptually congruent with the food they promote (i.e., a rabbit and a carrot), automatically evoke a pleasant feeling due to ease of processing the familiar character–product concept. This automatic feeling feeds into children's conscious evaluations, resulting in a more elaborate positive response toward the food, and increased consumption (De Droog, Buijzen, Opree, & Valkenburg, 2011a; De Droog, Buijzen, & Valkenburg, 2012; Hoffmann, 1986).

We anticipate that this effect of character–product congruence also applies to book characters and, thus, that easier processing of

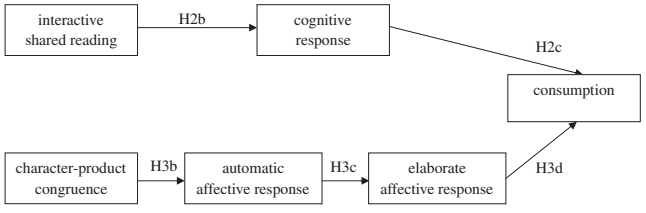

Fig. 1. Conceptual processing model of the impact of the carrot-promoting picture book on young children's carrot consumption.

the character–product combination in the book will increase children's carrot consumption (H3a). Specifically, we initially expect character–product congruence to induce an automatic positive response toward carrots (H3b) that will feed into a more elaborate affective response (H3c). In turn, this elaborate positive response toward carrots will enhance children's carrot consumption (H3d). This hypothesized mediated path is also presented in Fig. 1.

Method

Sample

Between October and December of 2011, 160 four- to six-year-old children (51% boys and 49% girls) were recruited from six primary schools situated in both urban and suburban districts of The Netherlands. Only schools without formal fruit and vegetable programs were selected. The sample consisted of various socioeconomic and cultural backgrounds. The majority of children were classified as of 'normal' weight (81%), with 12% classified as 'underweight', 5% as 'overweight' and 3% as 'obese' (see BMI classifications in the measures section). IRB approval for data collection and parental informed consent were obtained.

Design and procedure

The study had a 2 (type of shared reading: passive vs. interactive) × 2 (type of character: congruent vs. incongruent) between-subjects design, plus a baseline group. We were able to recruit 56 children for the baseline group, and another 104 children for the experimental groups. Children in the experimental groups were randomly assigned to the four experimental conditions (n = 26 per cell). Only the children in the experimental groups participated in the shared reading sessions of the picture book.

Children were read the picture book in a quiet room near their class on five consecutive days, because studies indicated that around five exposures are needed for an EE-production to be effective (e.g., Anderson et al., 2000; Crawley, Anderson, Wilder, Williams, & Santomero, 1999). Passive and interactive shared reading took place in groups of approximately four children. The composition of each group remained identical for all five days. A female daycare worker was trained for the shared reading task (storyteller) to ensure that, other than the experimental manipulations, the reading sessions were similar for all children. Children were provided with name badges to enable the storyteller to call them by their names. In the interactive sessions, the storyteller used a reading manual to ask children questions about the story and its characters before, during, and after the session. In the passive sessions, children were not asked any questions, but encouraged to sit quietly and listen.

Observations by the storyteller revealed that children in the interactive sessions were more involved and progressively active during the reading sessions than the children in the passive sessions. For example, these children listened attentively to the storyteller, raised their hands when a question was asked, loudly verbalized the correct answers, sang along enthusiastically with the song incorporated into the story and demonstrated modeling behavior (e.g., the character's 'fit and strong' pose). Two photographs of the interactive sessions are presented in Fig. 2. The storyteller was not involved in the measurements of the study.

Following the final reading session, the variables were measured. All children, including the baseline group, participated in this part of the study. Children were interviewed individually by a female experimenter who was unaware of each child's experimental condition. Initially, children completed a questionnaire on a 12-in. touchscreen notebook suitable for structured questionnaire research with young children (*HP Pavilion tx2-1150*) (cf. De Droog, Buijzen, Opree, Valkenburg, 2011a; De Droog, Buijzen, Valkenburg, 2012). Children were then invited to eat snacks in a more comfortable seating area. For a maximum of five minutes, children were permitted to eat from four bowls, each containing a different snack. At the outset, each bowl contained four equal-sized pieces. Size of pieces was also consistent across the different snacks, with the exception of the salty sticks (of which the size cannot easily be adjusted). After five minutes had elapsed, the experimenter counted the number of pieces of each snack eaten. Finally, children were weighed and measured to compute their body mass index (BMI).

Stimulus materials

The experimental stimulus was a picture book, created specifically for this study. The healthy food promoted in the picture book was carrots, because raw carrots are a common snack in the Netherlands that can easily be included into children's lunch boxes. The embedded health message in the picture book was that "eating carrots makes you fit and strong". A professional children's illustrator developed two identical picture books differing only in type of character (see Fig. 3): one book featured a product–congruent character (a rabbit), and the other featured a product–incongruent character (a turtle). We selected these characters based on a pretest among 40 children in which we tested six different animals drawn by the same illustrator (rabbit, mouse, caterpillar, turtle, rhino, and monkey) for both likability and congruence with carrots. The rabbit and turtle were selected because these characters were liked equally (measured on a 4-point scale: rabbit M = 3.43; turtle M = 3.31; $t(39)$ = .81, p = .43, d = .13), yet differed significantly in perceived character–product congruence (measured on a dichotomous scale: rabbit M = 0.85; turtle M = 0.41; $t(39)$ = 9.11, p < .001, d = 1.44).

The picture book story was written by a professional children's writer and described a main character rescuing his friend. A key premise of EE-productions aimed at young children is that the educational content (health message) and the entertaining content (story and characters) are intertwined (Fisch, 2000). Therefore, the main character in this story is able to rescue his friend only after eating carrots to make him fit and strong. The books were printed in A4-size, which is typical for classroom reading in small groups. For the interactive reading conditions, transparent sleeves containing a reading manual were placed on the book's back cover. This manual was based on Whitehurst's dialogic reading method (1992; Whitehurst et al., 1994). On each consecutive day of reading, a new manual of increasing difficulty was used. At the beginning of the week, children were asked completion-questions (e.g., to finish the song in the book) and wh-questions (what/where/why; e.g., "What does Rabbit give to his friend?"). As the week progressed, the children were also asked recall-questions (e.g., "Can you remember why Rabbit has to eat carrots?") and open-ended questions ("Now it's your turn to tell me about this page"). Children's responses were repeated by the storyteller and evaluated (praised or corrected).

Measures

Cognitive response carrots

To measure the cognitive response toward carrots, the following two items were used: "How strong do you get from eating carrots?" and "How fit do you get from eating carrots?". Children responded on a visual 4-point-scale containing squares of various sizes ranging from very small (1 = *not at all strong / fit*) to very big (4 = *very strong / fit*). These two scale items were averaged to

Fig. 2. Photos of the interactive shared reading sessions, in which children raised their hands to answer questions (left) and modeled the 'fit and strong' pose of the main character (right).

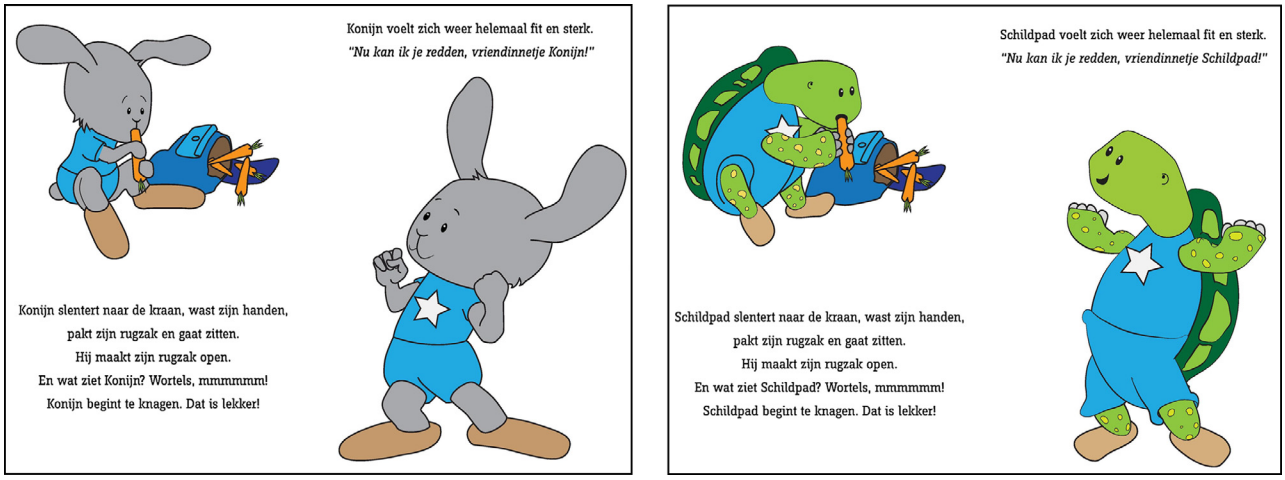

Fig. 3. Excerpts from the picture book containing the congruent character (left) and the incongruent character (right).

create a single measure of cognitive response (r = .49, M = 3.34, SD = .86).

Automatic affective response carrots

To measure the automatic affective response toward carrots, children indicated whether they liked carrots on a dichotomous smiley scale (unhappy face, happy face): 0 = *dislike*, 1 = *like* (M = 0.57, SD = .50). To evoke an automatic response, children were asked to tap on the smiley that best showed their liking of carrots as fast as they could (cf. De Droog et al., 2011a, 2012). The average reaction time was 1998 ms.

Elaborate affective response carrots

To measure the elaborate affective response toward carrots, we supplemented the De Droog et al.'s (2011a, 2012) original measure "How much do you like carrots?" with the more consumption-related item "How tasty do you find carrots?". To evoke an elaborate response on both items, children were given sufficient time to think before answering on a 4-point smiley scale (ranging from an unhappy to a happy face): 1 = *don't like at all*, 2 = *like a little bit*, 3 = *like quite a bit*, 4 = *like very much* (cf. De Droog et al., 2011a, 2012). The two scale items were averaged to create a single measure of elaborate affective response (r = .61; M = 2.61, SD = 1.17). The average reaction time was 4776 ms, which was significantly slower than their automatic response time: $t(159) = -11.41$, $p < .001$, d = .90.

Product consumption

To measure product consumption, four foods were selected for the eating task: the promoted vegetable (carrots), a non-promoted vegetable (cucumber), and two non-promoted unhealthy foods (cheese and salty sticks, high in saturated fats/salt; WHO, 1998). Like carrots, all selected non-promoted foods were common snacks in Dutch households. Because children tend to prefer sweet tastes (Desor, Maller, & Turner, 1977), we selected savory snacks in order to create more equal competition with carrots. Children's proportional product consumption was measured by dividing the number of pieces of each food eaten by the total number of pieces of foods eaten, for example: # carrots eaten / total # foods eaten (means and standard deviations are presented in Table 1). Proportional (and not absolute) scores were used, because these take into account that the impact of the picture book is greater when, for example, a child eats 3 carrots out of 4 foods than 3 carrots out of 11 foods.

Control variables

Children's BMI, hunger level, and time of snacking were measured because these variables may significantly influence

Table 1
Mean scores on children's proportional product consumption by study condition.

	Carrot consumption		Cucumber consumption		Cheese consumption		Salty stick consumption	
	M	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Experimental groups								
Interactive + congruent	0.18	(.17)	0.19	(.03)	0.17	(.04)	0.40	(.19)
Interactive + incongruent	0.15	(.15)	0.16	(.03)	0.26	(.04)	0.40	(.13)
Passive + congruent	0.11	(.11)	0.21	(.03)	0.26	(.04)	0.39	(.22)
Passive + incongruent	0.12	(.12)	0.19	(.03)	0.28	(.04)	0.35	(.19)
Baseline group	0.08	(.17)	0.24	(.02)	0.32	(.03)	0.38	(.18)

Note: Reported means and standard deviations for cucumber and cheese consumption are corrected for the covariates hunger level and time of snacking.

children's product consumption (e.g., Anschutz, Engels, & Van Strien, 2010). A BMI score was calculated for each child (weight/height^2) based on their weight measured without shoes using an electronic scale to the nearest 0.1 kg, and their height measured using a wall mounted stadiometer to the nearest 0.1 cm. Since BMI standards are highly sex and age dependent in young children, international standards were used to categorize children into the four BMI groups described above (Cole, Bellizzi, Flegal, & Dietz, 2000). BMI *z*-scores were used as covariate. Because these scores did not correlate with product consumption, BMI was not controlled for in our analyses.

Children's level of hunger was established prior to the eating task by asking them to point to how hungry they were on a 4-point smiley scale (ranging from an unhappy to a happy face): 1 = *not hungry*, 2 = *a little bit hungry*, 3 = *quite a bit hungry*, 4 = *very hungry*. Hunger level significantly correlated with cucumber and cheese consumption (cucumber $r = .16$; cheese $r = .16$; both $p < .05$), but not with carrot and salty stick consumption (carrots $r = .10$; salty sticks $r = -.10$; both $p > .21$). Time of snacking indicated when the child was offered the snacks. Because children were interviewed individually during the entire school day, the eating tasks were conducted between 09.00 AM and 03.00 PM. Time of snacking significantly correlated with cucumber and cheese consumption (cucumber $r = -.21$; cheese $r = .23$; both $p < .01$), but not with carrot and salty stick consumption (carrots $r = .06$; salty sticks $r = -.04$; both $p > .45$). Thus, hunger level and time of snacking were included as covariates in the analyses regarding cucumber and cheese consumption only. SPSS diagnostics indicated that collinearity was not an issue here (correlation between covariates: $r = .07$, $p = .39$; collinearity check: all VIF's < 10, all tolerance values > .2) (Field, 2005).

Results

Impact of picture book on children's food consumption

To investigate whether exposure to the carrot-promoting picture book influenced children's consumption of carrots (H1a) and other non-promoted healthy (H1b) and unhealthy (H1c) foods, we compared the consumption results of children exposed to the book with those of children not exposed. For each snack, we performed a separate analysis of (co-)variance with study condition (experimental groups vs. baseline group) as the between-subjects factor and product consumption as the dependent variable. Hunger level and time of snacking were included as covariates in the analyses for cucumber and cheese. Levene's test for each analysis indicated that the group variances were equal (carrots $F(1,158) = 2.66$; cucumber $F(1,158) = 3.33$; cheese $F(1,158) = 0.06$; salty sticks $F(1,158) = 0.30$; all $p > .05$), hence the assumption of homogeneity of variance was not violated due to unequal sample sizes (Field, 2005).

Because of the expected direction of the relations, all the reported significance levels in the results section are based on one-tailed tests. The analyses of (co-)variance yielded main effects for carrots, $F(1,159) = 7.08$, $p < .01$, $\eta^2 = .04$, cucumber, $F(1,159) = 3.29$, $p < .05$, $\eta^2 = .02$, and cheese, $F(1,159) = 4.97$, $p < .05$, $\eta^2 = .03$, with children exposed to the book consuming a higher proportion of carrots (experimental groups $M = 0.14$, $SD = .14$; baseline group $M = 0.08$, $SD = .17$), and a lower proportion of cucumber (experimental groups $M = 0.19$, $SD = .02$; baseline group $M = 0.24$, $SD = .02$) and cheese (experimental groups $M = 0.24$, $SD = .02$; baseline group $M = 0.32$, $SD = .03$). The analysis with salty sticks yielded no effect, because children in both conditions consumed a similar proportion of salty sticks (experimental groups $M = 0.39$, $SD = .19$; baseline group $M = 0.38$, $SD = .18$).

The impact of interactive shared reading and character–product congruence on carrot consumption

To explore how exposure to the carrot-promoting picture book increased children's carrot consumption (in proportion to other foods consumed), we first investigated whether interactive shared reading (H2a) and character–product congruence (H3a) enhanced the impact of the book by performing an analysis of variance with the two manipulations (type of shared reading, type of character) as the between-subjects factors and carrot consumption as the dependent variable. The analysis yielded only a main effect for type of shared reading, $F(1,103) = 3.49$, $p < .05$, $\eta^2 = .03$, with children in the interactive shared reading condition consuming a higher proportion of carrots ($M = 0.17$, $SD = .16$) than children in the passive shared reading condition ($M = 0.12$, $SD = .11$). Thus, only interactive shared reading (and not character–product congruence) was able to enhance the impact of the picture book on children's carrot consumption.

Second, to explore whether interactive shared reading increased children's carrot consumption by inducing a cognitive route of processing, we tested the hypothesized model presented in Fig. 1. The zero-order correlations presented in Table 2 indicate that character–product congruence was not related to any other variable. In addition, interactive shared reading was related positively to cognitive response, automatic affective response, and consumption, but not to elaborate affective response. Further, cognitive response was related positively to elaborate affective response, but not to automatic affective response or consumption. Finally, the two affective responses were related positively to each other and to consumption.

The paths in Fig. 1 were investigated using the structural equation modeling program AMOS 17.0. The analysis was based on two independent variables (interactive shared reading and character–product congruence), three mediating variables (cognitive response, automatic affective response and elaborate affective response), and one dependent variable (carrot consumption). To indicate the fit of the model, three model fit indices were used: the χ^2-test, the comparative fit index (CFI), and the root mean

Table 2
Zero-order correlations among main variables.

	1	2	3	4	5	6
1. Character–product congruence	–					
2. Interactive shared reading	.00	–				
3. Cognitive response carrots	.03	.18*	–			
4. Automatic affective response carrots	.04	.20*	.08			
5. Elaborate affective response carrots	.15	.13	.19*	.79**	–	
6. Carrot consumption	.03	.18*	−.03	.47**	.54**	–

* $p < .05$.
** $p < .01$.

square error of approximation index (RMSEA). The model would be supported with a nonsignificant χ^2, a CFI value of .95 or more, and a RMSEA value of .05 or less, with p-close > .05 (Browne & Cudeck, 1992).

The conceptual model in Fig. 1 yielded a reasonable fit to the data, $\chi^2(9, N = 104) = 16.40$, $p = .06$, CFI = .95, RMSEA = .09, with p-close = .16. Modification indices indicated that the fit could be improved by including two paths: one leading from cognitive response to elaborate affective response, and one leading from interactive shared reading to automatic affective response. Because these two relations are theoretically plausible (see Discussion), these paths were added to the model.

The adjusted model, presented in Fig. 4, fitted the data very well, $\chi^2(7, N = 104) = 7.88$, $p = .34$, CFI = .99, RMSEA = .04, with p-close = .51. No further meaningful modifications were viable. We thus accepted this model as our final model. Of the seven paths specified in the model, five were statistically significant. These paths were all positive and represented the relations between: interactive shared reading and cognitive response ($\beta = .18$, $p < .05$), interactive shared reading and automatic affective response ($\beta = .20$, $p < .05$), automatic affective response and elaborate affective response ($\beta = .79$, $p < .001$), cognitive response and elaborate affective response ($\beta = .12$, $p < .05$), and elaborate affective response and consumption ($\beta = .56$, $p < .001$). The variables in the final model accounted for 31% of the variance in carrot consumption.

The final model indicated that interactive shared reading was able to induce both a cognitive and an automatic affective response toward carrots. Additional analyses support this finding, with children in the interactive reading condition demonstrating a stronger cognitive response ($M = 3.90$, $SD = .35$; $F(1, 103) = 4.03$, $p < .05$, $\eta^2 = .04$) and more positive automatic response ($M = 0.75$, $SD = .44$; $F(1, 103) = 4.34$, $p < .05$, $\eta^2 = .04$) than children in the passive reading condition ($M = 3.63$, $SD = .70$ and $M = 0.56$, $SD = .50$ respectively). The final model also indicated that the cognitive response influenced children's carrot consumption only via the elaborate affective response.

To formally test the significance of the new mediating paths, we performed the bootstrap procedure of Preacher and Hayes (2004) to generate (1000 samples, $N = 104$) a 95% bias-corrected and accelerated confidence interval (BCA CI) for the indirect effects described above. First, the strength of the direct effect of interactive shared reading on carrot consumption was determined, which was significant ($\beta = .18$, $p < .05$, $R^2 = .03$). The new combined cognitive-affective route was tested next. When the cognitive and elaborate affective responses were included, the direct effect of interactive shared reading on consumption disappeared ($\beta = .12$, $p = .10$), while the mediating path from interactive shared reading to consumption via cognitive and elaborate affective responses was significant ($\beta = .02$, $p < .05$, $R^2 = .30$, BCA CI = .008–.055). Thus, the impact of interactive shared reading on children's carrot consumption was fully mediated by their successive cognitive and elaborate affective responses toward carrots.

Finally, the new affective route was tested. Again, the direct effect of interactive shared reading on consumption disappeared ($\beta = .11$, $p = .10$), while the mediating path from interactive shared reading to consumption via automatic and elaborate affective responses was significant ($\beta = .08$, $p < .05$, $R^2 = .31$, BCA CI = .013–.159). Thus, the impact of interactive shared reading on children's carrot consumption was fully mediated by their successive automatic and elaborate affective responses toward carrots.

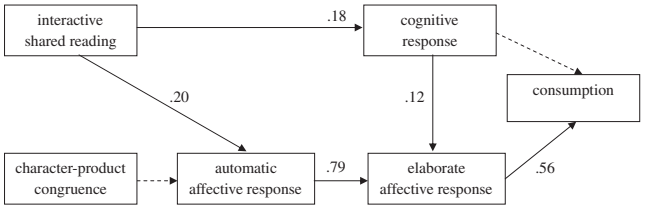

Fig. 4. Observed processing model of the impact of the carrot-promoting picture book on young children's carrot consumption. Solid arrows indicate significant relations, while broken arrows indicate nonsignificant relations. Coefficients represent standardized beta weights, all significant at least at $p < .05$.

Discussion

The present study investigated whether picture books can stimulate young children's vegetable consumption. The first aim was to investigate whether exposure to a carrot-promoting picture book can influence children's consumption of carrots and other (non-promoted) healthy and unhealthy foods. In line with hypothesis 1a, children exposed to the picture book consumed a higher proportion of carrots (relative to other foods consumed) than children not exposed to the book. Thus, in addition to improved academic and social skills (Fisch, 2000; Wilson, 2008), it appears that EE-productions are also capable of improving children's consumption of healthy foods, when these foods are specifically promoted in the production.

However, inconsistent with hypothesis 1b, the impact of carrot promotion on carrot consumption did not spill over to other vegetables. Perhaps the spill-over effects demonstrated in earlier research (e.g., Buijzen et al., 2008) are limited to similar products of different brands, and promotion of a certain carrot brand stimulates solely the consumption of other carrot brands. Nonetheless, consistent with hypothesis 1c, consuming more carrots appears to displace the consumption of certain unhealthy foods (i.e., the relative consumption of cheese). This is in line with nutrition studies suggesting that the high fiber content of vegetables decreases the appetite for unhealthy foods (Lin & Morrison, 2002; Tohill, 2005).

The second aim of our study was to investigate how the carrot-promoting picture book was able to increase children's carrot consumption. Consistent with hypothesis 2a, asking children questions about the story during the reading session (interactive shared reading) enhanced the impact of the book. This supports

adult-mediation and social susceptibility theories (Kirkorian, Wartella, & Anderson, 2008; Valkenburg & Peter, 2013), suggesting that the success of (health) communication interventions for young children – such as picture books – depends largely on how teachers, parents, and other important caregivers maximize the positive impacts of these interventions.

The impact of interactive shared reading on children's carrot consumption was anticipated to be the result of a cognitive route of information processing: interactive shared reading of the picture book would initially stimulate a stronger cognitive response toward carrots (i.e., being convinced that eating carrots makes you fit and strong) (H2b) which, in turn, would enhance children's carrot consumption (H2c). This hypothesized cognitive processing route was not fully supported. We did find that, in line with hypothesis 2b, interactive shared reading enabled children to fully process and comprehend the embedded health message "eating carrots makes you fit and strong", as measured in a strong cognitive response toward carrots.

However, inconsistent with hypothesis 2c, a stronger cognitive response toward carrots did not enhance children's carrot consumption directly. Only when children's cognitive response increased their liking of carrots (i.e., elaborate affective response), did they consume more carrots (in proportion to other foods consumed). This supports previous research with young children suggesting that affect is an important mediator of behavioral effects (Acuff & Reiher, 1997; Bahn, 1989; Contento, 1981; Zeinstra et al., 2007). Specifically, due to the limited reasoning capacities of children aged 6 and under, behavior change tends to be motivated by affective responses ("I like this") rather than cognitive responses ("eating this will make me strong"). While young children may learn that "eating carrots makes you fit and strong", it is not until age 7 that functional attributes are used as a direct motivation to behavior (Acuff & Reiher, 1997; Bahn, 1989).

Unexpectedly, interactive shared reading also induced an affective route of information processing, triggering an automatic positive response toward carrots initially, followed by an elaborate positive response that, in turn, enhanced children's carrot consumption. A reason for this finding could be that children generally enjoy interactive shared reading more than passive shared reading (Justice & Kaderavek, 2002). We also observed this in our study, with children in the interactive sessions showing increased enthusiasm as the week progressed. It is plausible that the enjoyment these children experienced was transferred automatically to the carrots promoted in the book, leading to an automatic positive response toward carrots.

Finally, we also looked at character–product congruence. Inconsistent with hypotheses 3a–b–c–d, using a book character that fitted conceptually well with carrots (a rabbit) did not enhance the impact of the carrot-promoting book on children's carrot consumption. Although more extensive analyses (as part of a larger research project; De Droog, 2013) indicated that character–product congruence was able to induce an automatic positive response toward carrots after a single book exposure, the present study demonstrated that this effect disappeared after five exposures. A rationale for this finding could be that children familiarized with the (initially incongruent) turtle–carrot combination as the week progressed, thereby inducing similar automatic positive responses as the rabbit–carrot combination. Thus, character–product congruence seems to be less important when children are exposed to the EE-production repeatedly.

Conclusions and implications

Research suggests that children should eat more vegetables (e.g., Lin & Morrison, 2002; Tohill, 2005), but many parents struggle with this task. Fortunately, this study presents an attractive and easy way for parents to enhance their children's vegetable consumption: by rendering shared book reading in the home environment more interactive, children may consume more of a vegetable after reading a book about that vegetable. Because 10–15 taste exposures may be required to elicit children's vegetable liking (Birch & Marlin, 1982), offering a taste of the vegetable after each reading session increases the chances of a long-term effect. In addition, we recommend the development of school programs in which vegetables are introduced via interactive reading sessions of vegetable-promoting picture books in class.

Finally, we provide three suggestions for future research. First, the long-term impact of picture books on children's healthy food consumption should be tested. Second, the impact of picture books should be measured in the home-environment to investigate whether children would also eat more carrots at home, whether they would ask for carrots when these are not available directly, and to investigate the impact of familiar storytellers (instead of an unfamiliar daycare worker). Finally, the study should be replicated with more bitter tasting vegetables (e.g., spinach and broccoli) to determine whether a picture book could also increase consumption of less popular vegetables.

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