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Consumers' practical understanding of healthy food choices: a fake food experiment

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Abstract

Little is known about laypeople's practical understanding of a healthy diet, although this is important to successfully promote healthy eating. The present study is the first to experimentally examine how consumers define healthy and balanced food choices for an entire day compared with normal choices and compared with dietary guidelines. We used an extensive fake food buffet (FFB) with 179 foods commonly consumed in the Swiss diet. The FFB is a validated method to investigate food choice behaviour in a well-controlled laboratory setting. People from the general population in Switzerland (*n* 187; 51·9 % females), aged between 18 and 65 years, were randomly assigned to one of two conditions. In the control group, the participants were instructed to serve themselves foods they would eat on a normal day, whereas in the 'healthy' group they were instructed to choose foods representing a healthy diet. Participants chose significantly more healthy foods, with 4·5 g more dietary fibre, 2 % more protein and 2 % less SFA in the 'healthy' group compared with the control group. However, in both experimental conditions, participants served themselves foods containing twice as much sugar and salt than recommended by dietary guidelines. The results suggest that laypeople lack knowledge about the recommended portion sizes and the amounts of critical nutrients in processed food, which has important implications for communicating dietary guidelines. Furthermore, the energy of the food served was substantially correlated with the energy needs of the participants, demonstrating the potential of the fake food buffet method.

Key words: Food choices: Portion size: Healthy eating: Fake foods: Dietary recommendations: Consumer behaviours

For effective promotion of healthy eating among the general population, more insights about people's understanding of healthy food choices and how they translate their knowledge into practice are needed. Although consumers are surrounded by dietary information from various sources such as television, the Internet, food labels and health professionals, which sometimes provide conflicting messages, laypeople's perception about healthy eating seems to be strongly influenced by national dietary guidelines[1]. For instance, fruits and vegetables are perceived as healthy, whereas consumers usually associate foods containing high amounts of fat, sugar and salt with unhealthy eating[1]. Although consumers have some ideas about the healthiness of specific foods, they also have conceptions about production and preparation methods, as well as knowledge about the concepts of balance, variety and moderation, as suggested by dietary guidelines[1–3].

However, in Switzerland, adherence to dietary recommendations is low for most food categories and has not significantly improved over the past decade[4,5]. A healthy diet is correlated with higher education and a healthier overall lifestyle[6], and adherence to dietary guidelines has been associated with reduced all-cause mortality[7,8]. Thus, further efforts are required to foster healthy eating. However, to set the right priorities among the large number of recommendations and strategies for implementing a healthy and balanced diet, it is important to know how laypeople define healthy eating for themselves and how they put their knowledge into practise. To the best of our knowledge, consumers have not yet been experimentally investigated in this regard, even though evidence exists that translating dietary recommendations into healthy food choices can be challenging[9] and that people have limited knowledge about portion sizes[10]. Laypeople may have difficulties when considering the recommended amounts of nutrients, such as Na or SFA, especially when it comes to evaluating the healthiness of entire meals[11]. In the same vein, the perceived healthiness of fruits and vegetables seems to be mainly independent of the consumed quantities, which can lead to biased evaluations of less-healthy food products that contain small quantities of fruits or vegetables. For instance, in one experiment, fruit lemonades were rated as healthier than other soft drinks with similar sugar content[12], and in another experiment breakfast cereals labelled as 'containing fruit sugar' were perceived as healthier than those only labelled as 'containing sugar'[13]. These results suggest that consumers' understanding of healthy food choices may differ from that of the experts, even though they seem to use similar criteria to evaluate the healthiness of foods[11].

It is important to identify potential misinterpretations or knowledge gaps with regard to dietary recommendations in order

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to implement successful healthy eating campaigns. Therefore, the present study examined consumers' practical understanding of healthy and balanced food choices and how this was related to their normal food choices and to current Swiss dietary recommendations[14], which are broadly in line with the World Health Organization[15] guidelines for a healthy diet, with the exception of the recommended fat intake, which is higher in Switzerland. To investigate people's food choice behaviour, the fake food buffet method[16] was applied: participants were asked to serve themselves foods for an entire day from a buffet consisting of fake foods (food replicas) – either as they would choose normally or as they would choose for a healthy and balanced diet. Next, the energy, nutrients and frequency of the served food items were compared across both experimental conditions and compared with the current Swiss dietary recommendations. The fake food buffet has been proven to be a valid and reliable method for assessing food choices under well-controlled conditions, as the amounts of fake food served were strongly correlated to the amounts of real food served, and selected amounts were consistent over a 2-week interval[16,17].

Methods

Study subjects

The required sample size for medium effects (Cohen's $d = 0{\cdot}5$–$0{\cdot}7$) was a minimum of fifty-five to 100 participants for each experimental condition[18]. In all, 204 persons were recruited via public advertising displayed in supermarket stores located near the ETH Zurich and posted on two locally accepted web sites related to social activities. To participate in the study, participants were required to speak fluent German and to be between 18 and 65 years of age. Participants who followed a special or medically prescribed diet (n 9), did not understand the instructions properly (n 5) or did not complete the subsequent survey (n 3) were excluded. Data from 187 participants were analysed (Table 1).

The study protocol was approved by the ETH Ethics Committee, Zurich, Switzerland (EK 2014-N-40). Written informed consent was obtained from all participants, and subsequent to study completion they were informed of the study's aim. The subjects received monetary compensation (forty Swiss francs) for participating.

Experimental procedure

Fake food buffet. To conduct the experimental study, a fake food buffet, which represented an extended version of the buffet used by Bucher *et al.*[16,17], was prepared (see Fig. 1). The buffet contained 179 labelled food items (see online Supplementary Appendix) representing a broad variety of healthy and unhealthy foods of different degrees of processing[19] typically consumed during the day. The food items were carefully selected by four nutrition experts to ensure that healthy and unhealthy foods were balanced. With the exception of alcoholic beverages, all food categories were represented. Of these items, 128 were food replicas (fake foods) and fifty-one were real foods, presented as single packet portions (e.g. jam)

Table 1. Descriptive characteristics and control variables of the 187 study participants, separated by the two experimental conditions
(Mean values and standard deviations)

	Control group (n 92)		'Healthy' group (n 95)		
	Mean	SD	Mean	SD	t (185)
Females (%)†	54·3		49·5		
Age (years)	30·53	10·14	30·59	10·43	0·04
Education‡	3·98	1·55	3·95	1·50	0·14
BMI (kg/m^2)	22·75	3·13	22·51	2·50	0·58
Energy needs (kJ)	10 674·31	2084·81	10 528·03	1941·86	0·50
Hunger status§	3·09	1·48	3·38	1·42	1·38
Authenticity of fake food§	4·62	1·32	4·28	1·37	1·71
Duration of the food selection task (min)	10·73	2·62	12·29	3·81	3·27*
Importance of choosing healthy foods§	4·29	1·36	4·96	0·99	3·83**

* $P < 0{\cdot}05$, ** $P < 0{\cdot}001$.
† Sex did not differ significantly between the two conditions χ^2 (1, n 187) = 0·45, NS.
‡ Categories ranged from 1 (compulsory school) to 5 (university degree).
§ Rating scales from 1 to 6.

Fig. 1. Fake food buffet containing 128 fake food products and fifty-one real foods.

Fig. 2. Two examples of the daily food selection by the participants: (left) food selection of a male participant in the control group and (right) food selection of a female participant in the 'healthy' group.

and purchased from local retailers (Migros and Coop). The contents of perishable real foods such as yogurt or butter were replaced with artificial material. For all items, the amounts of energy, macronutrients, SFA, sugar, Na and dietary fibre – also called the 'Big 8'[20] – were calculated on the basis of the values for the corresponding foods in the Swiss food composition database version 5.0 (http://www.naehrwertdaten.ch) or by retailer information for more processed foods such as hamburger. To estimate the energy and nutrient contents of fake foods, the products were systematically compared with corresponding real food items, as described by Bucher *et al.*[16]. A list of all food items in the fake food buffet is provided in the online Supplementary Appendix. In comparison with the fake food buffet used in previous studies[17,21,22], this version provided a more extensive food selection for an entire day, with a balance of healthy and unhealthy foods. In addition, sauces and condiments completed the buffet in order to estimate the total energy more precisely. To calculate the energy values and nutrient contents, the foods have been linked to the Swiss food composition database.

Experiment. First, the fake food buffet task and the questionnaire were pre-tested with five individuals. Next, study participants were individually invited to select the foods they consume during an entire day from the fake food buffet. An equal number of males and females were randomly assigned to either the control group or the 'healthy' group. For the control group, the participants were instructed to serve themselves breakfast, lunch, dinner and between-meal snacks (in the sequence stated) as they would eat on a normal day. For the 'healthy' group, the participants were instructed to serve themselves breakfast, lunch, dinner and between-meal snacks as they would eat for a healthy and balanced diet for themselves.

The following further information was then given to all participants: first, dressings had to be separately added from a variety of products in different sizes, and, second, multiplication cards (e.g. '0·5', '2×', '3×') were provided so that the participants could choose more or less of a single food item.

To serve the fake foods, participants could choose from a range of tableware: three different sizes of plates (27, 21 and 14 cm in diameter) and two types of bowls (16 and 12·5 cm in diameter) were provided for serving. The participants were instructed to arrange their meals and snacks on an empty table next to the fake food buffet in the order of the mentioned mealtimes.

After they had finished the selection task, the participants were asked to fill out a questionnaire including demographic and other control variables, such as weight and height or hunger status (Table 1). In the meantime, the investigator analysed the served meals by weighing the components if they consisted of continuous items such as rice or pasta and by counting pieces of single foods such as slices of pizza or fruits. In addition, a picture of the entire food selection was taken (Fig. 2).

Measures

Control variables. To examine whether the manipulation and randomisation of the experiment were successful, several control variables were assessed within the survey subsequent to the experimental task (Table 1). As expected, the mean values of the control group differed significantly from those of the 'healthy' group in the duration of the food selection task and the reported importance of choosing healthy foods (manipulation check), whereas no differences were found for all other control variables.

Besides demographic variables, such as sex, age and education, self-reported weight (kg) and height (cm) were assessed to calculate participants' BMI (kg/m^2).

Participants' energy needs per day were calculated by a formula based on sex, age, weight, height and activity levels ('How physically active are you in your everyday working life?' and 'How physically active are you in your leisure time?' rated on a scale from 1 to 3). First, the BMR was calculated on the basis of the Harris–Benedict equation[23]. In a second step, the BMR was multiplied by the activity factor, as suggested by Suter[24], and was finally converted into kilojoules per day by multiplying the result obtained by 4·2.

Participants rated their hunger status (1 = *not hungry at all* to 6 = *very hungry*) and the authenticity of the fake food items (1 = *not realistic at all* to 6 = *very realistic*). In addition, the investigator measured the duration of the individuals' meal selection process.

To examine whether the experimental manipulation was successful and the participants were aware of the instruction to choose a healthy and balanced diet in the 'healthy' group, a

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manipulation check was applied: participants rated how important it was for them to choose healthy foods from the fake food buffet (1 = *not important at all* to 6 = *very important*).

Outcome variables. In all, two different approaches were used to compare the two experimental conditions: the first focused on the proportion of nutrients, whereas the second condition was based on the amount of foods served from the food groups.

Proportion of nutrients. To compare the served amounts of total fat, SFA, protein, carbohydrate and sugar across the experimental conditions and with the current dietary recommendations, the percentage of total energy served from those nutrients was calculated: first, the energy (kJ) and nutrient contents (g) of all food items were summed up. The amount of total fat (g) and SFA (g) was multiplied by 37 kJ, and the amount of protein (g), carbohydrate (g) and sugar (g) was multiplied by 17 kJ to obtain the amounts of kilojoules served from those nutrients[24]. Finally, the kJ served from the nutrients were divided by the total energy served (kJ) and multiplied by 100. For the comparison of Na and dietary fibre, the contents of Na (mg) and dietary fibre (g) of all food items were summed up.

Food groups and selected food products. For the analysis of the amount of foods served, all items in the fake food buffet were classified into one of seven food groups based on the levels of the Swiss food pyramid[14], as classified in previous studies[17,25] (for classification details, see online Supplementary Appendix). The energy content and weight served from these food groups were calculated by separately summing up the energy content (kJ) and weight (g) of the selected food items. For a more detailed analysis, indicator foods for a healthy diet, such as fish or nuts, or indicator foods for an unhealthy diet, such as croissants, were compared between the experimental conditions by comparing the percentage of participants who chose these products. In addition, the amounts of sugar and Na in specific food groups were calculated by summing up the sugar (g) and Na (mg) contents of the appropriate food items to examine the main food sources of these critical nutrients.

Statistical analyses

Study variables are presented using means and standard deviations for continuous variables and percentages for categorical variables. Independent *t* tests were used to evaluate the mean differences between the two experimental conditions related to the control variables and the 'Big 8' (energy and nutrients). The outcome variables of the food groups were log-transformed because of skewed distributions. All statistical tests were performed using IBM SPSS version 22 for Mac (SPSS Inc.) and are based on a 0·05 significance level. In case of significance, the effect size Cohen's *d* for continuous variables and the effect size ϕ for categorical variables are reported.

Results

Overall, male participants served themselves on average 10 978 kJ and female participants served themselves 8801 kJ, which are close to the recommendations for adult men and women (Table 2). The amount of energy served was substantially correlated with participants' energy needs per day (r 0·37, $P < 0·001$), and the fake food was rated as authentic (mean 4·45, SD = 1·35), which indicates natural behaviour in the experimental settings. Overall, participants' food choices were on average 7·1 (SD 28·3) % below their energy needs, and differences were found for males (10·9 %) and females (2·2 %).

Nutrients and food groups were compared across the experimental conditions and with the Swiss dietary guidelines to examine participants' understanding of a healthy and balanced diet.

Proportion of nutrients

Results for the 'Big 8' are summarised in Table 2. Significant differences between the control and the 'healthy' group were found in terms of the percentage of protein, total fat and SFA

Table 2. Comparison of the 'Big 8' (energy and nutrients) between the experimental conditions and dietary recommendations (Mean values and standard deviations)

	Control group (*n* 92)		'Healthy' group (*n* 95)				
	Mean	SD	Mean	SD	*t* (185)	Cohen's *d*	Swiss dietary recommendations[13]
Total energy served (kJ)	9955·62	3187·69	9745·75	3003·13	0·46		Approximately 7560–10 500
Protein (g)	90·05	32·11	100·12	32·25	2·14*	0·32	
Protein (% of TE)	15·71	4·29	17·79	4·06	3·41**	0·50	10–20
Total fat (g)	102·74	41·32	94·82	34·21	1·43		
Total fat (% of TE)	37·88	8·37	35·81	5·31	2·03*	0·30	30–40
SFA (g)	39·38	17·40	34·14	14·34	2·25*	0·33	
SFA (% of TE)	14·52	4·28	12·79	3·30	3·10*	0·46	<10
Available carbohydrate (g)	259·40	96·81	252·31	92·59	0·51		
Available carbohydrate (% of TE)	44·37	8·32	43·81	6·89	0·32		45–55
Sugar (g)	122·80	60·26	120·50	54·85	0·27		
Sugar (% of TE)	20·98	7·47	21·00	6·32	0·00		<10
Na (mg)	3524·15	1532·03	3349·82	1294·57	0·84		Maximum 2000
Dietary fibre (g)	24·35	8·62	28·84	8·81	3·52*	0·52	Approximately 30

TE, total energy served.
* $P < 0·05$, ** $P < 0·001$.

related to the total energy served and in terms of dietary fibre, with medium-to-large effect sizes. Participants in the 'healthy' group served more protein and dietary fibre and less SFA (Table 2). Interestingly, the amount of sugar and Na served did not differ between the experimental conditions. Table 2 also shows that the participants' daily food selection on average distinctly deviates from the current Swiss dietary recommendations in both experimental conditions, except for protein and total fat. However, note that oils and fats as well as alcoholic beverages, salt and sugar for meal preparation were not considered in the fake food buffet task.

Food groups and selected food products

The comparison of food groups between the control and the 'healthy' group provides more explanatory insights into participants' average nutrient profiles, as presented in Table 3. The amount of selected unsweetened beverages corresponds to the recommended 1–2 litres of sugar-free drinks/d in both experimental conditions[14]. Although participants selected more fruits and vegetables in the 'healthy' group, the recommended minimum of three portions (each 120 g) of vegetables (including salad) per day[14] was not met in either of the two experimental conditions. Although slightly more starchy food products (g) were chosen in the 'healthy' group compared with the control group, the amount of foods containing protein (kJ and g) was not different, despite the significantly higher percentage of total protein served in the 'healthy' group (Table 2). This can be explained by substitution of food products, as shown in Table 4: protein-containing foods with a lower proportion of protein (e.g. sausages, yogurt) were less frequently chosen in the 'healthy' group, whereas protein-dense foods (e.g. fish, eggs and cheese) were more frequently chosen. In addition, participants selected more nuts and vegetarian meat substitutes in the 'healthy' group. The higher frequency of nuts, olives, cheese and salad dressings served in the 'healthy' group resulted in the somewhat counterintuitive fact that more oil- and fat-containing foods were selected in the 'healthy' group compared with the control group. Sweets, salty snacks, sugared beverages and fast food products were less frequently chosen in the 'healthy' group, but still accounted for 11·06 % of the total energy served. The mean portion sizes of the food products selected by the participants are presented in Table 4. They were very similar to the packages provided or the portion sizes at the fake food buffet (online Supplementary Appendix), even though the participants had the option of serving themselves less or more by using the multiplication cards.

The results in Table 4 show that less-healthy products such as sausages, croissants, fast food, flavoured yogurts, sweets and sugar-sweetened beverages were selected less frequently in the 'healthy' group. Further, the results provide insights into why no differences were found between the experimental conditions with regard to the amount of sugar and Na served.

In both experimental conditions, participants served themselves foods containing on average 21 % sugar (120 g), which is twice the recommended daily amount. In the 'healthy' group, the sugar was sourced mainly from fruits and fruit juice (mean 57·65, SD 37·25 g); starchy foods such as sugar-containing cereals and muesli (mean 16·36, SD 11·02 g); dairy products (mean 9·18, SD 11·52 g); sweets and sugar-sweetened beverages (mean 9·81, SD 17·60 g); and spreads and sauces such as marmalade or ketchup (mean 9·35, SD 11·24 g). In contrast, participants in the control group served themselves on average more sugar from sweets and sugar-sweetened beverages (mean 37·36, SD 46·00 g) and less sugar from fruits and fruit juice (mean 35·54, SD 30·22 g).

Furthermore, in both experimental conditions, participants' daily food selections contained 3·6 g more salt than recommended amounts. Participants consumed on average 3435 mg of Na, which corresponds to 8·6 g of salt. The main Na sources for both the control and the 'healthy' group were starchy foods (mean 1447, SD 875 mg), protein sources (mean 1062, SD 812 mg) and prepared foods such as fast food, sandwiches, dressings and sauces (mean 512, SD 612 mg).

Table 3. Comparison of the food groups based on the Swiss food pyramid between the experimental conditions (Mean values and standard deviations)†

	Control group (*n* 92)		'Healthy' group (*n* 95)			
Food groups based on the Swiss food pyramid‡	Mean	SD	Mean	SD	*t* (185)	Cohen's *d*
(6) Unsweetened beverages (ml)	1600·54	930·82	1578·68	855·06	0·60	
(5b) Vegetables (portions)	2·10	1·18	2·41	1·12	2·51*	0·37
(5a) Fruits (portions)	2·36	1·89	3·91	2·19	5·58**	0·82
(4) Starchy foods (g)	426·38	276·87	463·74	225·04	2·10*	0·31
(4) Starchy foods (kJ)	3257·78	1708·09	3419·31	1534·47	1·35	
(3) Protein sources (g)	431·99	243·03	427·69	204·59	0·42	
(3) Protein sources (kJ)	2566·32	1445·13	2492·03	1212·97	0·08	
(2) Oils and fats (g)	64·67	53·52	82·97	54·84	2·79*	0·41
(2) Oils and fats (kJ)	897·88	732·81	1013·15	697·76	2·01*	0·30
(1) Sweets and savoury snacks (g)	282·45	374·71	133·42	186·67	3·35*	0·49
(1) Sweets and savoury snacks (kJ)	2104·53	1982·08	1077·92	1233·88	3·45*	0·51

* $P<0·05$, ** $P<0·001$.

† Note that independent *t* tests were conducted on log-transformed data. Detailed information about the categorisation of the food items into the food groups is given in the online Supplementary Appendix.

‡ (6) Including water, tea and coffee; (5b) portion of vegetables = 120 g, (5a) portion of fruits = 120 g, portion of fruit juice = 200 g; (4) including bread, pasta, rice, potato, beans, cereals and prepared foods such as sandwiches; (3) including meat, poultry, fish, egg, tofu, maize, dairy products; (2) including dressings, butter, nuts, olives; (1) including chocolate, biscuits, cake, chips, soft drinks, fast food products, low-fat dressings such as ketchup.

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Table 4. Average portion size served and comparison of the frequencies of the selected food products between the experimental conditions (Mean values and standard deviations)

	Average portion size (g) served in both conditions		Frequencies of selected food products (%)			
	Mean	SD	Control group (*n* 92)	'Healthy' group (*n* 95)	χ^2	ϕ
Fruit juice	480·00	295·69	35·9	44·2	1·35	
Cereals	50·97	13·93	20·7	17·9	0·23	
Swiss muesli with yogurt and fruits	251·78	75·71	25·0	55·8	18·37**	0·31
Whole-grain bread	78·56	40·48	69·6	83·2	4·80*	0·16
Croissants	49·00	10·86	22·8	9·5	6·19*	0·18
Sausages	113·41	90·57	18·5	5·3	7·86*	0·21
Fish	119·85	63·38	26·1	66·3	30·40**	0·40
Eggs	47·76	22·35	28·3	65·3	25·69**	0·37
Cheese	91·35	66·22	67·4	81·1	4·57*	0·16
Flavoured yogurt with added sugar	189·73	41·26	26·1	13·7	4·53*	0·16
Vegetarian meat substitutes (tofu, falafel, veggie schnitzel, beans)	89·83	58·70	37·0	55·8	6·66*	0·19
Nuts and olives	50·83	17·83	35·9	54·7	6·71*	0·19
Salad dressings	40·60	18·63	64·1	86·3	12·40**	0·26
Fat-rich sauces (mayonnaise, pesto, cream sauces)	69·88	36·68	43·5	50·5	0·93	
Sweet spreads (marmalade, honey, Nutella)	33·58	9·80	29·3	42·1	3·31*	0·13
Fast food (hot dog, meat and veggie burgers, slice of pizza)	195·39	103·68	13·0	1·1	10·39**	0·24
Sweets (chocolate, biscuits, cake)	117·88	110·68	77·2	36·8	30·96**	0·41
Sugar-sweetened beverages	537·60	345·86	20·7	6·3	8·29*	0·21

* $P<0·05$, ** $P<0·001$.

† The mean and standard deviation of the portion size served in both conditions are based only on the participants who served these foods. Detailed information about the categorisation of the food items into the food product categories is given in the online Supplementary Appendix.

Discussion

In this study, we found that laypeople's practical understanding of healthy and balanced food choices differed significantly from the normal food choices in the control group. Moreover, the food choices of both of the experimental conditions differed from the current national dietary guidelines. In the 'healthy' group, participants served themselves significantly more food that is commonly perceived as healthy, such as fruits, vegetables, whole-grain bread, fish and other meatless protein sources. At the same time, they served themselves significantly less food that is perceived as unhealthy, such as sausages, croissants, sweets, fast foods and sugar-sweetened beverages, compared with the control group. Participants' food choices reflect at least some basic knowledge about the food pyramid, which recommends eating food in the lower levels of the pyramid in larger quantities than foods in the upper levels[14]. These experimental findings are in line with previous research that found laypeople's perception of healthy eating seems to be strongly influenced by national dietary guidelines[1]. Against this background, the significantly higher amount of protein served in the 'healthy' group and the smaller-than-recommended amount of available carbohydrate served in both experimental conditions may reflect the increased popularity of the low-carb diet approach in recent years[26]. In addition, the results show that people's normal food choices with regard to (saturated) fat and dietary fibre are worse than people's healthy food choices, which might be explained by environmental factors such as the ubiquitous supply of sweets and savoury foods and by individual factors such as motivation[27]. Experimental support for the latter is also given by the fact that participants' food selections took on average nearly 2 min longer in the 'healthy' group than in the control group, which indicates that choosing a healthy and balanced diet required more cognitive effort.

However, despite the food-based differences between the two experimental conditions, 60 % of the tested Swiss dietary guidelines[14] were not met in both conditions. In other words, although the participants selected more healthy food and less unhealthy food in the 'healthy' group compared with the control group, their healthy and balanced food choices differed distinctly from the experts' definition of a healthy and balanced diet. In both experimental conditions, participants' food choices contained far too much sugar, salt and SFA and not enough complex carbohydrates and dietary fibre compared with the current Swiss dietary recommendations, which are broadly in line with the WHO dietary guidelines with the exception of the recommended fat intake, which is higher in Switzerland[14,15].

Participants served foods containing twice as much sugar and salt as recommended, even though sugar, salt and fat for meal preparations were not considered in the fake food buffet. Therefore, the total fat served is also only marginally acceptable. These findings are consistent with a previous study by Bucher *et al.*[11], which showed that laypeople seem to be well informed about the relative healthiness of single food items but have difficulties evaluating the healthiness of a whole meal. In order to evaluate the overall diet, knowledge about the healthiness and balance of various food combinations, knowledge about recommended portion sizes and knowledge about the amount of nutrients in foods are all required. However, our results show that for most of the food groups the participants did not choose the portion sizes recommended by the Swiss

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dietary recommendations. For instance, in both experimental conditions, the recommended three portions of vegetables were not achieved, which might be the reason that the recommendation for dietary fibre was not met. In addition, the average portion size of fruit juice served was nearly half a litre – twice as much as recommended – thus accounting for the entire acceptable amount of sugar for females. Similarly, the average portion sizes for cheese, nuts, sweets, dressings and sauces were higher than the recommended portion sizes for these foods, which resulted in higher amounts of (saturated) fat, salt and sugar. Concerning packaged foods, participants mostly served the package size presented at the fake food buffet despite the possibility of using multiplication cards. Knowledge gaps concerning recommended portion sizes could explain why laypeople's understanding of healthy and balanced food choices did not meet the dietary guidelines. Thus, the portion sizes of pre-packaged foods seem to influence the amount of food consumed. Increasing portion sizes might have a negative impact on the overall energy consumed[28] as well as on the amount of consumers' food waste[29].

Furthermore, our results showed that consumers neglected the amounts of critical nutrients such as (saturated) fat, salt and sugar in their evaluations of the healthiness of their overall diet, particularly in terms of foods that are perceived as healthy. For instance, in the 'healthy' group, foods rich in salt, such as cheese; fish such as smoked salmon; vegetarian products such as falafel; and salad dressings and sauces were simultaneously served in >50 % of the cases. In addition, in the same group, the recommended maximum sugar intake was fully covered by participants' servings of fruits and fruit juice, whereas additional sugar-containing products such as muesli, cereals and sweet spreads were served as well. Our results suggest that consumers lack knowledge about the recommended intake of critical nutrients and their quantities in foods, which is supported by previous studies[11–13]. Moreover, the amounts of sugar and salt served might be a consequence of the large supply of ultra-processed products in high-income countries such as Switzerland[19], which were also represented at the fake food buffet (e.g. sweets and savoury snacks, soft drinks, fast food, meat substitutes, muesli, dressings and sauces). These ready-to-consume products contain more energy, salt, sugar and fat but less dietary fibre than unprocessed or only minimally processed foods, and their consumption has been associated with obesity and the metabolic syndrome[19].

To sum up, these experimental results provide evidence that Swiss consumers fail to meet recommended dietary guidelines because they are not aware of the recommended portion sizes and the amount of critical nutrients in healthy (e.g. sugar content in fruit juice) and processed products. This finding is in line with a previous study showing that perceived serving sizes were not correlated with corresponding weighted serving sizes[10]. For effective communication of dietary recommendations, tools such as food pyramids should not only focus on the relative healthiness of foods, but should also provide practical advice concerning the recommended portion sizes in relation to energy needs, which do not always correspond to the available package sizes. Consumers also need to be better informed about the sugar, salt and fat contents in processed foods that are perceived as healthy but contain high amounts of sugar, such as fruit juice, muesli and cereal bars, or high amounts of salt and fat, such as smoked salmon, and they should be encouraged to choose more fresh foods and fewer processed foods. However, as processed foods provide some convenient advantages for consumers, such as time-saving meals or long shelf lives, they have been well established in everyday life in recent years. Therefore, food companies should also take responsibility to reduce the amounts of critical nutrients in processed foods to reduce consumers' salt, sugar and fat intakes, which would help prevent nutrition-related diseases[19]. Further, more research is needed to investigate how people can be supported in transferring their knowledge about a healthy diet into practice.

One limitation of these interpretations is that the fake food buffet is a method of investigating food choice behaviour and not food intake; therefore, it cannot be concluded whether the participants would have eaten all of their selected food items or even more. In addition, the fake food buffet represents a controlled experimental setting that did not take into account factors such as price, which might also be important in daily food choices in real life. However, as participants' overall energy served was substantially correlated with their energy needs, their food choices seemed to be a good approximation of their daily energy intake. Moreover, the mean underestimation of 7 % was distinctly below the reported underestimations of about 20 % obtained by self-report measures such as diet records, recall and FFQ[30], which shows the great potential of the fake food buffet method to investigate people's food choices as a proxy for their eating behaviour. In addition, the buffet provided a large range of food items to account for individual differences, and over 90 % of the participants perceived the fake food as authentic. A second limitation is related to the study sample, which was on average younger and more educated than the average Swiss person. In order to generalise the finding that misconceptions regarding healthy and balanced food choices are responsible for laypeople's failure to meet dietary guidelines, further studies in other countries are needed. The fake food buffet method has potential because it can be easily linked to other nutrient databases to adjust for culture-specific differences.

Conclusions

This study examined, for the first time, consumers' practical understanding of healthy and balanced food choices over an entire day by using the fake food buffet method, which provides several advantages to investigating food choice behaviour under well-controlled conditions. The experiment revealed that laypeople's understanding of healthy food choices differed from both their actual daily food choices and from the current dietary guidelines. On the basis of the analyses of the food groups and nutrients served, the authors conclude that laypeople lack knowledge about the recommended portion sizes and the amounts of critical nutrients such as salt and sugar in processed food, which suggests some ways to improve communication about dietary recommendations.

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Supplementary material

For supplementary material/s referred to in this article, please visit http://dx.doi.org/doi:10.1017/S0007114516002130

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