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Changing children's eating behaviour - A review of experimental research

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ABSTRACT

The interest in children's eating behaviours and how to change them has been growing in recent years. This review examines the following questions: What strategies have been used to change children's eating behaviours? Have their effects been experimentally demonstrated? And, are the effects transient or enduring? Medline and Cab abstract (Ovid) and Web of Science (Thomson Reuters) were used to identify the experimental studies. A total of 120 experimental studies were identified and they are presented grouped within these 11 topics; parental control, reward, social facilitation, cooking programs, school gardens, sensory education, availability and accessibility, choice architecture and nudging, branding and food packaging, preparation and serving style, and offering a choice. In conclusion, controlling strategies for changing children's eating behaviour in a positive direction appear to be counterproductive. Hands-on approaches such as gardening and cooking programs may encourage greater vegetable consumption and may have a larger effect compared to nutrition education. Providing children with free, accessible fruits and vegetables have been experimentally shown to positively affect long-term eating behaviour. The authors recommend future research to examine how taste and palatability can positively affect children's attitudes and eating behaviour.

Contents

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1. Introduction

In this review, the term *eating behaviour* has been used to encompass a range of variables (i.e., food intake, choice, preference, hedonic response [liking], acceptance [intake], willingness to taste, and neophobia). Besides food intake, other measures provide insight into children's eating behaviour: *Preference* describes how a food is ranked in relation to other food items. Followingly, choice of certain foods over others indicates greater preference. *Liking* quantifies the attitude or degree of liking, or disliking, towards a food, and *neophobia* describes a reluctance to try novel foods.

Currently, great attention is paid to children's eating behaviour and how to change it in a desirable direction. From a political and a public health perspective, this is undoubtedly due to the rise in childhood obesity rates and the concerns of the long-term health consequences this may have (Must & Strauss, 1999). The rise in childhood obesity is worrying, not solely in connection with the increased risk of non-communicable diseases these children face but also due to the notion that children themselves cannot be held accountable for this unfortunate development. Although not all factors influencing eating behaviour are modifiable, many are: environment and food-related experiences have consistently been shown to be central to the development of children's eating behaviour (Birch, 1999). Furthermore, preferences formed early in life tend to continue into adult life (Nicklaus, Boggio, Chabanet, & Issanchou, 2004). As preferences are the main predictor of food intake in children (Gibson, Wardle, & Watts, 1998), understanding how these preferences are shaped through children's food experiences is central to understanding how parents, environment, and greater structural contexts might affect and shape children's current and long-term eating behaviour.

Public health interventions have predominately focused on nutrition education, guidelines, and legislation regarding food served at schools, nurseries etc. and often focused on increasing intake of fruit and vegetables and discouraging intake of energy-dense food that is high in sugar and fat (Jaime & Lock, 2009). At the same time, children's food intake remains a central parental concern: a large observational study examining the structure of 142 children's mealtime environment found that 85% of parents used varying strategies to encourage children to consume more food (Orrell-Valente et al., 2007). Common parental strategies used to influence or control children's food intake include prompting to eat, restriction/portion control, pressure to eat, reasoning, reward (praise and food), and punishments (withholding desired food or play privileges) (Orrell-Valente et al., 2007).

The strategies applied, knowingly or unknowingly, by governments, schools, parents, and other stakeholders concerned with childhood nutrition may affect children's dietary behaviour in a way that is judged to be positive (increased dietary variety and intake of fruit and vegetables, decreased pickiness and neophobia etc.) or negative (decreased intake of fruit and vegetables, increased levels of neophobia etc.) or simply have no effect on children's eating behaviour. Given the great public health focus, as well as parents' controlling approach to children's food intake, it is crucial to experimentally examine the outcome of these different approaches to changing children's eating behaviour. Accordingly, ***the objective*** of this review is to examine the following questions: What strategies are used to change children's eating behaviour? Have their effects been experimentally demonstrated (positive or negative)? And, if so, are the effects transient or enduring?

A range of variables has been *associated* with positive or negative effects on children's eating behaviour. However, in order to gain a better understanding on causality, the focus in this review is on experimental studies that include an intervention. All experimental studies that fitted the inclusion criteria were included in the review. This review does not consider the effect of socioeconomic status and wider political and structural influences on children's eating behaviour.

Evidence of the effects of non-associative (i.e. repeated exposure [RE]) and conditioned learning (i.e. flavour-flavour learning [FFL], and flavour nutrient learning [FNL]) have not been included in this review, as these approaches have recently been reviewed elsewhere (Appleton, Gentry, & Shepherd, 2006; Cooke, 2007; Keller, 2014). RE has been shown to positively change children's preferences for, and intake of, a new or initially disliked target food (Cooke, 2007). FFL learning, where a novel or disliked target food is combined with a food that is already liked, has also been demonstrated to positively affect children's accept of a novel food (Caton et al., 2013; Hausner, Olsen, & Møller, 2012; Remy, Issanchou, Chabanet, & Nicklaus, 2013). It should be noted that considerable individual differences in children's response to RE, FFL, and FNL have been demonstrated in a recent study (Caton et al., 2014). FNL pairs a novel or disliked flavour with a nutrient (e.g. fat), leading the flavour to be associated with the positive post-ingestive effects of the ingested nutrient. However, several studies have failed to show any great effect of FNL in human subjects (Yeomans, 2012). This review will examine *additional* strategies or behaviour that might facilitate a change in children's eating behaviour.

2. Method

The search was conducted using Medline (Ovid)/Cab abstract (Ovid) and Web of Science (Core Collection) in September to December 2015 and updated in January 2017. "Limit to English language" and "remove duplicates" was applied to all searches. An initial search in Web of Science, was done in order to identify key words/concepts within the topic of changing children's food preference, liking, intake, willingness to taste, and neophobia. Subsequently, an individual search was carried out for each identified approach. For all identified approaches, a general search word was applied, for instance (child* OR teenage* OR adolescen*) AND (food preference* OR taste preference* OR intake OR liking) combined with each specific approach, e.g. (social facilitation or peer influence* or friend* or peer model* social context*) etc. In addition to the studies identified during the search procedure, further studies were identified from the reference lists of the included studies. As this review encompassed an extensive search on 11 topics, the full search log cannot be included here, but can be obtained from the authors upon request.

Inclusion criteria: Studies included in the review were published in a peer-reviewed journal, primary research in English, and intervention/experimental studies measuring one or more of the

following outcomes: food choice, preference, liking, intake, willingness to taste, and neophobia. Age range included toddlers and children (i.e. 1–12 years of age). Studies that included teenagers (children aged 13+ years) were included in the review if the lower age rage of the sample was below 13 years of age, or if the study included both younger subjects (below 13 years) and older subjects (above 13 years).

Exclusion criteria: Studies on the effect of RE, FFL, FNL, and effects of non-modifiable variables such as genetics, age, and gender were excluded in the review. Studies that only included children aged 13 years and above were also excluded, as were intervention studies that failed to include a control group. Outcome measures such as weight status and BMI are not reported on. Studies testing multifaceted approaches were generally not included in the review, with the exception of school gardens and cooking classes, as these approaches have not been tested independently. Finally, we excluded research on effects of serving size and energy density, as these studies mainly aimed to decrease calorie intake, as well as studies on media use and advertisement.

3. Results

Eleven groups of studies were identified based on subjective expert assessment by the authors. These were: Parental control, reward, social facilitation, cooking programs, school gardens, sensory education, availability and accessibility, choice architecture and nudging, branding and food packaging, preparation and serving style, and offering a choice. A total of 120 experimental studies were included in this review.

A deeper understanding of the background and theoretical framework underpinning each specific approach is beyond the scope of this review and can be obtained elsewhere. This review will describe and summarise experimental research examining how children's food preferences, liking, and intake may be influenced by an array of different approaches. Results are presented by an outline and summary of each approach, followed by Tables 1–11, encompassing the relevant information on each included study. Only outcomes relevant to this review, as defined in the inclusion criteria, are reported in the tables.

3.1. Parental control

Parents play a central role in shaping children's eating patterns early in life. They control what food will be available in the household and act as role models, shaping attitudes and behaviour in the food domain. Furthermore, parents commonly use different strategies to influence or control children's food intake. In the food domain, *restriction* involves limiting access to particular foods, including favourite foods, as well as restricting the total amount of food. *Pressure* involves pressuring children to eat certain foods and pressure to eat more in general (Birch et al., 2001). Restriction and pressure are two primary aspects of control that have been linked to negative outcomes in terms of eating behaviour and weight status (Faith, Scanlon, Birch, Francis, & Sherry, 2004). However, the effect on weight status is not considered in this review.

Summary of experimental studies (Table 1): Pressure to eat a target food subsequently influences the preference for the food negatively, while restriction may increase preoccupation, preference, and subsequent intake of the restricted food item.

3.2. Reward/instrumental feeding

One common strategy used by parents in order to control children's eating behaviour and food intake is the use of rewards, which is also referred to as *instrumental feeding* (Orrell-Valente et al., 2007). Instrumental feeding includes food and non-food-based incentives to eating.

Summary of experimental studies (Table 2): The current evidence indicates that food-based rewards should not be used in order to make children eat every day, well-accepted foods. This may decrease the preference of the food in question and enhance the preference for any food, such as sweets or desserts, used as the reward. The use of small non-food-based rewards, such as stickers, may be useful in overcoming the initial neophobic response when introducing children to novel foods such as less palatable vegetables. As tasting is necessary for the effect of repeated exposure to take place (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987), a non-food price may therefore be an incentive for children with high levels of neophobia to actually put novel food to their mouths. However, since one study indicated that use of instrumental feeding may undermine the effect of simple exposure, this approach should be used with caution, and more research is needed to examine how instrumental feeding might affect children's intrinsic drive to explore novel food.

3.3. Social facilitation

Parents, childcare providers, teachers, and peers are central in children's social environment, and these are likely to exert an influence on their eating behaviour. This social facilitation of role models may positively or negatively influence children's food preferences, liking, intake, and degree of neophobia.

Summary of experimental studies (Table 3): The experimental studies carried out to date highlight the complexity of the influence that social facilitation exerts on children's eating behaviour. Research shows that peer modelling influences food preference, intake matching, and amount of foods consumed. This is evident to various degrees, depending on whether the peer is familiar, unfamiliar, a friend, an adult, or a parent. Younger children are more influenced by modelling than older children. Parents and adults may exert a stronger influence on young children, whereas older children might be more inclined to imitate the eating behaviour of their peers. Based on current experimental evidence, it is clear that the effect of peer models is complex and depends on contextual factors as well as variables in relation to the target child and the model. Peer and role modelling is likely to be effective in increasing the intake of food that is generally accepted and liked by the group, parent, or co-eater. However, children are also influenced by parents, friends, and peers expressing dislike of specific foods and high levels of neophobia and/or pickiness, as well as being influenced by social modelling of unhealthy foods. Whether social facilitation will positively affect children's eating behaviour, therefore, depends on whether the food being modelled is “healthy” or not, as well as on whether the modelling of the target food is negative or positive.

3.4. Cooking programmes

Cooking programmes are typically hands-on approaches where children engage in cooking and food preparation. However, few studies have thoroughly investigated how cooking programmes may influence outcomes such as food preferences, intake, or willingness to try new foods.

Summary of experimental studies (Table 4): Evidence suggests that cooking classes may positively change intake and preference for vegetables and that the effect might be mediated by tasting new fruit and vegetables. However, based on the little evidence currently available, no conclusions regarding best practise can be made. Additionally, long-term effects have not been investigated. Benefits of cooking classes are not merely increased preference or intake of vegetables but also life-skills such as food preparation skill

Table 1
Summary of experimental studies on the effect of parental control.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Fisher & Birch, 1999)	To test the hypothesis that restricting palatable food subsequently enhances children's behavioural responses to, selection of, and intake of that restricted food. → **Intake, choice, behavioural observations**	31 40	Exp. 1. Children ($n = 31$) aged 3–5 years in Pennsylvania, USA. Exp. 2. Children (n = 40) aged 3–6 years in Pennsylvania, USA.	Exp. 1. During five weeks, children were randomly assigned to receive one or another other type of restricted snack food. Children had access to a restricted target food and were also given free access to a control food. Exp. 2. Children participated in four unrestricted snack sessions in which the target food was freely available. This was followed by four restricted snack sessions in which access to the target food was limited. Behavioural observations were done during restriction. Choice and intake, by weighed food intake, was assessed before and after restriction.	Exp. 1. Restriction of a target food did not affect children's subsequent intake or selection of that food, although an increased behavioural response to that food relative to a similar control food was observed during restriction. The effect was greater in boys than girls. Exp. 2. Compared to periods where it was freely available, restriction of a palatable target food increased children's behavioural response to, selection, and intake of that food.
(Galloway et al., 2006)	To test the effect of pressure to eat on food intake in children. → **Intake, number of negative and positive food comments**	27	Preschool children aged 3–5 years in Pennsylvania, USA.	During a period of 11 weeks, children received either a corn or a squash soup. They were randomly assigned to eat one or the other soup under a pressure ("Finish your soup, please") or no-pressure condition. Outcomes were measured by weighed food intake and behavioural observations pre-, during, and post-intervention.	In both conditions intake increased over time. However, increase in intake was greater in the no-pressure condition. Comments made by children were overwhelmingly negative in the pressure condition compared to the no-pressure condition.
(Jansen, Mulkens, & Jansen, 2007)	To test whether a prohibition of a target food would subsequently lead to an increase in desire for the food and overeating. → **Intake, desire for target food, proportion of consumed target food**	74	Primary school children aged 5–6 years in The Netherlands, Germany, and Belgium.	Participants were randomly assigned to either a prohibition condition or a no-prohibition condition. During the first phase, children in the intervention group were prohibited from eating the red but not the yellow foods. This was followed by an all-you-can-eat phase. Desire for the prohibited food was assessed using a visual analogue scale (VAS) and intake assessed by weighed food intake.	Compared to the no-prohibition group, desire for the forbidden food increased in the prohibition group. No differences between groups were found in the absolute consumption of the food. However, children in the prohibition condition consumed a larger proportion of the prohibited snacks compared to the control condition. Children of parents reporting either low levels or high levels of restriction consumed more kcal during the whole experiment compared to children of parents reporting a moderate level of restriction at home.
(Jansen et al., 2008)	To test the effect of restricting sweets and relatively less attractive but healthy food, such as fruit, on children's intake and desire for the target food. → **Intake, desire for target food**	70	Primary school children aged 5–7 years in The Netherlands.	Participants were randomly assigned to one of three conditions: a no-prohibition condition, a fruit-prohibition condition, and a sweets-prohibition condition. Following one individual session where the respective foods were prohibited, all children were allowed to eat as much as they wanted to. Desire for the prohibited food was assessed on a 5-point Likert scale and intake assessed by weighed food intake.	Compared to the no-prohibition condition, children in both prohibition conditions consumed more of the formerly forbidden food when they were allowed non-restricted access to the foods. Desire for sweets remained high in the sweets-prohibition condition but decreased in the fruit-prohibition and no-prohibition conditions. Total food intake was greater in both prohibition conditions compared to the no-prohibition condition. Parental restriction did not predict intake.
(Tuorila & Mustonen, 2010)	To examine whether reluctance to try a new food would predict pleasantness ratings of a food. → **Expected liking, liking**	72	Children, either 8 years old ($n = 36$) or 11 years old (n = 36). Children were recruited as entire classes in Helsinki, Finland.	Children were presented with six unfamiliar foods and were asked questions as to whether they were willing to try to taste them. Pleasantness (or expected pleasantness if not tasted) of the foods was rated on a 7-point scale (words and smiley faces).	Children who wanted to try a new food, and tasted it, rated it pleasant. Children who were unwilling to try a new food, but tasted it regardless, rated the food negatively and similarly to the children who rated their expected pleasantness without tasting.
(Jansen, Mulkens, & Jansen, 2010)	To test the effects of restricting children's intake of fruit, presented in a regular or a visually appealing manner. → **Intake, desire for target food**	94	Primary school children aged 4–7 years in The Netherlands and Belgium.	Children were presented with two types of fruit (visually appealing and regular) and were randomly assigned to one of three conditions: no-prohibition group (allowed to taste both types of fruit) or prohibition of either type of	Intake of visually appealing fruit was greater compared to intake of regular fruit, but no effects of restriction were found.

				fruit. Desire for the target food was assessed on a 5-point Likert scale and intake assessed by weighed food intake while children could freely eat from both fruit types.	
(Ogden, Cordey, Cutler, & Thomas, 2013)	To test the impact of parental restriction on children's intake and preoccupation with foods in a naturalistic setting. → **Intake, preoccupation with target food and other sweet foods**	53 86	Study 1. Children aged 1–7 years and their parents in the UK. Study 2. Children aged 4–11 years and their parents in the UK.	Parents were randomly assigned to one of two conditions: restriction (only one chocolate at the time and no further in the next half an hour) vs non-restriction (children could freely eat the chocolate) of chocolate coins over a weekend (study 1) and Easter eggs over two weeks (study 2). Intake and preoccupation with foods was obtained via parental questionnaires.	Fewer chocolate coins and Easter eggs were consumed in the restriction condition. Preoccupation with chocolate coins or Easter eggs decreased over time. However, by the end, the restriction group was more preoccupied with the target food. Over time, there was an increased preoccupation with other sweet foods, and in the chocolate coins study this was greater in the non-restriction group.
(Rigal, Rubio, & Monnery-Patris, 2016)	To investigate the effect of harsh vs. gentle caregiving instructions on food acceptance in young children with low or high inhibitory control → **Intake**	98	Children aged 21–41 months in France.	Children's inhibitory control level was measured using questionnaires. Children were randomised to five repeated exposures of baby corn, with either a gentle ("You may eat that food. Try to taste it. It's good") or a harsh ("You have to eat that food") instruction. This resulted in four groups: Instructions (Gentle vs. Harsh) × Inhibitory control (Lower vs. Higher). Intake was evaluated, pre- post and during the intervention, by number of pieces eaten.	Change of intake was higher in the gentle condition than in the harsh condition. The change in intake was greater for children with higher inhibitory control consuming food with a gentle instruction, than in children with lower inhibitory control eating with under harsh instruction

and self-efficacy. It is clear that the evaluation of such programmes should not be based solely on dietary behaviour as a success criterion.

3.5. School gardens

School gardens are often part of a broader public heath strategy and are individually developed with their own set of intentions and goals. Some school gardens have clearly defined objectives, aiming to increase students' knowledge about nutrition and health as well as to increase their intake of fruit and vegetables. Other programmes aim to integrate the benefit of school gardens on a personal, school, and community level with a greater ecological and pedagogical perspective (Nowak, Kolouch, Schneyer, & Roberts, 2012). School gardening has been shown to have a positive effect beyond dietary outcomes, such as "working with groups" and "self-understanding" (Robinson & Zajicek, 2005). However, these outcomes are beyond the scope of this study. In the United States, it has been possible to gain federal funding for the initial cost of implementing school gardens to be used in conjunction with nutrition education since 2004 (Ozer, 2006). Therefore, several studies have compared nutrition education with or without a gardening component.

Summary of experimental studies (Table 5): The reviewed gardening programmes varied greatly in their design, implementation, and outcome measurements, and schools in all but two studies were not randomly assigned to the intervention. Ten studies were excluded due to lack of a control group. Furthermore, it is important to note that the reviewed gardening programmes all included tasting and cooking sessions, which in themselves are likely to exert an effect on the outcomes in question. With this limitation in mind, the evidence supports the notion that school gardens have a positive effect on preference for and intake of vegetables (but not fruit). Furthermore, gardening programmes appear more effective than nutrition education when it comes to positively changing these dietary outcomes.

3.6. Sensory education – taste lessons

Classes du goût (Puisais & Pierre, 1987) was originally a French sensory educational programme of 'taste lessons' that, through sensory impressions, aimed at teaching children how to become aware of the differences between foods and their qualities, with the intention of evolving children into well-informed consumers. The intention of the programme was to teach children about the pleasures of food by increasing children's awareness through exercises focusing on their senses that appealed to their curiosity and interest (Mustonen, Rantanen, & Tuorila, 2009). The French programme has been translated and adapted, and have now been implemented in kindergartens and schools in several countries. It is known under the name *Sapere method,* after the Latin word sapere referring to knowing, tasting, smelling, being able to. Other types of sensory education have also been developed. A handful of studies have experimentally tested the effect of such taste lessons on an array of variables, including food neophobia. However, all but one study based their measurements of neophobia on self or parental reports.

Summary of experimental studies (Table 6): Sensory lessons do not appear to greatly affect food preferences, but some studies found a decrease in neophobia, at least in the short term.

3.7. Availability and accessibility

One determinant that has been consistently associated with fruit and vegetable intake among children is the degree to which these foods are available and accessible to children (Rasmussen

Table 2
Summary of experimental studies on the effect of reward/instrumental feeding.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Birch, Zimmerman, & Hind, 1981)	To investigate the impact of different presentation contexts on the formation of preschool children's food preferences. → **Preference**	64	Preschool children aged 3–5 years in Illinois, USA.	Children were given a food (middle of the child's preference order) in one of four conditions: as a reward, non-contingently with adult attention, in a non-social context, or at snack time (control). Ranked reference was assessed at the beginning of the study, after 4 weeks, after 6 weeks, and at 6 weeks after the end of the study.	Compared to the control group, preference for the food presented in the reward and non-contingent attention condition increased. This increase was maintained at 6 weeks follow-up.
(Birch, Birch, Marlin, & Kramer, 1982)	To examine how food preference is affected when using a food in the instrumental component of a contingency. → **Preference**	12	Preschool children aged 3–4 years in Illinois, USA.	During a three-week period, children took part in six contingency sessions involving a juice and a play activity (e.g., "drink this juice and then you can ride the tricycle"). Ranked reference for the target activity/juice was assessed pre- and post-intervention.	At the end of the three-week study period, preference for the target juice decreased. Preference for the target play activity did not change.
(Birch, Marlin, & Rotter, 1984)	To investigate the effects of instrumental eating on food preferences. → **Preference**	45	Preschool children aged 3–5 years in USA.	Twice weekly for four weeks, children were randomly assigned to either consume an initially novel beverage to obtain a reward (tangible or verbal praise), or a control group that was not rewarded for eating. Ranked reference for the target beverage was assessed pre- and post-intervention.	In the reward conditions, preference for the novel beverage decreased, while preference in the control group did not change significantly.
(Stark, Collins, Osnes, & Stokes, 1986)	To examine the effects of behavioural procedures to modify the food choices of preschoolers during a snack period at school and at home. → **Choice**	8 9	Exp. 1. Preschool children ($n = 8$) aged 3–6 years. Exp. 2. Preschool children ($n = 9$) aged 2–5 years in West Virginia, USA.	Children were offered two "green" (healthy) and two "red" (not healthy) foods and promptly received negative feedback (e.g., "You picked a red food. Red foods aren't as good for you as green foods") or positive feedback (praise and a sticker). A similar procedure was tested in a home setting in exp. 2.	During intervention and nine days' maintenance, more children chose a green food compared to baseline. In experiment two, an initial increase in green food choice declined to baseline over time. *The study has a very small sample size.*
(Mikula, 1989)	To examine what impact "if-then" instructions (i.e., "if you eat X, then you will get Y") have on food preference of both the food in the "if" and the "then" parts of the instruction. → **Preference**	42 44 56	Exp. 1. Children ($n = 42$) aged 4–7 years. Exp. 2. Children ($n = 44$) aged 3–6 years. Exp. 3. Children ($n = 56$) aged 3–6 years in Austria.	In the first experiment, children in the treatment group had to eat one food before receiving another. In experiment two, a disliked food was given as the reward for the consumption of another food. In experiment three, a novel food was given to children by means of "if-then" instructions. Ranked reference for the target food was assessed pre- and post-intervention and at six-weeks follow-up.	Preference for food used as the "then" food increased and was maintained at the six-weeks follow-up compared to baseline and control. Preference for the "if" food did not significantly decline. No significant effects were obtained in the second study. Preference for a novel new food declined when it was the "if" food and was enhanced when it was offered in the "then" position.
(Hendy, 1999)	To compare the effectiveness of five teacher actions to encourage children's acceptance of novel fruits and vegetables presented during three preschool lunches. → **Number of foods, meals and bites**	64	Preschool children (mean age 54.8 months) in Pennsylvania, USA.	During lunch, four novel foods were on offer. Children and teachers were randomly assigned to a table and to one of five teacher actions: simple exposure (control), teacher modelling, reward (dessert), insisting ("Try one bite"), and choice-offering ("Do you want any of this?"). Outcomes recorded by an observer during the intervention.	Reward, insisting, and choice-offering were more effective than simple exposure for increasing all three outcomes. Reward and choice-offering were equally effective for all three measures. Insisting was as effective as reward and choice-offering to encourage at least one bite of a novel food but less effective than choice-offering to encourage many bites of the new foods. *Effects not measured post intervention.*
(Newman & Taylor, 1992)	To examine the effect of a means-end relationship on children's food preferences. → **Preference**	86	Elementary school children aged 4–7 years in New York, USA.	Children were randomly assigned to receive two snack foods in one of three conditions: means-end, sequential order, or simple mere exposure. Ranked preference for the target food was assessed pre- and post-intervention.	In the means-end group, preference for the means snack, relative to the reward snack, declined post treatment. There were no differences in preference between the two snacks in the sequential order and simple mere exposure groups.
(Hendy, 2002)		16		Children were trained by their teachers to serve as peer models (i.e., they were given a small toy	One month after being trained as peer models, these children gave the highest preference

	To examined the effect of reward on food preference (secondary aim). → **Preference, intake**		Preschool children (trained to act as peers) aged 3–6 years in Pennsylvania, USA.	in exchange for eating an assigned food and saying, "These taste good!"). Outcomes measured by rank order and number of bites taken at one-month follow-up.	ratings to the specific food they had modelled earlier, and they took the same amount of bites of the target foods as other foods.
(Wardle, Herrera, Cooke, & Gibson, 2003)	To evaluate the effect of a reward based approach to increase children's acceptance of an unfamiliar vegetable. → **Liking, intake**	49	Primary school children aged 5–7 years in London, UK.	During a two-week period, children were randomly assigned to taste sweet red pepper under one of three conditions: exposure, reward (a sticker) for tasting, or to a control condition. Liking was assessed pre- and post-intervention using a five-point smiley-faces scale.	In the exposure-based intervention, both liking and consumption increased post intervention compared to the control group. The reward-based intervention did not significantly differ from the exposure or control conditions.
(Hendy, Williams, & Camise, 2005)	To evaluate the effectiveness of the "Kids Choice" school lunch programme to increase children's F&V consumption and preference ratings. → **Preference, intake**	188	Elementary school children ($n = 131$ in 1st grade, 95 in 2nd grade, and 120 in 4th grade) (mean age 8 years) in Pennsylvania, USA.	Half the children were randomly assigned to receive a reward (tokens which could be traded for a small prize) for eating either fruits or vegetables over 18 meals. Outcomes assessed by observations and child interviews at baseline and intervention and at two-weeks and seven-months follow-up.	During the intervention period, intake of fruit (for children rewarded for fruit consumption) and for vegetables (for children rewarded for vegetable consumption) increased compared to baseline. During intervention and at two-weeks follow-up, preference ratings for fruit and for vegetables increased. At seven-months follow-up, preference ratings had returned to baseline. *Intervention also included food choice and conditions that encouraged peer participation and modelling.*
(Cooke et al., 2011)	To examined children's acceptance of a disliked vegetable under different conditions. → **Liking, intake**	472	Children in reception year and in year one in primary schools, aged 4–6 years in the UK.	Over 12 days, children were exposed to a disliked vegetable and cluster-randomised to one of four conditions: exposure plus tangible non-food rewards, exposure plus social reward (praise), exposure alone, or a control condition. Outcomes were assessed pre- and post-intervention and at one and three-month follow-ups.	Liking increased in all three intervention conditions compared to the control. These effects were maintained at follow-up. All three intervention groups increased intake compared to the control group post intervention. However, only in the reward conditions was this increase maintained at follow-up.
(Corsini, Slater, Harrison, Cooke, & Cox, 2011)	To examine the effect of offering sticker reinforcement on children's liking and consumption of a target vegetable not usually consumed. → **Liking, intake**	185	Children aged 4–6 years and their primary caregiver (172 mothers, 13 fathers) in Adelaide, South Australia.	For two weeks, children were randomly assigned to being introduced to a new vegetable under one of three conditions: exposure only, exposure plus reward, or a control. Outcome measurements were obtained at baseline, post intervention, and follow-up at four weeks and three months from baseline by a 3-point facial scale and weighed food intake.	The exposure plus reward group was able to achieve more days of taste exposure. Both interventions increased liking post intervention and at follow-up compared with control. All groups increased their intake of the target vegetable post intervention compared to baseline. Compared to baseline, intake in the exposure-plus-reward and control group continued to increase significantly over the follow-up period.
(Horne et al., 2011)	To assess the effect of modelling and rewards on preschool children's consumption of eight fruits and eight vegetables. → **Intake**	14	Children aged 24–52 months in a day care nursery in the UK.	Using a repeated measures design, children received a different food set daily. During the two separate interventions (fruit then vegetable, with a baseline in between), rewards were presented only at snack time and only for consumption of the fruit or vegetable components. A final baseline and six-month follow-up were conducted by visual estimation of food intake using a five-point scale.	Target fruit and vegetable consumption increased during the interventions, as did the paired, non-target foods. All increases generalised to the no-rewards lunchtime context. The increases were maintained at follow-up, six months after rewards were withdrawn. *Intervention also included videos of animated characters enthusiastically eating each target food.*
(Grubliauskiene, Verhoeven, & Dewitte, 2012)	To investigate the effect of tangible rewards and non-tangible rewards (praise) on children's selection of healthy food and unhealthy food. → **Choice**	161	Elementary school children aged 5–11 years in Belgium.	On two occasions, children were asked to choose between a healthy and an unhealthy food option. In the first session, half the children were informed that they would receive a reward (a game) if choosing the healthy option and half received praise for choosing the healthy option. During the second session three days later, no rewards were given.	During the second session, the effect of neither tangible rewards nor praise (received in the first session) influenced the children's choices by themselves; however, the combination of the two increased the likelihood of children selecting the healthy food choice.
	To test how a home-based exposure to an initially disliked vegetable affects	173	Children aged 3–4 years and their primary caregivers in London, UK.	At home, children were offered daily tastes, for 12 days, of a disliked vegetable. They were	Exposure paired with a tangible reward increased intake and liking of the target

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Table 2 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Remington, Añez, Croker, Wardle, & Cooke, 2012)	liking and intake under different reward conditions (i.e., tangible or social). → **Intake, liking**			randomly assigned to one of three groups: tangible reward (sticker), social reward (praise), or a control. Outcome was assessed by 3-point facial scale and weighed food intake pre- and post-intervention, and at one and three-month follow-up.	vegetable compared to simple exposure post intervention and three months later. The increase in the exposure paired with social reward did not increase intake and liking more than simple exposure.
(Añez et al., 2013)	To investigate whether the experience of food rewards affects subsequent responses to an exposure and reward-based interventions. → **Intake, liking**	137	Children aged 4–6 years and their parents or caregiver in the UK.	Children were categorized as frequently or rarely instrumentally-fed and offered a daily taste of a target vegetable for 12 days. Children were randomly allocated to one of four conditions: exposure only, a tangible reward (sticker), a verbal reward (praise), and a no-treatment control. Outcomes were measured by ranked order and weighed food intake pre- and post-intervention.	Children in all exposure groups increased liking compared to controls. Both reward groups increased intake compared to controls. This was irrespective of experience of instrumental feeding. However, in the non-rewarded exposure group, only children who had limited experience with food rewards increased their intake.
(Just & Price, 2013)	To examine the effect of a default F&V option and a combination of a default option and an incentive on children's intake and food waste. → **Intake**	–	Students at 18 elementary schools (41,374 child-day observations) across two experiments in Utah, USA.	One school district required students to place a fruit or vegetable on their tray and one did not. Data for both school districts was collected at baseline and during a five-day period where a small reward was given to children for eating at least one serving of fruit or vegetable. Intake estimated visually at the end of lunch.	Providing a reward for eating increased the fraction of children eating fruits and vegetables by 27 percentage points (an increase of 84%). Incentives implemented at schools with a default option saw an additional 4 percentage point increase in the fraction of children eating fruits and vegetables. *Effect following the removal of the reward not measured. The effect of intake might be none or negative.*
(Fildes, van Jaarsveld, Wardle, & Cooke, 2014)	To test the efficacy and acceptability of mailed materials giving instructions on taste exposure as a means of increasing acceptance of vegetables in preschool-aged children. → **Intake, liking**	442	Families of twins aged 3–4 years in the UK.	Families were randomised to an intervention or a control group. Parents in the intervention group were instructed, via mail, to offer each child daily tastes of a disliked (target) vegetable with a small reward (a sticker) if the child complied, during a two-week period. Intake was measured by number of pieces eaten, and liking was assessed by parents on a 9-point scale before, during, and after the intervention (without using a reward).	Over the intervention period, intake and liking of the target vegetable increased more in the intervention compared to the control group. *As the control group was not exposed to the target vegetable, effect due to repeated exposure cannot be ruled out.*

Table 3
Summary of experimental studies on the effect of social facilitation.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Duncker, 1938)	To explore the influence of peer models on food preference. → **Preference, choice**	22	Preschool children aged 2–6 years in London, England.	In a number of experiments, children were paired with a peer who showed preferences for foods that differed from their own. Secondly, children in the intervention group only were told a story lasting 5 min about a fictional hero with a food preference that differed from their own. Outcome measures were food choice and ranked food order.	Children's food preferences shifted to match the preferences of the peer. Younger children were more likely to imitate the older child than the other way around. Compared to the control group, children's preferences for a previously disliked food changed to match the preferences of the fictional hero.
(Harper & Sanders, 1975)	To examine how adults' eating with children affects young children's acceptance of unfamiliar foods. → **Putting food to mouth**	80	Children aged 14–20 and 42–48 months. California, USA.	Children were offered unfamiliar food under one of two conditions: Offer only condition and Adult-eating condition. Within each group half of the subjects received the food items from their mother, the other half from the visiting researcher. The study was partly randomised and partly balanced for age/sex.	More children put the food to their mouths when an adult was eating compared to the Offer only condition. In the Offer only condition, more children put food to their mouths when their mother was offering compared to when the researcher was offering the food.
(Birch, 1980)	To examine how peer models influence children's food selections, eating behaviours, and preferences for vegetables. → **Intake, choice, preference**	39	Preschool children aged 2–5 in Illinois, USA.	The target child was seated with peers with opposite preference patterns. Children were served their preferred and non-preferred vegetables and asked to choose one. The target child chose first on the first day, the peers chose first on the following three days. Intake was assessed by tablespoons eaten/wasted and preference by rank order.	Compared to their peers, target children chose more of their non-preferred foods, shifting their choice from their preferred food on day one to that of their peers on day four. Target children showed an increase in preference for the initially non-preferred foods and a decreased preference for the initially preferred foods. Younger children, compared to older children, were more influenced by their peers' food choices.
(Hendy & Raudenbush, 2000)	To examine the effect of teacher modelling on food preferences under different conditions and how the effect might be influenced by a competing peer. → **Acceptance**	–	Preschool children in Pennsylvania, USA. Study 2 ($n = 34$) Study 3 ($n = 23$) Study 4 ($n = 26$) Study 5 ($n = 14$)	Study 2 and 3: One teacher was randomly assigned to either eat or not eat the food offered to the children (silently). Study 4: Twice during the meal, the teacher modelled food acceptance (e.g., "Mmm! I love mangos") and tasted the food during the meal. In the control group, the teacher did not eat or place any new food on her plate. Study 5: Five new foods presented with either enthusiastic teacher modelling, enthusiastic peer modelling for a competing food, or simple exposure. Acceptance was assessed by number of bites taken.	Study 2 and Study 3 found that silent teacher modelling was ineffective in encouraging food acceptance of both familiar and new food. Study 4 found that enthusiastic teacher modelling maintained new food acceptance across all five meals. Study 5 found that enthusiastic teacher modelling could not encourage new food acceptance when a competing peer model was present. Study 5 also found that girls were more responsive to the peer model compared to boys.
(Hendy, 2002)	To examine whether trained peer models can enhance food acceptance in preschool children (short and long term) and to investigate the effect of later food acceptance of the trained peer models. → **Acceptance, preference**	38	Preschool children aged 3–6 years in Pennsylvania, USA.	In exchange for a small toy, 16 children were trained to act as peer models for one of three novel foods. The remaining 22 children were allocated to one of three conditions: girl peer modelling, boy peer modelling, or no modelling. Outcome was measured by rank order and number of bites taken.	For children of both genders, (using girl but not boy models), food intake of the modelled novel food increased from baseline to modelled meals. One month later, the positive effects on food acceptance were no longer evident in the target children or the trained peer models.
(Addessi, Galloway, Visalberghi, & Birch, 2005)	To investigate how adult eating affects children's acceptance of novel foods. → **Intake, putting food in mouth and chewing it or chewing food already in mouth**	27	Preschool children aged 2–5 years in Pennsylvania, USA.	Children were tested individually in one of three conditions: adult model was not eating (Presence condition), adult model was eating a food of a different colour (Different colour condition), and adult model was eating a food of the same colour (Same colour condition). Outcome measures were assessed by observed recording and weighed food intake.	In the Same colour condition, children accepted and ate more novel food, compared to the Different colour condition and in the Presence condition. There was no significant difference in food intake or acceptance between the Presence condition and the Different colour condition.
(Lumeng & Hillman, 2007)	To determine whether children's food consumption increased by the size of the group	54	Children aged 2–6 years in USA.	In random order, each child ate a standard snack in a group of three children and in a group of nine children. Snacks were consumed in	Amount eaten and snack duration were correlated. There was no effect of group size on amount eaten during short snack sessions.

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Table 3 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
	of children in which they are eating. **→ Intake**			children's regular classroom. Intake assessed by weighed food intake.	During long snack sessions, amount of food eaten increased by nearly 30% in large groups compared to small groups.
(Salvy, Coelho, Kieffer, & Epstein, 2007)	To investigates how peer influence affects food intake differently in children who are overweight and children who are normal weight. **→ Intake**	32	Children aged 6–10 years in USA.	Children were given free access to pizza and play in a playroom and could freely switch between activities. Children were tested alone and in a group on two different occasions in random order. Intake assessed by weighed food intake.	Overweight children consumed more food when alone compared to when they were in a group and compared to normal-weight children eating alone. Whereas normal weight children ate more in the group condition compared to eating alone.
(Salvy, Romero, Paluch, & Epstein, 2007)	To examine how weight status of a co-eater might influence normal- and overweight preadolescent girls' food intake. **→ Intake**	46	Girls aged 8–12 years in USA.	In pairs of two, participants were given free access to snack foods while working on a sorting task. The pairs were: lean–lean (7 dyads), overweight–overweight (7 dyads), and lean–overweight (9 dyads). Intake assessed by weighed food intake.	Overweight girls consumed more kcal when they ate with an overweight peer compared to when they ate with a normal-weight peer. For normal-weight girls, the weight status of the co-eater did not affect amount eaten. Food intake by one co-eater was a significant predictor of the partners' food consumption.
(Salvy, Kieffer, & Epstein, 2008)	To assess the impact of peer influence on food consumption and selection of healthy/ unhealthy foods in children. **→ Intake**	49	Children aged 10–12 years in USA.	On alternating occasions, participants were tested alone or with an unfamiliar peer. Children were provided with games and had access to both high- and low-calorie food items during the test sessions. Intake assessed by weighed food intake.	Overweight children consumed more kcal when they were alone compared to when they were with a peer. Overweight children consumed more kcal than normal-weight children (alone and in group). Consumption of healthy snacks was predicted by the partner's consumption of healthy snack.
(Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008)	To examine the effects of social influence on children's food intake and modelling of eating depending on the familiarity of the co-eater. **→ Intake**	42	Children aged 5–11 years in USA.	Children were invited to join a 20-min sorting task while having free access to cookies. Participants were tested either alone, with a sibling, or with an unfamiliar child. Intake assessed by weighed food intake.	Children eating with a sibling ate more cookies compared to children eating with an unfamiliar peer or children eating alone. Matching of intake was high among strangers and not significant among siblings.
(Greenhalgh et al., 2009)	To test the effects of peer modelling on children's acceptance of novel foods. Additionally, to test whether positive modelling could reverse the effects of negative modelling. **→ Intake**	36 44	Study 1 ($n = 36$). Primary school children aged 5–7 years in the UK. Study 2 ($n = 44$). Primary school children aged 6–9 years in the UK.	Children were randomly allocated to one of three groups. On four occasions children received a novel blue food under varying conditions (e.g. positive modelling, negative modelling and eating alone). Intake assessed visually using a five-point scale.	Positive peer modelling did not significantly increase intake of the novel food compared to the control. However, negative modelling decreased intake compared to the control group. Positive peer modelling could successfully reverse the effect of negative modelling in the older children but not in the younger children.
(Romero, Epstein, & Salvy, 2009)	To assess the effect of a video model on the food intake of preadolescent girls. **→ Intake**	44	Preadolescent girls aged 8–12 years in USA.	Children were shown a video of another child consuming cookies before being offered cookies themselves. The girls were randomly assigned to a video, where the model was selecting either a small or large serving size of cookies. Intake assessed by weighed food intake.	Participants exposed to the large serving size video consumed more cookies than compared to those exposed to the small serving size video. Overweight participants consumed more cookies than non-overweight participants.
(Salvy, Howard, Read, & Mele, 2009)	To examine how eating with a familiar or unfamiliar peer affect food intake in overweight and non-overweight youth. **→Intake**	72	Children aged 9–15 years in USA.	Participants were paired with either a friend or an unfamiliar peer during a 45-min-long session. They had access to an array of games and puzzles and were free to eat as much or as little as they liked of energy-dense and nutrient-dense foods. Intake assessed by weighed food intake.	Children eating with a friend ate more compared to eating with an unfamiliar peer. Overweight children who ate with an overweight partner consumed more food compared to overweight participants who ate with a normal-weight partner. Matching of intake was greater between friends than between unfamiliar peers.
(Salvy, Elmo, Nitecki, Kluczynski, & Roemmich, 2011)	To compare the influence of mothers and peers on children of different ages' energy intake from healthy and unhealthy foods. **→ Intake**	50	Children ($n = 23$) aged 5–7 years and adolescents ($n = 27$) aged 13–15 years, USA.	On two separate occasions lasting 20 min, participants (children and adolescents) ate a buffet-style meal with their mother on one occasion and with a same-sex peer (friend) on another occasion. Intake assessed by weighed food intake.	Children consumed less energy from unhealthy snacks when eating with their mother compared to when they were eating with a friend. Female adolescents consumed less energy from unhealthy snacks and more energy from healthy snacks when they ate with a friend compared to when they ate with their mother.

(Bevelander, Anschütz, & Engels, 2012a)	To investigate how weight status and amount eaten by a co-eater influence children's food intake directly and over time. → **Intake**	223	Primary school children aged 6−11 years in The Netherland.	Participants (overweight and normal weight) were paired with a normal-weight peer and asked to solve a puzzle while having access to food. The peer was instructed to either eat nothing, a small amount, or a large amount during the session. In the second session a few days later, the participants had to solve the puzzle alone while again having access to food. Intake assessed by weighed food intake.	When the peer was not eating, overweight children ate more compared to normal-weight children. Normal-weight children consumed less kcal in the no-intake condition compared to the low- and high-intake condition where intake was equal. Overweight children consumed an almost equal amount in the no- and low-intake condition but consumed more in the high-intake condition. There was an effect of the experimental condition from the first session on the intake during the second session.
(Bevelander, Anschütz, & Engels, 2012b)	Investigate the impact of a remote (fictitious) peer model on children's food choice of familiar vs. unfamiliar low- and high-energy-dense food in a computer task. → **Choice (pictured food)**	346	Children (mean age of 7.13 SD 0.75 years) from 12 schools in The Netherlands.	In a computer-based task, children chose between pictures of familiar and unfamiliar low-energy-dense and high-energy-dense food. Participants in the intervention group were exposed to the food choices of a fictitious peer (same sex and age) who was allegedly completing the same task at another school.	Food choices of a fictitious peer increased children's choosing of unfamiliar foods in the intervention group; however, these tended to be high-energy-dense foods over low-energy-dense foods. *Choice of actual food not measured.*
(Holley et al., 2016)	To investigate the role of parental feeding practices, child temperament and child eating behaviours as predictors of intervention success. → **Intake**	90	Children aged 2−4 years and their parents in the UK.	Parents completed measures of feeding practices, child eating behaviours and child temperament. Parents offered their child a disliked vegetable daily for two weeks under four conditions: Simple exposure; modelling + exposure; rewards; and modelling + rewards. Intake was measured during and after the intervention period.	Child sociability was significantly correlated with greater consumption post-intervention as well as greater consumption change scores. Child food fussiness was significantly correlated with lower consumption of a disliked vegetable, both pre and post-intervention
(Andersen et al., 2016)	To investigate how children respond to a new type (New Nordic Diet) of school meal and whether classmates affect meal evaluations. → **Liking**	834	Children aged 8−11years from 9 schools (46 classes) in Denmark.	Children were randomised by class in this cross-over study. In two consecutive three-month periods, children consumed a lunch that was either; based on the New Nordic Diet (intervention) or; their usual lunch packs (control). Liking ratings were assessed on a five-point smiley scale after each three-month period.	Unlike children's liking of packed lunches, liking of the New Nordic Diet meals, varied by school class. This means that classmates influenced children's ranking of a new type of school meal, but not rankings of familiar lunch packs.
(Zeinstra et al., 2016)	To test the effect of TV idol role modelling, combined with repeated exposure and a period of restriction, on children's intake of a familiar vegetable. → **Intake, choice**	93	Children aged 4−6 years in Arnhem, The Netherlands.	Children were randomised by classroom to one of three conditions: In both intervention conditions, children ate carrots while they watched TV idols acting as enthusiastic role models over eight sessions. In one of the conditions, children watched the video without eating carrots for five sessions prior to the eight convivial eating sessions. The control group ate carrots twice only, and never watched the role modelling video. Choice between four vegetables and intake of vegetables was assessed pre- and post-intervention and at nine month follow-up.	Carrot intake did not increase, following the intervention period. At nine months follow-up, carrot intake was 20−30 g higher in both intervention conditions, compared to the control group. About 40% of all children were classed as non-eaters; they consistently ate little or no carrots. Children classed as non-eaters scored higher on neophobia and food fussiness, and lower on liking raw carrot and liking raw vegetables compared to children classed as eaters.

Table 4
Summary of experimental studies on the effect of cooking programmes.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Quinn, Horacek, & Castle, 2003)	To test whether a cooking programme would improve attitudes toward and increase F&V consumption in students. → **Intake, self-reported willingness to try**	126	Children in 5th grade from three schools in New York State, USA.	One control and one intervention group. Intervention consisted of 11 classroom cooking lessons and parental involvement over one year. Outcomes assessed by 24-h recall and questionnaires pre- and post-intervention (only post measurement for the control group).	Intervention did not affect intake of F&V in the treatment group compared to control. Self-reported food exposure and willingness to try new foods increased in the intervention compared to the control group.
(Fulkerson et al., 2010)	Primary objective was to develop and test the feasibility and acceptability of a childhood obesity prevention programme. → **Intake**	44	Children aged 8–10 years and their parent, USA.	Parent-child dyads were randomised to an intervention (five, 90-min sessions consisting of interactive nutrition education, taste testing, cooking skill building, parent discussion groups, and hands-on meal preparation) or control condition. Outcomes measured pre- and post-intervention, and 6-month follow-up using 24-h recall.	Intervention did not significantly increase F&V intake but did increase intakes of key nutrients compared to the control.
(Caraher, Seeley, Wu, & Lloyd, 2013)	To measure the impact of a cooking intervention (chefs in schools) on food preparation skills, cooking confidence, and consumption of vegetables. → **Intake**	169	Primary school children in years 4 and 5 (age range 9–11 years) in England, UK.	Schools were allocated to receive either the intervention or to the control condition. Intervention consisted of two hands-on cooking sessions with a professional chef. Outcomes were assessed using a questionnaire two weeks pre- and two weeks post-intervention.	In the treatment group, vegetable consumption increased after the intervention with the chef. No increase was observed in the control group.
(Cunningham-Sabo & Lohse, 2013)	To assess the effect of a school-based cooking programme, "Cooking With Kids", on children's vegetable preferences, attitudes, and self-efficacy for food and cooking. → **Self-reported preference**	257	Children in 4th grade in four schools in Colorado, USA.	Children were randomised to a control condition or an intervention (Cooking With Kids) consisting of three 2-h cooking classes and three 1-h F&V tasting sessions over 10 weeks. Outcome measures obtained via questionnaire pre- and post-intervention.	Intervention increased self-reported vegetable preference compared to control. Increase in fruit preference was not statistically significant. *Liking with five response options was assessed (i.e., actual preference was not assessed).*
(Cunningham-Sabo & Lohse, 2014)	To compare effects of a school-based cooking curriculum vs. a less-intense, tasting-only curriculum on attitudes and behaviours and the influence of gender and prior cooking experience. → **Self-reported preference**	961	Children mainly in 4th grade aged 8–12 years of age, USA.	Two intervention groups received either an education programme of 52-h cooking and 51-h fruit and vegetable tasting lessons throughout the school year (cooking and tasting) or a tasting-only curriculum (tasting only) over two years. A control group received no intervention. Outcome measures obtained via questionnaire pre- and post-intervention.	Compared to control, self-reported preference for vegetables (but not fruit) improved in both interventions and the increase was not significantly different in the two treatment groups. *Liking with five response options was assessed, (i.e., actual preference was not assessed).*
(Allirot, da Quinta, Chokupermal, & Urdaneta, 2016)	To explore the effects of involving children in cooking activities on subsequent willingness to taste novel hunger, intake and liking. →**Willingness to choose and taste novel food, intake, liking**	137	Children aged 7–11 years old from San Sebastian, Spain.	Children in 28 groups were randomly assigned to a cooking workshop or a control condition. Afterwards, children could choose between three familiar vs. unfamiliar foods for an afternoon snack. Willingness to choose and taste unfamiliar foods, intake (visual estimate) and liking (5-point scale) was then assessed.	Mean number of unfamiliar foods chosen per child was higher in the cooking workshop group compared to the control group. In the cooking workshop, overall willingness to taste unfamiliar foods was higher, as was liking for the whole afternoon snack, for 2 of 3 unfamiliar foods and for 1 of 3 familiar foods compared to the control.

Table 5
Summary of experimental studies on the effect of school gardens.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Morris & Zidenberg-Cherr, 2002)	To test whether nutrition lessons combined with a vegetable garden would have a greater effect on children's vegetable preferences and nutrition knowledge compared with nutrition lessons alone. → **Preference, knowledge**	213	Children in 4th grade aged 9–10 years in California, USA.	One school received in-class nutrition lessons (NL), one received nutrition lessons plus gardening (NG), and one was the control. Nine lessons over 17 weeks. Outcomes measured by questionnaires and taste and rate six vegetables pre-, post-, and six months following intervention.	The intervention increased vegetable preference in both the NL and NG groups. At six month follow up's increased preference was evident for one vegetable for the NL group and for three vegetables for the NG group. The intervention did not affect willingness to taste. Nutrition knowledge improved in the NL and NG groups after the intervention and at six-month follow-up.
(O'Brien & Shoemaker, 2006)	To evaluate the effect of an after-school gardening program on increasing children's nutrition knowledge, F&V preference, and outcomes such as self-efficacy. → **Self-reported preference, knowledge**	38	Children in 4th grade in Kansas, USA.	A hands-on gardening and nutrition curriculum for 10 weeks (eight-lessons) and a control group. Outcomes were assessed by questionnaires pre- and post-intervention.	The intervention had no effect on nutrition or preference for F&V (both groups had high preference scores for fruit at baseline and end-programme).
(McAleese & Rankin, 2007)	To investigate the effects of a garden-based nutrition education programme and a nutrition only programme on adolescents' F&V intake → **Intake**	99	Children aged 10–13 years in 6th grade at three elementary schools in Idaho, USA.	Each school was assigned one of three conditions: nutrition education, nutrition education plus gardening, or a control during a 12-week time period. Intake was assessed by 24-h recall pre- and post-intervention.	Nutrition education plus gardening increased intake of F&Vs compared to nutrition education alone or control. Children in the nutrition education plus gardening group increased intake of fruit by 1.13 servings and vegetable consumption by 1.44 servings compared to baseline.
(Parmer, Salisbury-Glennon, Shannon, & Struempler, 2009)	To examine the effects of a garden-based nutrition education programme vs. a nutrition education only programme on children's F&V knowledge, preference, and consumption. → **Intake, choice, preference, knowledge**	115	Elementary school children in 2nd grade in USA	Classes were divided into a nutrition education and gardening (NE+G) group, a nutrition education only (NE) group, or a control group (CG) during a 28-week intervention. Outcomes measured pre- and post-intervention by questionnaires, taste and rate, and lunchroom observations.	Nutrition knowledge and taste ratings increased in both intervention groups compared to the control. Following the intervention, the NE+G group was more likely to choose and consume vegetables in a lunchroom setting compared to both the NE or CG groups.
(Morgan et al., 2010)	To investigate the impact of nutrition education alone or combined with a school garden on outcomes such as F&V consumption, preferences, and quality of school life. → **Intake, preferences, willingness to taste**	127	Children in 5th and 6th grade in New South Wales, Australia.	One intervention school with two groups: nutrition education plus garden (NG) or nutrition education only (NE). Intervention lasted 10 weeks. The control was from a different school. Outcomes measured by 24-h recall and a "taste and rate" method pre- and post-intervention.	Compared to control, NG and NE increased overall willingness to taste vegetables and overall taste ratings of vegetables. NG increased ability to identify vegetables, willingness to taste a number of vegetables (capsicum, broccoli, tomato, peas), and student preference to eat broccoli and peas as a snack.
(Wang et al., 2010)	To examine the effect of a high vs. low exposure to a garden, cooking, and nutrition intervention on nutrition-related outcomes. → **Intake, self-reported preference**	269	Children in 4th and 5th grade in California, USA.	Four schools after two of three years of intervention at varying degrees. For example, high level vs. low level of student exposure to nutrition, cooking, and gardening intervention. Questionnaire and 3-day food diary was completed annually.	Compared to baseline students most exposed to the intervention increased consumption of F&V by one standard serving, whereas consumption decreased by 0.5 standard servings in students least exposed to the intervention. Greater exposure increased self-reported preference for fruit and green leafy vegetables compared to students least exposed to the intervention.
(Ratcliffe, Merrigan, Rogers, & Goldberg, 2011)	To describe the effects of garden-based education on children's attitudes and behaviours associated with vegetable	320	Children in 6th grade aged 11–13 years in San Francisco, USA.	Two intervention schools and one control school. Intervention included one-hour weekly garden-based	Compared to the control, intervention increased preference for vegetables generally and for those grown in the

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Table 5 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
	consumption. → **Preference, willingness to taste, vegetable intake**			learning sessions during four months. Outcome measured pre- and post-intervention. Intake was measured using a food frequency questionnaire and students were asked to name, taste, and rate five raw vegetables.	school garden increased children's willingness to taste vegetables, and children reported having tried more varieties of vegetables (results from the questionnaires). However, these findings were not confirmed in the taste test, which found no difference in willingness to taste the vegetables.
(Cotugna, Manning, & DiDomenico, 2012)	To examine the effect of a school garden project and serving school garden produce at school lunch on children's choice of vegetables at school lunch. → **Choice**	359	Elementary school children in 4th and 5th grade at three elementary schools in Delaware, USA.	Students in two schools participated in a hands-on gardening programme, one did not. Salad choice was observed pre and post garden intervention and then again where the salad was made primarily with produce from the school garden.	In both intervention schools, the percentage of students who chose a salad increased following the joint effect of the gardening programme and the offering of garden produce at lunch. No effect was observed in the control group.
(Evans et al., 2012)	To measure the effects of different levels of exposure to a multiple-component garden-based intervention on school children's (F&V) consumption and to determine the effects of each intervention component on consumption. → **Intake, preference**	214	Children 6th and 7th grade in USA.	Four intervention and one control school. Components of intervention were: (1) in-class lessons, (2) after-school gardening programme, (3) farm-to-school, (4) farmers' visits to schools, (5) taste testing, (6) field trips to farms. Outcomes measured by questionnaire post-test only.	Exposure to two or more intervention components increased scores for F&V intake, self-efficacy, and knowledge and lowered scores for preference for unhealthy foods. For every additional intervention component, the student was exposed to, F&V consumption increased by 0.35 servings.
(Gatto, Ventura, Cook, Gyllenhammer, & Davis, 2012)	To assess the effect of a garden-based intervention (LA Sprouts) on behaviour associated with dietary intake and psychosocial factors. → **Self-reported preference for F&V**	104	Children in 4th and 5th grade in Los Angeles, USA.	Students attending an after-school club participated in weekly garden classes for 12 consecutive weeks. Students not attending after-school club acted as control. Outcome measured by questionnaire pre- and post-intervention.	Compared to control, the intervention increased self-reported preference for vegetables (not fruit) overall, increased preferences for three target fruits and vegetables, as well as improved perceptions that "vegetables from the garden taste better than vegetables from the store".
(Jaenke et al., 2012)	To examine if gender differences exist in the impact of a school garden and nutrition curriculum on food-related outcomes. → **Intake, willingness to taste, preference**	127	School children aged 11–12 years in New South Wales, Australia.	Classes assigned to nutrition education only (NE), nutrition education/ gardening (NE + G), or a control over 10 weeks. Outcomes measures pre- and six weeks post-intervention using 24-h recalls and rating on a 5-point smiley scale.	Willingness to taste increased in NE + G and NE compared to control and was also increased in NE + G compared to the NE. Girls in the NE group increased fruit intake more compared to NE + G girls and control girls (only seen in girls who had a lower fruit intake at baseline). Vegetable intake was not affected.
(Gibbs et al., 2013)	To evaluate the effect of a specific (Stephanie Alexander) kitchen garden programme on children's appreciation of diverse, healthy foods. → **Intake, self-reported willingness to taste**	612	Primary school children ($n = 612$) and their parent or guardian in Victoria, Australia.	Six schools were included in the intervention and six schools in the control. Intervention consisted of weekly gardening and kitchen classes over two years. Outcomes measured pre- and post-intervention by questionnaires, interviews, and classroom observations were also conducted.	In the intervention schools, increased willingness to try new foods was a dominant theme, based on data from interviews, focus group discussions, and class observations. Based on questionnaires, the odds for self-reported willingness to try new foods increased in the intervention at follow-up. However, the intervention did not have an effect on dietary intake.
(Christian, Evans, Nykjaer, Hancock, & Cade, 2014)	To evaluate the impact of two school garden interventions on children's F&V intake. → **Intake**	641	Children, mean age 8.1 years, in London, UK.	Schools ($n = 23$) were randomised into two treatment groups: one received the Royal Horticultural Society (RHS)-led intervention, the control received a less involved teacher-led intervention. A 24-h food diary and questionnaires	No difference in F&V was observed between the two groups. However, improving gardening score by 3 levels (a measure of school gardening involvement, from 0 = 'no garden' to 5 = 'community involvement') resulted in an increase of 81 g of F&V per day

				were administered pre- and post-intervention, 18 months apart.	compared to no change in gardening level, irrespective of group allocation.
(Wansink, Hanks, & Just, 2015)	To examine whether high school gardens in can influence vegetable intake in the absence of nutrition education. → **Selection, food waste**	370	High school students in New York, USA.	Salads were served as usual before the intervention day (control), on which harvested greens were included in the salad (intervention). Changes in selection and plate waste were measured.	Including garden produce increased the percentage of students selecting a salad from 2% to 10%. On average, students ate two-thirds of the serving they took. Waste increased relative to the control day from 6% to 33% per serving. *Lasting effect or novelty?*
(Davis, Martinez, Spruijt-Metz, & Gatto, 2016)	To evaluate the effect of a nutrition, cooking, and gardening intervention on a number of determinants of dietary behaviours. → **Self-reported preference, willingness to try**	304	Children in 3rd to 5th grade in USA.	Children were randomly allocated to a 12-week after-school nutrition, cooking, and gardening intervention or a control group. Determinants of dietary behaviour were measured by questionnaire at baseline and post-intervention. Preference for and identification of F&V was assessed using a 25-item scale. Willingness to try was assessed by a neophobia scale.	Compared to controls, the intervention improved scores for identification of vegetables, nutrition and gardening knowledge, and the likelihood of students gardening at home. The intervention did not affect preference for F&V or willingness to try.

et al., 2006). *Availability* of food means that a given food is present in the children's immediate environment (e.g., fruit and vegetables present in the home and available in the school). *Accessibility* concerns not only availability but also whether the given foods are present in a place and form that facilitates their consumption (e.g., pre-sliced fruit and vegetables available at locations easily accessed by children) (Cullen et al., 2003).

Summary of experimental studies (Table 7): Despite the strong association between greater availability and access to fruit and vegetables and higher intakes among children, very little experimental research has been conducted in the area. The studies currently conducted support this association. Making fruit and vegetables available and accessible to children, by providing them free of charge to school children, appear to be an effective strategy for increasing the intake of fruit and vegetables. The repeated exposure to a variety of fruit and vegetables appears to effectively increase children's intake, even after the free provision has ended, offering an actual and sustainable effect on children's eating behaviour.

3.8. Choice architecture and nudging

Choice architecture refers to an alteration of the context where decisions are made. A nudge is the result of choice architecture which leads to a predictable changed behaviour, without limiting choices or changing economic incentive (Thaler & Sunstein, 2009). In this way, choice architecture might nudge children to make better choices – in this case, healthier food choices – without restricting or eliminating their choices of less healthy options.

Summary of experimental studies (Table 8): In school settings, choice architecture and nudging have been shown to positively increase selection and overall consumption of fruits and vegetables in the short term. However, evidence for long-term benefits is sparse. Only one randomised trial looked at the effects of extended exposure to choice architecture on food selection and consumption (Cohen et al., 2015). This study did find a long-term positive effect of choice architecture on the selection of fruit or vegetable dishes; however, without improved palatability, consumption did not increase. This finding also indicates positive effects of a wider gastronomic approach. Persons with a good culinary knowledge have the capacity to select the preparation methods that serve each type of stimulus best, thereby increasing the palatability of the food. Choice architecture, combined with other interventions, such as increasing palatability, may therefore convey a greater change in fruit and vegetable intake. Considering the very low cost of such interventions, further research in the field should be conducted with a greater focus on evaluating long-term effectiveness.

3.9. Branding, food packaging, and spokes-characters

Food companies use branding to create a unique name and image for a product to make it consistent and recognisable for the consumer. Branding and the use of spokes-characters, either specially created as a mascot for the product or a licensed character from popular children's television shows, may affect not only choice of specific foods but also hedonic rating of the foods.

Summary of experimental studies (Table 9): Packaging evidently has the ability to influence children's food preferences, and the aesthetics might be as important as any particular branding - at least in younger children. Current research suggests that using well-known spokes-characters to promote healthy foods to children might indeed be an effective strategy. Even the use of unfamiliar spokes-characters could be successfully employed to incite greater liking of a range of food items. Although the effect of increasing liking through these methods appears to be slightly

Table 6
Summary of experimental studies on the effect of sensory education/taste lessons.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Reverdy, Chesnel, Schlich, Köster, & Lange, 2008)	To measure and report on the effect of a sensory education programme developed in France on neophobia in school children → **Neophobia, willingness to taste novel food**	180	School children aged 8–10 years in France.	Half of the children (four classes) received the intervention of 12 sessions of taste lessons "Les classes du goût". Another group served as the control group. Neophobia was evaluated pre- and post- intervention and at ten month follow -up. Willingness to taste was evaluated by the presentation of eight unknown foods.	Food neophobia scores decreased in the intervention group compared to the control group at the end of the education period, but the increase was not significant compared to baseline. The increased willingness to taste novel food observed in the intervention group compared to the control group did not reach significance. No effect was observed at follow-up 10 months later.
(Mustonen et al., 2009)	To test how sensory education affects taste and odour awareness and food ratings in school children → **Self-reported willingness to try unfamiliar vs. familiar foods**	175	Second and fifth grade children aged 7–11 years at baseline. Helsinki, Finland.	Children at one school received 10 "Classes du goût" lessons and five lessons familiarising children with different food categories over a 2-year period, children in another school acted as control. Measurements were conducted at baseline and four follow-up sessions via self-reported questionnaires.	Children's odour and taste perceptions and ability to describe different sensory properties of food was improved in the sensory education group, but not in the control group. However, self-reported willingness to taste unfamiliar foods did not change compared to the control group. *Actual willingness to try was not tested.*
(Mustonen & Tuorila, 2010)	To examine the effect of a sensory education programme on outcomes such as intake of novel food and neophobia scores. → **Parental-reported liking, neophobia, intake, familiarity of unfamiliar and familiar foods**	164	Children aged 8 and 11 years at baseline and their parents. From two schools in Helsinki, Finland	Children were assigned to either a control or intention group. The intervention group received up to two waves of sensory lessons following the principles of the French programme "Classes du goût", questionnaires assessing outcomes were sent to parents at baseline and after each wave of sensory lessons.	After receiving sensory lessons, children had tried a larger proportion of unfamiliar foods than at baseline. No change was observed in the control group. Food neophobia score decreased in the intervention group, while no change was seen in the control group. A stronger effect was observed in the younger children compared to the older children. *It was parental report of outcomes.*
(Woo & Lee, 2013)	To examine the effect of sensory education on knowledge and neophobia in school children. → **Neophobia, self-reported willingness to taste novel food, knowledge**	75	Children in 2nd, 3rd, and 6th grade in Changwon, Korea.	Children were divided into an intervention group (12 lessons of sensory education) and two control groups. Children answered a self-administered questionnaire pre- and- post intervention.	Sensory education improved nutrition knowledge scores in the intervention group compared to baseline, no increase was observed in the control groups. Food neophobia decreased in the intervention group, no change was observed in the control groups. *The study's use of the food neophobia scale is unclear and the results should be interpreted with caution.*
(Battjes-Fries, Haveman-Nies, Renes, Meester, & van 't Veer, 2014)	To assess the effect a Dutch school-based education programme, "Taste Lessons", on a number of food-related behaviour. → **Target behaviours: tasting unfamiliar food, eating healthy and a variety of foods**	1183	Elementary school children aged 9–12 years in grades 5–8, in forty-nine classes, The Netherlands.	In a quasi-experimental study design, children were divided into an intervention and a control group. The intervention group received 10–12 taste lessons which including experiments, cooking, and tasting. Knowledge etc. towards the two target behaviours were assessed via questionnaires at baseline, four weeks, and six months post intervention.	After the lessons, knowledge in the intervention group increased compared to the control group and this persisted at six-month follow-up. Foods known and foods tasted increased in the intervention group compared to the control group. These effects did not remain significant at six-month follow-up.

Table 7
Summary of experimental studies on the effect of availability and accessibility.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Bere, Veierød, Bjelland, & Klepp, 2006)	To evaluate the effect of a free school fruit programme intervention on children's consumption of F & V. → **Intake**	517	Children (mean age, 11.3 years at baseline) in Norway.	Schools were randomly assigned to receive an intervention consisting of an educational programme and subscription to a school fruit programme ($n = 9$) or to serve as control schools ($n = 10$). Measurements were obtained using 24-h recall and food frequency questionnaire pre- and post-intervention and at one-year follow-up	Post intervention, average F&V intake was 0.6 portions higher in the intervention group compared to the control group (both at school and all day). At follow-up one year after the end of the intervention, differences between intervention and control groups were sustained for F&V all day (0.5 portions).
(Reinaerts, Crutzen, Candel, De Vries, & De Nooijer, 2008)	To evaluate and compare the long-term effectiveness of two primary school-based interventions on children's F&V consumption. → **Intake**	436	Primary school children and their parents in The Netherlands.	Six schools were randomly assigned to either a daily free F&V distribution programme, or a multicomponent programme consisting of a classroom curriculum and parental involvement (without free F&V). Six schools served as controls. Measurements were obtained using a food recall and food frequency questionnaire, pre- and post-intervention (one year) and at one-year follow-up.	Compared to the control group, both interventions increased children's fruit consumption over time (7.2 and 15.2 g/day for the free distribution programme and the multicomponent program, respectively). However, only the distribution intervention increased children's vegetable consumption over time (3.25 g/day).
(Swanson, Branscum, & Nakayima, 2009)	To examined how slicing fruit affects children's selection and consumption. → **Intake, selection**	800	One school of approximately 800 students from kindergarten to 5th grade in Kentucky, USA.	On one day (students $n = 491$) had the option of selecting sliced apples and oranges, on another day (students $n = 488$) apples and oranges were offered whole. Outcome measures were collected for all students eating the school cafeteria lunch on the study days.	The percentage of children selecting and consuming oranges (but not apples) was increased by slicing. Younger children were more likely to select apples and oranges when sliced, and are more likely to consume oranges when sliced compared to older children.
(Tak, Te Velde, & Brug, 2009)	To evaluate the long-term effects of a F&V scheme aimed at improving availability, accessibility, and exposure to F&V in primary schools. → **Intake**	771	Primary school children and their parents. Mean age 9.9 years at baseline. The Netherlands.	Data obtained from control schools ($n = 24$) or intervention schools ($n = 31$). Children in the intervention group received a free piece of fruit or vegetable twice a week during a fruit break, for one year. Measurements were obtained pre- and post-intervention and at one-year follow-up by parent and child questionnaires.	At follow-up, fruit intake in the intervention group was higher than in the control group for both child-reported and parent-reported intake (difference, pieces/d: 0.145 and 0.185, respectively). No significant effects on vegetable intake were observed.
(Bica & Jamelske, 2012)	To investigate the impact of a free F&V distribution on intake and other behaviours related to F&V consumption among 4th and 5th grade students. → **Intake**	129	Children in 4th and 5th grade in Wisconsin, USA	One intervention school and one control school. In the intervention school, free F&V was served three times a week at snack time. Outcome measurements were obtained via interviews (open-ended question on intake) over three days, and a survey pre-implementation and six months into the programme.	Six months into the intervention, average fruit intake during school snack increased compared to baseline. No change was observed in the control group. Out of 51 students, 47 ate the apple served on the first day, 43 ate the kiwi served on the second day. Due to early release, no snacks were served on the last day.
(Olstad, Goonewardene, McCargar, & Raine, 2015)	To examine the effect of increased availability of healthy foods on sales figures in a community sport, commercial context. → **Sales**	–	Foods/beverages sold from two concessions at an outdoor community pool (n = 17,262 items sold).	The intervention increased the availability of healthy items from 9.1% at baseline to 25.0% during the intervention period (40 days), returning to 9.1% post intervention. Purchases of all foods/beverages were assessed across the three periods.	Sales of healthy items increased from 7.7% at baseline to 22.7% during the intervention, falling to 9.8% post intervention. The proportion of total revenues per patron did not differ by period.
(Sharma et al., 2016)		717			

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Table 7 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
	To determine the effect of a school-based intervention using a food co-op model to increase access to fresh F&V on children's intake of F&V and parental food practices. → **Intake**		Children in 1st grade and their parent in Texas, USA.	Children at three intervention schools received a 16-week school-based program, including weekly distribution of 50–60 servings of fresh F&V, weekly healthy recipe tastings during pick up time, and health education. Three schools were selected as controls to receive nutrition education only. Data were collected via questionnaires pre-mid and post-intervention.	Children in the intervention schools increased their intake of F&V servings and decreased their intake of added sugars following the intervention compared to the children in the control schools. Intervention also affected home environment positively: Frequency of cooking, serving F&V at meals, and limiting portion sizes all increased for children in the intervention schools. *Intervention included recipe tastings and health education for parents.*

more effectively applied to unhealthy foods, they have still been showed to be useful tools to increase children's preference for healthy foods. Additionally, presenting fruit and vegetables in appealing packaging, with stickers or images of well-liked characters, could be easily implemented by parents, school canteens, etc. However, no studies have adequately examined the effect of branding, food packaging, and spokes-characters over time.

3.10. Preparation and serving style

We argue that preparation and serving style are connected to accessibility. Although a range of foods may be available to children, it is the preparation as well as serving style that makes them accessible for them to eat. To date, very few studies have examined how children's intake of a given target food is related to the food's preparation method, serving style, or serving order.

Summary of experimental studies (Table 10): Preparation method, serving style, and serving order clearly have the ability to influence children's intake and liking of vegetables. However, preparation method preferences may be linked to how children are accustomed to having their vegetables prepared, and research is needed on how serving style, order, and preparation method might affect eating behaviour in the long term.

3.11. Offering a choice

Providing choice in the food domain to young children might cause an experience of autonomy and facilitate greater overall intake of vegetables. A large meta-analysis of 41 studies examined the effect of choice on intrinsic motivation on an array of outcomes (Patall, Cooper, & Robinson, 2008). The results indicated that choice enhanced intrinsic motivation and that the effect of choice on intrinsic motivation was stronger for children compared to adults (Patall et al., 2008). However, to our knowledge, only few experimental studies have examined the effect that choice might exert on young children's subsequent intake of a target food.

Summary of experimental studies (Table 11): Due to the limited and conflicting results of the effect of choice offering, more research is needed in order to draw any conclusions. The effectiveness of offering children a choice may depend on the social context in which the food is offered.

4. Discussion and conclusion

The objective of this review was to examine what strategies are commonly used to change children's eating behaviour and to examine how these approaches may affect eating behaviour in the short and long term. Overall, 11 topics were identified and several of these demonstrated clear effects on children's eating behaviour. In the following key findings from these will be discussed following the same structure as the result section, but with thematic grouping of topics.

It is evident that a controlling approach to children's eating (i.e., restriction, pressure to eat, and the use of reward) may impact eating behaviour negatively and in the opposite direction to that which was intended. In regard to pressure to eat only two experimental studies were identified and included in this review. However, the finding that pressure to eat negatively affect intake of a new food compared to simple exposure, is in line with previous findings from longitudinal studies: Gregory, Paxton, and Brozovic (2011) found that maternal use of pressure to eat at 1 year of age, predicted lower levels of fruit intake at 2 years, with the same trend observed for vegetable intake. Likewise, Galloway, Fiorito, Lee, and Birch (2005) found that the mothers' use of pressure when their daughters were 7 years old, predicted eating patterns two years

Table 8
Summary of experimental studies on the effect of choice architecture/nudging.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Schwartz, 2007)	To evaluate an environmental intervention intended to increase consumption of fruit serving among elementary school children. → **Intake, selection**	646	Students at two schools in the same school district (where, on average, 50% of the 646 children buy lunch) in New England, USA.	Two schools were randomly assigned to a control or intervention condition, where cafeteria workers provided a verbal prompt, "Would you like fruit or juice with your lunch?" Outcome variables (selection of a fruit serving and subsequent consumption) were done by observation on two days.	Overall, during the intervention (day one and two), nearly 70% of the children at the intervention school consumed a fruit serving at lunch compared to fewer than 40% of the children in the control school. *Effect of verbal prompt over time not tested.*
(Courchesne, Ahrens-barbeau, & Barnes, 2012)	To assess the effect of placing photographs in cafeteria lunch trays on vegetable consumption. → **Intake, selection**	800	Children (n = approximately 800) in kindergarten to 5th grade in Minnesota, USA.	Vegetable consumption at lunch was compared on a control day and an intervention day. The intervention consisted of photographs of carrots and green beans placed in the lunch tray compartments. After lunch, all uneaten vegetables were collected and weighed.	Intervention increased the amount of green beans consumed per student, from 1.2 g on the control day to 2.8 g on the intervention day. The amount of green beans eaten by students who took them did not differ between the days. Overall carrot consumption increased from 3.6 g on the control day to 10.0 g on the intervention day. The amount of carrots eaten by students who took them was lower on the intervention day compared to the control day. *Effect of intervention not tested over time.*
(Morizet, Depezay, Combris, Picard, & Giboreau, 2012)	To examine whether the use of a food label would increase the frequency of choice of a new vegetable dish in natural lunch settings (i.e., school canteens). → **Selection**	62	Children (n = 62, average on test days) aged 8–11 years in three school canteens in France.	Schools were randomised to one of three conditions (one condition on day one, another on day two): no label condition (i.e., control [both familiar and the new versions of the vegetable dishes were presented]); basic label condition (the new dish was labelled "new carrot/broccoli recipe"); and model-related label condition (the new dish was labelled "new carrot/broccoli recipe, Special Mix for Super Heroes"). Selection was recorded on two test days.	In the control condition, children chose the familiar version of the dish more often. In the basic label or model-related label condition, choice frequency for the new vegetable dish increased for carrots but not for broccoli. No further benefit of a model-related label was observed.
(Wansink, Just, Payne, & Klinger, 2012)	To examining the effect of using fun or attractive names on children's selection of vegetables in school lunchrooms. → **Intake, selection, sales**	147 –	Study 1: Five elementary schools (n = 147) in New York, USA. Study 2: Two elementary schools (purchase observations for 1552 students) in New York, USA.	Study 1. Carrots were served on three days. On day two (intervention), they were named "X-ray Vision Carrots", "The Food of the Day", or unnamed (control). Schools measured selection and consumption on the test days. Study 2. Tracked food sales of vegetables in two schools for 40 days (20 days of intervention). During intervention, hot meals in one school were given names such as "Power Punch Broccoli", "Silly Dilly Green Beans", and "Tiny Tasty Tree Tops".	Study 1. The intervention had no impact on the amount of carrots students selected but did effect consumption. Children ate more of their carrots when named "X-ray Vision Carrots" (66%) compared to when named "Food of the Day" (32%), or when unnamed (35%). Study 2. Students were 16% more likely to persistently choose more hot vegetable dishes when these were named during the intervention.
(Hanks, Just, & Wansink, 2013)	To investigate the collective effect of small changes to school cafeterias on student's choice and consumption of healthy foods. → **Intake, selection**	–	Two high schools (7th–12th grade) in New York, USA.	Pilot study. Multiple interventions (collectively termed the "smarter lunchroom makeover") were implemented. Researchers visited the cafeterias and recorded tray waste for each student who purchased a school lunch before (two days) and after (four days) the intervention was in place.	The intervention increased the likelihood of students taking a piece of fruit by 13.4% and taking a vegetable by 23%. Compared to pre-intervention, the implementation of "smarter lunchroom" increased actual fruit consumption by 18% and vegetable consumption by 25%. *Effect of intervention over time not tested.*
(Wansink, Just, Hanks, & Smith, 2013)	To examine the effect of offering pre-sliced fruit in school cafeteria on sales and children's selection and intake of fruit. → **Intake, selection, sales**	2150	Students from six middle schools in New York, USA.	Schools were randomly assigned to an intervention or a control condition. In intervention schools, students received sliced apples when requesting apples. Outcome measures were obtained by observation on two days before and two days during the intervention (only during the intervention for the control schools).	Intervention increased average daily apple sales by 71% compared to control schools. The intervention increased the percentage of students who selected apples and ate more than half by 73%, and the percentage of children that wasted half or more decreased by 48%. *This could also be a measure of increased accessibility*

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Table 8 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Cohen et al., 2015)	To evaluate the short- and long-term effects of chef-enhanced meals and extended exposure to choice architecture on healthier school food selection and consumption. → **Intake, selection**	2638	Students in 3rd to 8th grade in Massachusetts, USA.	Schools were initially randomised to have a professional chef improve school meal palatability (chef schools) or to a control group. After three months, schools were then randomised to a chef plus smart café (to assess the effect of choice architecture) or to the control group for a further four months. School food selection was recorded, and consumption was measured using plate waste methods at baseline and after three and seven months.	At seven months, fruit selection had increased in the chef, smart café, and chef plus smart café schools compared with the control schools, while fruit consumption also increased in the chef schools. Vegetable selection increased in the chef, smart café, and chef plus smart café schools compared to control. Consumption also increased in the chef and chef plus smart café schools; however, the smart café intervention alone had no effect on consumption.

later. Their results showed that mothers who consumed more fruit and vegetables were less likely to pressure their child to eat. High maternal fruit and vegetable intake and low maternal pressure to eat was in turn associated with lower levels of picky eating and higher levels of fruit and vegetable intake in the daughters.

It has been suggested that parental control should be subcategorised into two discrete constructs – that is, *covert* and *overt* control (Brown, Ogden, Vögele, & Gibson, 2008; Ogden, Reynolds, & Smith, 2006). Overt control refers to control that can be detected by the child, such as being firm about how much the child should eat. Covert control, on the other hand, is not detected by the child. It refers to practices such as not buying and keeping unhealthy foods in the house (Ogden et al., 2006). In cross-sectional studies, these two approaches to control have been shown to affect children's diets in different ways (Brown et al., 2008). However, no experimental studies have investigated how the use of covert versus overt control might affect children's food preferences.

Though some studies indicate that the use of non-food-based rewards may increase intake of novel or originally disliked food, instrumental feeding may negatively affect intrinsic motivation and the expected effect of repeated exposure (Añez, Remington, Wardle, & Cooke, 2013). Instrumental feeding, pressure, and restriction may also teach children to override their internal cues of pleasure (Galloway, Fiorito, Francis, & Birch, 2006), hunger, and satiety (Jansen, Mulkens, Emond, & Jansen, 2008). More research is needed regarding the effect of overt vs. covert control on children's eating behaviour. Based on the current experimental research however, a controlling approach to children's eating is not advised. Given that the majority of parents uncritically employ a range of control strategies in order to increase and control their children's food intake (Orrell-Valente et al., 2007), and that evidence indicates that these strategies have a negative effect on eating behaviour, the authors recommend raising parents' awareness of this contradiction.

Social facilitation has been consistently shown to shape children's food preferences. Modelling positive eating behaviour is therefore important in order for children to imitate this behaviour. In this way, parents' influence on their children's food intake is more related to their own eating behaviour rather than the way they might insist on certain foods being eaten. Attention should be given to the direction of the modelling to ensure it affects the behaviour as intended.

Actively engaging children in growing, preparing, and choosing food they are eating are approaches worth pursuing in the future. Cooking and gardening appears to positively influence children's eating behaviour, possibly mediated by repeated exposure, and also teaches useful life skills and critical thinking, which more passive and controlling approaches may not stimulate (Miller, 2007). This was also the conclusion from a recent meta-analysis that examined the effect of nutrition education programmes and garden programmes: they concluded that gardening programmes had a significant positive effect on preference for and intake of vegetables, whereas the effect of nutrition education was found to be marginal or non-significant. Nutrition education actually resulted in a marginally significant decrease in fruit consumption (Langellotto & Gupta, 2012). Surprisingly, the majority of school garden projects simply aim to increase fruit and vegetable preference and intake of the grown target food, without further exploring if children's subsequent participation in preparing the grown foods facilitates further behavioural changes. We recommend that future studies should examine the students' role in these interventions and how it affects the outcomes. Can students' preferences and selection of preparation styles lead to preparation of vegetables in a way that increases subsequent liking and intake? Otherwise, it can be argued that if the primary goal of gardening is merely to get children to

Table 9
Summary of experimental studies on the effect of branding, food packaging, and spokes-characters.

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
(Robinson, Borzekowski, Matheson, & Kraemer, 2007)	To examine the influence of branding from a heavily marketed source on taste preferences. → **Preference**	63	Preschool children aged 3–5 years in USA.	Children tasted two identical samples of five foods items wrapped in either McDonald's packaging or an identical plain white wrapper. The children were instructed to point to the item that tasted the best or to indicate if they found that they tasted the same.	For four of five food items, the food items in the McDonald's packaging were preferred. Carrot was the one food item where preference for the branded sample was not significantly greater than the unbranded. *A dislike of the plain wrapping, rather than a preference for the branding, could be possible.*
(Roberto, Baik, Harris, & Brownell, 2010)	To examine how popular, licensed cartoon characters on food packaging affect young children's taste preferences. → **Preference, choice**	40	Preschool children aged 3–6 years in Connecticut, USA.	Children tasted three pairs of identical foods presented in packages either with or without a popular cartoon character. Children indicated whether they found the food tasted the same or one tasted better. Children then selected which of the food items they would prefer to eat for a snack.	Children preferred the taste of two out of three food items when a licensed character appeared on the package. The difference did not reach significance for one paired sample (carrots). Snack selection of food with a licensed-character was greater compared to non-licensed-character food (72.5%–87.5%).
(de Droog, Valkenburg, & Buijzen, 2011)	To investigate whether brand characters increase liking of and purchase request intent for fruit compared to candy. → **Liking, purchase request intent**	216	Kindergarten school children aged 4–6 years in The Netherlands.	Children were randomly allocated to a mixed factorial design: 3 (character on package condition: familiar vs. unfamiliar vs. no character) x 2 (snack condition: healthy [fruit] vs. unhealthy [candy]). Children indicated liking and purchase request intent was measured using a smiley face 4-point-scale.	Liking scores and purchase request intent was lower for healthy fruit snack compared to candy in the absence of a character. Characters on the package increased children's liking of and purchase request intent for fruit up to a level similar to candy. The effects on liking and purchase request intent did not differ between familiar and unfamiliar characters.
(Lapierre, Vaala, & Linebarger, 2011)	To examine the effect of spokes-characters and nutrition cues on food packaging on children's liking of products. → **Liking**	80	Children aged 4–6 years in a shopping centre in Pennsylvania (USA).	A 2 × 2 between-subjects design with 4 conditions (healthy cereal name, sugary cereal name, character present, and character absent) was used. The children tasted the cereal and indicated liking on a 5-point rating scale consisting of smiley faces.	Liking was greater when a popular media character appeared on the box compared to the box with no character on it. Children who were told the cereal was named Healthy Bits liked the taste more than those who were told it was named Sugar Bits.
(Keller et al., 2012)	To test a behavioural marketing approach to increase the incentives for eating and increase the intake of F&V among young children. → **Intake**	16	Parents and their children aged 4–5 years living in New York City, USA.	In a pilot study over seven weeks, participants were randomised to one of two conditions: parents in the intervention group offered their child a colourful package of fresh fruits and vegetables + familiar character, redeemable sticker for a prize, and nutritional counselling; and parents in the control group offered their child F&V in a plain package. Intake assessed by weighed food intake.	The intervention significantly increased children's vegetable intake compared with the control group. Intake of fruit increased by one serving per day from baseline in the intervention compared to the control group. However, due to the small sample size, this was not statistically significant ($p = 0.61$). *Effect due to familiar characters cannot be distinguished from the effect of a nutritional counselling or use of incentives.*
(Keller et al., 2012)	To test the effect of branded food on intake. → **Intake**	41	Children aged 7–9 years in New York City, USA.	Children attended two dinner sessions where they received, in random order, either a meal with fast food logos or one without fast food logos.	Girls ate about 100 calories more when the meals were branded compared to unbranded.
(Kotler, Schiffman, & Hanson, 2012)	To investigate the role of familiar and unfamiliar characters in influencing children's food choices. → **Preference (pictured food), willingness to taste, food intake**	343 207	Study 1 ($n = 343$). Children aged 2–6 years from childcare centres around New York City, USA. Study 2 ($n = 207$). A subset of children from study 1.	Study 1. From each of nine pictured pairs of food items, each child was asked to pick the one he/she would like to eat. Children were randomly allocated to select their favourite foods from pairs with no characters (control group), or their preferred food with either a Sesame Street character or unknown character on the target foods. Study 2. Children were presented with	Study 1. Indicated preference for a target food was more likely when a Sesame Street character was associated with the food item compared with no character or an unknown character. Study 2. Children consumed more pieces of foods when branded with Sesame Street compared with an unknown character.

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Table 9 (*continued*)

Study	Aim/→ Outcome	n	Population	Intervention	Key findings/Comments
				three sets of food under three conditions (Sesame Street, unknown character, or no character on the target food). Children were told that they could have what they wanted of each. Food chosen and amount eaten was recorded.	
(Smits & Vandebosch, 2012)	To compare the effectiveness of 'celebrity' and 'non-celebrity' spokes-characters, in promoting healthy and non-healthy foods. → **Intended intake, frequency of purchase requests, appetite**	57	Primary school children aged 7–8 years in Belgium.	Between-subjects questionnaire-based study. A set of questions was repeated for four pictured food items: grapes, chocolate, apples, and cookies. At follow-up, the picture was presented with either a familiar celebrity character or an unknown gnome. Children indicated "consumption frequency" and the "frequency of purchase requests" on a 10-point scale and "appetite" on a five-point scale.	All food items presented with spokes-characters obtained higher scores for appetite, (intended) consumption frequency, and the (intended) purchase requests compared with no characters. Celebrity spokes-characters had a stronger effect than non-celebrity characters and the effect was stronger for unhealthy compared to healthy foods.
(Wansink, Just, & Payne., 2012)	To investigate whether branding can be used to improve the attractiveness of healthier foods in a school setting. → **Choice**	208	School children aged 8–11 years from seven schools in New York, USA.	Cross-over study spanning five school days. Children were given a choice of an apple and a cookie each day. Children were given a choice between: an unbranded apple and a cookie with a sticker of a known character on it, an unbranded cookie and an apple that had a known character on it, and an unbranded cookie and an apple with a sticker of an unknown character. Choice was observed by a researcher.	The sticker with a known character led children to nearly double their apple choice compared with the pre-test control. There was no effect of an unknown character icon on the apple. There was no choice effect of a character on the cookie.
(Elliott, Den Hoed, & Conlon, 2013)	To examine how differently packaged foods influence taste preferences. → **Preference**	65	Preschool children aged 3–5 years in Alberta, Canada.	Children tasted five pairs of identical foods in packaging from McDonald's and in matched packaging that was either plain, Starbucks-branded, or colourful. Children were asked if the foods tasted the same or if one tasted better.	Children preferred the taste of foods wrapped in decorative wrappings over plain wrapping. Aesthetics rather than familiar branding affected preference.
(Cravener et al., 2014)	To test the effect of presenting vegetables as the default snack paired with stickers and cartoon packaging on vegetable intake. → **Intake**	24	Children aged 3–5 years in Pennsylvania, USA.	Children were randomly allocated to two groups both receiving weekly (for four weeks) supplies of plain packaged vegetables presented as a free choice with an alternative snack (granola bar) during baseline and follow-up. During the intervention, the treatment group received vegetables packaged with their favourite cartoon characters, with sticker incentives presented as the default choice. Intake was measured by weighed food intake.	During intervention period (week 2), the treatment group doubled their vegetable intake (increased intake by 1 serving/day) from baseline, while the control showed no change. However, the effect was transient; at week 3 and 4 (follow-up), no difference from baseline was observed. *NB. Effect due to branding cannot be distinguished from the effect of a default choice or use of incentives.*
(Letona, Chacon, Roberto, & Barnoya, 2014)	To examine the influence of packaging and licensed characters on children's liking and taste preferences. → **Preference, liking, choice**	124	Preschool and elementary school children (mean age 7.4 years) in Guatemala.	Children tasted three food items, each presented in two packages: one with a licensed character and one without. Children tasted the paired foods and answered whether they tasted the same or which one tasted better. They indicated liking on a five-point scale and chose which one they would pick as a snack.	Children were more likely to prefer the taste of the foods that featured a licensed character compared with the one in the plain package. More children (66%) chose the food in the package with the character for a snack. Compared to older children, younger children were more likely to prefer the taste of the food inside the package with the character.

(Tim, Beevi, & Yeap, 2014)	To examine how well-known fast-food branding affects taste preference of foods. → **Preference**	60	Preschool children aged 3–6 years in Malaysia.	Children tasted three pairs of identical foods, presented in either popular fast-food brand or neutral unbranded packaging, before being asked to indicate if the food tasted the same or point to the food that tasted the best.	Food presented in popular brand packaging was preferred by 63.3% of the participants. *A dislike of the plain wrapping, rather than a preference for the branded packaging, could be possible.*
(Enax et al., 2015)	To investigate the effects of packaging on liking and effort provision for healthy food items in elementary school children. → **Liking, effort provision task (handgrip strength)**	179	School children, in four primary schools, aged 8–10 years in Dortmund, Germany.	Children tasted three, identical, yogurt-cereal-fruit snacks presented in different packaging (plain label, label focusing on health aspect, and a label that further included unknown cartoon characters). Children were asked to indicate how much they would like to have each product by pressing a dynamometer and to rate the taste of the respective food items on a 7-point scale.	Applied effort (handgrip strength) and taste ratings were significantly higher for the items where the packaging included cartoon characters.

accept and eat fruit and vegetables, this goal could be reached simply by offering children free school meals or snacks containing fruit and vegetables on a daily basis. Nevertheless, not all hands-on approaches have been shown to have a positive, long-term impact on eating behaviour. Furthermore, based on the research currently available, little can be concluded on how cooking and gardening programmes may be optimally designed and implemented to increase preferences and consumption of fruits and vegetables. Although sensory education aims to actively engage children and increase awareness of sensory aspects of food, this approach does not seem to have an effect on children's food preferences.

Children's eating behaviour is fundamentally governed by what foods are available and accessible to them, and the food made available to them, intentionally or unintentionally, will affect what they eat (Rasmussen et al., 2006). In this way, simply providing children with free, accessible fruits and vegetables have been experimentally shown to affect long-term eating behaviour. Interventions based on this concept might therefore be worth implementing. As children grow older, they will be increasingly faced with choosing between a growing number of foods available to them. Choice architecture and nudging will not restrict any of these choices but might encourage healthy choices simply by the design of the environment in which the choices are made. In the short term, this approach may positively affect eating behaviour, but more research is needed to assess outcomes in the long term. Consciously re-assessing the setting where food choices are made is a simple, easily implemented strategy. However, it should be emphasized that this approach can also be used to influence children's intake in less healthier directions (e.g. by placing snack-sized bags of chips instead of fruits right by the counter).

Despite preference being the main driver for food intake in children (Gibson et al., 1998), little research has examined the effect of increasing the palatability of a variety of healthy foods. Although based on results from a single randomised controlled study, improved palatability of school meals resulted in long-term increase in fruit and vegetable intake (Cohen et al., 2015). Given the relatively moderate effects achieved by interventions identified in this review, it might be useful to examine how food preparation and applied culinary understanding may alter palatability and subsequent intake of a range of health-promoting foods. This strategy could very well be combined with other approaches; for example, hands-on approaches can encourage children to prepare foods in a way that positively stimulates their senses. Furthermore, this may encourage tasting opportunities and repeated exposure to a range of novel foods and food combinations.

When analysing children's individual responses to either RE, FFL, and FNL, Caton et al. (2014) classified children in four categories: “learners”, who responded positively to the intervention (40% of the sample); “plate-clearers”, who consistently consumed what was served (21%); “others”, who expressed no distinct consumption pattern (23%); and “non-eaters”, who ate very little and did not change systematically during the intervention (16%). Such individual differences have not been investigated for the strategies covered by this review, but it is very likely that children also respond differently to these approaches. For instance, children's personality influenced intake in a choice offering study, where children's level of *reactance* (sensitivity towards psychological and persuasive pressure) was linked to their intake (Zeinstra, Kooijman, & Kremer, 2016). Likewise, another study demonstrated that individual characteristics, such as child sociability and food fussiness, was predictive for intervention outcome, when testing the effect of exposure, reward and modelling (Holley, Farrow, & Haycraft, 2016). This should be further investigated, and it is likely that different children will require different strategies to make positive changes to their eating behaviour.

Table 10
Summary of experimental studies on the effect of preparation and serving style.

Study	Aim/Outcome	n	Population	Intervention	Key findings/Comments
(Jansen et al., 2010)	To test the effects of presenting fruit in a visually appealing manner versus restricting fruit intake. → **Intake, desire for target food**	94	Primary school children aged 4–7 years in The Netherlands and Belgium.	Children were presented with two types of fruit (visually appealing and regular) and were randomly assigned to one of three conditions: no-prohibition group (children were allowed to taste both types of fruit) or prohibition of either type of fruit. Outcomes were measured while children could freely eat from both fruit types.	Children consumed more fruit presented in a visually appealing way (135 g) compared to regularly presented fruit (73 g).
(Spill, Birch, Roe, & Rolls, 2010)	To investigate the effect of increasing vegetable portion size served at the start of a meal on children's vegetable consumption and total meal energy intake. → **Intake**	51	Children aged 3–5 years in Pennsylvania, USA.	Children were served a test lunch once a week for 4 weeks in their day-care centre in a crossover design. A first course of raw carrots (either 30, 60, or 90 g, or no first course) was served to the children, followed by an *ad libitum* main course. Intake was assessed by weighed food intake.	Total vegetable consumption increased as the portion size of carrots increased. Doubling the portion size of carrots increased consumption by 47% (12 ± 2 g). Tripling the portion size of carrots did not increase further intake.
(Zeinstra, Koelen, Kok, & de Graaf, 2010)	To investigate how preparation method influences liking in different age groups, and to examine which sensory attributes predict liking? → **Preference**	52	Children aged 4–6 years, 7–8 years, and 11–12 years in Wageningen and Bennekom, The Netherlands.	Three age groups of primary school children and a group of young adults completed a taste test in which they made a preference rank-order for six preparations of each target vegetable (carrots and string beans) (i.e., mashed, steamed, boiled, stir-fried, grilled, and deep-fried). Preference was measured using a three-point facial scale	Target vegetables boiled and steamed were preferred by all participants over the other preparations. The most familiar preparation methods for both vegetables were boiled and stir-fried. Liking was positively related to a uniform surface and the typical vegetable taste, and moderately related to crunchiness. Brown colouring and a granular texture were negatively related to liking.
(Poelman & Delahunty, 2011)	To investigate the effect of preparation method or typicality of colour, on children's acceptance of vegetables. → **Acceptance**	104	Children aged 5–6 years in Sydney, Australia.	Children's acceptance of sweet potato, cauliflower, and beans (three typically coloured target vegetables cooked using three different methods and one atypically coloured vegetable [boiled]). Acceptance was tested using three-point facial scale.	Acceptance of cauliflower and beans was greater when boiled compared with baked/stir fried samples. Atypical colour influenced expected preference positively but not on acceptance upon tasting. Preparation method was more important for children who liked fewer vegetables compared to those who liked many vegetables.
(Spill, Birch, Roe, & Rolls, 2011a)	To investigate the effect of incorporating puréed vegetables into entrées on vegetable and energy intake over 1 day in preschool children. → **Intake, preference**	40	Children aged 3–5 years in Pennsylvania, USA.	In a crossover study, children were served all meals and snacks with an energy density (ED) manipulated entrée once a week for three weeks. The three experimental conditions were 100% ED (standard), 85% ED (tripled vegetable content), and 75% ED (quadrupled vegetable content). Side dishes and snacks were not manipulated and *ad libitum*. Outcome measures assessed by weighed food intake and three-point facial scale.	Daily vegetable intake increased by 52 g (50%) in the 85% ED condition and by 73 g (73%) in the 75% ED condition compared with the standard condition. The greater consumption of vegetables in entrées did not affect the consumption of the vegetable in the side dishes. Liking ratings of the manipulated entrées were similar across conditions.
(Spill, Birch, Roe, & Rolls, 2011b)	To test the effect of varying portions of vegetable soup served at the start of a meal on meal energy and vegetable intakes in children. → **Intake**	72	Children aged 3–5 years in Pennsylvania, USA.	In a crossover design, children were served a test lunch once a week for four weeks at their day-care facility. In the four sessions, tomato soup, either 150, 225, 300 g or no soup, was served before the start of the main meal. Intake was assessed by weighed food intake.	Total vegetable consumption increased as the portion of soup was increased. The amount of soup served at lunch did not affect intake of snack vegetables during the afternoon snack session. Total vegetable intake over lunch and afternoon snack increased as the portion size of soup increased.
(Donadini, Fumi, & Porretta, 2012)	To assess how different preparation methods influence the hedonic	52	Children aged 4–5 years in Italy.	Before lunch in the kindergarten canteen, children were presented with one vegetable per day (carrot, tomato,	Raw carrot and tomato were preferred over other raw vegetables. Boiled carrot, tomato, and zucchini were preferred over boiled spinach,

	response to vegetables of preschoolers → **Preference**			zucchini, spinach, fennel, and Catalogna chicory) served in three different ways: raw, boiled, and oven-baked. Ranked preference was assessed on a 5-point facial scale.	fennel, and chicory. Tomato and fennel were preferred raw over boiled and oven-baked. Boiled and oven-baked spinach were preferred over raw spinach. Preparation methods did not affect preference for carrot, chicory, and zucchini.
(Mathias et al., 2012)	To determine effects of F&V portion size on food and energy intakes in children. → **Intake**	38	Children aged 4–6 years and their primary caregivers in Philadelphia, USA.	Once a week for five weeks, children had their dinner under four experimental conditions: vegetable portion size (75 g and 150 g) and fruit portion size (75 g and 150 g) as part of a standard meal. Intake was assessed by weighed food intake.	Children's vegetable intake increased by 37% and fruit intake by 70% when portion size was doubled from 75 g to 150 g. Vegetable portion size effects were not influenced by offering more fruit and vice versa. Effect of portion size was limited to children who liked that particular food.
(Olsen, Ritz, Kraaij, & Møller, 2012)	To investigate effects on vegetable liking and intake gained from exposing children to snack vegetables of different liking levels. → **Intake, liking**	345	Children aged 9–11 years in Copenhagen, Denmark.	In the first period (six days), classes were randomised to one of three conditions: exposure to a mixture of a neutrally liked and a liked vegetable, a neutrally liked vegetable only, or a mixture of a neutrally liked and a disliked vegetable. During the second period, all children were served all vegetables. Intake of vegetables was measured daily. Liking was assessed using a 7-point smiley scale, before and after exposures and at follow-up five weeks later.	During the exposure periods, liking for most vegetables decreased but tended to recover during follow-up. Intake of all vegetables was either stable or decreased during the intervention, and no increases were observed. Children consumed more of the neutrally liked vegetable when it was served alongside a liked vegetable compared to when served alone or together with a disliked vegetable.
(Olsen, Ritz, Kramer & Møller, 2012)	To investigate the effect of serving styles (size and shape) of snack vegetables on liking in children. → **Liking**	138	Children aged 9–12 years in Copenhagen, Denmark.	During school hours, children were presented with three snack vegetables (carrots, cucumber, and red pepper) presented in eight different serving styles (i.e., two different sizes: small and ordinary, and four different shapes: whole/chunk, slices, sticks, and figures [stars]). Palatability/liking was assessed using a visual analogue score (VAS) scale.	Children liked figures more than slices and sticks. Liking did not differ between slices and sticks – both were liked more than ordinary-sized vegetables served whole or as chunks. Small-sized whole vegetables were liked less than ordinary-sized chunks. For slices, sticks, and figures, size did not matter.
(Zampollo, Kniffin, Wansink, & Shimizu, 2012)	To evaluate whether adults and children demonstrate different preferences for various ways in which food can be presented on plates → **Preference (visual)**	46 23	Adults ($n = 46$) and children ($n = 23$) age 5–12 years in New York, USA.	Children and adults were individually presented with photos of 48 different combinations of food on plates. Photographed plates varied according to seven dimensions; e.g. number of items, placement of entrée and organization of the food. Preference was measured by asking participants "which is the picture that you like the most?"	Children tended to prefer seven different items and six different colours on their plates, while adults tended to prefer three different colours and three different items. *Not intake but visual preference measured.*
(Poelman, Delahunty, & de Graaf, 2013)	To investigate the impact of preparation time and method on children's acceptance of vegetables. → **Preference**	82	Children 5–6 years in Sydney, Australia.	Children tasted and evaluated two vegetables (broccoli and cauliflower). The vegetables were either boiled or steamed, and three different cooking times were applied (short, medium, and long), resulting in six variations of each vegetable. Preference was assessed using a five-point hedonic facial scale.	Acceptance did not differ between boiled or steamed samples. Medium cooking times were preferred over short and long cooking times for both vegetables.
(Correia, O'Connell, Irwin, & Henderson, 2014)	To test two strategies to increase vegetable consumption and willingness to try vegetables: (1) the pairing of a vegetable with a liked food, and (2) increasing the visual appeal of a	42	Children aged 4 years from a child care centre in Connecticut, USA.	Classrooms were randomly assigned to the intervention or control condition lasting one week. The following week, the children switched to the other condition. For a snack, raw cucumber	There was no difference in vegetable intake or willingness to try between the two conditions.

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Table 10 (*continued*)

Study	Aim/Outcome	n	Population	Intervention	Key findings/Comments
	vegetable. → **Intake, willingness to try**			was served either as semicircles with chive and an olive garnish or arranged in a visually appealing manner (in the shape of a caterpillar). Outcomes measured assessed by weighed food intake.	
(von Germeten & Hirsch, 2015)	To determine if preparation method (freshly prepared or pre-sliced and packaged) of F&V influences children's acceptance. → **Liking**	118	Children aged 8–10 years in Germany.	Children in the school already received 100 g F&V three days per week, which was prepared by teams of children. For six weeks, this was replaced in the intervention group with pre-sliced and packaged F&V by an external supplier. Liking assessed by a 5-point smiley face scale.	Compared to baseline, liking of F&V decreased in the treatment group following the intervention. Liking remained constant in the control group. *Decline in liking could also the importance of freshness, the benefit of actively involving children in the food preparation process.*
(de Wild, de Graaf, & Jager, 2016)	To test the effect of vegetable preparation on preference and intake of in young children. → **Intake, preference, liking**	104	Preschool children aged 2–4 years in Wageningen, The Netherlands.	Children were randomised to one of four conditions: Over 6 weeks at home, children were served either; plain spinach, creamed spinach, spinach ravioli, or green beans (control). During the intervention parents reported on intake and liking on an 9-point scale. Intake, assessed by weighed food intake and preference (spinach vs. green beans) was assessed pre- and posttests.	Spinach intake in all conditions increased significantly from (53.4 g) at pretest to (90.6 g) at posttest. Effect on intake depended on the child's neophobia status (Children with high neophobia was less responsive) and pre-intervention spinach consumption (children who ate more spinach pretest was more responsive). Preference for spinach over green beans did not shift significantly, from pretest to posttest. Spinach ravioli was liked less than the other vegetable products.
(Elsbernd et al., 2016)	To determine the effect of offering vegetables before lunch on overall consumption of vegetables at school lunch. → **Intake**	500–575	School children in kindergarten to 5th grade in Minnesota, USA.	The experiment was conducted over one control day followed by three intervention days three weeks apart and then one follow-up control day. On intervention days, children were served a small portion (26–33 g) of a raw bell peppers while they waited in line for lunch. Intake was measured by weighed food intake.	The intervention increased the number of students eating vegetables. On intervention days the majority of vegetables consumed came from the vegetables-first portions. Total vegetable consumption was higher on intervention days (5.4 g) compared to control and follow-up days (4.0 g).

Table 11
Summary of experimental studies on the effect of offering a choice.

Study	Aim/Outcome	n	Population	Intervention	Key findings/Comments
(Zeinstra, Renes, Koelen, Kok, & De, 2010)	To investigate how having a choice between two different vegetables affects children's liking and consumption of vegetables. → **Intake, preference, liking**	303	Children aged 4–6 years and their parent in The Netherlands.	Children were randomly assigned to one of three conditions in a restaurant setting. Two similarly liked vegetables were presented. The child had either: no choice, a pre-meal choice, or an at-meal choice. At the end of the meal, food was weighed, liking assessed by a 3-point smiley scale and preference ranked.	Children appreciated having a pre-meal choice between two vegetables. There was no difference in liking and consumption of vegetable between the conditions.
(Domínguez et al., 2013)	To test the effect of choice-offering on children's vegetable intake in a school setting. → **Intake**	152	Children aged 4–6 years and their parents in Granada, Spain.	Children were assigned to one of three conditions: discrete choice condition (DDC) (choice at the beginning of the meal), continuous discrete choice plus variety condition (CDCP) (having two vegetables available during the meal), and a no-choice condition (NCC) (receiving only one vegetable). Children received cooked vegetables (zucchini and/or green beans) in a single session where intake was recorded.	Both choice conditions (DCC and CDCP) increased children's intake of vegetables compared to the no-choice condition.
(Roe, Meengs, Birch, & Rolls, 2013)	To examine the effect of providing a variety of familiar F&V during snack time on preschool children's subsequent selection and intake. → **Intake, selection**	61	Children aged 3–5 years in Pennsylvania, USA	Children were offered a snack on eight occasions in a crossover design over four weeks. In four snack sessions, children were offered vegetables (either a single type or a variety of three types of vegetables). At the other four snack sessions, children were offered fruit (either a single type or a variety of three types of fruits). Outcome measures were assessed by number of pieces eaten and weighed food intake.	In the variety condition, more children chose some pieces of snacks (94%) compared to the single snack condition (70%). Children consumed more of both vegetables and fruit in the variety condition compared to the single snack condition. The difference in intake was 31 ± 5 g. Independent of condition, children were more likely to select and consume fruit compared to vegetables.
(de Wild, de Graaf, Boshuizen, & Jager, 2015)	To test the effect of choice-offering on children's vegetable intake in an in-home setting. → **Intake**	70	Children aged 2–5 years in The Netherlands.	Children were randomly assigned to one of two conditions: choice or no-choice. Children were exposed (12 occasions) to six familiar target vegetables. Two selected vegetables were offered in the choice group, whereas only one was offered in the no-choice group. Vegetable intake was measured by weighed food intake.	There were no significant differences in vegetable intake between the two groups.

By far the majority of studies included in this review have used fruits and/or vegetables as target foods. However, children need a variety of other foods in their diets to remain healthy. Furthermore, fruit and vegetable intake cannot be used in isolation as a marker of healthy eating behaviour. When translating current research into practice, this should be kept in mind. Children's preferences for vegetables are generally low compared to other foods (Appleton et al., 2016). Therefore, combining vegetables with healthy fats, protein, and grain products may not only increase palatability but also challenge the notion that healthy foods are not tasteful or satisfying.

Summing up, there are several of the reviewed topics which have shown either positive effects or some potential for changing children's eating behaviour – and also some which have shown the opposite. Communicating this knowledge to childcare professionals and parents will be an important next step. Identifying how children's individual traits may influence the outcome of these interventions will be a future task for researchers – as well as identifying further approaches affecting children's eating behaviour.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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