Personality and Situation Predictors of Consistent Eating Patterns

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Abstract

Introduction

A consistent eating style might be beneficial to avoid overeating in a food-rich environment. Eating consistency entails maintaining a similar dietary pattern across different eating situations. This construct is relatively under-studied, but the available evidence suggests that eating consistency supports successful weight maintenance and decreases risk for metabolic syndrome and cardiovascular disease. Yet, personality and situation predictors of consistency have not been studied.

Methods

A community-based sample of 164 women completed various personality tests, and 139 of them also reported their eating behaviour 6 times/day over 10 observational days. We focused on observations with meals (breakfast, lunch, or dinner). The participants indicated if their momentary eating patterns were consistent with their own baseline eating patterns in terms of healthiness or size of the meal. Further, participants described various characteristics of each eating situation.

Results

Eating consistency was positively predicted by trait self-control. Eating consistency was undermined by eating in the evening, eating with others, eating away from home, having consumed alcohol and having undertaken physical exercise. Interactions emerged between personality traits and situations, including punishment sensitivity, restraint, physical activity and alcohol consumption.

Conclusion

Trait self-control and several eating situation variables were related to eating consistency. These findings provide a starting point for targeting interventions to improve consistency, suggesting that a focus on self-control skills, together with addressing contextual factors such as social situations and time of day, may be most promising. This work is a first step to...
Introduction

Consistent behaviour can be life-saving. For example, when driving a car, the goal is to stay consistently in the lane. That task can be quite challenging—single vehicle road departure accidents cause a third of all driving fatalities in Europe and the US [1,2]. Factors undermining driving consistency depend on both the driver and the situation; these factors include driver inattentiveness and fatigue, driving under the influence of alcohol, weather conditions, and having several people in car [3]. Modern cars monitor these factors with electronic assistance systems to help drivers stay on track (e.g., [4,5–9]).

Consistent behaviour can be just as beneficial in eating regulation. One example of consistency is having meals at similar times of a day. This has been recommended as a part of the 10 Top Tips intervention for weight loss, as consistency is expected to encourage healthy habit development [10]. In addition, eating behaviors can be consistent in terms of maintaining a similar dietary pattern across different eating episodes. This does not imply having exactly the same food every day. Rather, people can have varied individual food items as recommended, for example, in the American Dietary Guidelines [11], but their day-to-day meals are consistent in terms of energy content and healthiness. Consistency in these dimensions is likely to support healthy eating [12–14], and are the focus of the current study.

Being consistent with regards to food intake might be particularly difficult in the current food environment, in which cheap calories are widely available [15–18], and aggressively marketed [19]. Humans implicitly value higher-calorie foods, so the availability of food and its marketing might divert people from their typical eating patterns. While thriftily acting upon food cues, and thus deviating from typical eating patterns, might have been beneficial in a distant past marked by food scarcity ([20,21], c.f., [22]), in today’s world full of appetitive temptations, over-reliance on external food cues can be a disadvantage [23–26].

There is some evidence that the ability to maintain consistent eating regardless of the food environment may be adaptive. For example, Pachucki [27] recently compared the obesity risk of participants with different diet trajectories. Body mass index (BMI) levels were largely the same for participants with consistent trajectories or participants making a healthy change in diet. Participants with inconsistent trajectories or making an unhealthy change in diet were considerably more likely to have a higher BMI (Table 5 in [27]). Another study concluded that participants eating a similar number of calories each day have lower body fat percentage, lower fat and energy intake compared to those with more inconsistent caloric intake [28]. Self-reported eating consistency is associated with an array of more general health benefits, including successful weight maintenance [29–31] and lower risk for metabolic syndrome [32].

Despite the health benefits of eating consistency, the determinants of this behaviour are largely unknown. Understanding any behaviour requires considering both person-related and environment-related variables [33]. This approach has already proved fruitful to explain driving consistency [3]. Therefore, the goal of the current study is determine the person and situation factors predicting eating consistency. Knowing the determinants of eating inconsistency can lead to more informed methods for designing interventions.

Person factors include any characteristic of the person, including age, body weight, and psychological traits. One study on eating consistency suggests that males and older people are...
more consistent [34]. However, more complex psychological person factors of eating consistency have not been studied. Usually, these person factors are analysed in the framework of personality traits—aggregate summaries of what people want, say, do, feel, or believe [35,36]. Based on personality-consistency studies from other behavioural domains [37–40] and our own recent review of personality predictors of BMI [41] we hypothesize that traits facilitating reactivity to environment (punishment sensitivity, reward sensitivity) will be associated with decreased consistency, and traits associated with self-control will be associated with increased consistency.

Situations refer to features of the environment that influence human behaviour. Many studies have demonstrated that changes in situations can result in surprisingly robust changes in eating behaviour (e.g., [42,43,44]). However, the evidence is quite scattered—unlike in the field of personality, a coherent, widely-accepted taxonomy of eating situations has yet to emerge (c. f., [45,46]). In the current study, we focus on a few situation factors that have been shown to influence eating: eating outside the home, eating with others and alcohol consumption have all been shown to increase food consumption (e.g., [47,48–50]). These situations involve being in novel situations, and having fewer attentional resources available for conscious control (e.g., [51]). As a result, one could expect that in these situations a more automatic reaction to environmental food signals could trigger a reduction in eating consistency. Physical activity has also been suggested to increase palatability of food and change food intake, especially in women [52,53]. However, such changes in intake might not be necessarily maladaptive. According to a recent interpretation, being physically active leads to better responsiveness to one’s energy needs [54]. Therefore, physical activity could cause eating inconsistency, but this might be an appropriate response. The same logic applies for physical work (e.g., [55]).

Other studies suggest an influence of time. There is some evidence showing that people are less consistent on weekends than on weekdays (see [56] for an overview). Consistency could also be lower in the evening, as Baumeister and Heatherton propose that people are more likely to break their diet later during the day because they are fatigued and have fewer self-control resources available [57]. This view has been challenged by Bandura who proposes that self-regulation failure is instead caused by the particular situations the person is in (e.g., drinking alcohol). The evening effect emerges because such situations are more common later in the day [58].

Finally, some of the aforementioned situations are also known to interact with personality traits. For instance, restrained persons are known to consume less food when they have consumed alcohol [49,59]. Similarly, overweight and restrained persons tend not to increase their food intake after exercise [53]. Therefore, restraint could reduce the effects of alcohol consumption and physical activity on consistency.

In sum, we believe that eating consistency is an under-studied behavioural phenotype relevant to supporting various positive health outcomes. The current study seeks to explore how this phenotype is influenced by person and situation factors known to influence eating and consistency in general. In particular, we test the predictive properties of various personality tests and situations on eating consistency measured by the Experience Sampling Method (ESM).

Methods

Participants

195 white adult women were initially recruited from the general population of Montreal by local advertisement. Complete data on ESM and personality were available for 139, forming the final sample used for the majority of analysis. The age range was wide (mean years = 44.9,
SD = 17.8, ranging from 18 to 75), and, based on body mass index (BMI, kg/m²) [60,61], most women were of normal weight (mean BMI = 22.8, SD = 3.2, ranging from 16.6 to 32.7). When only personality questionnaires were analysed in section Factor analysis of personality traits, we used an extended sample, as personality questionnaire data were available for 164 women (mean age in years = 45, SD = 18, mean BMI = 22.8, SD = 3.1). The ethics committee of McGill University approved the protocol. All participants provided written, informed consent before engaging in a series of experiments, and received monetary compensation for their participation. The data were collected as part of a broader study on age differences in affect, emotions, and lifestyle behaviours in women.

Methods for measuring consistency

Determining an individual’s consistency rate is labour-intensive, as proper measurement involves sampling eating behaviour across multiple days. Early studies objectively measured food intake and reported that some people vary more in day-to-day food intake than others [28,56,62–67]. Other research has analysed repeated dietary recall measures. Here, lack of consistency is often considered as noise ([68–73], reviewed in [74]). Only one study explicitly considered variation, finding that only a third of people remained consistent during the study period [27]. Finally, a few studies asked people to estimate their consistency with single items asking about regularity or similarity of meals [29–32]. While these measures are less accurate, self-assessments of behavioural consistency have nonetheless been shown to relate strongly to objective measures of behavioural consistency [75].

Here, we studied consistency in a dataset [76] gathered with the Experience Sampling Method (ESM). ESM provides, for the same individual, repeated snapshots of a particular eating behaviour in typical everyday contexts in a reliable and valid form (e.g., [77]) and has been used previously in studies of eating behaviours and self-control (e.g., [78,79,80]). ESM provides a reasonable trade-off as a measure of eating consistency, offering more accuracy and ecological validity than single questions [31,32], but being less labour-intensive and intrusive than precise weighing of food intake [28,56] or repeated assessment of food intake with food-frequency questionnaires [27] or daily recalls [70].

Data Collection with the Experience Sampling Method

The study lasted 19 days, with participants sampling their behaviour every other day. During the 10 ESM observation days, participants were prompted 6 times a day by an electronic beeper to fill out a short paper-and-pencil questionnaire concerning their emotional states, meals eaten, and situational setting in the previous 2 hours. Participants also had to note the time and day of the event. In total, 9365 observations were made and 3950 meal episodes were reported. The number of meal episodes included in the analysis was reduced because of incomplete data (n = 889) and inconsistent timestamps (i.e., first episode taking place 18:00 and second 10:00, n = 281). A large proportion of the remaining 2780 episodes had timestamps completely missing (n = 651). To avoid losing power when time is involved in the analysis, we used the number of the prompt in a day (1–6) as a proxy measure for time in the final analysis, as these indicators were highly related (see section Descriptive statistics of situations). Therefore, 2780 meal episodes were included in the final analysis (20.0 episodes per participant). In the overall dataset, there was little variation for different days of the week—Tuesday had the fewest episodes (13.0%), whereas Saturday had the most episodes (15.6%). Mean percentage per weekday was 14.3%, SD = 0.8%. On the individual level, most participants expectedly had more meal episodes from weekdays than from weekends or holidays. The average ratio (n weekend+n holiday) / n weekday was 0.52 (SD = 0.25). The ratio was more extreme in a few participants with
fewer than 10 meal episodes—the ratio was 2.0 for 2 participants, and 0 for 1 participant. Generalized linear mixed models (GLMM) are robust to unbalanced data, and excluding these participants did not change the analysis; we therefore report the analysis that included them. Further details of the ESM procedure, as well as the effects of emotional states have been reported in a previous analysis [76].

**Developing an ESM measure of eating consistency.** To assess eating consistency, we asked participants to rate the perceived nutritional quality and quantity of each meal in comparison with their own corresponding baseline meal for breakfast, lunch, or dinner. The baseline was established during an introductory, face-to-face session. Participants were first asked to describe their own typical food choice for each of the three main meals (breakfast, lunch, and dinner). The experimenter provided information about the nutritional and caloric quality of the food each participant typically consumed on each meal occasion [81]. The experimenter then explained to participants that, throughout the entire study, they should indicate the relative nutritional quality of the meal being reported by comparing that particular meal with the baseline, “typical” meal they described at this introductory session. While people can be systematically mistaken about the actual caloric content, they are still able to judge different meals in terms of their relative caloric content [82]. Therefore, they should be able to tell when meals differ from their regular meal. Detailed characteristics of a typical meal (weekend or weekday, typical situations) were not obtained in the current study as this provided a simpler reference point for participants, and avoided making participants aware of the detailed study objectives. The specific questions asked in ESM were, “In the last 2 hours . . . If you have eaten a meal, . . . how does this meal compare to the typical meal you generally take at the same time of the day in terms of composition (i.e., the types of food you had): same as usual, healthier food than usual, or less healthy food than usual.” Similar question was asked about perceived meal size (i.e., same as usual, smaller, or larger than the baseline meal). A meal was considered to be consistent if was similar to baseline in terms of both quality and quantity (coded 1), and inconsistent (coded 0) if not. The composite index is depicted in Fig 1, along with the frequency of various behaviours.

**ESM measures of situations.** Social setting was assessed with two indicators. Participants were asked to indicate the location of the meal they were reporting—responses were coded “0” if they were home, and “1” if they were away from home. When they had eaten a meal within the last 2 hours, they had to indicate if the meal was alone (“0”) or with others (“1”). Information about physical activity and alcohol was gathered with the following questions: “In the last 2 hours . . . Have you done leisure physical activities not related to work? Have you done physical activities related to work? Have you had an alcoholic drink(s)?” Responses were either “yes” scored as “1” or “no” scored as “0”.

**Questionnaire measures of persons**

At enrolment, participants were given a set of questionnaires that they completed at home and returned at the next session. Based on previous evidence that several questionnaires can capture similar underlying mechanisms [83–86], we also expected similar overlap here. The current analysis included various questionnaires known to relate to obesity or other maladaptive eating behaviours [25,41,87–93]: punishment sensitivity (Neuroticism, behavioural inhibition, sensitivity to punishment, emotional eating), reward sensitivity (external eating, reward sensitivity, and Extraversion), and self-control (Conscientiousness, impulsivity, restraint).

The Big Five Inventory (BFI, [94]) is a 44 item questionnaire capturing the broad personality dimensions of the Five-Factor Model. Here three dimensions were included—Neuroticism
(\(\alpha = 0.83\)), Extraversion (\(\alpha = 0.82\)), and Conscientiousness (\(\alpha = 0.82\)) that commonly relate to eating behaviours [41,88,95].

Behavioural Inhibition System and Behavioural Activation System Scales (BIS/BAS, [96]) is a questionnaire designed to measure Gray’s behavioural inhibition and behavioural activation systems [97], also known as punishment and reward sensitivity. The BIS scale has 7 items (\(\alpha = 0.74\)). The BAS scale divides into three sub-dimensions—reward responsiveness (5 items, \(\alpha = 0.74\)), drive (4 items, \(\alpha = 0.89\)), and fun-seeking (4 items, \(\alpha = 0.84\)), which may provide more detailed insight into the mechanisms of the Behavioural Activation System.

The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ, [98]) is a newer measure of Gray’s traits. Both sensitivity to punishment (\(\alpha = 0.84\)) and sensitivity to reward (\(\alpha = 0.72\)) subscales have 24 items with yes-no answers. In comparison to BAS scales, the sensitivity to reward scale focuses on specific rewards, whereas BAS scales focus on non-specific rewards [98].

The Barratt Impulsiveness Scale-11 (BIS-11, [99]) is a 30 item widely used impulsivity measure. In the current study, the BIS-11 was inadvertently administered with a yes-no scale instead of the usual 1–4 response scale. Therefore, only the total score was used from the scale (\(\alpha = 0.77\)). Nevertheless, the scale maintained its measurement range—the BIS-11 total score replicated known correlations with other scales, such as Conscientiousness (\(r = -0.52\), c.f., [84]), and with impulsive behaviour, such as alcohol consumption (\(r = 0.27\), c.f., [100]). The

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**Fig 1. Composite index of consistency.** A meal was considered consistent, if it was similar to the regular meal (black circle). If the meal was smaller, larger, healthier, or unhealthier than the regular meal, it was considered inconsistent (grey circle). Percentages denote the rates of various behaviours. The sum of percentages is more than 100% as several inconsistent behaviours could occur at the same time.

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BIS-11 was included in the study, as impulsivity is an important trait explaining other eating behaviours [41,92].

Weekly alcohol consumption was measured with items from the Canadian Community Health Survey [101]. Participants indicated how many drinks they have had in the previous seven days. The responses were averaged across days ($\alpha = 0.72$).

The Dutch Eating Behaviour Questionnaire (DEBQ, [102]) is a 33 item questionnaire distinguishing three dimensions: restraint ($\alpha = 0.90$), external eating ($\alpha = 0.84$), and emotional eating ($\alpha = 0.96$). The test was adapted and reproduced by permission of Boom test publishers, Amsterdam, the Netherlands.

The Restraint Scale [103] is another measure of restraint that discriminates between concern for dieting (CD) and weight fluctuation (WF) tendencies. Although the original Restraint Scale was administered, the scoring method of the revised 8 item version (RS-8, [104]) gave better Cronbach alphas (CD: $\alpha = 0.67$, WF: $\alpha = 0.77$) in the current study and was therefore substituted.

**Statistical Analysis**

To provide an overview of the ESM dataset, we first provide descriptions of consistency, situations, and how they vary in time. We also inspected the relationship between time, prompt number and consistency to demonstrate that prompt number (i.e. 1–6) could be used as a proxy for time.

The many eating-related personality traits that have been identified may in fact reflect a smaller number of shared underlying traits [41,85,86]. To capture the underlying traits, we factor analysed personality trait scores and used factor scores to predict consistency. This approach also reduces the number of potentially multicollinear predictors in a regression model.

Probability of consistent behaviour was predicted by generalized linear mixed models (GLMM with binomial family and logit link). GLMM allows for more flexibility than generalized linear models by allowing a hierarchical data structure. In the current dataset, both consistency and situations have been measured multiple times within person. GLMM allows studying the effect of situations on consistency at each event, while controlling for mean individual differences in consistency across participants. To achieve that, participants are entered into the model as random factors. We ran a step-wise approach, gradually increasing model complexity by adding new parameters or specifications and then determining if the increased model complexity resulted in a substantially better explanation of consistency. The first modelling step was determining the appropriate random intercepts—we tested if the null model would improve if we added random intercepts for persons, accounting for the individual differences in the mean levels of consistency across all episodes. After determining the relevance of random intercepts, the next steps were adding control and personality variables as fixed effects, adding time and situations as fixed effects, adding time and situations as random slopes (i.e., testing if the slope of an effect varies from person to person), and adding two-way interactions. The model complexity-explanatory power trade-off were assessed with Akaike Information Criterion (AIC) and Bayes Information Criterion (BIC)—additional predictors were only retained in the model if the new model resulted in a lower AIC and/or BIC compared to the previous model. To facilitate comparison of the relative effect sizes of continuous personal factors vs binary situations we also present results in a standardized manner as advocated by Gelman [105]—all continuous variables were scaled by dividing them by two standard deviations. All variables were also centered to have a mean of 0 for easier interpretation of interactions.
All analysis was conducted in the R environment 3.2.0 [106]. Factor analysis was conducted with "psych" package [107], general multi-level modelling with "lme4" package command glmer() [108], and subsequent standardizing with "arm" package [109]. For data manipulation and plotting we further depended on packages, such as "plyr", "sjPlot", "ggplot2", "effects", "streamgraph", and "gridExtra" [110–115].

**Results**

**Individual and time differences in consistency**

First, we tested for individual differences in consistency. To plot these differences (Fig 2), we calculated the mean scores of consistency for each participant, and found considerable variation in consistency (mean = 57.6%, SD = 23.5, ranging from 0–100).

To inspect the role of time, we aggregated the mean consistency rate for each full hour (7–24) and for each prompt (1–6). We excluded hours 1–6, as these had very few observations (n = 19). As can be seen in Fig 3, consistency starts high in the morning, but there is a considerable decrease thereafter. The decrease is considerably slower in the evening period. As prompt number was highly correlated with time of day (r = 0.85), the prompt plot shows a similar tendency (Fig 4). To account for non-linearity and to reduce data complexity, prompts were recoded into a binary time variable—prompts 1–2 were coded as 0, i.e. morning (mean hour = 10.5, SD = 2.2), and prompts 3–6 were coded as 1, i.e. evening (mean hour = 17.3, SD = 3.6). This morning-evening dichotomy approach is common in other work on the effect of time of day on behaviour (e.g., [116]). After accounting for the effect of morning vs evening on consistency (OR = 0.42, 95% CI [0.36, 0.5]), there was no additional effect of weekday vs holiday or weekend day (OR = 0.88, 95% CI [0.75, 1.04]).

**Descriptive statistics of situations**

We assessed the prevalence of various types of eating situations—in 49.6% of episodes participants ate with others, in 26.6% episodes they were away from home, in 6.8% of episodes participants had consumed alcohol, in 34.3% episodes they had exercised, and in 12.2% episodes they had undertaken physical work prior to the eating event. In 39.6% of eating episodes, at least two situational factors were present (e.g., away from home and with others). At the same time, 22.2% of eating episodes were eating-only—there was no other situational factor present. Fig 5 shows the count of various types of eating situations at different times of day. We tested if prevalence of these situations was predicted by binary time variable. As suggested by Bandura, drinking alcohol (OR = 14.17, 95% CI [7.43, 31.48]), being away from home (OR = 1.22, 95% CI [1.02, 1.46]), and being in social situations were more likely in the evening (OR = 2.74, 95% CI [2.34, 3.23]), whereas eating-only situations were less likely (OR = 0.91, 95% CI [0.89, 0.94]). Only physical exercise (OR = 0.99, 95% CI [0.84, 1.17]) and physical work (OR = 1.19, 95% CI [0.94, 1.52]) were equally likely throughout the day. Therefore, time is an important covariate when studying the effects of situations.

**Factor analysis of personality traits**

Factor analysis was conducted on the sum-scores of individual questionnaires. Parallel analysis suggested the extraction of four factors. However, to segregate the two eating-related factors [41,86], a five-factor solution was preferred, which explained 56% of the variance (Table 1). The first three factors captured self-control (Conscientiousness and impulsivity), punishment sensitivity (Neuroticism, sensitivity to punishment, behavioural inhibition) and reward sensitivity (Extraversion, behavioural activation). The last two factors were eating-specific, the
fourth was the combination of emotional and external eating, summarized as Uncontrolled Eating [85], and the fifth a combination of two restraint scales. The weight fluctuation subscale of the Restraint Scale was excluded as it had low communality (18%) and the Sensitivity to Reward scale was excluded as it loaded on many different factors. Factor scores of each factor were extracted for subsequent analysis. The factor loadings and factor scores of self-control were reversed for ease of interpretation.

Predictors of consistency

The stepwise procedure for model building is summarised in Table 2. Although some steps increased BIC, they were still included because of theoretical relevance. Only steps decreasing both AIC and BIC were excluded. First, we entered age and BMI as control variables—older people were more consistent (OR = 1.54, 95% CI [1.03, 2.29]). Next, we entered the five factor scores extracted from factor analysis. Self-control positively predicted eating consistency (Fig 6). Adding self-control also caused the age effect to disappear. Thereafter, we turned to situational variables by first adding binary time—morning vs evening and then the social situations. As expected, eating later, eating with others, eating away from home, having consumed alcohol and doing physical exercise negatively predicted consistency (Fig 6). Only physical work

Fig 2. A histogram of the frequencies of different mean eating consistency rates of different individuals, aggregated across all episodes.
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episodes had no main effect. Thereafter, we tried modelling time and situations as random slopes for each participant—this model had increased AIC and BIC and therefore this step was excluded (Table 2). A possible explanation could be that situations have similar effects on consistency across people. Finally, we tested all two-way interactions between fixed effects. Only a handful of interactions emerged, and only these interactions were included in the final model (Fig 6). These interactions (Fig 7) highlight that the effects of restraint and punishment sensitivity may only emerge in certain situations. Further, the discrepancy between morning and evening seems to be bigger in older participants.

Discussion

The current study explored how several personality traits and situations can influence consistency in eating, as measured by ESM. As previous studies have noted, there were considerable individual differences in consistency. For the first time, we demonstrated that eating consistency can be influenced by both the personality of the participant and by the situations the participant experienced. Further, several person-situation variables interacted with each other. We hope that understanding the personality and situational factors influencing eating consistency...
can lead to interventions helping to successfully manage the temptations of today's eating environment (e.g., [10]).

Self-control has been highlighted as the key variable in various health-related behaviours, including eating [41,90,117,118]. People scoring high in self-control can be expected to have well-ordered lives and to strive to meet their goals in a planned and deliberate manner (e.g., Conscientiousness in [119]). In the current context, people scoring high in self-control are better at keeping their meals consistent. The fact that self-control explained the effect of age is expected, as aspects of self-control are known to improve with age [120]. A possible underlying mechanism of self-control could be better planning capabilities. For instance, recent research in trait self-control has highlighted that the main strategy of successful self-controllers is not fighting off unexpected distractions and temptations. Instead, successful self-controllers tend to design effective habits to avoid being confronted with temptations in the first place [78]. Hence, interventions aimed at improving eating consistency should focus on strategies that help people to avoid being confronted with temptations and distractions.

As expected, people were less consistent in the evening. This is in accordance with the fatigue hypothesis [57], that later in the day people have less self-control capabilities. Importantly, the effect did not interact with trait self-control, suggesting that personality is unable to
“protect” from that effect. However, the evening effect was magnified for older women, suggesting that they might be more vulnerable to the fatigue effect. We found no support that people would be less consistent on the weekend.

The undermining role of various social situations has been demonstrated in other contexts and was further cemented here—people eat less consistently when eating with others, away from home, when they have consumed alcohol and when they have exercised. Here, eating differently after exercising could be considered reasonable, as calories have to be restored. Future research capturing objective intake could look for further moderators, as people differ widely in their objective intake response to physical activity [54]. In turn, other situations might lead to unwanted change in food consumption, as alcohol and social situations divert attention away from food, and social situations likely offer food different than usual. While these situations do little harm in isolation, frequent eating in these contexts could have permanent health effects. People looking to improve their eating consistency should be aware of the power of situations. The effects of situations were independent of time, suggesting that both fatigue and the situations independently influence consistency, supporting the models of both Baumeister and Heatherton [57], as well as Bandura [58].

Some situations further interacted with personality traits. An expected interaction was that while unrestrained eaters are less consistent after consuming alcohol, restrained eaters are more consistent. This result mirrors the findings of Polivy and Herman [49,59] who propose alcohol leads to an elevated mood which facilitates less restrained people to restrain even less, and more restrained people to restrain more. An unexpected finding was that higher restraint related to inconsistency after physical work. Usually, restrained persons tend not to compensate after physical exercise [53]. It could be speculated that restrained eaters were rationalizing their lapse in consistency by justifying it by the preceding physical work. However, in this case one would also expect justification with other situations. Participants low in punishment
sensitivity were more likely to be inconsistent after physical exercise. A potential explanation could be that less punishment sensitivity (i.e., more anxiety) leads people to be more sensitive to their bodily signals and therefore to be more likely to compensate after intensive physical activity.

Table 1. Factor loadings and correlation between factor scores.

|                         | Self-Control | Punishment sensitivity | Sensitivity to Reward | Uncontrolled Eating | Restraint |
|-------------------------|--------------|------------------------|-----------------------|---------------------|-----------|
| Conscientiousness       | 0.80         | -0.20                  | 0.11                  | 0.01                | 0.00      |
| BIS-11                  | -0.65        | -0.13                  | 0.11                  | 0.14                | -0.05     |
| Sens to Punishment      | -0.08        | 0.82                   | -0.08                 | 0.00                | 0.01      |
| BIS                     | 0.00         | 0.55                   | 0.25                  | 0.15                | 0.04      |
| Neuroticism             | -0.25        | 0.43                   | 0.19                  | 0.18                | -0.06     |
| BAS Drive               | 0.08         | -0.02                  | 0.71                  | 0.03                | 0.06      |
| BAS Reward Resp         | -0.38        | -0.22                  | 0.56                  | -0.05               | -0.05     |
| BAS Fun Seeking         | 0.19         | 0.26                   | 0.59                  | -0.01               | 0.02      |
| Extraversion            | -0.06        | -0.33                  | 0.39                  | 0.03                | 0.02      |
| D Emotional Eating      | 0.04         | -0.02                  | -0.03                 | 0.86                | 0.06      |
| D External Eating       | -0.05        | 0.07                   | 0.03                  | 0.72                | -0.05     |
| D Restraint             | 0.09         | 0.01                   | 0.04                  | -0.14               | 0.80      |
| Controlled Dieting      | -0.11        | -0.01                  | -0.01                 | 0.19                | 0.77      |
| Cumulative variance explained | 0.11     | 0.23                   | 0.34                  | 0.46                | 0.56      |

Correlation between factor scores

|                         | Self-Control | Punishment sensitivity | Sensitivity to Reward | Uncontrolled Eating | Restraint |
|-------------------------|--------------|------------------------|-----------------------|---------------------|-----------|
| Punishment sensitivity  | -0.20        |                        |                       |                     |           |
| Sens to Reward          | -0.11        | -0.16                  |                       |                     |           |
| Uncontrolled Eating     | -0.41        | 0.34                   | 0.17                  |                     |           |
| Restraint               | 0.20         | 0.11                   | 0.08                  | 0.37                |           |

Note: Factor analysis based on minres extraction with oblimin rotation. Bold marks loadings larger than 0.35. Loadings of Self-control have been multiplied by -1 for conceptual clarity. In the factor score correlation matrix, correlations ≥ 0.16 have p < 0.05. BIS = Behavioral Inhibition System scale; BIS-11 = Barratt Impulsiveness Scale-11; BAS = Behavioral Activation System scale; D = Dutch Eating Behavior Questionnaire; Sens = Sensitivity; Resp = responsiveness.

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Table 2. Summary of models tested.

| Model | Model description                          | AIC  | BIC  |
|-------|--------------------------------------------|------|------|
| M0    | Null model                                 | 3795.8 | 3801.7 |
| M1    | M0 +random intercepts                      | 3551.7 | 3563.6 |
| M2    | M1 + control variables                     | 3551.3 | 3575.0 |
| M3    | M2 + personality traits                    | 3539.2 | 3592.5 |
| M4    | M3 + time                                  | 3430.8 | 3460.5 |
| M5    | M4 + situations                            | 3309.4 | 3398.3 |
| M6*   | M5 + situations as random slopes           | 3330.0 | 3579.1 |
| M7    | M5 + two-way interactions                  | 3285.1 | 3397.8 |

Note. AIC = Akaike Information Criterion. BIC = Bayes Information Criterion. Models with an asterisk were not included in the final model. M0 was estimated with generalized linear models with binomial family, other models were estimated with generalized linear mixed models with binomial family and logit link. The R formula for final model (M7) was: consistency ~ control variables + time + traits + situations + four trait-situation interactions + (1 | participant ID).

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Consistency as defined in the current study does not imply having exactly the same food items across different days. Research on sensory specific satiety suggests that people like to vary their diet [121]. In the current study, participants could still be consistent while enjoying different types of fruit, vegetables, or meat. To achieve consistency, the overall meal size or meal healthiness of the meals should be the same. This could be achieved by following the general healthy eating index guidelines (e.g., [12,13]) while mixing individual components.

The current results are a step towards understanding the determinants of eating consistency. Individual differences in consistency are well-known but the psychosocial predictors have not been studied, despite the known health benefits of better consistency. One reason may be the resource-intensive data collection required to repeatedly measure eating behaviours. This limitation is less relevant today, as repeated probing of participants about their behaviour is

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**Fig 6. Odds ratios of person and situation predictors of eating consistency.** All variables have been standardized as per Gelman [105]—odds ratios denote a change from “no” to “yes” in situations and a 2SD increase in continuous variables. Lines denote 95% confidence intervals. PE = physical exercise. *** = p < 0.001. ** = p < 0.01 * = p < 0.05.

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significantly simplified thanks to the prevalence of smart-phones, with multiple apps available for this purpose [122]. Of course, ESM-based measures of consistency need to be validated against more objective measures of consistency, perhaps by asking participants to take pictures of foods or tracking participants’ food purchases. A low-effort and objective measure of

Fig 7. Detailed plots of the interactions in the final model. X axes denotes factor scores of personality traits or age in years, y axis denotes mean eating consistency rate for different situations. Mean value is depicted by bold red/blue line, gray areas denote 95% confidence intervals.

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consistency could be as helpful for people making eating decisions, as lane and fatigue trackers are for car drivers.

Knowing consistency-related factors could also be beneficial for research determining the usual diet from dietary recall measures. For instance, Neuhaus et al. [34] concluded that dietary data from older persons are more consistent—based on the current results one could argue that knowing trait self-control would be more informative than age. Another possibility is to collect situational data along with dietary recall data. Such additional data would allow distinguishing between self-directed dietary choices and those that reflect environmental influences. Of course, having various situations present during eating could be part of a participant’s regular life; fully excluding them would provide an incomplete picture of a participant’s dietary patterns. Still, mapping the effects of situations could be beneficial. From an intervention perspective, having situational information could help focus counselling efforts either on a person’s own food preferences or on the effects of situations shifting these preferences.

Limitations

One potential limitation of the study is that the ESM data were based on participants’ subjective assessment of meal consistency, and the accuracy of these assessments was not estimated. These issues could be addressed in a future study. We note that previous evidence suggests that people are generally able to assess the relative caloric difference in meals, although they might underestimate actual caloric intake [82]. Therefore, the current approach should be a reasonable proxy for detecting deviations from regular meals. Nonetheless, we agree that would be useful to replicate current explorative results using more direct measurements of actual food intake (e.g., [56,64]). Direct measurements would also solve the problem of reference meals—currently we asked participants to focus on their typical meal, which could have been a different meal in different contexts for different participants. Further, objectively capturing food intake would enable more precise analysis of actual deviations—as suggested by Pachucki [27], only certain healthful changes in diet are more beneficial than consistency. To inspect the predictors of these particular healthful changes, more detailed food intake data are needed. Future meal analysis could also incorporate energy density, which is another important aspect influencing caloric intake [123].

Another limitation is the non-standard scoring of BIS-11. However, the correlations of BIS-11 with Conscientiousness and alcohol consumption are similar to already known correlations, suggesting this issue is not of major concern. Participants in this study were mostly non-obese white English-speaking women in good health. The choice of this homogenous sample is justified by its theoretical relevance and the increased power it gives in examining the associations between eating consistency, situations, personality measures and their interactions. However, the lack of obese persons might explain why BMI did not relate to eating consistency—the link between eating consistency and body fat percentage was established in an exclusively obese sample [28]. Prospective work is needed to clarify the longer-term predictive power of the consistency measure used in this study. In addition, the generalizability of the results will have to be tested in samples that vary in gender and culture as well as samples that include children and obese populations.

Conclusions

Despite these limitations, this study provides several important contributions to eating behaviours research. We demonstrated that people vary in their consistency of eating, as measured by the Experience Sampling Method. Further, we found that consistency can be predicted by both personality traits, situations, and by their interactions. We hope that these findings can
inform interventions that would help people maintain their personal diet and be less influenced by external situations. Perhaps one day dieters will have access to personal eating consistency aids as elegant as the ones supporting consistent driving.

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**Author Contributions**

Conceived and designed the experiments: LD JL. Performed the experiments: LD JL. Analyzed the data: UV. Contributed reagents/materials/analysis tools: UV. Wrote the paper: UV LD JL LKF.

**References**

1. DaCoTA. Traffic Safety Basic Facts 2012. Single vehicle accidents [Internet]. European Commission; 2012. Available: http://ec.europa.eu/transport/road_safety/pdf/statistics/dacota/bfs2012-dacota-ntua-single_vehicle_accident.pdf
2. NHTSA. FARS Encyclopedia: States—Crashes and All Victims [Internet]. 2012 [cited 19 Feb 2015]. Available: http://www-fars.nhtsa.dot.gov/States/StatesCrashesAndAllVictims.aspx
3. Liu C, Subramaniam R. Factors Related to Fatal Single-Vehicle Run-Off-Road Crashes. 2009; Available: http://trid.trb.org/view.aspx?pid=913013
4. MacKenzie A. Volvo XC90 to boast two world-first safety features. In: Gizmag [Internet]. 25 Jul 2014 [cited 30 Jan 2015]. Available: http://www.gizmag.com/volvo-xc90-safety-world-firsts/33064/
5. Eidehall A, Pohl J, Gustafsson F, Ekmark J. Toward Autonomous Collision Avoidance by Steering. IEEE Trans Intell Transp Syst. 2007; 8: 84–94. doi:10.1109/TITS.2006.88606
6. Eidehall A, Pohl J. Method and system for collision avoidance [Internet]. US8112225 B2, 2012. Available: http://www.google.com/patents/US8112225
7. Barr L, Howarth H, Popkin S, Carroll RJ. A review and evaluation of emerging driver fatigue detection measures and technologies. Natl Transp Syst Cent Camb US Dep Transp Wash Disponivel Em http://www.Ecse.Rpi.Edu/ QijFatiguefatiguereportdot.Pdf. 2005; Available: http://www.ecse.rpi.edu/ Homepages/qij/Fatigue/fatigue_report_dot.pdf
8. Williamson A, Chamberlain T. Review of on-road driver fatigue monitoring devices. NSW Inj Risk Manag Res Cent Univ New South Wales. 2005; Available: http://www.lumeway.com/Products_files/ Review_of_on-road_driver_fatigue_monitoring_devices.pdf
9. Victor T. System and method for monitoring and managing driver attention loads [Internet]. US6974414 B2, 2005. Available: http://www.google.com/patents/US6974414
10. Beeken RJ, Croker H, Morris S, Leurent B, Omar R, Nazareth I, et al. Study protocol for the 10 Top Tips (10TT) Trial: Randomised controlled trial of habit-based advice for weight control in general practice. BMC Public Health. 2012; 12: 667. doi: 10.1186/1471-2458-12-667 PMID: 22898039
11. 2010 Dietary Guidelines—health.gov [Internet]. [cited 2 Nov 2015]. Available: http://health.gov/dietaryguidelines/2010/
12. Guenther PM, Casavale KO, Reedy J, Kirkpatrick SL, Hiza HAB, Kuczynski KJ, et al. Update of the Healthy Eating Index: HEI-2010. J Acad Nutr Diet. 2013; 113: 569–580. doi: 10.1016/j.jand.2012.12.016 PMID: 23415902
13. Akbaraly TN, Ferrie JE, Berr C, Brunner EJ, Head J, Marmot MG, et al. Alternative Healthy Eating Index and mortality over 18 y of follow-up: results from the Whitehall II cohort. Am J Clin Nutr. 2011; 94: 247–253. doi: 10.3945/ajcn.111.013128 PMID: 21613557
14. Hall KD, Sacks G, Chandramohan D, Chow CC, Wang YC, Gortmaker SL, et al. Quantification of the effect of energy imbalance on bodyweight. The Lancet. 2011; 378: 826–837. doi: 10.1016/S0140-6736(11)60812-X
15. Lakdawalla D, Philipson TJ. The growth of obesity and technological change: A theoretical and empirical examination [Internet]. 2002. Available: http://ssrn.com/abstract=312659
16. Drewnowski A. Obesity, diets, and social inequalities. Nutr Rev. 2009; 67 Suppl 1: S36–39. doi: 10.1111/j.1753-4887.2009.00157.x PMID: 19453676

17. Jones NRV, Conklin AI, Suhrcke M, Monsivais P. The Growing Price Gap between More and Less Healthy Foods: Analysis of a Novel Longitudinal UK Dataset. PLoS ONE. 2014; 9: e109343. doi: 10.1371/journal.pone.0109343 PMID: 25296332

18. Rao M, Afshin A, Singh G, Mozaffarian D. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. BMJ Open. 2013; 3: e004277. doi: 10.1136/bmjopen-2013-004277 PMID: 24309174

19. Chandon P, Wansink B. Is food marketing making us fat? A multi-disciplinary review. Found Trends Mark. 2010; 5: 113–196. doi: 10.1561/1700000016

20. Neel JV. Diabetes Mellitus: A “Thrifty” Genotype Rendered Detrimental by “Progress”? Am J Hum Genet. 1962; 14: 353–362. PMID:13937884

21. Prentice AM, Hennig BJ, Fulford AJ. Evolutionary origins of the obesity epidemic: natural selection of thrifty genes or genetic drift following predation release? Int J Obes. 2008; 32: 1607–1610. doi:10.1038/ijo.2008.147

22. Genné-Bacon EA. Thinking Evolutionarily About Obesity. Yale J Biol Med. 2014; 87: 99–112. PMID: 24910556

23. Leikas S, Lönnqvist J-E, Verkasalo M, Kolak M, et al. Eating meals irregularly: A novel environmental risk factor for the metabolic syndrome. Obesity. 2008; 16: 1302–1307. doi: 10.1038/oby.2008.203 PMID: 18388902

24. Neuhaus JM, Murphy SP, Davis MA. Age and sex differences in variation of nutrient intakes among U. S. adults. Epidemiol Camb Mass. 1991; 2: 447–450.

25. Ozer DJ, Benet-Martinez V. Personality and the Prediction of Consequential Outcomes. Annu Rev Psychol. 2006; 57: 401–421. doi: 10.1146/annurev.psych.57.102904.190127 PMID: 16318601

26. Roberts BW, Kuncel NR, Shiner R, Caspi A, Goldberg LR. The Power of Personality: The Comparative Validity of Personality Traits, Socioeconomic Status, and Cognitive Ability for Predicting Important Life Outcomes. Perspect Psychol Sci. 2007; 2: 313–345. doi: 10.1111/j.1745-6916.2007.00047.x PMID: 26151971

27. Block J. Ego identity, role variability, and adjustment. J Consult Psychol. 1961; 25: 392–397. doi: 10.1037/h0042979 PMID: 13670048

28. Donahue EM, Robins RW, Roberts BW, John OP. The Divided Self: Concurrent and Longitudinal Effects of Psychological Adjustment and Social Roles on Self-Concept Differentiation. J Pers Soc Psychol. 1993; 64: 834–846. PMID: 8505712

29. Sherman RA, Nave CS, Funder DC. Situational similarity and personality predict behavioral consistency. J Pers Soc Psychol. 2010; 99: 330–343. doi: 10.1037/a0019796 PMID: 20658847

30. Leikas S, Lønnqvist J-E, Verkasalo M. Persons, situations, and behaviors: Consistency and variability of different behaviors in four interpersonal situations. J Pers Soc Psychol. 2012; 103: 1007–1022. doi: 10.1037/a0030385 PMID: 23066881
41. Vainik U, Dagher A, Dubé L, Fellows LK. Neurobehavioural correlates of body mass index and eating behaviours in adults: A systematic review. Neurosci Biobehav Rev. 2013; 37: 279–299. doi: 10.1016/j.neubiorev.2012.11.008 PMID: 23261403

42. Wansink B. Environmental factors that increase the food intake and consumption volume of unknowing consumers. Annu Rev Nutr. 2004; 24: 455–479. doi: 10.1146/annurev.nutr.24.011203.132140 PMID: 15189128

43. Story M, Kaphingst KM, Robinson-O’Brien R, Glanz K. Creating Healthy Food and Eating Environments: Policy and Environmental Approaches. Annu Rev Public Health. 2008; 29: 253–272. doi: 10.1146/annurev.pubhealth.29.020907.090926 PMID: 18031223

44. Cohen D, Farley TA. Eating as an automatic behavior. Prev Chronic Dis. 2008; 5: A23. PMID: 18082012

45. Wagerman SA, Funder DC. Personality psychology of situations. In: Corr PJ, Matthews G, editors. The Cambridge handbook of personality psychology. New York, NY, US: Cambridge University Press; 2009. pp. 27–42.

46. Rauthmann JF, Gallardo-Pujol D, Guillaume EM, Todd E, Nave CS, Sherman RA, et al. The Situational Eight DIAMONDS: A Taxonomy of Major Dimensions of Situation Characteristics. J Pers Soc Psychol. 2014; doi: 10.1037/a0037250

47. de Castro JM, King GA, Duarte-Gardea M, Gonzalez-Ayala S, Kooshian CH. Overweight and obese humans overeat away from home. Appetite. 2012; 59: 204–211. doi: 10.1016/j.appet.2012.04.020 PMID: 22565154

48. de Castro JM. Eating behavior: lessons from the real world of humans. Nutr Burbank Los Angel Cty Calif. 2000; 16: 800–813.

49. Polivy J, Herman CP. Effects of alcohol on eating behavior: Influence of mood and perceived intoxication. J Abnorm Psychol. 1976; 85: 601–606. doi: 10.1037/0021-843X.85.6.601 PMID: 993457

50. Robinson E, Thomas J, Aveyard P, Higgs S. What Everyone Else Is Eating: A Systematic Review and Meta-Analysis of the Effect of Informational Eating Norms on Eating Behavior. J Acad Nutr Diet. 2014; 114: 414–429. doi: 10.1016/j.jand.2013.11.009 PMID: 24388484

51. Baumeister RF, Vohs KD, Tice DM. The Strength Model of Self-Control. Curr Dir Psychol Sci. 2007; 16: 351–355. doi: 10.1111/j.1467-8721.2007.00534.x

52. Elder SJ, Roberts SB. The Effects of Exercise on Food Intake and Body Fatness: a Summary of Published Studies. Nutr Rev. 2007; 65: 1–19. doi: 10.1111/j.1753-4887.2007.tb00263.x PMID: 17310855

53. Martins C, Morgan L, Truby H. A review of the effects of exercise on appetite regulation: an obesity perspective. Int J Obes. 2008; 32: 1337–1347. doi: 10.1038/ijo.2008.98

54. Blundell JE. Physical activity and appetite control: can we close the energy gap? Nutr Bull. 2011; 36: 356–366. doi: 10.1111/j.1467-3010.2011.01911.x

55. Mayer J, Roy P, Mitra KP. Relation between caloric intake, body weight, and physical work: Studies in an industrial male population in West Bengal. Am J Clin Nutr. 1956; 4: 169–175. PMID: 13302165

56. Tarasuk V, Beaton GH. The nature and individuality of within-subject variation in energy intake. Am J Clin Nutr. 1991; 54: 464–470. PMID: 1877501

57. Baumeister RF, Heatherton TF. Self-Regulation Failure: An Overview. Psychol Inq. 1996; 7: 1–15. doi: 10.1207/s15327965spi0701_1

58. Bandura A. Failures in Self-Regulation: Energy Depletion or Selective Disengagement? Psychol Inq. 1996; 7: 20–24. doi: 10.1207/s15327965spi0701_3

59. Polivy J, Herman CP. The effects of alcohol on eating behavior: Disinhibition or sedation? Addict Behav. 1976; 1: 121–125. doi: 10.1016/0306-4603(76)90004-6

60. Eknayan G. Adolphe Quetelet (1796–1874)—the average man and indices of obesity. Nephrol Dial Transplant. 2008; 23: 47–51. doi: 10.1093/ndt/gfm517 PMID: 17890752

61. Quetelet A. A treatise on man and the development of his faculties [Internet]. Edinburgh: W. and R. Chambers; 1842. Available: http://archive.org/details/treatiseonmandev00quet

62. Hankin JH, Reynolds WE, Margen S. A Short Dietary Method for Epidemiologic Studies II. Variability of Measured Nutrient Intakes. Am J Clin Nutr. 1967; 20: 935–945. PMID: 6054511

63. Hunt WC, Leonard AG, Garry PJ, Goodwin JS. Components of variance in dietary data for an elderly population. Nutr Res. 1983; 3: 433–444. doi: 10.1016/S0271-5317(83)80005-0

64. Tarasuk V, Beaton GH. Day-to-day variation in energy and nutrient intake: Evidence of individuality in eating behaviour? Appetite. 1992; 18: 43–54. doi: 10.1016/0195-6663(92)90209-O PMID: 1562201

65. Hunter DJ, Sampson L, Stämpfer MJ, Colditz GA, Rosner B, Willett WC. Variability in Portion Sizes of Commonly Consumed Foods Among a Population of Women in the Unitedstates. Am J Epidemio. 1988; 127: 1240–1249. PMID: 3369422
66. Edholm OG, Adam JM, Healy MJR, Wolff HS, Goldsmith R, Best TW. Food intake and energy expenditure of army recruits. Br J Nutr. 1970; 24: 1091–1107. PMID: 5484729

67. Cellier KM, Hankin ME. Studies of Nutrition in Pregnancy I. Some Considerations in Collecting Dietary Information. Am J Clin Nutr. 1963; 13: 55–62. PMID: 14019614

68. Acheson KJ, Campbell IT, Edholm OG, Miller DS, Stock MJ. The measurement of food and energy intake in man—an evaluation of some techniques. Am J Clin Nutr. 1980; 33: 1147–1154. PMID: 7369162

69. Beaton GH, Milner J, Corey P, McGuire V, Cousins M, Stewart E, et al. Sources of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. Am J Clin Nutr. 1979; 32: 2546–2559. PMID: 506977

70. Stuff JE, Garza C, Smith EO, Nichols BL, Montandon CM. A comparison of dietary methods in nutritional studies. Am J Clin Nutr. 1983; 37: 300–306. PMID: 6823893

71. Sempos CT, Johnson NE, Smith EL, Gilligan C. Effects of Intraindividual and Interindividual Variation in Repeated Dietary Records. Am J Epidemiol. 1985; 121: 120–130. PMID: 3964987

72. Nelson M, Black AE, Morris JA, Cole TJ. Between- and within-subject variation in nutrient intake from infancy to old age: estimating the number of days required to rank dietary intakes with desired precision. Am J Clin Nutr. 1989; 50: 155–167. PMID: 2750686

73. Carriquiry AL. Estimation of Usual Intake Distributions of Nutrients and Foods. J Nutr. 2003; 133: 601S–608S. PMID: 12566510

74. Chun OK. Variation in Nutrient Intakes and Required Number of Days for Assessing Usual Nutrient Intake among Different Populations. J Nutr Disord Ther. 2012; 02.

75. Bem DJ, Allen A. On predicting some of the people some of the time: The search for cross-situational consistencies in behavior. Psychol Rev. 1974; 81: 506–520. doi: 10.1037/h0037130

76. Lu J, Huet C, Dubé L. Emotional reinforcement as a protective factor for healthy eating in home settings. Am J Clin Nutr. 2011; 94: 254–261. doi: 10.3945/ajcn.110.006361 PMID: 2161564

77. Christensen T, Barrett L, Bliss-Moreau E, Lebo K, Kaschub C. A practical guide to experience-sampling procedures. J Happiness Stud. 2003; 4: 53–78.

78. Hofmann W, Baumeister RF, Förster G, Vohs KD. Everyday temptations: An experience sampling study of desire, conflict, and self-control. J Pers Soc Psychol. 2012; 102: 1318–1335. doi: 10.1037/a0026545 PMID: 22149456

79. Khare A, Inman JJ. Habitual behavior in American eating patterns: The role of meal occasions. J Consum Res. 2006; 32: 567–575.

80. Seacat JD, Dougal SC, Roy D. A daily diary assessment of female weight stigmatization. J Health Psychol. 2014; doi: 10.1177/13591053145215067

81. Dubé L, LeBel JL, Lu J. Affect asymmetry and comfort food consumption. Physiol Behav. 2005; 86: 559–567. doi: 10.1016/j.physbeh.2005.08.023 PMID: 16209880

82. Chandon P, Wansink B. Is Obesity Caused by Calorie Underestimation? A Psychophysical Model of Meal Size Estimation. J Mark Res. 2007; 44: 84–99. doi: 10.1509/jmkr.44.1.84

83. Judge TA, Erez A, Bono JE, Thoresen CJ. Are measures of self-esteem, neuroticism, locus of control, and generalized self-efficacy indicators of a common core construct? J Pers Soc Psychol. 2002; 83: 693–710. doi: 10.1037//0022-3514.83.3.693 PMID: 12219863

84. Whiteside SP, Lynam DR. The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. Personal Individ Differ. 2001; 30: 669–689.

85. Vainik U, Neseliler S, Konstabel K, Fellows LK, Dagher A. Eating traits questionnaires as a continuum of a single concept. Uncontrolled eating. Appetite. 2015; 90: 229–239. doi: 10.1016/j.appet.2015.03.004 PMID: 25769975

86. Price M, Suzanne Higgs, Lee M. Self-reported eating traits: Underlying components of food responsiveness and dietary restriction are positively related to BMI. Forthcoming.

87. Lunn TE, Nowson CA, Worsley A, Torres SJ. Does personality affect dietary intake? Nutrition. 2014; 30: 403–409. doi: 10.1016/j.nut.2013.08.012 PMID: 24607300

88. Gerlach G, Herpertz S, Loeber S. Personality traits and obesity: a systematic review. Obes Rev. 2015; n/a–n/a. doi: 10.1111/obr.12235

89. van der Laan LN, Smeets PA. You are what you eat: a neuroscience perspective on consumers’ personality characteristics as determinants of eating behavior. Curr Opin Food Sci. 2015; 3: 11–18.

90. Jokela M, Hintsanen M, Hakulinen C, Batty GD, Nabi H, Singh-Manoux A, et al. Association of personality with the development and persistence of obesity: A meta-analysis based on individual—participant data. Obes Rev. 2012; n/a–n/a.
91. Macht M. How emotions affect eating: A five-way model. Appetite. 2008; 50: 1–11. PMID: 17707947

92. Guerrieri R, Nederkoorn C, Jansen A. The effect of an impulsive personality on overeating and obesity: Current state of affairs. Psychol Top. 2008; 17: 265–286.

93. Johnson F, Pratt M, Wardle J. Dietary restraint and self-regulation in eating behavior. Int J Obes. 2011; 36: 665–674. doi: 10.1038/ijo.2011.156

94. John OP, Naumann LP, Soto CJ. Paradigm shift to the integrative Big-Five trait taxonomy: History, measurement, and conceptual issues. In: John OP, Robins RW, Pervin LA, editors. Handbook of personality: Theory and research. New York, NY: Guilford Press; 2008. pp. 114–158.

95. Vainik U, Mõttus R, Allik J, Esko T, Realo A. Are Trait—Outcome Associations Caused by Scales or Particular Items? Example Analysis of Personality Facets and BMI. Eur J Personal. 2015; n/a–n/a. doi: 10.1002/per.2009

96. Canver CS, White TL. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. J Pers Soc Psychol. 1994; 67: 319–333.

97. Gray J. The neuropsychology of emotion and personality. In: Stahl S, Iverson S, Goodman E, editors. Cognitive neurochemistry. Oxford, UK: Oxford University Press; 1987. pp. 171–190.

98. Torrubia R, Ávila C, Moitó J, Caseras X. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) as a measure of Gray’s anxiety and impulsivity dimensions. Personal Individ Differ. 2001; 31: 837–862.

99. Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. J Clin Psychol. 1995; 51: 768–774. PMID: 8778124

100. Granö N, Virtanen M, Vahtera J, Elovainio M, Kivimäki M. Impulsivity as a predictor of smoking and alcohol consumption. Personal Individ Differ. 2004; 37: 1693–1700. doi: 10.1016/j.paid.2004.03.004

101. Government of Canada SC. Canadian Community Health Survey (CCHS) [Internet]. 1 Jan 2003 [cited 16 Jan 2015]. Available: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SurvId=1630&InstaId=4995

102. van Strien T, Frijters JER, Bergers GPA, Defares PB. The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. Int J Eat Disord. 1986; 5: 295–315.

103. Polivy J, Herman CP, Warsh S. Internal and external components of emotionality in restrained and unrestrained eaters. J Abnorm Psychol. 1978; 87: 497–504. PMID: 701602

104. van Strien T, Breteler MHM, Ouwens MA. Restraint Scale, its sub-scales concern for dieting and weight fluctuation. Personal Individ Differ. 2002; 33: 786–802. doi: 10.1016/j.paid.2004.03.004

105. Gelman A. Scaling regression inputs by dividing by two standard deviations. Stat Med. 2008; 27: 2865–2873. doi: 10.1002/sim.3107 PMID: 17960576

106. R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria [Internet]. 2013. Available: http://www.R-project.org/

107. Revelle W. psych: Procedures for Psychological, Psychometric, and Personality Research [Internet]. 2014. Available: http://cran.r-project.org/web/packages/psych/index.html

108. Bates DM. lme4: Mixed-effects modeling with R. URL http://lme4.R-Forge.R-Project.Org book. 2010; 36: 665–674. Available: https://hrbrmstr.github.io/streamgraph/

109. Gelman A, Su Y-S, Yajima M, Pittau MG, Kerman J, et al. arm: Data Analysis Using Regression and Multilevel/Hierarchical Models [Internet]. 2014. Available:http://cran.r-project.org/web/packages/arm/index.html

110. Luı́ddeck R. sjPlot: Data Visualization for Statistics in Social Science [Internet]. 2015. Available: http://cran.r-project.org/web/packages/sjPlot/index.html

111. Wickham H. Ggplot2: elegant graphics for data analysis. New York: Springer; 2009.

112. Fox J. Effect displays in R for generalised linear models. J Stat Softw. 2003; 8: 1–27.

113. Rudis B. Introduction to the streamgraph htmlwidgtet R Package [Internet]. 2015 [cited 17 Jun 2015]. Available: https://hrbrmstr.github.io/streamgraph/

114. Augusie B. gridExtra: functions in Grid graphics [Internet]. 2012. Available: http://cran.r-project.org/web/packages/gridExtra/index.html

115. Wickham H. The Split-Apply-Combine Strategy for Data Analysis. J Stat Softw. 2011; 40. Available: http://econpapers.repec.org/article/jssjstsof/40_3a01.htm

116. Kouchaki M, Smith IH. The Morning Morality Effect The Influence of Time of Day on Unethical Behavior. Psychol Sci. 2014; 25: 95–102. doi: 10.1177/0956797613498099 PMID: 24166855

117. Jokela M, Batty GD, Nyberg ST, Virtanen M, Nabi H, Singh-Manoux A, et al. Personality and All-Cause Mortality: Individual-Participant Meta-Analysis of 3,947 Deaths in 76,150 Adults. Am J Epidemiol. 2013; kw170. doi: 10.1093/aje/kwt170
118. Bogg T, Roberts BW. Conscientiousness and health-related behaviors: A meta-analysis of the leading behavioral contributors to mortality. Psychol Bull. 2004; 130: 887–919. doi:10.1037/0033-2909.130.6.887 PMID: 15535742

119. Costa PT, McCrae RR. Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEOFFI)—professional manual. Odessa, FL: Psychological Assessment Resources, Inc.; 1992.

120. Jackson JJ, Walton KE, Harms PD, Bogg T, Wood D, Lodi-Smith J, et al. Not all Conscientiousness Scales Change Alike: A Multimethod, Multisample Study of Age Differences in the Facets of Conscientiousness. J Pers Soc Psychol. 2009; 96: 446–459. doi:10.1037/a0014156 PMID: 19159142

121. Rolls BJ. Sensory-specific Satiety. Nutr Rev. 1986; 44: 93–101. doi:10.1111/j.1753-4887.1986.tb07593.x PMID: 3515243

122. Conner T. Experience Sampling and Ecological Momentary Assessment with Mobile Phones [Internet]. University of Otago, New Zealand; 2013 Nov. Available: http://www.otago.ac.nz/psychology/otago0474751.pdf

123. Ello-Martin JA, Ledikwe JH, Rolls BJ. The influence of food portion size and energy density on energy intake: implications for weight management. Am J Clin Nutr. 2005; 82: 236S–241S. PMID: 16002828