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Healthy eating in the wild: An experience-sampling study of how food environments and situational factors shape out-of-home dietary success

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ABSTRACT

Across many parts of the world, people increasingly eat out-of-home. Simultaneously, many people strive to eat a healthier diet, but it remains unclear to what extent and how eating out helps or hinders people in achieving their dietary goals. The present study investigated how characteristics of the physical micro-environment in out-of-home food outlets (e.g., cafeterias, supermarkets, and restaurants) influence the healthiness of food choices among a sample of German adults with a goal to eat healthier. We used an experience sampling method to obtain detailed information about people's motivation for selecting a specific food outlet and the outlet's micro-environment. We further asked for people's mood, visceral state, and thoughts during their food choice and obtained evaluations of food choices reported near their occurrence and in externally valid conditions. The data was collected via a mobile app over a period of six to eleven days between November and December of 2018 in Germany with a sample of 409 participants ($n_{obs} = 6447$). We find that even health-conscious people select food outlets and their respective micro-environments based on short-term goals, such as ease, taste, and speed of a consumption episode rather than long-term health outcomes. Using multiple regression, we show that micro-environments that promote healthy food, make such food more appealing and easier to select facilitate healthy food choices. We further identify some of the psychological mechanisms through which the micro-environment can affect food choices, as well as how individual characteristics moderate the relationship between specific micro-environmental factors and goal success. Taken together, our findings suggest the opportunity for, and arguably also necessity of, reshaping food environments to better facilitate healthier choices and support public health in the face of increasing out-of-home food consumption and the adverse consequences of unhealthy diets.

1. Introduction

Unhealthy diets, marked by an overconsumption of foods high in energy, saturated fats, free sugars and salt and a lack of fruit, vegetables, and whole grains, are considered a leading global health risk (WHO, 2020). While many experts point to a complex interplay of individual, social, and environmental factors for rising obesity levels, unhealthy diets are considered a key culprit (Leng et al., 2016; Schwartz et al., 2017; Swinburn et al., 2011). Many interventions to promote healthier diets and prevent obesity have focused on people's dietary behavior by seeking to improve individual knowledge and agency, education, and provide accurate nutritional information. Such individual-focused interventions, and especially those targeting people's conscious motivational processes, have, however, often proven ineffectual in inducing lasting behavior change on a larger scale (Howells, 2005; Webb and Sheeran, 2006) and may have contributed to weight stigma (Brewis, 2014).

Against this backdrop, a recent stream of research points to changes in environmental factors as being important drivers of the rising intake of unhealthy foods (Hobbs et al., 2021; Larson and Story, 2009; Wu et al., 2021). These factors include the increased and ubiquitous exposure to convenient, low quality food, as well as the social practices and norms around snacking and particularly out-of-home consumption (Swinburn et al., 2011; Van Rongen et al., 2020). Public health experts

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increasingly warn of "obesogenic environments" (Saelens et al., 2012). Yet, despite an increasing consensus about the importance of environmental influences on dietary behavior, knowledge remains fragmented about the pathways through which environments affect people's food choices, and how some people navigate obesogenic environments better than others (Marteau et al., 2012). Answers might be found in research on the determinants of dietary goal success linking health-promoting behavior to economic and motivational factors (French et al., 2010), as well as individual differences in food cue response and self-control (Hofmann et al., 2014; Schüz et al., 2015). These research streams have, however, rarely been linked with the food environments people encounter in everyday life.

The present study provides a detailed account of the interplay between selected elements of the food environment and people's food choices. Specifically, the study aims to identify the environmental and situational factors in out-of-home consumption that affect people's ability to make choices in line with their dietary goals. We therefore analyze motivations for selecting a specific food outlet and how its micro-environment affects food choice. We supplement our main analysis by exploring potential psychological pathways (e.g., health goal salience, unhealthy desires) and how visceral states, current mood, and individual characteristics (e.g., trait self-control) relate to dietary goal success. These findings enrich our understanding of the barriers and facilitators of healthy food choices in real-life and can inform the development of effective interventions to promote public health.

1.1. Food environments and related research

Food environments have been studied at different levels (Caspi et al., 2012). According to the ANGELO framework (Swinburn et al., 1999), the macro-environment concerns higher-level systems, including the educational system, infrastructure, industries, and the media, whereas micro-environments (also called proximal physical micro-environments) refer to settings where people directly interact with food, such as shops, restaurants, and bars, and are exposed to choice-related stimuli (Hollands et al., 2017). Both are interlinked and some previous macro-level studies have tried to link geographic distance and regional density of fast-food and convenience stores with the healthiness of diets or BMI measures (Feng et al., 2010; Hall et al., 2021; Hobbs et al., 2019, 2021). These results are, however, often inconclusive, which has been attributed to the inability of such macro approaches to account for relevant micro-environmental factors (Caspi et al., 2012; Cobb et al., 2015).

The assessment of micro-environmental influences on food choice has traditionally focused on aspects of healthy food access (i.e., availability, accessibility, affordability, accommodation, acceptability) (Penchansky and Thomas, 1981). However, following the seminal work on choice architecture (Thaler and Sunstein, 2008), substantial research has focused on more subtle aspects of the micro-environment concerning food presentation and selection. Micro-environmental interventions or so-called nudges have been found to effectively promote healthy food consumption (Bauer and Reisch, 2019a; Cadario and Chandon, 2020; Hollands et al., 2019) and are promoted as supplementary, cost-effective tools for policymakers (Benartzi et al., 2017). However, skeptics remain unconvinced by the current state of empirical evidence and criticize the limited theorizing around the mechanisms underlying the predominately empirical research field. Specifically, most evidence on micro-environmental effects are evaluated in the short term using experiments (Cadario and Chandon, 2020) and the estimated effects might not persist or be sensitive to differences in context and target population, which usually remains underappreciated or unmeasured (Bauer and Reisch, 2019b; Johnson, 2019; Leng et al., 2016). This makes it hard to generalize from results, which impairs the robust identification of micro-environmental effects on food choice and ultimately determining their role in rising obesity levels (Johnson, 2019; Lusk, 2014; Marchiori et al., 2017).

The current research on micro-environments, we contend, has focused primarily on targeting food choices within a specific micro-environment (within stores; e.g., burger vs. salad) instead of the selection among different micro-environments (between stores; e.g., fast-food restaurant versus a salad restaurant). For example, the psychological literature on self-control suggests that successful goal pursuit may be better achieved by avoiding specific environments or situations that can elicit temptations (e.g., to eat unhealthy food) rather than having to resist such temptations in situ (Hofmann et al., 2012a; Williamson and Wilkowski, 2020). In this study, we employ a two-layered operationalization of micro-environments that represents both the selection among and within micro-environments, even though we acknowledge that the selection between micro-environments could also be considered as operating at the meso level (e.g., Garfinkel-Castro et al., 2017). Independent of operationalization preferences, only few studies have investigated the interplay between the two levels of food decision-making, i.e., between- and within-store micro-environments and a better understanding of these dynamics might help to disentangle environmental effects on food choice and inform policy.

1.2. Experience sampling, micro-environments, and food choices

A promising method for overcoming some of the challenges sketched above is experience sampling. Experience sampling is a specific type of ecological momentary assessment method (EMA) (Bolger and Laurenceau, 2013) that typically involves using smartphone apps to send multiple short questionnaires distributed throughout the day to assess the situations, decisions, and emotions people experience in everyday life with limited intrusion of memory biases. In the food domain, experience sampling has mostly been used to study the situational and emotional determinants of dietary choices, even though several studies have acknowledged the important interplay between intrapsychic processes and the micro-environment (Goldstein et al., 2018; Hofmann et al., 2014; Prinsen et al., 2018; Richard et al., 2017; Wahl et al., 2020).

So far, only a few studies have used experience sampling for obtaining detailed accounts of micro-environments and their influences on food choices. For example, a recent review of EMA studies found limited and inconclusive evidence for specific factors that reliably predicted unhealthy food choices (Maugeri and Barchitta, 2019). While many studies find support for some micro-environmental characteristics, such as close proximity and availability of food and snacks (Elliston et al., 2017a; Grenard et al., 2013; Seto et al., 2016), null findings are also frequently observed (Elliston et al., 2017b; Goldstein et al., 2018). For example, Richard et al. (2017, p. 222) concluded that "future studies should aim at investigating a more comprehensive set of environmental (e.g., availability of food) and individual characteristics."

1.3. Present study

In this study, we investigate micro-environment influences on food choices through a large experience-sampling study conducted in Germany with a sample of individuals who share the goal to eat a healthier diet. To best capture micro-environmental influences, we focus our analysis on out-of-home food choices, which includes all meal and snack purchases from retail or food service sector (e.g., cafeterias, take-away, and read-to-eat foods from supermarkets; henceforth, food outlets) intended for immediate consumption. The location of actual consumption could, however, differ. We focus on out-of-home meals as people increasingly rely on such meals (Janssen et al., 2018; Saksena et al., 2018), have limited control over the design of micro-environments, and often underestimate micro-environmental influences (Jebb, 2018). Additionally, the micro-environments in out-of-home consumption can be easier targeted through policymaking than those in private households, where policy interventions are likely to be considered governmental overreach. Thus, targeting out-of-home food micro-environments may represent a promising avenue for promoting

healthy food choices that could supplement other policy instruments.

To dissect micro-environmental influences on food choice, we primarily investigate how people select their food micro-environments and which specific elements within these environments affect their choices. We also provide a detailed account of how individual characteristics (i.e., trait self-control and dietary restraint) and visceral states (e.g., hunger and stress) relate to the selection of micro-environments and affect the healthiness of peoples' food choices. As it is difficult to assess the healthiness of food objectively, we rely on participants' self-assessment about the extent to which their food choice was in line with their goal to eat a healthier diet (see Pannicke et al., 2021 for a similar approach). Deviations from personal dietary goals and their determinants have been studied intensively in the self-control literature. This literature has primarily focused on internal processes, such as goal strength and conflict (Mann et al., 2013), situational factors like acute stress (Pannicke et al., 2021), but also external cues that can activate health goals or trigger unhealthy desires during decision-making (Hofmann and Van Dillen, 2012; Papies, 2016). Hence, we also investigate whether the salience of a healthy eating goal and desire experiences for unhealthy food, both of which have been identified as key processes involved in self-control (Hofmann et al., 2014; Ratneshwar et al., 2001), serve as potential mechanisms for how micro-environments affect food choices.

For the study, we restricted our sample to people who are unsatisfied with the healthiness of their current diet and have a goal to improve it. We focus on this sub-sample of the population as people without a goal to improve their diet do not represent a clear target group for policy-making compared to those who face barriers toward a healthier diet in their daily life and have at least some form of an intention-behavior gap. Hence, the results from this study do not aim to be representative of the general population but yield a more homogenous sample and more precise estimates for people for whom environmental factors are a potential determinant of dietary goal success or failure.

2. Methods

2.1. Study design

The study design entails three steps of data collection which started on 17th of November and ended for the mobile data on 19th of December 2018. Participants were first screened to only include those who had a goal to eat a heathier diet (see Supplementary Information (SI) for details) before completing an intake survey that collected information on socio-demographics (e.g., age, sex, and employment) and psychographics (e.g., trait self-control and dietary restraint). The experience sampling data was collected via the mobile phone app Qmob. Participants were asked to report details on all meals and snacks consumed, and they received two prompts a day to do so (13:00 and 19:00). As instruction to the study and reiterated in the app, participants were explicitly instructed to report on their last meal or snack retrospectively and provide an evaluation of the eating experience itself. No time limit was given to respond to a specific meal or the two daily prompts. The median time between finishing a meal or snack and the response was 30 min in the full sample. We find no evidence that time delay in reporting affects our analysis (see SI for detailed information).

Participants were requested to provide at least seven reports in total. Reports were provided over a period of six to eleven days with additional compensation offered if more than 15 reports were completed. The study concluded with an exit survey. Participants were required to complete all three parts to receive their compensation and for their data to be included in the analyses (see SI for further details). The data collection was pre-registered on OSF (https://osf.io/c39hb). This included all measures from the three surveys of which not all were used in the present analysis. The pre-registration includes a description and rationale of the research question, the study design, and data quality measures. We did not pre-register our analytical strategy and consequently label all analyses as exploratory. The study was sufficiently powered to detect small effect sizes (see SI for details). Ethical approval was provided by the Copenhagen Business School.

2.2. Participants

Starting from 8752 participants entering the screening questionnaire, the final sample consisted of 409 adults who completed the study (see Fig. S1 for a detailed flow chart). They provided a total of 6447 responses. Fifty-eight percent of the participants were female with an average age of 36.7 years ($SD = 8.7$, $min = 18$, $max = 55$). Nearly all participants were of German nationality (98%), with 46% being married or living with a partner. Level of education was well distributed with 25% having a university degree and 36% with a completed vocational education. The majority worked full-time (54%) with 19% part-time workers, 13% students, and 5% being retired. The mean of BMI was 27.4 ($SD = 6.4$).

2.3. Measures

All measures used in the main analysis are described below (see Table S1 for further details). From the intake survey, we included measures of *trait self-control* using the Brief Self-Control Scale (Cronbach's alpha (α) = 0.76; Bertrams and Dickhäuser, 2009) and *dietary restraint* using the relevant subscale of the Dutch Eating Behavior Questionnaire (DEBQ; $\alpha = 0.90$; Nagl et al., 2016).

Our main analysis mostly relies on the experience sampling data. As shown in Fig. 1, the surveys included measures for the *type of meal* (e.g., breakfast, lunch, dinner) and whether the food was *homemade* or purchased specifically for this meal (i.e., *out-of-home*). Participants further reported on their main *motivations* for selecting a specific food outlet (e.g., to eat fast, for social or healthy reasons; binary indicators with multiple choice) and provided an assessment of the *micro-environment* related to healthiness of the food options they encountered in the outlet (e.g., healthy food was specifically promoted, appealing, or more expensive; seven-point Likert-scale).

Additional measures included participants' *visceral states and mood* during food selection (e.g., hungry vs. satiated, stressed vs. relaxed; seven-point bipolar scale), as well as their *thought processes* during selection (e.g., experience of unhealthy desires and salience of their health goal; seven-point Likert-scale).

At the end, participants reported on a seven-point Likert scale how *healthy* (0 = very unhealthy, 6 = very healthy) and *tasty* (0 = not tasty at all, 6 = very tasty) they thought this meal was. They also reported *whether the food was in line with the participants' dietary goal to eat healthier* (henceforth goal success; 0 = not at all to 6 = completely), which served as our main outcome variable. As in Goldstein et al. (2018), if the response was any other than "completely", they responded to a follow-up binary question about whether they thought they ate "*too much*", "*too unhealthy*", or "*unnecessarily*".

2.4. Data analytic strategy

For the analysis, we focus on regression results estimated using individual fixed-effects (FE) (see Geiger and MacKerron, 2016 for a similar approach). Accounting for time-invariant unobserved heterogeneity, we can address potential bias from factors that remain fixed during the study, such as differences in socio-demographics, the food macro-environment, or individual personality traits. Therefore, we require weaker assumptions for the exogeneity of our independent variables. As FE estimates tend to be conservative under random measurement error (Collischon and Eberl, 2020) we also provide estimates from a random intercept model for robustness. Unless otherwise specified we included the *type of meal* (e.g., breakfast, lunch, dinner) as control variables.

Due to the nested structure of the experience sampling data (level 1:

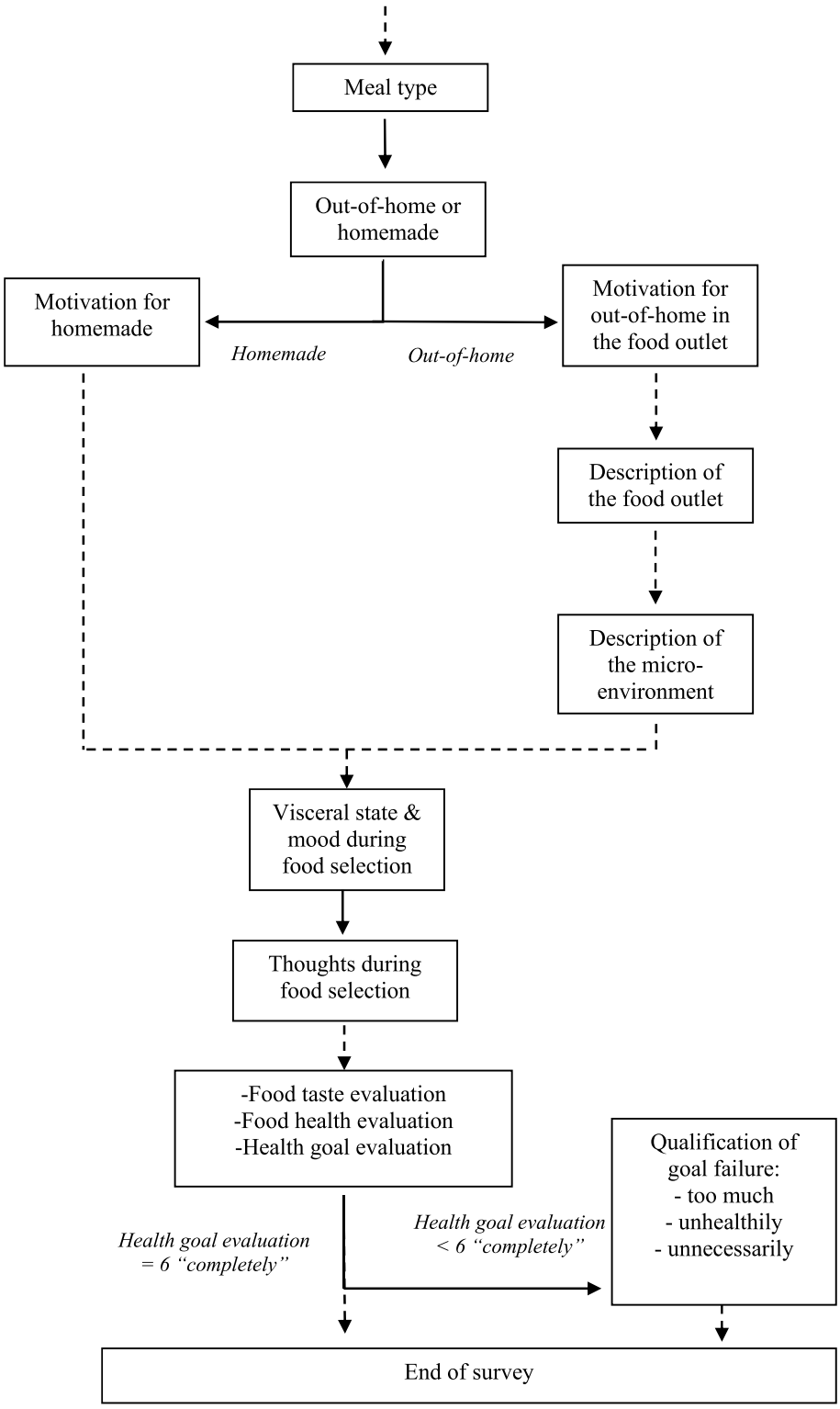

Fig. 1. Flow chart of the experience-sampling surveys. Straight lines indicate a direct path; dotted lines indicate that questions not relevant to this study were asked in-between.

repeated consumption episodes from the experience sampling surveys; level 2: characteristics on the individual level from the intake survey), we clustered the standard errors on the individual level. For the analysis of individual characteristics in section 3.5., we z-standardized the data on the full distribution of level 2 units. All analyses were conducted with STATA 17 unless specified otherwise.

2.5. Missing data and attrition

All closed questions in the surveys were forced choice and, hence, the data does not contain missing values in single variables. We therefore conduct a complete case analysis. However, our results will be biased if the data violates the ignorability assumption (Sidi and Harel, 2018), which implies that incomplete data is missing at random once all

observed and unobserved time-invariant characteristics are controlled for, and that the relationship between goal success and our independent variables of interest remain unrelated to the probability of reporting a specific food episode. While this assumption is difficult to test directly with our data, we use data from the intake survey to predict which participants were more likely to miss reports (see Table S5). This analysis provides little evidence for selective non-response based on individual characteristics. With a similar approach we could identify a few significant variables predicting the successful completion of the study (see Table S6; see SI for more details).

3. Results

3.1. Descriptive and frequency data

Our sample of 409 participants provided details on 6447 food choices where 85% were categorized as either breakfast, lunch, or dinner (see Table 1). On average, participants' self-reported evaluation of the extent to which their food choice was in line with their goal to eat a healthy diet was moderate ($M = 3.2$, $SD = 2.1$, range 0–6), and for 39% of reported meals participants reported eating too unhealthily. Most meals were homemade ($n = 4803$) whereas 23% ($n = 1458$) were purchased out-of-home. For 186 meals, neither homemade or out-of-home was selected, and participants instead chose the available "others" category. These reports were excluded as several variables relevant for out-of-home food choices were not available.

Table 1 displays a comparison of food evaluations between out-of-home and homemade foods. Recall that homemade meals referred to food prepared by participants themselves or their friends and family, whereas out-of-home referred to food specifically purchased for the relevant food episode (i.e., ready to eat). Supporting our focus, participants reported less goal success for out-of-home food choices compared to choices made at home (2.2 vs. 3.5; see Table 1), and 35% of out-of-home choices were "not at all" in line with their goal to eat healthier; this proportion was only 11% for homemade meals (see Fig. S2).

Table 1
Descriptive statistics of food choices.

	All	Out-of-home	Homemade
Meal evaluations:			
Goal success (mean)	3.18	2.18	3.52[a,b]
	(2.07)	(2.11)	(1.94)
Tastiness (mean)	5.06	5.08	5.06
	(1.13)	(1.17)	(1.11)
Healthiness (mean)	3.31	2.42	3.60[a,b]
	(1.78)	(1.87)	(1.64)
Ate too much (%)	20	19	20
Ate too unhealthily (%)	39	57	33[a,b]
Ate unnecessarily (%)	7	7	6
Meal type:			
Breakfast (%)	26	11	31[a,b]
Lunch (%)	26	36	24[a,b]
Dinner (%)	33	26	36[a,b]
Snack (%)	14	27	9[a,b]
Others (%)	<1	<1	<1
Location:			
Restaurant (%)	.	14	.
Fast-food (incl. take-away) (%)	.	25	.
Cafeteria (%)	.	17	.
Supermarket/convenience store (%)	.	41	.
Others (%)	.	2	.
Number of observations (N)	6447	1458	4803

Notes: Sample standard deviation in parenthesis. Healthiness, tastiness, and goal success were reported on an increasing 7-point Likert-scale ranging from 0 to 6. Detailed regression analyses are provided in Table S9.

[a] Indicates a significant difference estimated by a fixed-effects model; $p < .05$.

[b] Indicates a significant difference estimated by a random-effects model; $p < .05$.

3.2. Motivation for out-of-home food purchases

To further unpack the comparatively (un)healthiness of out-of-home meals, we next examined participants' motivations for selecting the specific food outlet to purchase their meal (and its associated micro-environment). We here report the motivational reasons for all out-of-home purchases, including food purchased in restaurants, cafeterias, supermarkets, etc. The frequencies of these motivational reasons are shown in Fig. 2. The most frequently reported motivation for choosing a specific out-of-home food outlet was its easy access – a motivation reported for more than half of out-of-home purchases followed by the food's taste and that it could be eaten quickly, which were reported for more than 30% of the meals. Interestingly, healthiness was only reported as a motivation for 75 out of 1458 purchased meals (representing 5%). Table 2, column 1 additionally displays the differences in these motivations between out-of-home and homemade foods. While ease and trying something new were more associated with out-of-home foods, eating as usual, healthy, or high-quality food were more frequently named as a motivation for eating homemade food.

When estimating the effect of these motivations on participants' evaluation of the extent to which their meal was in line with their goal to eat healthily, we observed that only a few motivations were consistently related to goal success. As shown in Table 2, column 2, the statistically significant predictors of goal-consistent food choices were when people wanted to eat sustainable, high quality or particularly healthy food. People selecting a food outlet with the intention to eat healthy food were estimated to have a three-point higher evaluation of dietary goal success, which was measured on a 7-point scale. The associations between the more hedonic or convenience-based motivations and goal success were mostly insignificant, although some small negative effects emerged in the random-effects model when food purchases were motivated by good taste and peers' choices (Table S10). Adding all motivational variables did substantially increase the predictiveness of our model ($f^2 = 0.228$).

We can also show that out-of-home food choices were made in adverse visceral states as people who were more hungry, stressed, and tired were more likely to make out-of-home food choices. All three variables were also associated with less dietary goal success (see SI for detailed results).

3.3. Assessment of the micro-environment

While participants' motivations, to some extent, predicted the healthiness of purchased meals, we next investigated the influence of specific characteristics of the micro-environment on goal success (see Fig. S3 for the distributions). Because the micro-environment presumably depended on the selected food location, we estimated its effects while controlling for participants' motivation. Here, we again used goal success as the dependent variable. As shown in Table 3, column 1, the availability of healthy food options was not a significant predictor of goal success. By contrast, the presence of appealing healthy food, ease of selection, and promotion of healthy food were positively associated with goal success. The availability of sufficient nutritional information exhibited a small but negative estimate.

Although a correlation analysis of the micro-environmental variables indicated that some measures were correlated (see Table S11), the variance inflation factors did not indicate a strong multicollinearity problem, which increases our confidence in these estimates. The correlation among the different micro-environmental variables, however, contributed to an overall small effect for each micro-environmental element. For instance, a ceteris paribus increase in the appeal of healthy food from someone to strongly disagree "0" to strongly agree "6" is associated with a 0.74 point increase the goal success measure ($f^2 = 0.01$; 7-point scale). Adding all eight micro-environmental variables, however, leads to a larger improvement of our model in predicting goal success ($f^2 = 0.138$). Taken together, these findings indicate that the

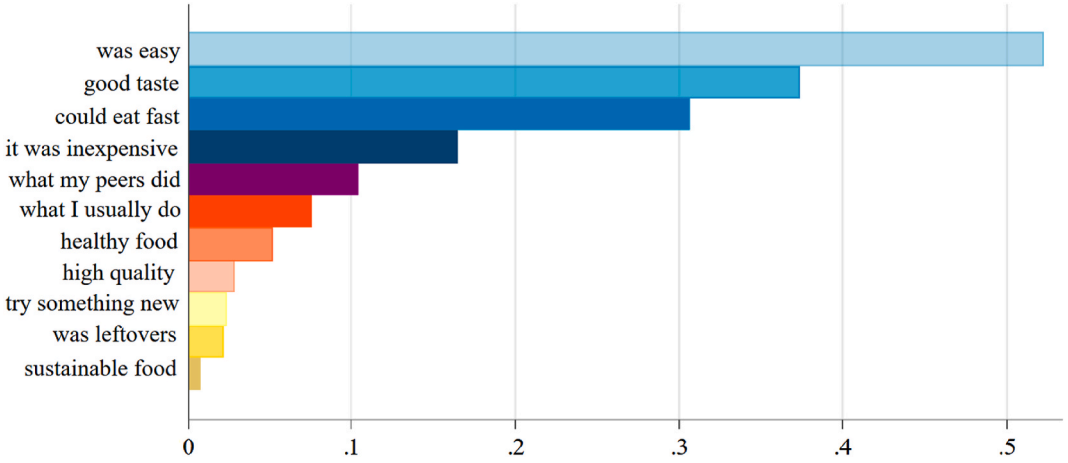

Fig. 2. Relative frequencies of motivations for selecting out-of-home food outlets (n = 1458).

Table 2
Estimates of motivation on out-of-home and goal success.

	(1)	(2)
	Out-of-home (=1) vs. Homemade (=0)	Goal success
because it was inexpensive	−0.04	0.21
	[-0.08, 0.00]	[-0.11, 0.52]
because it was convenient/easy	0.11***	0.08
	[0.08, 0.13]	[-0.15, 0.32]
because it was what I usually do	−0.20***	0.40
	[-0.23, −0.17]	[-0.04, 0.83]
to finish my meal fast	−0.01	−0.01
	[-0.04, 0.01]	[-0.22, 0.19]
eat tasty food	0.02	−0.10
	[-0.01, 0.05]	[-0.35, 0.16]
to eat food of high quality	−0.07**	1.90***
	[-0.12, −0.02]	[1.29, 2.52]
to eat healthy food	−0.15***	3.09***
	[-0.18, −0.11]	[2.57, 3.62]
to eat organic/sustainably produced food	−0.03	1.59**
	[-0.12, 0.06]	[0.61, 2.57]
to try something new	0.12*	0.77*
	[0.02, 0.22]	[0.01, 1.53]
because it was what my family/friends/colleagues did	−0.00	−0.21
	[-0.05, 0.04]	[-0.59, 0.17]
because it was leftover food which had to be eaten	−0.19***	0.44
	[-0.23, -0.16]	[-0.16, 1.03]
Controls:		
Meal type	Yes	Yes
N	6261	1458
adj. R^2	0.17	0.19

Notes: Results based on FE estimates using meal type as a control. Dependent variable one is a binary indicator with 1 = out-of-home and 0 = homemade. Goal success is measured on an increasing 7-point Likert scale. The independent variables of motivation are binary. For (1) estimates are based on the full sample, while (2) uses the people who eat out-of-home. 95% CIs based on cluster robust S.E. in brackets. P-values: *<0.05, **<0.01, ***<0.001. Random-effects results are presented in Table S10.

micro-environment can indeed exert important influences on dietary goal success.

3.4. Potential mechanisms

The results above provide evidence for the influence of micro-environments on food choices but give little insight into how these environmental factors affect individual decision-making. The following section presents two psychological constructs as potential mechanisms: goal salience and desire experiences. We tested their mediating role using participants' self-reports about whether their goal to eat healthily was salient during decision-making and whether they experienced a desire to eat unhealthily. Specifically, we first estimated the relationships between goal salience, desire experiences, and goal success. As expected, goal salience was positively correlated with goal success (FE: $B = 0.45$, $p < .001$), whereas the experience of unhealthy desires was negatively correlated (FE: $B = -0.27$, $p < .001$; see Table S13). Noteworthy, goal salience and (unhealthy) desire experiences also interacted, meaning that the presence of strong unhealthy desires reduced goal salience's positive effect on goal success (FE: $B = -0.03$, $p = .039$; see Table S13).

In a second step, we estimated the effects of the micro-environmental variables on goal salience and unhealthy desires (see Table 3). This enabled us to partly deconstruct the key findings. We find that healthy

Table 3
Estimates of micro-environment on goal success and potential mechanisms.

	(1)	(2)	(3)
	Main effect	Potential mechanisms	
	Goal success	Health goal salience	Unhealthy desires
Healthy food was available	0.06	0.06	0.07
	[-0.04, 0.16]	[-0.05, 0.16]	[-0.08, 0.10]
Healthy food was appealing	0.12**	0.07	−0.10*
	[0.05, 0.20]	[-0.03, 0.16]	[-0.18, −0.02]
Large portions provided	−0.05	−0.02	0.12**
	[-0.11, 0.02]	[-0.10, 0.06]	[0.04, 0.20]
Clear what is healthy	0.02	0.02	0.05
	[-0.05, 0.10]	[-0.05, 0.09]	[-0.04, 0.13]
Easy to select/find healthy food	0.10*	0.08	−0.09*
	[0.01, 0.18]	[-0.02, 0.18]	[-0.18, −0.01]
Healthy food was expensive	−0.06	−0.05	0.01
	[-0.12, 0.00]	[-0.12, 0.02]	[-0.06, 0.08]
Nutritional information avail.	−0.07*	0.01	0.03
	[-0.13, −0.01]	[-0.05, 0.07]	[-0.03, 0.10]
Healthy food was promoted	0.12**	0.11*	−0.05
	[0.05, 0.20]	[0.03, 0.19]	[-0.14, 0.04]
Controls:			
Motivations	Yes	Yes	Yes
Meal type	Yes	Yes	Yes
N	1458	1458	1458
adj. R^2	0.29	0.20	0.16

Notes: Results based on FE estimates using meal type as a control. Dependent variables are measured on an increasing 7-point Likert scale. The independent variables for the micro-environment are measured on a 7-point Likert scale. All estimates are based on the eating out-of-home sub-sample. 95% CIs based on cluster robust S.E. in brackets. P-values: *<0.05, **<0.01, ***<0.001. Random-effects estimates of the main results are presented in Table S12. For the mechanisms see Table S14.

food promotions were associated with greater salience of participants' health goal, whereas the appeal of healthy food and the ease of selection were associated with fewer desire experiences to eat unhealthily. When regressing goal success on all micro-environmental factors and adding goal salience and unhealthy desires as a mediator the effect size estimates, i.e., the regression coefficients, of the micro-environmental factors were reduced by 33%–50% (see Table S15). This finding provides evidence for a mediating role of the psychological constructs but also suggests that micro-environments affect goal success even when goal salience and unhealthy desires are unaffected. See Table S16 for a supplementary analysis of two alternative thoughts, i.e., need for reward, desire to eat a large portion, that were omitted here for brevity as they did not predict goal success.

3.5. Individual characteristics

So far, we have documented the effects of the micro-environment on food choices and identified potential mechanisms for such effects. These effects may, however, not be equally strong for everyone as some people are likely more susceptible to micro-environmental influences than others. To entertain this possibility, we analyzed whether trait self-control and dietary restraint (a measure of efforts to purposefully restrict calorie intake) moderated any of the micro-environmental effects. We modelled this as an interaction of the potential moderator with all the micro-environmental variables.

Overall, only a relatively small proportion of interaction tests yielded significant effects, suggesting that micro-environmental effects were not strongly qualified by individual characteristics. In the following, we briefly highlight the interaction effects that emerged (see Table S17 for full results). For trait self-control, we found that the availability of healthy food translated into higher goal success when people exhibited higher levels of trait self-control (interaction effect; FE: $B = 0.10$, $p = .008$; see Fig. 3, upper panel, for an illustration of the effect). The promotion of healthy foods, however, showed a small negative interaction effect that failed to reach statistical significance (interaction effect; FE:

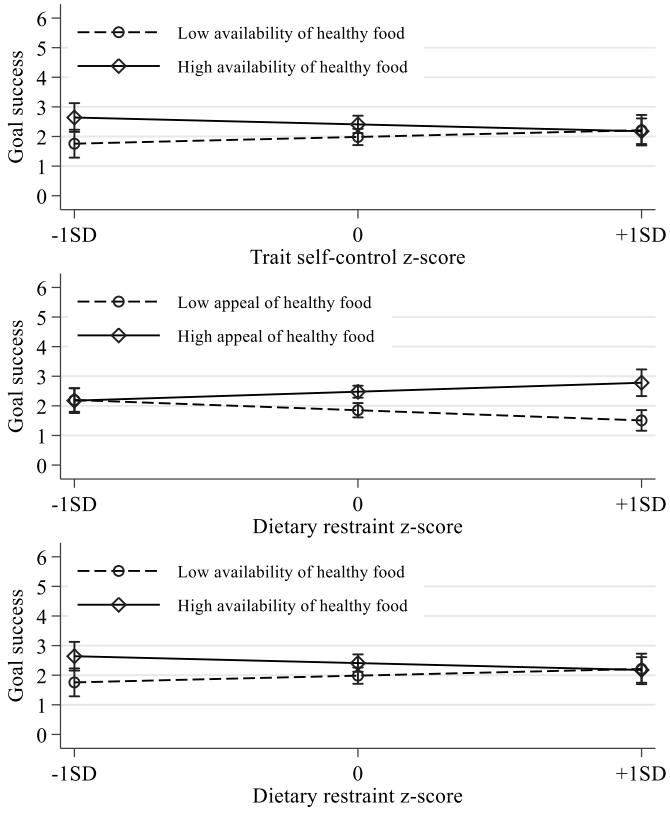

Fig. 3. Moderation analyses of micro-environment effects on health goal success estimated with FE. Linear predictions at ± 1 SD of the moderator. Highest (6) and lowest (0) values used for availability/appeal. Error bars display the 95% CIs. See Table S17 for further details.

$B = -0.06$, $p = .108$).

With increasing dietary restraint, we observed that dietary goal success increased when healthy food was perceived appealing (interaction effect; FE: $B = 0.11$, $p = .001$, mid panel). On the other hand, availability showed a small, and only partially significant, negative interaction effect with dietary restraint (interaction effect; FE: $B = -0.08$, $p = .075$; Fig. 3, lower panel).

4. Discussion

A growing wave of research has documented the important role of micro-environments in determining food choices (Bauer and Reisch, 2019a; Hollands et al., 2019; Marteau et al., 2019). The present study extends this line of research and provides a novel window into people's decision-making process in out-of-home food choices. The main insights from this study can be summarized as follows.

First, participants reported that food choices made out-of-home are much less in line with their goals of eating a healthier diet. This seems partly attributable to participants' motivations for selecting a particular food outlet, which was rarely done for health reasons, even though our sample consisted of people with an explicit goal to eat healthier. Our results point to different, potentially dovetailing explanations. The literature on self-regulation, which subsumes the concept of self-control, stipulates that people pursue different goals that compete for finite resources. These resources can be motivational, temporal, financial, and cognitive in nature (Inzlicht et al., 2021; Stroebe et al., 2013). The self-reported motivations for selecting food outlets indicate competing short-term goals, i.e., having a low-effort, fast, and tasty meal, that seem to frequently emerge in everyday life, undermining the activation of long-term health goals. An overly narrow focus on the present might be further exacerbated by the fact that people reported being more hungry, stressed, and tired when making out-of-home food choices compared to homemade meals. Extensive evidence suggests that such adverse states can make people more myopic and increase short-sighted tradeoffs in intertemporal decisions (Loewenstein, 1996; Mullainathan and Shafir, 2013).

Alternatively, we can speculate that people might underestimate the importance of selecting a healthy food outlet or simply overestimate their ability to exercise self-control in the face of delicious, but unhealthy food temptations (Appelhans et al., 2016; Hofmann et al., 2009).

Nevertheless, our results clearly indicate that participants rated their food choices as significantly more in line with their dietary health goal when they selected food outlets based on healthiness, which is well-aligned with recent self-control research identifying situation selection (or avoiding temptations) as a particularly effective strategy for ensuring goal-consistent behavior (Hofmann et al., 2012a; Williamson and Wilkowski, 2020).

Second, the repeated observations of the same participants allow for a more credible causal interpretation of the estimated relationship between characteristics of the micro-environment and goal success. Our findings are consistent with existing research (Bauer and Reisch, 2019a) and suggest that at least some micro-environmental effects, which are largely studied in short-term experiments, influence food choices in the long-term. This, in turn, provides further support for the importance of micro-environments in shaping food choices at a significant scale (Bianchi et al., 2018; Hollands et al., 2017).

Third, we identify potential psychological mechanisms through which food micro-environments affect people's choices. Goal salience and desire experiences have been considered critical for successful self-control (Ghoniem et al., 2020; Hofmann et al., 2014; Kotabe and Hofmann, 2015), and our results suggest they are also relevant constructs for understanding how the micro-environment affects food choice.

Fourth, based on selected individual characteristics, we also show that some people are more likely to be affected by the micro-environment than others. Effects varied moderately between participants with different levels of trait self-control and dietary restraint. As research has consistently identified self-control as an important predictor of health and financial outcomes (Moffitt et al., 2011), our findings suggest that people's greater sensitivity to micro-environmental effects could be one potentially mediating factor in explaining such findings. While dietary restraint itself does not directly predict behavior, people with high dietary restraint in our sample can be categorized as unsuccessful dieters. We find that high availability of healthy food is insufficient on its own for ensuring dietary success for these people. The food choices of people with high dietary restraint were instead more influenced by food appeal. This aligns with previous research showing that people high in restraint (or low in self-control) are less skilled at regulating their impulses and have a higher cue-sensitivity in food-choice situations (Ahern et al., 2010; Hofmann et al., 2009). Moreover, laboratory studies have shown that hedonic responses, such as liking, can subconsciously lead to dieting failure (Sato, 2020).

4.1. Implications

Consistent with previous research (Lachat et al., 2012; Nguyen and Powell, 2013), our results suggest that under conditions that were frequently encountered by our study participants, out-of-home food consumption poses a risk to people's dietary goals. We identified multiple compounding factors in out-of-home food choices that can contribute to dietary goal failure and targeting these through a systematic transformation of food environments may be a promising way to increase healthy food choices at scale.

Out-of-home food choices are often made in unfavorable and less controllable conditions that make it harder to eat healthily. By implication, the frequency of people's failure to eat healthily can, at least partly, be attributed to the micro-environment, which highlights the important role of food outlets in either facilitating or inhibiting healthy food choices. This role is made even more important by the fact that people are often not completely free to select their micro-environment. For example, corporate and public cafeterias often create a lock-in effect as their preferential location caters directly to the short-term motivations underlying outlet selection and significantly impair competition. Additionally, people living in food deserts (Duran et al., 2013), who typically have lower socioeconomic status, are particularly burdened by the absence of healthy and affordable food outlets that can be reached easily and fast. This constitutes an additional burden, particularly for vulnerable and less mobile people (Fitzpatrick et al., 2019), which likely increases unhealthy food consumption and reinforces existing health inequalities. We also identify certain individual characteristics that amplify people's vulnerability to micro-environmental effects, such as having low trait self-control or high dietary restraint.

Based on the findings, we propose that a clear way to promote healthier diets is to adapt and carefully design micro-environments, acknowledging the limits of people's self-control abilities (for similar recommendations see Marteau et al., 2012, 2020). Specifically, healthy alternatives must also be convenient, salient (e.g., through promotion), and appealing. Finding ways to increase the appeal of healthy food options may be especially beneficial for people with high dietary restraint who struggle with regulating their caloric intake. For instance, a simple tool may be to use attractive dish names that elicit "deliciousness" and increase the desirability of healthier options (Rossi et al., 2017).

Taken together, our results support the common advice made by behavioral scientists that desirable alternatives should be easy, attractive, and timely available (EAST-Framework). This further echoes the need for policymakers, public institutions, and private organizations to create health-enabling environments and "foodscapes" (Mikkelsen, 2011).

4.2. Limitations and future research

Although this study provides strong support for the importance of

out-of-home micro-environments for food choices and dietary goal success, it is not without limitations. For example, despite experience sampling being generally praised for its external validity, participants' assessment of specific characteristics of the micro-environment were subjective and could have suffered from attention and memory biases (Bolger and Laurenceau, 2013). Table S18 provides some objective validation for the subjective food assessments (goal success), listing the most frequent words used in text descriptions of the reported foods. These are generally well-aligned with common nutritional guidelines.

Another limitation is that we cannot account for potential reporting biases such as participants consciously misattributing their goal success or failure to specific micro-environmental factors that were particularly salient or considered important. Moreover, the participation in this study could also have altered participants' decision-making processes and food choices by making them more attentive to their behavior. For example, we observed a linear increase in the overall healthiness of participants' food choices throughout the study period, suggesting that monitoring by itself can increase goal success (consistent with extensive self-regulation research; Hennessy et al., 2020). The fact that the data collection ended with the onset of the Christmas season in mid-December might have additionally influenced the temporal trend.

Finally, any causal claim made in this study rests on several assumptions. For the main effects, these foremost require that by accounting for time-invariant unobserved individual heterogeneity and observed situational variables (i.e., motivation and meal type), we sufficiently control for all important confounders. While we find these assumptions relatively plausible, they remain untested (Hill et al., 2020). Similarly, the identification of mediators and moderators remain a challenge in observational data, particularly concerning the assessment of their relative importance (Bullock et al., 2010). However, we observed a robust direct effect of the micro-environment on goal salience and unhealthy desires for which the identifying assumptions mimic those of our main effects, and a number of previous studies supports their importance for goal success (e.g., Hofmann et al., 2012b).

We further note that our pre-registration did not specify an explicit analytical strategy and therefore welcome replication efforts to assess the robustness of the exploratory analyses reported here. While this study focused on people who wanted to improve their diet, future research should also assess how the food micro-environment affects people without a goal to eat healthily–a group for whom change through non-cognitive processes might be particularly relevant if they have no motivation to change (Hollands et al., 2016). Such studies might particularly benefit from including more objective measures of the healthiness of foods and the micro-environment more generally, potentially linking participants' location data with a systematic assessment of the micro-environment they encountered in the moment of decision-making. Overall, future research should strive to obtain better population estimates of how food environments affect individual dietary choices.

We hope our results encourage further research on the selection between micro-environments to facilitate healthier choices but also show the need for better targeting to increase the effectiveness of interventions within the food micro-environment. For example, we observed that the appeal of healthy food was primarily relevant for people with high dietary restraint. This supports recent calls for a greater focus on heterogeneity in intervention effects (Bryan et al., 2021). Finally, because food choices were frequently determined by short-term goals, it would be interesting to explore the importance of meal planning and to better understand the role of unplanned food choices in response to internal or external eating cues.

5. Conclusion

This study provides several insights into the interplay between micro-environmental factors and individual decision-making in out-of-home food consumption. We find that the success and failure of people to make healthy food choices and act in accordance with their dietary health goals are the result of a sequence of external influences and choices to navigate between and within food micro-environments. Features of micro-environments exerted important influences on people's food choices and their healthiness. Health considerations where, however, rarely an important motivator for selecting a specific micro-environment; these were mainly selected to have a fast, easy, and tasty meal. Furthermore, some people were more vulnerable to these micro-environmental effects than others. Taken together, this study highlights the potential (and need) for policymakers and other actors to reconfigure micro-environments in ways that better promote healthy food consumption.

Credit author statement

Jan Michael Bauer: Conceptualization, Methodology, Formal analysis, Writing – original draft; **Kristian S. Nielsen:** Conceptualization, Methodology, Writing – original draft; **Wilhelm Hofmann:** Conceptualization, Methodology, Writing – review & editing; **Lucia A. Reisch:** Conceptualization, Funding acquisition, Writing – review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.114869.

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