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# Healthy eating strategies: Individually different or context-dependent?

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ABSTRACT

Individuals can apply different healthy eating strategies to help them make healthy eating choices. Previous research showed that individuals differ in their preferred strategy, but also that a mix of strategies is often applied by a single person across contexts. The current research investigated the extent to which differences within an individual across contexts (i.e., meal moments, social environment and physical environment) predicted openness to healthy eating strategies in addition to personal predictors that differ between individuals (i.e., intrinsic motivation, self-efficacy, physical opportunity and social opportunity). A representative sample of the Dutch adult population was recruited (N = 892). The within-individual (contextual) predictors were measured nine times just before a meal moment over a period of three weeks, by means of a smartphone application. The between-individual (personal) predictors were administered with a baseline questionnaire. Exploratory factor analysis distinguished three healthy eating strategies: *Increasing healthy foods*, *Limiting unhealthy foods* and consuming *Light products*. A random intercept model, in which within-individual predictors and between-individual predictors were entered successively, showed that context matters for openness to all three strategies, but is most important for increasing healthy foods and least important for light products. Individuals are most open to increase healthy foods at dinner as compared to breakfast, whereas the opposite is true for limiting unhealthy foods and consuming light products. Eating at home is beneficial for openness to all three strategies and eating with others positively influences openness to increase healthy foods but has no effect on the other strategies. Insights gained from this research increase our understanding of an individual's openness to apply healthy eating strategies.

## 1. Introduction

Current dietary patterns are related to severe diet-related non-communicable diseases such as Type 2 diabetes, cardiovascular disorders, hypertension and some forms of cancer (Afshin et al., 2019; Caballero, 2007; Key et al., 2004; Ng et al., 2014; Willett et al., 2019). Behaviour change is needed to shift towards a more healthy diet. A consumer can use different strategies to achieve a more healthy diet (Falk, Sobal, Bisogni, Connors, & Devine, 2001; Verain, Raaijmakers, & Reinders, unpublished results a). Healthy eating strategies can be defined as the rules, procedures and/or techniques that people use to facilitate their healthy food choice process within different contexts (Falk et al., 2001; Sobal, Bisogni, Devine, & Jastran, 2006). The study by Verain et al., (unpublished results a) identifies four healthy eating strategies: (1) an increase in the consumption of more healthy products (e.g. eating more vegetables and drinking more water), (2) a restricted consumption of unhealthy products (e.g. drinking less alcohol and consuming less red meat) (3) a change in dietary pattern (e.g. consuming smaller portion), and (4) a shift towards consumption of light products (i.e. products that are labelled as being light/slim products such as low-fat products or low-calorie products).

Research regarding healthy eating strategies suggests that there are inter-individual differences: individuals differ in their preferred strategy (Falk et al., 2001; Verain et al., unpublished results a). Recent research, however, recognizes the importance of taking contextual factors into account in understanding consumer behaviour more and more. Scholz (2019) recently addressed the need to include temporal dimensions in health psychology. The importance to consider context is also valid regarding food consumption. Food intake fluctuates over the day (van Rossum et al., 2020) as well as the underlying food choice motives as they depend on the meal context (Verain et al., unpublished results b). As an example, Inauen, Shrout, Bolger, Stadler, and Scholz (2016) researched unhealthy snacking and found that both intentions and actual behaviour fluctuate within individuals over the day. When it

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concerns healthy eating strategies, little is known about whether openness to apply these strategies varies within persons, for example during different mealtimes (breakfast, lunch, dinner, snack), in different locations (at home, out-of-home), and/or in different social contexts (alone, with family, with friends). Therefore, the current study aims to investigate both individual differences and contextual differences regarding the openness to different healthy eating strategies.

### 1.1. Between-individual differences

The literature discusses a whole range of individual characteristics that can be important to consider in relation to healthy eating. A vested model in this respect is the MOA-model developed by Rothschild (1999). This model states that when individuals want to achieve a goal, such as eating more healthily, they need to be 1) motivated, 2) able and 3) have the opportunity to behave in the desired way. Motivation is an important factor when studying healthy eating, as individuals only engage in preventive health behaviours if they perceive the need and have the drive to act (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). Self-determination theory is a motivational theory that has been related to health behaviours (Deci & Ryan, 2000; Williams, Grow, Freedman, Ryan, & Deci, 1996). Intrinsic motivation is the most desirable form of motivation, as this type of motivation is driven by an individual's own satisfaction instead of external consequences (Ryan & Deci, 2000) and it is argued that when individuals are intrinsically motivated it is more likely that long-term behaviour change occurs (Teixeira, Patrick, & Mata, 2011). de Ridder, de Wit, and Adriaanse (2009) found that people with a higher intrinsic motivation were more willing to implement a healthy dietary goal. In addition, a study by Verain et al., (unpublished results a) showed that the more consumers are intrinsically motivated to eat healthily, the more open they are to apply healthy eating strategies. Therefore, we hypothesize that *intrinsic motivation to eat healthy foods positively affects an individual's openness to implement healthy eating strategies.*

Next to being motivated, it is important to feel able to perform a certain behaviour in order for behaviour change to occur (Rothschild, 1999). Ability is often operationalized through the concept of self-efficacy, which is the extent to which individuals believe that they are capable to perform a certain behaviour (Bandura, 1977). Chan, Prendergast, and Ng (2016) found that self-efficacy is an important predictor of intentions to engage in healthy eating. In addition, Trapp et al. (2015) found that healthy eating is related to an individual's confidence to prepare a healthy meal. Regarding openness to healthy eating strategies, Verain et al., (unpublished results a) showed that a higher perceived self-efficacy to eat healthily in social or indulgent occasions leads to more openness to increase consumption of healthy foods and light products. As such, we hypothesize that *self-efficacy regarding healthy eating positively affects an individual's openness to implement healthy eating strategies.*

The last factor that the MOA-model identified as essential for desired behaviour to occur is opportunity to behave in a certain way. "Environments may make healthier choices easier choices or may even reduce the number of options or possibilities for unhealthy choices" (Brug, 2009, p. 52). The physical environment refers to the available options that are present in the environment to make healthy versus unhealthy food choices. Based on a literature review, Brug (2009) concluded that availability and accessibility of healthy foods and less unhealthy foods positively influenced healthy eating behaviour. Trapp et al. (2015) confirmed the importance of physical opportunity. Unhealthy food choices were associated with eating takeaway, cafe and restaurant meals and having more unhealthy than healthy food products at home. Moreover, Viaene and Gellynck (1997) found that trying light products for the first time is influenced by the availability at home. Therefore, we hypothesize that *physical opportunity to consume healthy foods has a positive effect on an individual's openness to implement healthy eating strategies.*

Besides physical opportunity, social opportunity is an important factor when it concerns healthy eating. Think for example of social support to eat more healthy food or the feeling of social pressure to limit unhealthy food consumption (Brug, 2009). In a study by Loth, MacLehose, Larson, Berge, and Neumark-Sztainer (2016), it was found that the family eating environment influences adolescent dietary intake. Viaene and Gellynck (1997) found that trying light products for the first time is influenced by the opinion of family. Congruent to this finding, Hill, Knox, Hamilton, Parr, and Stringer (2002), found that the rejection of reduced-fat foods is, among other aspects, influenced by the preference of other household members. Therefore, we hypothesize that *social opportunity to consume healthy foods has a positive effect on an individual's openness to implement healthy eating strategies.*

### 1.2. Contextual differences

Next to differences between people, openness to implement healthy eating strategies is expected to fluctuate within people during the day. The meal moment, the location and the presence of others can all have an influence on how inclined the person is to think about healthy eating and how open the person is to apply a certain healthy eating strategy. A study by Inauen et al. (2016) showed that the time of the day is important with regard to healthy eating, as they found that 50% of the variance regarding the intention to avoid unhealthy snacking can be attributed to within-individual differences and 50% to between-individual differences.

Several studies suggest that food choice motives differ across meal moments (Machín, Giménez, Vidal, & Ares, 2014; Phan & Chambers, 2018; Verain, Sijtsema, Taufik, Raaijmakers, & Reinders, 2020; Verain et al., unpublished results b). Different meal moments have different characteristics (Rappoport, Downey, & Huff-Corzine, 2001). Evening meals are for example more often consumed with others than meals at lunchtime, suggesting that personal preference is more relevant for lunch than for dinner (Machín et al., 2014). Based on these insights we hypothesize that *openness to healthy eating strategies differs within individuals between meal moments, with a negative effect of dinner.*

Food and eating is a social act, and therefore the social context has an influence on food consumption. For example the presence of others has an influence on how much and what is eaten (norms) (Wansink, 2004). Being with more people often means higher food intake (Wansink, 2004). Literature indicates that individuals are more open to make changes to their diet when consuming alone. As dinner is often consumed together with others, individuals are less inclined to adopt healthy eating advices at dinner compared to other meal moments, such as breakfast, which is the meal that is most frequently consumed alone (Rappoport et al., 2001). Therefore we hypothesize that *openness to healthy eating strategies differs within individuals between different social eating environments, with a positive effect of being alone and a negative effect of being with others.*

As described earlier, the physical environment has an influence on food choices and consumption. For example, eating out-of-home is often linked to higher energy intakes and obesity (Bezerra, Curioni, & Sichieri, 2012; Lachat et al., 2012). An important factor that plays a role here is the availability of healthy and unhealthy products at certain locations (Connors, Bisogni, Sobal, & Devine, 2001). A study by Verain et al., (unpublished results b) showed that healthy food choice motives were less important when consuming out-of-home, as compared to consuming at home. Based on the above, we hypothesize that *openness to healthy eating strategies differs within individuals between different physical eating environments, with a positive effect of being at home and a negative effect of being out-of-home.*

### 1.3. Present study

This research adds to the existing literature by exploring how openness to different healthy eating strategies differs between individuals as well as within individuals across contexts. The ratio

between individual and contextual variability is not often researched, especially not in the domain of consumer motivations regarding healthy eating, but is important to get a full understanding of when and by whom which healthy eating strategy is preferred.

## 2. Method

### 2.1. Design and procedure

Data were collected in January 2020. Participants were recruited through a professional market research company (i.e. Ipsos). Ipsos has their own consumer panel and smartphone application to collect repeated measurement data. A representative sample of the Dutch adult population has been recruited based on gender, age, education and region. Two selection criteria were applied. First, participants had to own a smartphone, as a smartphone was needed for the data collection. Second, only people who indicated to eat breakfast, lunch and dinner at least three times a week were included in the study. After these questions, individuals were judged on eligibility and were screened out if necessary.

The study started with an online baseline questionnaire of approximately 15 min. It consisted of questions on demographic characteristics and the between-individual predictors. All participants were provided with a definition of healthy food consumption based on the guidelines of the Dutch Nutrition Centre at the start of the study. After the baseline questionnaire, a within-subjects design was used where participants monitored their preferred healthy eating strategy over a period of three weeks. Each participant was approached nine times (on Mondays, Tuesdays and Thursdays) before meal time. Participants received a push notification on their phone and the questionnaire was available for a certain period (breakfast: 5.00AM–11.00AM; lunch: 11.00AM - 4.00PM; dinner: 4.00PM–9.00PM). To control for order effects, participants were randomly divided into six conditions and within every condition the order of the three meal moments varied using a Latin Square design (Table 1). In addition to their openness to healthy eating strategies, questions were asked about where and with whom they planned to consume their meal. Participants needed approximately 5 min to complete the questionnaire on their smartphone.

### 2.2. Sample

A total of 1503 participants took the baseline questionnaire and 895 participants filled out at least one repeated measurement. Fifty nine measurements were deleted as participants indicated that they were not planning to eat a meal at the meal moment of interest. This resulted in the deletion of three participants that remained with zero completes for the repeated measurements, resulting in a final sample of 892 participants for the repeated measurements analyses. Table 2 shows an overview of the number of times participants filled in the repeated measurements.

The baseline sample (N = 1503) included 58% females with a mean age of 44.3 (12.7) years. Education level was distributed as follows: 13.4% low, 36.2% medium and 50.4% high. The repeated measurements sample (N = 892) included 62% females. Age ranged from 18 to 65 years with a mean of 44.3 (12.7) years. Education level was distributed as follows: 11.2% low, 34.8% medium and 54.0% high. The study was approved by the Social Sciences Ethics Committee of Wageningen University & Research and the study complies with the Netherlands Code of Conduct for Research Integrity.

**Table 2**
Overview of the number of times participants filled in the repeated measurements.

| Amount of entries | Number of participants | Percentage of total |
|---|---|---|
| 1 | 109 | 12.2 |
| 2 | 95 | 10.7 |
| 3 | 78 | 8.7 |
| 4 | 58 | 6.5 |
| 5 | 56 | 6.3 |
| 6 | 99 | 11.1 |
| 7 | 107 | 12 |
| 8 | 136 | 15.2 |
| 9 | 154 | 17.3 |

### 2.3. Measures

#### 2.3.1. Baseline questionnaire

The baseline questionnaire started with the screening and background questions to meet the sample criteria. *Demographic characteristics*, including gender, age, education and region, were asked to recruit a national representative sample. In addition, participants were asked whether they possessed a smartphone. Moreover, the frequency of taking breakfast, lunch and dinner was asked. After these selection questions, individuals were judged on eligibility and were screened out if necessary. Eligible individuals continued with a range of questions on their personal characteristics (between-individual predictors). *Intrinsic motivation to eat healthily* (α=.884) was measured with six items based on Kato, Iwanaga, Roth, Hamasaki, and Greimel (2013). *Self-efficacy regarding healthy eating* (α=.869) was measured with the seven items of the healthy eating self-efficacy scale, developed by Wilson-Barlow, Hollins, & Clopton, 2014. *Opportunity to eat healthily* was measured with two scales. *Physical opportunity* (α=.891) was measured with four items based on Bos, van der Lans, van Rijnsoever, and van Trijp (2015) to measure availability of healthy food. *Social opportunity* (α=.756) was measured with four items based on Lea and Worsley (2001) who developed a scale to measure social context as a barrier for healthy eating. All individual characteristics were measured on a 7-point Likert answering scale ranging from totally disagree (1) to totally agree (7).

#### 2.3.2. Repeated questionnaire

*Openness to a range of healthy eating strategies* was measured with 17 items based on Verain, Dagevos, and Antonides (2015) and Verain et al., (unpublished results a) on a 7-point scale ranging from not at all (1) to very much (7). Example questions are: “How open are you at this moment for the following options to apply to your breakfast/lunch/dinner?” “Eat more vegetables”, “eat less red meat”, or “choose a light product”. Next, the respondents were asked about the

**Table 1**
The order of meal moments assigned to the 6 conditions by using a Latin Square design.

| *Condition* | Week 1 | | | Week 2 | | | Week 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mon* | Tue | Thu | Mon | Tue | Thu | Mon | Tue | Thu |
| 1 | B** | L | D | D | B | L | L | D | B |
| 2 | B | D | L | L | B | D | D | L | B |
| 3 | L | B | D | D | L | B | B | D | L |
| 4 | L | D | B | B | L | D | D | B | L |
| 5 | D | B | L | L | D | B | B | L | D |
| 6 | D | L | B | B | D | L | L | B | D |

*Note.* *Mon = Monday, Tue = Tuesday, Thu = Thursday; **B = breakfast, L = lunch, D = dinner.

*social environment* (alone, with household, with family, with friends, with colleagues, other) and the *physical environment* (home, school, work, on the go, out of home, at someone else, other) in which the participant planned to eat the meal shortly after. Finally, participants were asked whether they planned to consume their breakfast/lunch/dinner shortly after they completed the questionnaire and to enter the *time* at which they planned to start with their meal. If the questionnaire had not been filled in just before the meal, a warning text popped up, asking the participant to make sure to fill in the questionnaire right before the meal the next time.

### 2.4. Data analysis

The data was analysed with SPSS version 25 and R version 3.6.1. First exploratory factor analyses (EFA) with Maximum Likelihood as the extraction method and oblique rotation (Oblimin) were performed in SPSS to check whether the same underlying factors could be distinguished as in Verain et al., (unpublished results a). For each of the respondents, only the first measurement moment was used in the EFA. Factor structure was checked for breakfast, lunch and dinner separately, and for the total of the three meal moments. Reliability of the resulting factors was checked with Cronbach's Alpha. A mean score per factor was computed by taking the average of the included items.

Next, a multilevel model has been used to analyse the data, because of the multilevel nature of the data with observation at different points in time nested within individuals. A multilevel model enables to judge between- and within-individual variations at the same time. The model can handle participants with missing data, as standard errors are appropriately adjusted for unbalanced designs (Schneider et al., 2012). A random intercept model was used to control for the correlated errors that result from coherence of the within-individual scores. The R-package lme 4-R was used for the random intercept models.

A series of three nested models was run for each of the identified healthy eating strategies separately. A baseline random intercept model (model 1) was estimated, with the respective healthy eating strategy as the dependent variable, and username as the random factor. The usernames were included as a random factor to generate a random intercept for every respondent. In a step-down procedure, the baseline model without any predictors was fitted (model 1) followed by a model with only within-individual predictors (model 2) and a model with within-individual and between-individual predictors (model 3). Meal moment (i.e. breakfast, lunch, dinner; dummy coded), social environment (i.e. alone, with others) and physical environment (i.e. at home, out-of-home) were included as within-individual (level 1) predictors. Intrinsic motivation, self-efficacy, physical opportunity and social opportunity were included as between-individual (level 2) predictors. The condition (1 thru 6; dummy coded) was included in the models to control for order effects. However, condition was not a significant predictor of the healthy eating strategies and also did not improve the fit of the model. Therefore, it was not included in the final model. All predictors were added to the model as fixed factors, to capture effects on averages across all participants. For each of the three healthy eating strategies, likelihood ratio tests were carried out to compare the three models, as well as a comparison of AIC and BIC.

## 3. Results

### 3.1. Identification of heathy eating strategies

The results of the exploratory factor analysis showed that three of the original factors, 'increasing healthy food', 'limiting unhealthy food' and 'light products', were found in our data for the different meal moments. Even though a few items did not consistently load high onto the expected factor for all meal moments, the similarity of the factors across the meal moments, the theoretical interpretation of the factors and the reliability led us to decide to continue analyzing with the three factors 'increasing healthy foods', 'limiting unhealthy foods' and 'light products'. Reliability analyses showed that all three factors had a medium reliability (Cronbach's Alpha>.6).[1] Limiting unhealthy food has a Cronbach's Alpha of .685 and consists of items on drinking less soda, drinking less alcohol, consuming less red or processed meat, not adding sugar to food or drinks, careful with adding salt and consuming less ready-to-eat meals. Increasing healthy food had a Cronbach's Alpha of .613 and consists of items on eating more vegetables, more fruits, more whole grain products, more plant-based proteins, more fish and drinking more water. Finally, light products had a Cronbach's Alpha of .633 and consists of items on consuming light products and low-fat (lean) or fat free products. The factor 'dietary pattern', which entails changing an individual's dietary pattern, was not found in our data. This makes sense, as changing a dietary pattern concerns the whole day and cannot be used as a healthy eating strategy at a single meal moment. Three items were deleted: 'eating smaller portions' because of inconsistent loadings, 'vary your diet' because it loaded onto the factor 'increasing healthy foods' where it theoretically does not fit and 'choosing healthy fats' because it substantially reduced the Cronbach's Alpha of the factor 'light product'.

Overall, the respondents indicated to be most open to decrease their amount of unhealthy foods, followed by increasing the amount of healthy foods (Table 3).[2] The mean of the openness to consume light products was the lowest, but the standard deviation was the highest, indicating that the within-individual differences were largest for this strategy. When looking at the different meal moments, the same order of openness to healthy eating strategies was observed for all three moments.

### 3.2. Personal and contextual differences in openness to healthy eating strategies

Variances between and within individuals have been examined for the three identified healthy eating strategies separately (Table 4). The percentage of the total variance that is attributable to within-individual differences and the Intra Class Coefficient (ICC) showed that context effects are most important for openness to increase healthy foods and least important for openness to use light products. The standard deviations (SD) within and between individuals revealed that openness to light products fluctuates most both within individuals over contexts and across individuals.

### 3.3. Model comparison for the healthy eating strategies

The next step was to examine to what degree adding within-individual predictors (level 1) and between-individual predictors

**Table 3**
Openness to healthy eating strategies per meal moment (means (SD)).

| | Total | Breakfast | Lunch | Dinner |
|---|---|---|---|---|
| *N* | 4862 | 1545 | 1647 | 1670 |
| Increasing healthy foods | 4.88 (1.15) | 4.59 (1.18) | 4.96 (1.13) | 5.08 (1.09) |
| Limiting unhealthy foods | 5.51 (1.17) | 5.59 (1.22) | 5.53 (1.18) | 5.41 (1.12) |
| Light products | 4.46 (1.71) | 4.60 (1.70) | 4.51 (1.70) | 4.30 (1.70) |

[1] Initially EFA revealed that the factor 'increasing healthy foods' was divided into two factors. However, the Cronbach's Alpha's of these separate factors were lower than when they were combined into one factor. Thus, we decided to keep 'increasing healthy foods' as one factor.

[2] NB: all repeated observations have been included to compute these means.

**Table 4**
Within- and between-individual variances for three healthy eating strategies.

| | Mean | SD | | Within-individual variance (%) | ICC |
|---|---|---|---|---|---|
| | | Between-individuals | Within-individuals | | |
| Increasing healthy foods | 4.88 | 0.865 | 0.752 | 43 | .57 |
| Limiting unhealthy foods | 5.51 | 0.927 | 0.718 | 37 | .63 |
| Light products | 4.46 | 1.452 | 0.886 | 27 | .73 |

*Note.* Number of observations = 4862; Groups (Username) = 892.

(level 2) to the three baseline models for increasing healthy food, limiting unhealthy food and light products would improve the model fit. As shown in Table 5, adding within-individual predictors to the baseline model significantly improved the fit for all three healthy eating strategies. Moreover, adding between-individual predictors further improved the fit significantly for openness to increase the consumption of healthy foods and openness to limit the consumption of unhealthy foods. However, for openness to consume light products results were ambiguous. Although the addition of between-individual predictors did lead to a significant increase in Chi-square, the BIC did not further decrease relative to the model with only within-individual predictors. This suggests that the more complex model with the two levels of predictors performs significantly better than the model with only within-individual predictors, although the BIC suggests that the improvement does not outweigh the increased complexity. For reasons of completeness, we report both within-individual and between-individual predictors for all three healthy eating strategies.

### 3.4. Between- and within-individual predictors of openness to healthy eating strategies

#### 3.4.1. Openness to increase healthy food

Results for the random intercept model are shown in Table 6. A number of within-individual predictors affected the level of openness to increase the consumption of healthy food. The level of openness to consume more healthy foods was predicted to be higher at lunch compared to breakfast (estimate = 0.38, SE = 0.03, p < .001), higher at dinner compared to breakfast (estimate = 0.47, SE = 0.03, p < .001), higher when with others compared to being alone (estimate = 0.07, SE = 0.03, p < .01) and lower when out of home compared to when at home (estimate = −0.07, SE = 0.03, p < .05).

Some of the between-individual predictors also significantly predicted openness to consume more healthy food. Higher levels of intrinsic motivation to eat healthy (estimate = 0.24, SE = 0.04, p < .001) and higher levels of self-efficacy to eat healthy (estimate = 0.18, SE = 0.04, p < .001) predicted higher levels of openness to consume more healthy foods.

**Table 6**
Random intercept model with first and second level predictors for increasing healthy food.

| | Estimate | *SE* | *t* | Confidence intervals | |
|---|---|---|---|---|---|
| | | | | 2.5% | 97.5% |
| Fixed effects | | | | | |
| Intercept | 2.56 | 0.21*** | 12.235 | 2.152 | 2.974 |
| Within-individual (first level) | | | | | |
| Meal Moment1 (breakfast, lunch) | 0.38 | 0.03*** | 13.618 | 0.329 | 0.440 |
| Meal Moment1 (breakfast, dinner) | 0.47 | 0.03*** | 16.300 | 0.411 | 0.524 |
| Social Environment (alone, with others) | 0.07 | 0.03** | 2.707 | 0.020 | 0.127 |
| Physical Environment (at home, out-of-home) | −0.07 | 0.03* | −2.356 | −0.136 | −0.012 |
| Between-individual (second level) | | | | | |
| Intrinsic Motivation | 0.24 | 0.04*** | 6.445 | 0.166 | 0.310 |
| Self-efficacy | 0.18 | 0.04*** | 4.754 | 0.107 | 0.258 |
| Physical Opportunity (availability) | 0.01 | 0.03 | 0.261 | −0.048 | 0.063 |
| Social Opportunity (social context as a barrier) | −0.05 | 0.03 | −1.857 | −0.101 | 0.003 |

*Note.* *$p < .05$; **$p < .01$; ***$p < .001$; p-values estimated via t-tests using the Satterthwaite approximations to degrees of freedom.

#### 3.4.2. Openness to limit unhealthy food

Results for the random intercept model are shown in Table 7. A number of within-individual predictors affected the level of openness to decrease the consumption of unhealthy foods. The openness to consume less unhealthy foods was predicted to be lower at dinner compared to breakfast (estimate = −0.14, SE = 0.03, $p < .001$) and lower when out of home compared to when at home (estimate = −0.1, SE = 0.03, $p < .01$).

In addition, some of the between-individual predictors significantly predicted openness to decrease the consumption of unhealthy foods. Higher levels of intrinsic motivation to eat healthy (estimate = 0.26, SE = 0.04, $p < .001$), higher levels of self-efficacy to eat healthy (estimate = 0.12, SE = 0.04, $p < .01$) and higher perceived barriers in the social context (estimate = 0.06, SE = 0.03, $p < .05$) predicted higher levels of openness to consume less unhealthy foods.

#### 3.4.3. Openness to consume light products

Results for the random intercept model are shown in Table 8. A number of within-individual predictors affected the level of openness to consume light products. Openness to consume light products was predicted to be higher at breakfast compared to dinner (estimate = −0.26, SE = 0.04, $p < .001$) and lower when out of home compared to when at

**Table 5**
Model comparison for the three healthy eating strategies.

| Model | Df | AIC | BIC | logLik | deviance | $\Delta X^2$ | $\Delta X^2$ Df | *p* |
|---|---|---|---|---|---|---|---|---|
| Increasing healthy | | | | | | | | |
| 1 (no predictors) | 3 | 12790 | 12809 | −6392 | 12784 | | | |
| 2 (level 1 predictors) | 7 | 12413 | 12458 | −6200 | 12399 | 384.99 | 4 | <.001 |
| 3 (level 1 & level 2 predictors) | 11 | 12251 | 12323 | −6115 | 12229 | 169.68 | 4 | <.001 |
| Limiting unhealthy | | | | | | | | |
| 1 (no predictors) | 3 | 12506 | 12526 | −6250 | 12500 | | | |
| 2 (level 1 predictors) | 7 | 12468 | 12513 | −6227 | 12454 | 46.61 | 4 | <.001 |
| 3 (level 1 & level 2 predictors) | 11 | 12340 | 12412 | −6159 | 12318 | 135.54 | 4 | <.001 |
| Light products | | | | | | | | |
| 1 (no predictors) | 3 | 14925 | 14944 | −7460 | 14919 | | | |
| 2 (level 1 predictors) | 7 | 14854 | 14900 | −7420 | 14840 | 78.45 | 4 | <.001 |
| 3 (level 1 & level 2 predictors) | 11 | 14850 | 14921 | −7414 | 14828 | 12.82 | 4 | <.05 |

**Table 7**
Random intercept model with first and second level predictors for limiting unhealthy food.

| | Estimate | *SE* | *t* | Confidence intervals | |
|---|---|---|---|---|---|
| | | | | 2.5% | 97.5% |
| Fixed effects | | | | | |
| Intercept | 3.14 | 0.26*** | 13.917 | 2.696 | 3.581 |
| Within-individual (first level) | | | | | |
| Meal Moment1 (breakfast, lunch) | 0.004 | 0.03 | 0.134 | −0.051 | 0.059 |
| Meal Moment1 (breakfast, dinner) | −0.14 | 0.03*** | −4.777 | −0.193 | −0.080 |
| Social Environment (alone, with others) | −0.03 | 0.03 | −0.919 | −0.078 | 0.028 |
| Physical Environment (at home, out-of-home) | −0.10 | 0.03** | −3.099 | −0.159 | −0.036 |
| Between-individual (second level) | | | | | |
| Intrinsic Motivation | 0.26 | 0.04*** | 6.441 | 0.178 | 0.334 |
| Self-efficacy | 0.12 | 0.04** | 2.798 | 0.035 | 0.197 |
| Physical Opportunity (availability) | 0.03 | 0.03 | 1.147 | −0.025 | 0.095 |
| Social Opportunity (social context as a barrier) | 0.06 | 0.03* | 2.106 | 0.004 | 0.116 |

*Note.* *$p < .05$; **$p < .01$; ***$p < .001$; p-values estimated via t-tests using the Satterthwaite approximations to degrees of freedom.

**Table 8**
Random intercept model with first and second level predictors for light products.

| | Estimate | *SE* | *t* | Confidence intervals | |
|---|---|---|---|---|---|
| | | | | 2.5% | 97.5% |
| Fixed effects | | | | | |
| Intercept | 4.18 | 0.37*** | 11.325 | 3.456 | 2.974 |
| Within-individual (first level) | | | | | |
| Meal Moment1 (breakfast, lunch) | −0.03 | 0.03 | −1.002 | −0.103 | 0.033 |
| Meal Moment1 (breakfast, dinner) | −0.26 | 0.04*** | −7.276 | −0.327 | −0.188 |
| Social Environment (alone, with others) | −0.01 | 0.03 | -.0288 | −0.076 | 0.057 |
| Physical Environment (at home, out-of-home) | −0.11 | 0.04** | −2.789 | −0.186 | −0.032 |
| Between-individual (second level) | | | | | |
| Intrinsic Motivation | 0.00 | 0.06 | 0.016 | 0.126 | 0.129 |
| Self-efficacy | 0.07 | 0.07 | 0.960 | −0.068 | 0.198 |
| Physical Opportunity (availability) | 0.11 | 0.05* | 2.150 | 0.009 | 0.205 |
| Social Opportunity (social context as a barrier) | −0.10 | 0.05* | −2.153 | −0.193 | −0.009 |

*Note.* *$p < .05$; **$p < .01$; ***$p < .001$; p-values estimated via t-tests using the Satterthwaite approximations to degrees of freedom.

home (estimate = −0.11, SE = 0.04, $p < .01$).

In addition, some of the between-individual predictors significantly predicted openness to consume light products. Higher perceived physical opportunity (better availability) (estimate = 0.11, SE = 0.05, $p < .05$) and lower perceived barriers in the social context (estimate = −0.10, SE = 0.05, $p < .05$) predicted higher levels of openness to consume light products.

## 4. Discussion

Individual differences in dietary habits and underlying sociopsychological characteristics have been investigated extensively (e.g. Geeroms, Verbeke, & Van Kenhove, 2008; Verain et al., 2020). However, the situational context in which dietary choices take place have been largely overlooked, even though we know that the consumption context plays an important role in food choice (Edwards, Meiselman, Edwards, & Lesher, 2003; King, Meiselman, Hottenstein, Work, & Cronk, 2007; King, Weber, Meiselman, & Lv, 2004; Meiselman, 2006). Currently, the importance of considering the context when studying health behaviours such as healthy food consumption is increasingly being acknowledged by scientists (Inauen et al., 2016; Millar, 2017; Scholz, 2019). The current study addressed this research gap by considering both within- and between-individual characteristics in studying an individual's openness to apply healthy eating strategies.

### 4.1. Openness to healthy eating strategies

Three healthy eating strategies have been identified in the current study: increasing the consumption of healthy foods, limiting the consumption of unhealthy foods and consuming light products. The identified strategies are in accordance with the work by Verain et al., (unpublished results a), who developed the Openness to Healthy Eating Strategies Scale, with one exception: the original scale identified an additional strategy, called moderation, concerning the frequency and portion size of food intake. A possible reason that this strategy was not identified in the current paper is the difference in data collection. The original paper investigated openness to healthy eating strategies on a general level, whereas the current paper applied the scale to measure the openness in specific contexts and at different times of the day. The moderation strategy may be a more general strategy that transcends individual contexts, and that determines when and how much to consume across the day.

Overall, when looking at the three healthy eating strategies, individuals were most open to limit their amount of unhealthy foods, followed by increasing the amount of healthy foods. Openness to consume light products was lowest. This was found for all meal moments (breakfast, lunch and dinner). In the study by Verain et al., (unpublished results a), respondents indicated to be more open to increase healthy foods than to limit unhealthy foods. Again, the difference in level of measurement (general versus for a specific context) may explain the difference in these findings. When responding in general, people may aim to increase the amount of healthy foods they eat, but when reporting in a specific context and at a specific time, unavailability of healthy foods or not being in the mood to consume a certain healthy product may be barriers, which may make it easier to limit unhealthy consumption instead of increasing healthy consumption.

### 4.2. Personal and contextual differences in openness to healthy eating strategies

The results show that in understanding openness to all three healthy eating strategies, context(within-individual predictors) is important to consider. In other words, openness to healthy eating strategies fluctuates within a person, over the day, across different contexts. This is in line with what could be expected based on existing literature. Inauen et al. (2016) showed that even 50% of the variance in intention to avoid unhealthy snacking can be attributed to within-individual differences. Although we found slightly smaller percentages, we draw the same conclusion that within-individual differences are highly relevant in studying healthy eating. The ratio of differences across contexts versus across individuals shows that context is relatively most important for increasing healthy foods, and least important for light products.

### 4.3. Personal and contextual predictors of openness to healthy eating strategies

#### 4.3.1. Personal predictors of openness to healthy eating strategies

When looking at personal (between-individual) predictors of openness to healthy eating strategies, we found that, in accordance with our first two hypotheses, intrinsic motivation and self-efficacy towards healthy eating are relevant for increasing the consumption of healthy foods and decreasing the consumption unhealthy foods, but not for consuming light products. In contrast, the hypothesis that the physical opportunity to eat healthy positively affects an individual's openness to implement healthy eating strategies has only been confirmed for the consumption of light products. That this has not been found for increasing healthy foods and limiting unhealthy foods goes against the work by Brug (2009) and Trapp et al. (2015) who both emphasized the importance of availability of healthy foods. Apparently, the general availability of healthy foods is not predictive of in-context openness to those two strategies. Possibly because the physical opportunity cannot be considered as stable trait and is therefore better represented in the specific physical environment (home or out-of-home) of a particular consumption moment. The hypothesis that the social opportunity to eat healthy positively affect an individual's openness to implement healthy eating strategies has only been confirmed for the consumption of light products. For limiting unhealthy foods, even an opposite effect is found, with a higher openness to limiting unhealthy foods when the social context is more perceived as a barrier to consume healthy foods. This finding is difficult to explain, but possibly consumers who are motivated to have a more healthy diet find it easier to limit unhealthy foods than to increase healthy foods when the social context is not very supportive of healthy eating. Further research is needed to better understand this finding.

#### 4.3.2. Contextual predictors of openness to healthy eating strategies

The meal moment, the location and the social context of consumption are all found to be relevant to better understand fluctuations in openness to healthy eating strategies within individuals across the day. More specific, individuals' openness to eat more healthy foods is higher at lunch and dinner compared to breakfast. In contrast, openness to limit unhealthy foods and the consumption of light products is higher at breakfast compared to dinner. These insights nuance the literature, stating that health is more relevant for predicting food choices at breakfast than at lunch or dinner (Peters, Rappoport, Huff-Corzine, & Nelsen, 1995; Rappoport et al., 2001). This seems true for the healthy eating strategies limitation of unhealthy eating and consuming light products, but not for increasing healthy foods. Our findings partly confirmed the hypothesis that healthy eating strategies differ within individuals between meal moments, with a positive effect of breakfast and lunch and a negative effect of dinner. As expected, openness to healthy eating strategies varies across meal moments, but the positive effect of breakfast was only found for limiting unhealthy foods and consuming light products.

Our hypothesis that openness to healthy eating strategies differs within individuals between different physical eating environments, with a positive effect of being at home and a negative effect of being out-of-home was confirmed. Additionally, the hypothesis that the openness to healthy eating strategies differs within individuals between different social eating environments, with a positive effect of being alone and a negative effect of being with others has not been confirmed.

### 4.4. Implications for stimulating healthy eating

The main implication of this study is that in stimulating individuals to apply healthy eating strategies, it is important to consider which healthy eating strategy best matches the person in a particular context, as we found that both individual factors and contextual factors predict an individual's openness to apply a certain healthy eating strategy. This suggests that it could be beneficial to promote the implementation of multiple healthy eating strategies by the same person in different contexts. Literature indicated that although some people have a clear dominant strategy, most individuals use multiple strategies, depending on the situation (Falk, Bisogni, & Sobal, 1996; Falk et al., 2001; Sobal et al., 2006). Using multiple strategies seems beneficial, as it enables individuals to better adapt to different food choice contexts (Falk et al., 1996).

Our findings on the between-individual predictors imply that it is valuable to develop strategies that aim at increasing intrinsic motivation and self-efficacy regarding healthy eating to stimulate healthy food consumption. For instance, according to a meta-analysis by Prestwich et al. (2014) an effective behavioural change technique to increase dietary self-efficacy is stress management.

Additionally, with regard to contextual differences, stimulating individuals to consume more healthy foods is most promising at lunch and dinner compared to breakfast. In contrast, stimulating a limitation of unhealthy foods and the consumption of light products is most promising at breakfast compared to dinner. Furthermore, our study showed that all healthy eating strategies are most promising to be promoted when individuals consume at home and interventions focusing on increasing healthy foods are most promising in situations in which individuals consume alone. The presence of others was not predictive of limiting unhealthy foods or promoting light products, which suggest that these healthy eating strategies are more individual choices, whereas increasing healthy foods is more dependent on present others. This makes sense as consuming healthy foods is often a matter of meal choice, which is similar for all those joining at the table, whereas limiting unhealthy foods can be a matter of portion size, or avoiding one of the meal components, which can more easily be made on an individual level. Also consuming light products is more often an individual choice, specifically when it entails the choice for light beverages.

The results of this study can be valuable in the development of personalized nutrition services. Considering both individual characteristics and contextual factors can help to tailor nutrition advice in such a way that the content best matches with the preferred strategy of the person in that particular context, and as such lead to the most effective advice (Celis-Morales, Lara, & Mathers, 2015; Macready et al., 2018; Rimer & Kreuter, 2006). Betts and Gonzalez (2016) even argued that within-individual differences across the day could be more important to consider in personalized dietary advice than the differences across people.

### 4.5. Limitations and future research

This study has some limitations which should be addressed in future research. First of all, the repeated measurements that we used may have only partly uncovered contextual differences in openness to apply healthy eating strategies. For example, snack moments have not been researched in this study. It would be interesting to research openness to healthy eating strategies for snacking moments as well, as other studies have shown that motivations are different for snacking as compared to main meals (Onwezen et al., 2012; Phan & Chambers, 2016; Phan & Chambers, 2018; Verain et al., 2018, unpublished results b). Also, snacking differs from main meals in what types of food products are consumed. The physical environment may be more important for snacking as compared to main meals, as research showed that availability of unhealthy foods particularly leads to unhealthy eating behaviour at night (Millar, 2017). Therefore, different healthy eating strategies may be more prevalent for snacking versus main meals. Reduction of unhealthy foods might be a more relevant healthy eating strategy for snacking for example.

Similarly, this study focused on weekdays only, but the distinction between week days and weekends might also be interesting to study. Future research could therefore focus on fluctuations in openness to apply healthy eating strategies not only during the day but also during

the week. This is particularly interesting as social opportunities for various temptations to eat unhealthy typically arise more often on Thursday, Friday, and Saturday nights (Dvorak, Pearson, Sargent, Steverson, & Mfon, 2016).

Furthermore, the measurements that we used in our study were self-reported. Even though our study design tried to minimize response bias by asking participants about their situation at that specific time, participants may have exhibited social desirability in their reporting of openness to healthy eating strategies. Future research could test whether the results that we obtained in this study can be replicated when healthy eating strategies are measured more objectively, for example, by taking actual behavioural food choices into account.

Finally, future research can focus on how insight into between- and within-individual differences in their openness to healthy eating strategies could be implemented in nutrition advice. For example by tailoring the advice both to the individual (or consumer segments) and to the meal moment, location and social context. We believe that there is a lot of room for improving (personalized) dietary advice by making it more context specific.

## 5. Conclusion

This study shows the importance of considering contextual predictors in understanding an individual's openness to apply several healthy eating strategies. More specific, the added value is shown of including meal moment, location and social context, in addition to personal predictors (motivation, social and physical opportunity and ability) in understanding an individual's openness to increase the consumption of healthy foods and to decrease the consumption of unhealthy foods. Insights gained from this research increased our understanding of an individual's openness to apply healthy eating strategies. Providers of dietary advice can benefit from these insight by both considering individual differences as well as contextual differences in the development of personalized or tailored healthy eating advice.

## Data sharing statement

The anonymous dataset is available with the authors, upon reasonable request.

## Ethical statement

Informed consent was obtained from all individual participants included in the study. The study was reviewed and approved by the Social Sciences Ethics Committee of Wageningen University & Research, and the study complies with the Netherlands Code of Conduct for Research Integrity.

## CRediT authorship contribution statement

**Muriel C.D. Verain:** Conceptualization, Methodology, Writing – original draft. **Emily P. Bouwman:** Conceptualization, Methodology, Formal analysis, Writing – review & editing. **Joris Galama:** Conceptualization, Writing – review & editing. **Machiel J. Reinders:** Conceptualization, Methodology, Writing – review & editing.

## Declaration of competing interest

None.

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