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"I'm eating healthy now": The relationship between perceived behavior change and diet

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A B S T R A C T

Public health campaigns often encourage people to increase the consumption of vegetables and fruits while limiting sugar, fat, and salt intake. Furthermore, recent approaches increasingly suggest accumulating small behavioral shifts to change eating behavior. However, when individuals actually do notice a positive change in their diet behavior has rarely been studied to date. Accordingly, the present research examined the relationship between felt and actual changes in healthy food intake. Food choice was assessed in two longitudinal studies (Study 1: *N* 743; Study 2: *N* 489) using a validated food frequency questionnaire. For assessing perceived healthy eating shifts, participants stated at a second measurement-point whether they had changed their eating patterns in the previous six months. Accordingly, participants were classified into four 'Perceived Change' groups: Changers, Attempters, Non-Attempters, and Healthy Eaters. In Study 1, participants who claimed they had made a healthy shift in their eating behavior (Changers) shifted from a regular to an optimal dietary pattern. Furthermore, Changers reduced their intake of five food categories: chocolate, cakes/pastries/biscuits, sausages/ham, meat, and eggs. No systematic changes were observed in the remaining groups. These results were replicated in Study 2. Participants perceived a change in their diet only if they had achieved a healthy shift in their dietary pattern. Moreover, Changers in both studies exhibited a significant decrease in their BMI. Overall, the group of Changers improved their diet, potentially reducing their risk for non-communicable diseases. Implications of these findings for public health campaigns are discussed.

1. Introduction

Unhealthy eating represents a modifiable risk behavior for non-communicable diseases such as coronary heart disease, stroke, heart failure, and cancer (Bechthold et al., 2019; Key, Allen, Spencer, & Travis, 2002; Lavie, Milani, & Ventura, 2009). Furthermore, reviewing epidemiological studies, Cena and Calder (2020) concluded that adhering to a healthy diet reduces the risk of non-communicable diseases. In accordance with empirical findings, a healthy diet has been recognized worldwide as an important health topic and food-based dietary guidelines have been published in 90 countries (Herforth et al., 2019), encouraging the consumption of vegetables and fruits while limiting sugar, fat, and salt intake.

There is evidence that the public is generally aware and informed about dietary guidelines. For instance, Bucher, Müller, and Siegrist (2015) asked participants to indicate how healthy they think various food items and meals were. The findings revealed that the perceived healthiness of food items was closely aligned with their actual nutrient profiles (see also Sproesser, Kohlbrenner, Schupp, & Renner, 2015). However, there seems to be a gap between relevant knowledge and actual eating behavior. In many countries, individuals consume fewer fruits and vegetables but more sugar, fat, and salt than recommended by dietary guidelines. For instance, in the European Union, only 62% of women and 49% of men report to consume fruits daily. Consumption of vegetables is even lower, with only 56% of women and 44% of men reporting to eat vegetables daily (Lange & Finger, 2017). Noteworthy,

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low adherence to dietary recommendations does not seem to reflect a lack of motivation or effort; a recent meta-analysis estimates that 42% of adults indicated that they tried to lose weight in the past year (Santos, Sniehotta, Marques, Carraça, & Teixeira, 2017).

Considering the current diet of many people, recommendations provided by dietary guidelines such as eating four to five portions of vegetables and fruits every day may represent a challenging behavior change goal. The discrepancy between the *status quo* and the desired outcome has been addressed by self-regulation approaches to goal setting and goal striving (Gollwitzer & Oettingen, 2012, 2019). While goal setting emphasizes committing to the realization of a desired outcome (Oettingen, 2012, 2014), goal striving focuses on the planning of actions (when, where, and how) one wants to perform in order to achieve goal attainment (Gollwitzer, 1990, 2014; Gollwitzer & Sheeran, 2006; Schwarzer, 2008). However, when the desired behavior is not a one-time action but requires the formation of new habits to reach long-term goals and lasting behavior change, accumulating smaller behavioral steps may be relevant to achieve the desired change (e.g., 'baby steps'; Fogg, 2020, 2009a, 2009b). For instance, Hills, Byrne, Lindstrom, and Hill (2013) emphasize the value of small and incremental changes in diet and physical activity for weight management. Similarly, the current Dietary Guidelines for Americans, produced by the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture, recommend making small shifts in one's daily eating habits to improve one's health in the long run (U.S. Department of Health, Human Services (HHS), 2020).

The notion that small and incremental changes in eating behavior may be relevant to reach the goals specified in dietary guidelines raises the question of when people feel that they have changed their behavior. In past research, dietary change has been primarily examined with a focus on the accuracy of the reported diet rather than whether participants themselves noticed a behavior change. While studies report that consumers on average tend to perceive the quality of their own diet to be better than the actual calculated diet quality (e.g., Bech-Larsen & Kazbare, 2014; O'Brien, Fries, & Bowen, 2000; Variyam, Shim, & Blaylock, 2001) or the diet quality of their peers (Sproesser et al., 2015), perceptions of change in food intake have hardly been researched so far. An exception is a study by Arnold et al. (1996) in which the authors observed a stronger decrease in fat intake after 18 months among patients with diabetes who reported a change in their eating habits when compared to patients who did not report such a change. Moreover, Lake, Adamson, Hyland, and Mathers (2004) examined how participants perceived their own dietary change by surveying respondents twice, in their early teens and again 20 years later. The results showed an association between actual and felt change in food intake. Compared to individuals who perceived their current diet to be less healthy than 20 years ago, those who perceived it to be healthier than in the past exhibited larger increases in their fruit and vegetable intake as well as larger decreases in fat or sugar intake. Furthermore, the relationship between perceived and actual behavior change has been addressed recently in the domain of physical activity (Szymczak et al., 2020). In general, people only then felt that they had become more physically active when a substantial increase in vigorous physical activity had occurred.

The main aim of the present set of two studies was to investigate the relationship of actual and perceived change in eating habits. Specifically, we focused on individuals who perceived their current diet as healthier than that of six months ago ('Changers'), assessing the changes in their food intake. We compared these participants to three control groups: (1) 'Attempters', that is, participants who indicated that they had intended to change but did not succeed, (2) 'Non-Attempters', that is, participants who reported that they did not try to change their eating behavior, and (3) 'Healthy Eaters', that is, participants who indicated that they were already eating a healthy diet. To examine what degree of change participants perceive as a meaningful change, we considered both the overall quality of the food intake pattern (i.e., unfavorable, regular, optimal) and changes across several food categories. The central hypothesis was that the group of Changers significantly improved their diet. This effect's specificity was examined by including three control groups, for which we predicted no change in their diet. Furthermore, the extent to which the group of Changers improved their diet can provide first insights into whether only a substantial or already a small change in diet is associated with the perception of a behavior change. In addition, we decided to conduct two studies in order to provide a direct replication of the main findings of the first study by collecting data with a second but similar sample and holding all the research methods and procedures constant (see National Science Foundation, 2018).

2. Material and methods

2.1. Procedures and participants of studies 1 and 2

Data were collected as part of an ongoing longitudinal multiple-cohort study, the Konstanz Life Study, launched in spring 2012 (e.g., König, Sproesser, Schupp, & Renner, 2018; Renner, Sproesser, Klusmann, & Schupp, 2012; Sproesser, Klusmann, Schupp, & Renner, 2015a; Szymczak et al., 2020; Konstanzer Life Studie, 2019). The overall goal of the Konstanz Life Study is to investigate the many influences on health behavior, such as dietary behavior and physical activity across time. Measures include fasting blood samples, anthropometric measures, cognitive and physical fitness tests, as well as a variety of questionnaires. Individuals aged 18 years and older from the general population without acute infectious diseases are eligible for participation in the Konstanz Life Study. For each time point of investigation, new participants were recruited via flyers, posters, and newspaper articles. Participants who took part in a preceding time point were re-invited via email. In the present analyses, we included three time points each half a year apart. For Study 1, participants who attended the Konstanz Life Study in spring 2012 and fall 2012 were examined. For Study 2, participants who took part in fall 2012 and spring 2013 were analyzed.

2.1.1. Ethics

For data processing and security, a register of processing operations was developed in cooperation with and approved by the Center for Data Protection of the Universities in Baden-Württemberg (ZENDAS) in 2012, and subsequently reviewed by the Commissioner for Data Protection in Baden-Württemberg. All participants gave written informed consent prior to participation. The study adhered to the guidelines of the German Psychological Society and the Declaration of Helsinki and was conducted in compliance with relevant institutional guidelines. The study protocol was approved by the University of Konstanz ethics committee.

2.1.2. Study 1

Of the 1321 individuals who attended in spring 2012, 799 re-attended in fall 2012 and therefore were eligible for analyses. Of these, 56 participants were excluded due to missing data on either dietary or perceived change measures. Thus, 743 participants (58% female) were included in the analyses for Study 1. Mean age was 46.4 years ($SD = 17.2$, range from 18 to 86). On average, participants had completed 15.8 years of education ($SD = 2.4$), and they had an average BMI of 25.0 kg/m^2 ($SD = 3.9$). Compared to the German population, the sample of Study 1 was 2.1 years older, comprised 7% more females, and had a slightly lower BMI by 1 kg/m^2 (Statistisches Bundesamt, 2017, 2018a, 2018b).

The eligible ($N = 743$) and non-eligible participants ($N = 578$) did not differ significantly regarding their BMI ($t(1305) = 1.15$, $p = 0.251$), or gender ($\chi^2(1) = 0.50$, $p = 0.478$). However, the non-eligible participants were significantly younger ($M = 40.6$, $SD = 17.8$; $t(1310) = 5.93$, $p < 0.001$) and reported slightly fewer years of education ($M = 15.3$, $SD = 2.5$; $t(1284) = 3.45$, $p < 0.001$).

2.1.3. *Study 2*

Out of the 883 individuals who attended in fall 2012, 587 re-attended in spring 2013 and were thus eligible for analysis. Of these, 98 participants had to be excluded due to missing data. The remaining 489 participants (56% female) were on average 48.7 years old (SD = 16.7, ranging from 20 to 87), had an average BMI of 24.8 kg/m^2 (SD = 3.8), and had accumulated 15.8 (SD = 2.5) years of education. Compared to the German population, the study sample was 4.4 years older, consisted of 5% more women, and had a slightly lower BMI by 1.2 kg/m^2 (Statistisches Bundesamt, 2017, 2018a, 2018b).

Comparing eligible (N = 489) and non-eligible participants (N = 394) revealed no significant differences regarding BMI ($t(868) = 0.10$, $p = 0.921$), years of education ($t(826) = 0.98$, $p = 0.326$), age ($t(868) = 1.27$, $p = 0.205$), or gender ($\chi^2(1) = 2.47$, $p = 0.116$).

2.2. *Measures*

2.2.1. *Actual food intake*

At each assessment, actual food intake was assessed via a validated food frequency questionnaire (FFQ) sampling 24 food categories (e.g., vegetables, fruits, chocolate, cake, meat, salty snacks; Winkler & Döring, 1995, 1998; see also Sproesser et al., 2015a; Sproesser, Strohbach, Schupp, & Renner, 2011). Participants indicated how often on average they eat certain food items, ranging from 1 (*almost daily)* to 6 (*never)*. A food frequency index (FFI) was computed by aggregating 15 food categories (see Table 1) reflecting dietary quality with a possible range from 0 to 30. In line with the recommendations of the German Nutrition Society and the norms for German samples on the basis of the WHO MONICA Augsburg Dietary Survey (Winkler & Döring, 1995; Winkler, Döring, & Keil, 1991), scores below 14 imply an 'unfavorable' dietary pattern, scores of 14 and 15 a 'regular' dietary pattern, and scores above 15 an 'optimal' dietary pattern (see also Sproesser et al., 2015a, 2011).

2.2.2. *Perceived change in eating habits*

To assess perceived change, participants were asked the following question at the respective second time point of Studies 1 and 2: "Since your last participation in the Konstanz Life Study, are you eating more healthily and balanced than before?" Participants were asked to choose the one statement they would agree with the most regarding their eating behavior and were classified accordingly: [1] Changers ("Yes, I eat more healthily and balanced now"), [2] Attempters ("No, but I tried to eat more healthily and balanced"), [3] Non-Attempters ("No, and I have not (even) tried"), [4] Healthy Eaters ("No, because I already ate healthily and balanced on a regular basis before"). Each answer represents a different stage of intention and behavior (cf., Klusmann, Musculus, Sproesser, & Renner, 2016; Szymczak et al., 2020).

2.2.3. *BMI*

Height and weight of the participants were measured by trained research staff following standardized procedures. Participants wore light indoor clothing and were asked to take off their shoes. Height was measured using a wall-mounted stadiometer. Weight was measured using a digital scale (Omron Body Composition Monitor, BF511). Measures were taken to the nearest 0.001 m and the nearest 0.1 kg, respectively (e.g., Gamp, Schupp, & Renner, 2018; Sproesser et al., 2015a). BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

2.3. *Analytical procedure*

Data were analyzed using SPSS Statistics 25.0. For FFI and BMI, a mixed 4 between (Perceived Change: Changers vs. Attempters vs. Non-Attempters vs. Healthy Eaters) × 2 within (Time: 1st vs. 2nd measurement) ANOVA was conducted.

For the analysis of food groups, a mixed 4 between (Perceived Change) × 2 within (Time) × 15 within (Food Groups) ANOVA was conducted. To follow up on the three-way interaction effect, repeated measures ANOVAs with the Time and Food Groups factors were conducted separately for each of the four perceived change groups. Significant interaction effects were followed up by the calculation of simple effects. To replicate findings, analyses were performed analogously for Study 2.

When appropriate, the Greenhouse-Geisser procedure was used to correct for violations of sphericity, and the Benjamini-Hochberg procedure (BH, Benjamini & Hochberg, 1995) was applied to correct for multiple testing.

3. Results

3.1. *Dietary change*

The first set of analyses focused on overall food intake as indicated by the food frequency index (FFI). We expected that only Changers would report a significant change in their food intake pattern. Fig. 1 displays the mean FFI for the different groups, times, and studies.

3.1.1. *Study 1*

The significant main effect of Perceived Change ($F(3, 739) = 28.30$,

Table 1
Study 1: Changes within food categories as a function of Perceived Change between Baseline (B; spring 2012) and Follow-Up (F; fall 2012).

	Changers		Attempters		Non-Attempters		Healthy Eaters	
	B	F	B	F	B	F	B	F
Food Category	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Meat (without sausages)	3.0 (1.3)	3.2 (1.3) **	2.8 (1.2)	2.9 (1.2)	2.5 (1.1)	2.5 (1.1)	3.1 (1.4)	3.2 (1.4)
Sausages / Ham	3.0 (1.5)	3.3 (1.6) ***	2.7 (1.4)	2.9 (1.4)	2.4 (1.3)	2.4 (1.3)	3.2 (1.6)	3.3 (1.5)
Fish	3.8 (1.0)	3.8 (1.1)	4.0 (1.1)	4.0 (1.1)	4.0 (1.0)	4.1 (1.0)	3.7 (1.0)	3.7 (1.1)
Potatoes	3.0 (1.2)	3.1 (1.1)	3.1 (1.2)	3.2 (1.0)	3.0 (1.0)	3.2 (1.1)	3.0 (1.1)	2.9 (1.1)
Pasta	2.6 (1.0)	2.8 (1.2)	2.7 (1.1)	2.6 (1.0)	2.3 (0.9)	2.3 (0.9)	2.7 (1.0)	2.7 (1.1)
Rice	3.3 (1.1)	3.3 (1.1)	3.4 (1.1)	3.5 (1.1)	3.3 (0.9)	3.3 (1.0)	3.2 (1.0)	3.3 (1.1)
Salad or vegetable, raw	1.9 (0.8)	1.8 (0.8)	2.1 (1.1)	2.1 (1.1)	2.1 (0.9)	2.1 (1.0)	1.6 (0.8)	1.7 (0.7)
Vegetable, cooked	2.1 (0.9)	2.0 (1.0)	2.3 (1.0)	2.2 (0.9)	2.4 (0.9)	2.3 (0.9)	1.9 (0.9)	1.9 (0.8)
Fresh fruit	1.6 (0.9)	1.6 (0.9)	1.8 (1.0)	1.9 (1.1)	2.0 (1.0)	2.2 (1.1)	1.4 (0.7)	1.4 (0.7)
Chocolate, chocolates	3.0 (1.4)	3.3 (1.4) ***	2.7 (1.3)	2.7 (1.3)	2.7 (1.4)	2.8 (1.3)	2.9 (1.4)	3.1 (1.4)***
Cakes, pastries, biscuits	3.0 (1.2)	3.4 (1.2) ***	3.0 (1.2)	2.9 (1.2)	3.0 (1.1)	2.9 (1.0)	3.0 (1.2)	3.1 (1.1)
Salted snacks	4.2 (1.2)	4.4 (1.2)	4.0 (1.1)	4.0 (1.2)	4.0 (1.1)	4.0 (1.2)	4.3 (1.1)	4.4 (1.2)
Whole grain bread, black bread	2.0 (1.2)	2.1 (1.2)	2.2 (1.2)	2.3 (1.3)	2.3 (1.2)	2.3 (1.2)	2.1 (1.2)	2.2 (1.3)
Flaked oats, muesli, cornflakes	3.1 (1.7)	2.9 (1.7)	3.2 (1.8)	3.0 (1.7)	3.3 (1.7)	3.3 (1.8)	2.7 (1.7)	2.8 (1.7)
Eggs	2.9 (1.1)	3.1 (1.1) *	2.9 (1.1)	3.0 (1.0)	3.0 (1.1)	3.1 (1.0)	3.0 (1.1)	3.1 (1.1)

Note. Answer scale ranged from 1 (almost daily) to 6 (never);
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ (corrected for multiple testing).

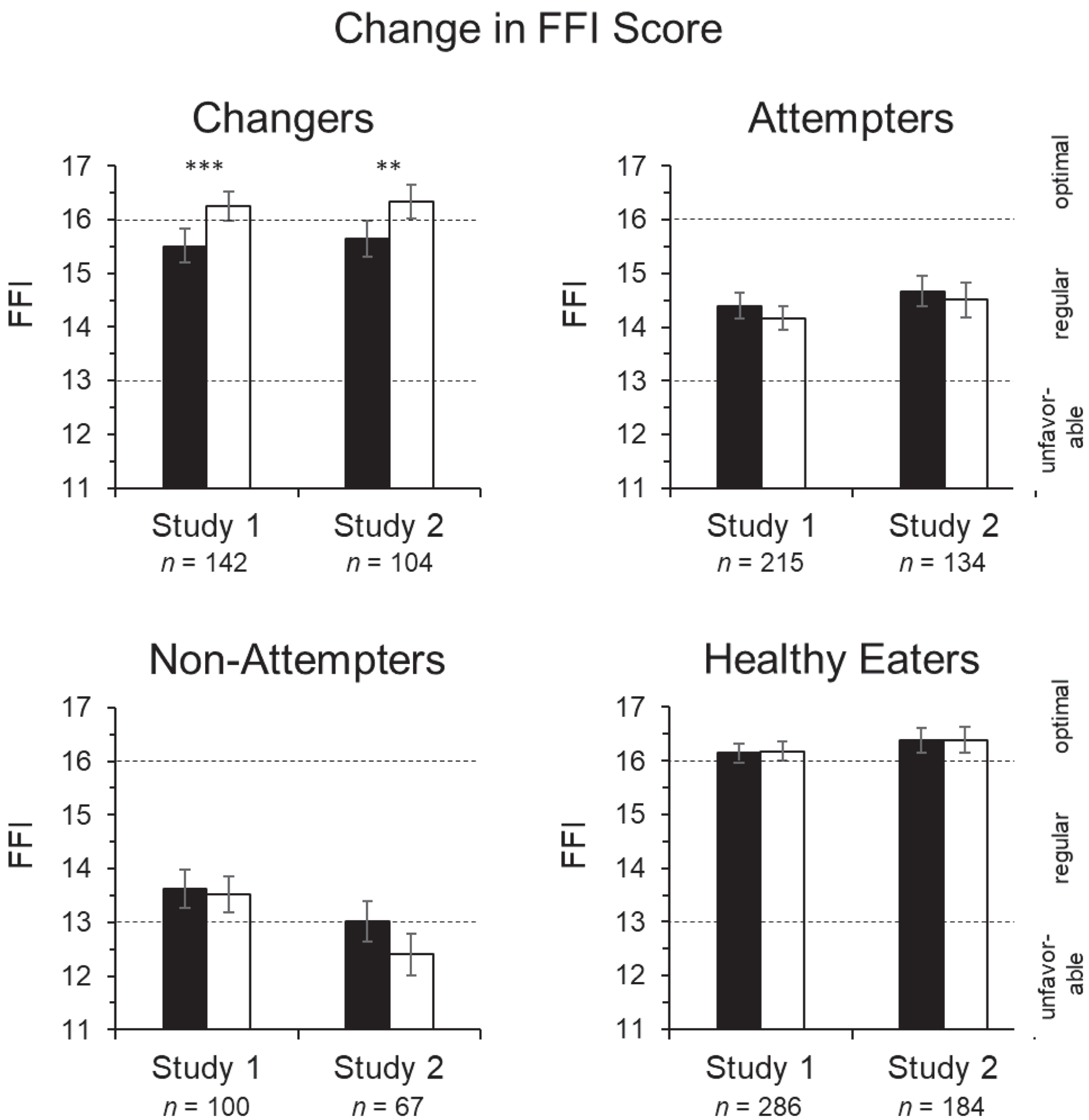

Fig. 1. Mean Food Frequency Index (FFI) as a function of Perceived Change, Time, and Study. Error bars represent standard errors. Significant changes from Time 1 (black columns) to Time 2 (white columns) are marked with an asterisk (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; corrected for multiple comparisons). The horizontal lines represent cut-off values for dietary quality: Scores below 14 signify an 'unfavorable' food intake pattern, scores of 14 and 15 a 'regular' dietary pattern, and scores above 15 an 'optimal' dietary pattern.

$p < 0.001$, $\eta_p^2 = 0.10$) was qualified by a significant interaction with Time ($F(3, 739) = 4.70$, $p = 0.003$, $\eta_p^2 = 0.02$). Simple effects analyses revealed that Changers increased their dietary quality ($F(1, 739) = 12.71$, $p < 0.001$, $\eta_p^2 = 0.02$). In contrast, no change in dietary intake occurred in the other three groups, that is, Attempters ($F(1, 739) = 1.76$, $p = 0.185$), Non-Attempters ($F(1, 739) = 0.23$, $p = 0.634$), and Healthy Eaters ($F(1, 739) = 0.06$, $p = 0.814$).

3.1.2. Study 2

Again, a significant main effect of Perceived Change emerged ($F(3, 485) = 27.64$, $p < 0.001$, $\eta_p^2 = 0.15$), which was qualified by a significant interaction with Time ($F(3, 485) = 4.55$, $p = 0.004$, $\eta_p^2 = 0.03$). Simple effects analyses showed that Changers exhibited a positive change in their food intake pattern ($F(1, 485) = 8.73$, $p = 0.003$, $\eta_p^2 = 0.02$), whereas, Attempters and Healthy Eaters did not show a significant change in diet quality ($F(1, 485) = 0.58$, $p = 0.448$; $F(1, 485) = 0.01$, $p = 0.926$, respectively). Non-Attempters showed a decrease in dietary quality ($F(1, 485) = 4.39$, $p = 0.037$, $\eta_p^2 = 0.01$); however, this p-value did not reach the pre-determined α-level of 0.017 (to correct for multiple comparisons).

3.2. BMI change

To validate the findings for eating behavior change based on the FFI with an objective indicator, changes in BMI were analyzed (please see Fig. 2).

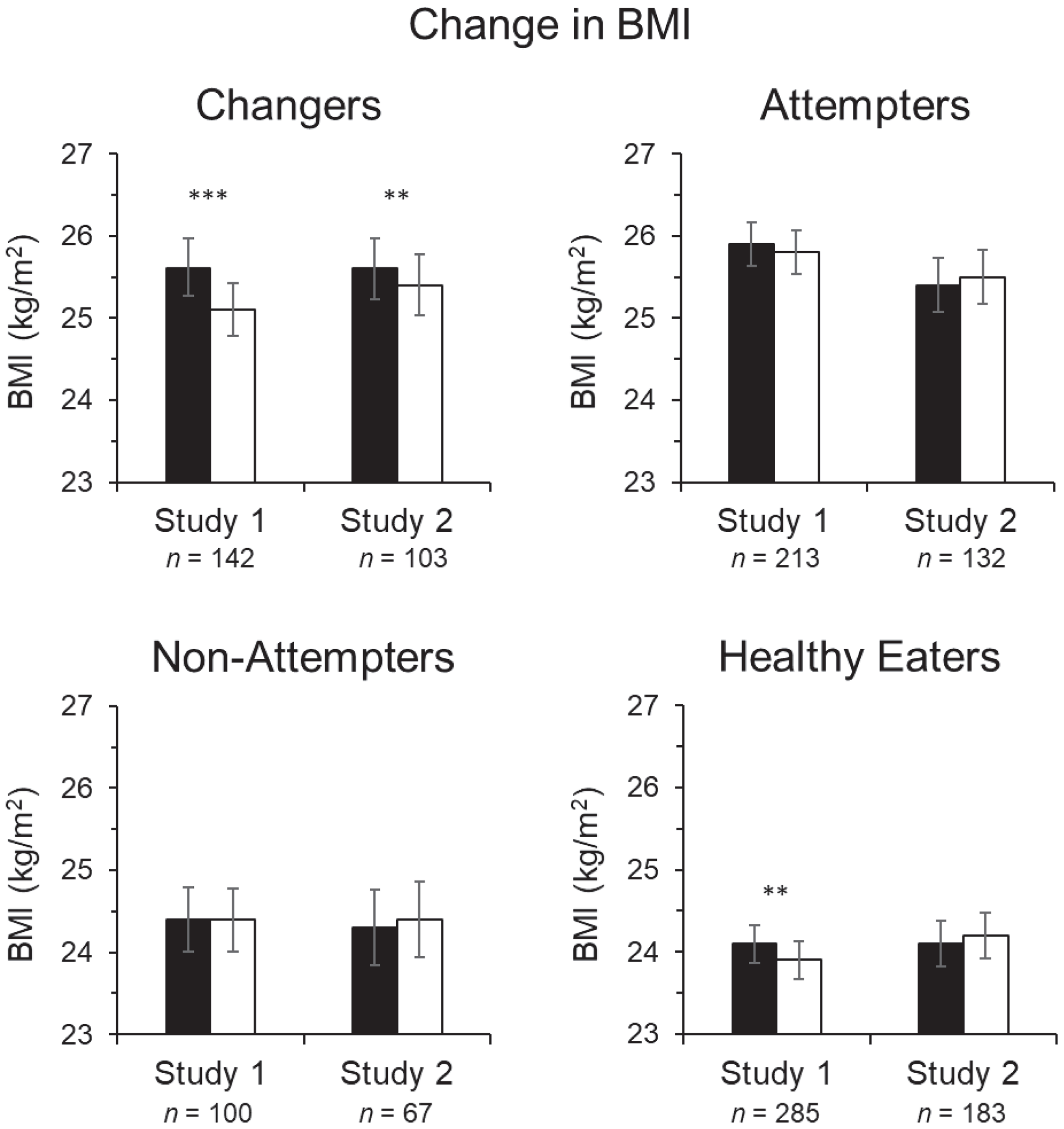

Fig. 2. Mean BMI as a function of Perceived Change, Time, and Study. Error bars represent standard errors. Significant changes from Time 1 (black columns) to Time 2 (white columns) are marked with an asterisk (**: $p < 0.01$; ***: $p < 0.001$; corrected for multiple comparisons).

3.2.1. Study 1

Significant main effects for Perceived Change ($F(3, 736) = 11.06$, $p < 0.001$, $\eta_p^2 = 0.04$) and Time ($F(1, 736) = 32.96$, $p < 0.001$, $\eta_p^2 = 0.04$) were qualified by a significant interaction with Time ($F(3, 736) = 11.64$, $p < 0.001$, $\eta_p^2 = 0.05$). Simple effects analyses showed that Changers ($F(1, 736) = 59.64$, $p < 0.001$, $\eta_p^2 = 0.08$) decreased their BMI from the first to the second assessment ($M = 25.6$, $SD = 4.2$ to $M = 25.1$, $SD = 4.0$). No change in BMI was observed in Attempters and Non-Attempters ($F(1, 736) = 2.09$, $p = 0.149$, $M = 25.9$, $SD = 4.5$ to $M = 25.8$, $SD = 4.5$; and $F(1, 736) = 0.0$, $p = 0.951$, $M = 24.4$, $SD = 3.2$ to 24.4, $SD = 3.3$; for Attempters and Non-Attempters, respectively). Furthermore, like Changers, Healthy Eaters ($F(1, 736) = 8.36$, $p = 0.004$, $\eta_p^2 = 0.01$) also decreased their BMI from the first to the second assessment significantly, $M = 24.1$, $SD = 3.4$ to $M = 23.9$, $SD = 3.4$.

3.2.2. Study 2

The significant main effect for Perceived Change ($F(3, 481) = 4.49$, $p = 0.004$, $\eta_p^2 = 0.03$) was again qualified by a significant interaction with Time ($F(3, 481) = 4.86$, $p = 0.002$, $\eta_p^2 = 0.03$). Simple effects analyses revealed that Changers decreased their BMI ($F(1, 481) = 9.22$, $p = 0.003$, $\eta_p^2 = 0.02$; from $M = 25.6$, $SD = 3.8$ to $M = 25.4$, $SD = 3.6$). No change in BMI was observed in Attempters and Non-Attempters ($F(1, 481) = 0.56$, $p = 0.456$, $M = 25.4$, $SD = 4.2$ to $M = 25.5$, $SD = 4.4$; and $F(1, 481) = 1.39$, $p = 0.240$, $M = 24.3$, $SD = 3.6$ to $M = 24.4$, $SD = 3.5$; for Attempters and Non-Attempters, respectively). In contrast to Study 1, Healthy Eaters increased their BMI only slightly ($F(1, 481) = 3.82$, $p = 0.051$, $\eta_p^2 = 0.01$; from $M = 24.1$, $SD = 3.5$ to $M = 24.2$, $SD = 3.5$); the p-value did not reach the pre-determined α-level of 0.017.

3.3. *Food category intake change*

The second aim of our studies was to investigate the change in actual food intake for individual food categories as a function of perceived change.

3.3.1. *Study 1*

Table 1 displays the mean consumption frequency of food categories. A significant three-way interaction effect was found for Perceived Change × Food Category × Time ($F(35.87, 8836.76) = 2.37$, $p < 0.001$, $\eta_p^2 = 0.01$). Thus, follow-up analyses were conducted for each of the four groups separately.

For Changers, the Food Category by Time interaction was significant ($F(10.23, 1441.85) = 4.94$, $p < 0.001$, $\eta_p^2 = 0.03$). Results of subsequent simple effects analyses showed a significant decrease in consumption for the following food categories: (1) chocolate, chocolates, $t(141) = 4.65$, $p < 0.001$, (2) sausages/ham, $t(141) = 4.10$, $p < 0.001$, (3) cakes, pastries, biscuits, $t(141) = 3.85$, $p < 0.001$, (4) meat (without sausages), $t(141) = 2.72$, $p = 0.007$, and (5) eggs, $t(141) = 2.44$, $p = 0.016$. Furthermore, intake of salted snacks (salted peanuts, crisps, and others) was also reduced ($t(141) = 2.17$, $p = 0.031$); the p-value did not reach the pre-determined α-level of 0.02.

The group of Attempters also showed a significant interaction of Food Category by Time ($F(11.23, 2402.47) = 2.31$, $p = 0.008$, $\eta_p^2 = 0.01$). A decrease in consumption of (1) eggs, $t(214) = 2.45$, $p = 0.015$, and (2) sausages/ham, $t(214) = 2.84$, $p = 0.005$, was observed, however, both p-values did not reach the α-levels ($p = 0.003$ and $p = 0.007$, respectively), pre-determined to correct for multiple comparisons.

For Healthy Eaters, the significant Food Category by Time interaction ($F(11.56, 3293.15) = 1.83$, $p = 0.040$, $\eta_p^2 = 0.01$) was associated with a decreased consumption of (1) chocolate, chocolates, $t(285) = 3.83$, $p < 0.001$, (2) eggs, $t(285) = 2.28$, $p = 0.023$, and (3) sausages/ham, $t(285) = 2.02$, $p = 0.045$. When correcting for multiple testing, only the effect for chocolate remained significant.

No significant interaction was observed for Non-Attempters, $F(11.34, 1122.65) = 0.68$, $p = 0.761$, $\eta_p^2 = 0.01$.

3.3.2. *Study 2*

A significant three-way interaction effect was found for Perceived Change × Food Category × Time, $F(35.55, 5747.62) = 1.66$, $p = 0.008$, $\eta_p^2 = 0.01$. Again, this interaction was followed up by separate analyses for each group.

For Changers, a significant Food Category by Time interaction effect emerged, $F(11.10, 1142.80) = 3.34$, $p < 0.001$, $\eta_p^2 = 0.03$. Simple effects analyses indicated a decrease in consumption for (1) chocolate, chocolates ($t(103) = 2.81$, $p = 0.006$), (2) salted snacks ($t(103) = 2.49$, $p = 0.014$), and (3) sausages/ham ($t(103) = 1.99$, $p = 0.049$). In addition, Study 2 indicated an increased consumption of (4) fish ($t(103) = 2.45$, $p = 0.016$), and (5) rice ($t(103) = 2.40$, $p = 0.018$). However, none of these effects remained significant when correcting for multiple testing (see Table 2, Supplement).

For Attempters, there was a significant interaction of Food Category by Time ($F(11.26, 1497.96) = 1.80$, $p = 0.048$, $\eta_p^2 = 0.01$) indicating the decreased consumption of (1) cooked vegetables ($t(133) = 2.54$, $p = 0.012$), and an increase in consumption for (2) eggs ($t(133) = 2.01$, $p = 0.046$). However, none of these effects remained significant after correcting for multiple testing.

There were no significant Food Category by Time interactions for Non-Attempters ($F(9.36, 617.83) = 1.18$, $p = 0.306$, $\eta_p^2 = 0.02$) and Healthy Eaters ($F(10.69, 1956.94) = 0.54$, $p = 0.871$, $\eta_p^2 < 0.01$).

3.4. *Control analyses*

3.4.1. *Gender*

Control analyses were conducted to determine whether the effects varied as a function of gender. Accordingly, gender was added to the mixed 4 between (Perceived Change) × 2 within (Time) ANOVA as an additional between-subjects factor.

For the FFI, no higher-order interactions were found in Studies 1 and 2 (Study 1: $F(3, 735) = 1.80$, $p = 0.146$; Study 2: $F(3, 481) = 0.84$, $p = 0.474$). As expected (Courtenay, McCreary, & Merighi, 2002; Fagerli & Wandel, 1999; Wardle et al., 2004), a main effect for gender was found for diet quality in both studies (Study 1: $F(1, 735) = 7.95$, $p = 0.005$, $\eta_p^2 = 0.01$; Study 2: $F(1, 481) = 4.38$, $p = 0.037$, $\eta_p^2 = 0.01$). Overall, women (Study 1: $M = 15.6$, $SD = 3.0$; Study 2: $M = 15.7$, $SD = 3.2$) reported a healthier diet than men ($M = 14.6$, $SD = 3.3$; $M = 14.8$, $SD = 3.4$, respectively).

For BMI, no significant three-way interaction effect was observed in either of the two studies (Study 1: $F(3, 732) = 0.41$, $p = 0.746$; Study 2: $F(3, 477) = 1.19$, $p = 0.312$). However, in both studies a significant main effect of gender (Study 1: $F(1, 732) = 17.81$, $p < 0.001$; $\eta_p^2 = 0.02$; Study 2: $F(1, 477) = 23.00$, $p < 0.001$, $\eta_p^2 = 0.05$) was found, indicating that women (Study 1: $M = 24.3$, $SD = 4.0$; Study 2: $M = 24.1$, $SD = 3.9$) had a lower BMI than men ($M = 25.7$, $SD = 3.6$; $M = 25.7$, $SD = 3.5$, respectively).

3.4.2. *Physical activity change*

Health behavior change in one domain might facilitate change in other domains ("carry-over effects", "spill-over hypothesis"; e.g., Dohle & Hofmann, 2019; Fleig, Kerschreiter, Schwarzer, Pomp, & Lippke, 2014; Joo, Williamson, Vazquez, Fernandez, & Bray, 2019). Thus, the decrease in BMI observed for Changers in Studies 1 and 2 and Healthy Eaters in Study 1 might also result from a concurrent change in physical activity. Physical activity was assessed using an adapted version of the short form of the International Physical Activity Questionnaire (Craig et al., 2003; The IPAQ Group, 2005), and the level of physical activity calculated as MET-hours per week of moderate-to-vigorous physical activity. A mixed 4 between (Perceived Change) × 2 within (Time) ANCOVA with physical activity change as covariate was conducted to ensure that the decrease in BMI was not based on an increase in physical activity. This analysis revealed a significant interaction of Perceived Change with Time (Study 1: $F(3, 706) = 11.02$, $p < 0.001$, $\eta_p^2 = 0.05$; Study 2: $F(3, 457) = 4.47$, $p = 0.004$, $\eta_p^2 = 0.03$), even when controlling for physical activity.

4. Discussion

The presented studies examined the relationship between the actual change in eating behavior and how individuals perceived this change. The main finding was that participants who felt that their diet had become healthier over the last six months (Changers) did show an actual improvement in their food intake pattern. Their diet changed from a 'regular' to an 'optimal' overall intake pattern, and they reduced their intake of sugary sweets and fatty meats. Furthermore, consistent with their reported changes in eating behavior, Changers successfully decreased their BMI. The analysis of the control groups, that is, Attempters, Non-Attempters, and Healthy Eaters, showed no systematic changes in their diet, suggesting that the observed changes in self-reported food intake were specific to the group of Changers.

The association between the perceived behavior change and the improved diet was observed with regard to both the overall diet quality and the analysis of specific food groups. Regarding diet quality, Changers improved from a regular to an optimal dietary pattern reaching a similar level compared to people perceiving themselves to be Healthy Eaters. This improvement of diet quality in the group of Changers may reflect a shared norm of healthy eating presumably informed by dietary recommendations. Considering behavior change at the level of food categories revealed that participants in Study 1 significantly decreased their consumption of chocolate, sausages/ham, cakes/pastries/biscuits, meat, and eggs; the decrease in the intake of salted snacks approached significance. Noteworthy, limiting food intake in these food categories aligns with dietary recommendations provided by public health organizations in Germany. However, it must be noted that these findings were only partially replicated in Study 2, possibly reflecting reduced statistical power due to the smaller sample size. Overall, the group of Changers improved their diet, potentially reducing their risk for non-communicable diseases.

Our findings also provide first insights regarding the question of whether the perceived change in diet reflects only larger shifts in food intake. One may argue that changing diet quality from a regular to an optimal dietary pattern demands a rather comprehensive change in food intake. However, a somewhat different perspective emerges when considering the actual amount of improvement needed to reach the optimal level of diet quality. As Fig. 1 indicates, while Changers fell in the regular diet category, they were already near the 'optimal' level. Thus, considering diet healthiness from a continuous rather than a categorical perspective, one may argue that the groups of Changers were already sensitive to modest shifts in food intake. Future research is needed to resolve this issue more conclusively, overcoming the limitations of the present research. Specifically, relying on self-reported food intake via a food frequency questionnaire may have limited the present research in its capability of precisely capturing the individual amount of change in eating behavior. In future research, mobile technologies should be used as they have the potential of improving the accuracy of assessment of eating behavior by, for instance, allowing individuals to take images of eating events. Various mobile applications based on sophisticated technology have been developed in recent years (e.g., TADA, My Meal Mate, PANDA, SMARTFOOD; for an overview, see Boushey, Spoden, Zhu, Delp, & Kerr, 2017; Eldridge et al., 2019). These apps are increasingly used for assessing and changing eating behavior in different populations, including generally healthy adolescents and adults as well as patients (Boushey et al., 2015; Villinger, Wahl, Boeing, Schupp, & Renner, 2019), showing high adherence and low missing event rates (Ziesemer et al., 2020).

The present findings also point towards the importance of baseline differences with respect to the healthiness of food intake between Changers and Attempters. Specifically, while both groups fell in the regular diet category, Attempters had a considerably lower diet quality score than Changers. Assuming that goal commitment not only depends on a high desirability of the aspired-to goal but also on its feasibility, the group of Attempters faced a larger discrepancy between the goal and the actual status, possibly putting a too heavy burden on the self-regulation needed to strive for their goals (e.g., Avishai, Conner, & Sheeran, 2019; Chang, Webb, Benn, & Stride, 2017; Gollwitzer & Oettingen, 2012, 2019; Thürmer, Wieber, & Gollwitzer, 2017). For Changers, in contrast, the comparatively smaller discrepancy might have been the key to success. The relevance of baseline differences in diet healthiness is further highlighted by the group of Non-Attempters, which showed an unfavorable diet quality. Control theory (Carver & Scheier, 1998), goal setting theory (Locke & Latham, 2013), and the theory of planned behavior (Ajzen, 1991) share the assumption that the discrepancy between aspired-to goals and actual behavior is critical for taking action. If this gap is perceived as insurmountable, however, people may not even try to improve their diet (Non-Attempters). In addition, identity-based motivation theory assumes that engagement in health behaviors is, in part, dependent on social identity (Oyserman, Fryberg, & Yoder, 2007). This implies that there might be systematic differences between various social groups in how they define health behaviors which may have impacted their perceived need and motivation to change.

A recent related study on physical activity observed that people only felt that they had changed their physical activity behavior when there was a substantial increase in vigorous physical activity (Szymczak et al., 2020). The present data do not clearly demonstrate that this is also true for eating, possibly indicating a greater sensitivity for moderate changes in food intake. However, given that the four groups of perceived change had vastly different baseline levels across the two studies, no clear conclusions can be drawn regarding differences between these two domains of health behavior. Specifically, while Szymczak et al. (2020) found that Changers, Attempters, and Non-Attempters had approximately similar levels of physical activity at baseline, these groups in the present studies differed considerably in the healthiness of their eating behavior. One may speculate on the reasons for this difference between domains. Both physical activity and a healthy diet have been the focus of public health campaigns and received similar attention in the media. Thus, it is likely that the public is well-informed about the need to improve these health behaviors and take the relevant appropriate actions. However, health domains may differ with respect to the social embeddedness of the critical behaviors, the expected ratio of the positive consequences to the invested effort and time, or the painfulness of previous attempts to change these behaviors, to name only a few likely candidates. Resolving the issue of possible differences between physical activity and healthy eating may be relevant for public health campaigns. Novel approaches do emphasize the value of small and incremental changes in diet and physical activity for weight management (Hills et al., 2013; U.S. Department of Health, Human Services (HHS), 2020). If future research reveals that participants' perception of a behavior change systematically differs between physical activity and healthy eating, health behavior interventions would need to address the different thresholds for noticing a behavior change.

Authors' contributions

BR and HTS designed the study and coordinated data collection with contribution from GS. LK and PG made substantial contributions to the design of the work. BR and HS conceived the analyses. HS and HTS analyzed the data and drafted the manuscript. HTS, HS, and BR interpreted the data. BR, LK, LJD, JK, NCL, GS, and PMG revised the manuscript substantially. All authors read and approved the final manuscript.

Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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