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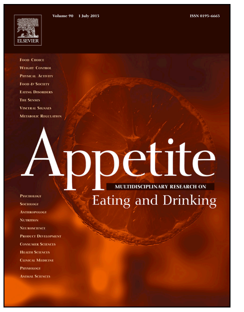

Compensatory health beliefs and unhealthy snack consumption in daily life

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Abstract

Compensatory health beliefs (CHBs) are beliefs that an unhealthy behavior (unhealthy eating) can be compensated for by engaging in a healthy behavior (physical activity). Previous research focused on CHBs as rather stable beliefs (trait). Some studies indicated that situation-specific CHBs (state) might be important in situations, in which people are confronted with an unhealthy snack. This study aims to investigate the association between CHBs and unhealthy snack consumption in daily life with a special focus on the distinction between trait and state CHBs. Overall, N=45 participants (66.7% female; age: 18–45 years, M=21.9) received a link to an online questionnaire five times daily for seven consecutive days (n=1575 possible diary entries). They reported unhealthy snack consumption, state and trait CHBs concerning the compensation with subsequent eating behavior and physical activity. The results showed that trait and state CHBs were significantly positively related to unhealthy snack consumption in daily life. Different effects appeared for CHBs concerning the compensation with subsequent eating behavior compared to the compensation with physical activity. This study demonstrates that both, state and trait CHBs are important for unhealthy snack consumption in daily life. Findings emphasize the need for further daily diary approaches to understand the temporal sequence of state CHBs that could further explain the use of CHBs as a maladaptive strategy for unhealthy eating.

Keywords: Compensatory health beliefs; eating behavior; snack consumption; intensive longitudinal methods; real life.

Compensatory health beliefs and unhealthy snack consumption in daily life

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Abstract

Compensatory health beliefs (CHBs) are beliefs that an unhealthy behavior (unhealthy eating) can be compensated for by engaging in a healthy behavior (physical activity). Previous research focused on CHBs as rather stable beliefs (trait). Some studies indicated that situation-specific CHBs (state) might be important in situations, in which people are confronted with an unhealthy snack. This study aims to investigate the association between CHBs and unhealthy snack consumption in daily life with a special focus on the distinction between trait and state CHBs. Overall, N=45 participants (66.7% female; age: 18–45 years, M=21.9) received a link to an online questionnaire five times daily for seven consecutive days (n=1575 possible diary entries). They reported unhealthy snack consumption, state and trait CHBs concerning the compensation with subsequent eating behavior and physical activity. The results showed that trait and state CHBs were significantly positively related to unhealthy snack consumption in daily life. Different effects appeared for CHBs concerning the compensation with subsequent eating behavior compared to the compensation with physical activity. This study demonstrates that both, state and trait CHBs are important for unhealthy snack consumption in daily life. Findings emphasize the need for further daily diary approaches to understand the temporal sequence of state CHBs that could further explain the use of CHBs as a maladaptive strategy for unhealthy eating.

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Introduction

Unhealthy food products rich in fats and carbohydrates are available almost anywhere and anytime. Obesity has risen dramatically across many industrialized countries (Ng et al., 2014). Unhealthy snack consumption, which is the consumption of energy dense foods between main meals, represents an important risk factor for obesity that is in turn closely linked to chronic non-communicable diseases, such as diabetes, stroke or cancer (WHO, 2018). Even though a significant proportion of the population has sufficient knowledge about a healthy diet (see De Ridder, Kroese, Evers, Adriaanse, & Gillebaart, 2017), food cues of unhealthy foods in daily life can increase the desire to eat an unhealthy snack and promote consumption (Wadhera & Capaldi-Phillips, 2014). In such a situation, when people are tempted with the accessibility of an unhealthy snack (e.g. chocolate), but also try to follow a long-term health goal (e.g. eating healthily) a motivational conflict can result (Rabiau, Knäuper, & Miquelon, 2006). One strategy to overcome a motivational conflict is the activation of compensatory health beliefs (CHBs; Knäuper, Rabiau, Cohen, & Patriciu, 2004) as described in the compensatory health beliefs model (CHB-model; Rabiau et al., 2006). CHBs are beliefs that an unhealthy behavior (such as eating unhealthily) can be compensated for by a subsequent healthy behavior (such as eating healthily or being physically active). There is evidence that people with stronger CHBs are drinking more alcohol (Matley & Davies, 2018), smoke more cigarettes (Radtke, Scholz, Keller, & Hornung, 2011) and have a higher calorie intake (Kronick, Auerbach, Stich, & Knäuper, 2011). However, CHBs can be problematic, for example, when people use them as a justification for indulgence but do not engage in the subsequent compensatory behavior.

Regarding unhealthy snacks, there are cross-sectional studies indicating that CHBs are positively associated with unhealthy snack consumption in a laboratory setting (Radtke, Inauen, Rennie, Orbell, & Scholz, 2014) and in a computerized unhealthy snack task (Sim &

Cheon, 2019). Also, people had higher compensatory beliefs after eating unhealthy snacks compared to people who eat healthy snacks with equivalent calorie content (Petersen, Prichard, Kemps, & Tiggemann, 2019). Longitudinal studies showed that CHBs are related to unhealthy snack consumption during the day (Kronick et al., 2011) and are associated with the intention to reduce unhealthy snacks (Amrein, Rackow, Inauen, Radtke, & Scholz, 2017). In sum, CHBs seem to play an important role for unhealthy snack consumption.

Previous studies on CHBs usually assessed CHBs on a general level and assumed that CHBs across different compensatory behaviors (e.g. healthy eating, physical activity) can predict different unhealthy behaviors (e.g. unhealthy snack consumption; see CHB-scale; Knäuper et al., 2004) . However, several studies started to examine the effects of CHBs on unhealthy behaviors by comparing different compensatory behaviors (Poelman, Vermeer, Vyth, & Steenhuis, 2013; Radtke et al., 2014). Only one study focused on unhealthy snack consumption and found a positive association between unhealthy snack consumption and CHBs regarding physical activity but not regarding eating behavior (Radtke et al., 2014), but studies in real life are lacking.

Some studies that investigated the relation between CHBs and unhealthy snack consumption have highlighted the distinction between two different levels of the construct: trait vs. state (Kronick et al., 2011; Petersen et al., 2019; Radtke et al., 2014). CHBs that represent a trait or an overall belief are assessed on a broad level, are stable over time and vary between individuals. For example, people with higher scores in trait CHBs (“If I am physically active on a regular basis, I can afford to eat more unhealthy foods”) have a lower intention to eat healthily than persons with lower trait CHBs (Fleig, Kerschreiter, Schwarzer, Pomp, & Lippke, 2014). The second aspect defines CHBs as a strategy that is activated in the moment of temptation (in line with the definition of CHBs in the CHB-model; Rabiau et al., 2006). Here, CHBs are beliefs that arise in a specific moment of conflict, e.g. when tempted with a delicious but unhealthy snack, and serve as situational justification (e.g. "In the moment of eating an unhealthy snack, I have thought to compensate it later"). These situational CHBs can be considered state CHBs. There is evidence that people activate such compensatory thoughts in moments of temptations, e.g. when confronted with a high caloric snack in the lab (Kronick et al., 2011) or in daily life when people speak about specific temptations during the day (Amrein et al., 2017). Assessing CHBs only at a trait level may fail to capture whether CHBs depend on specific contexts in daily life. A previous cross-sectional study showed that both aspects of CHBs, trait and state, separately relate to unhealthy snack consumption (Radtke et al., 2014). However, considering the ecological validity of state CHBs, the authors suggested that future studies use ecological momentary assessments (EMA; Shiffman, Stone, & Hufford, 2008) to investigate the relation between trait and state CHBs and unhealthy snack consumption in real life. EMA enables distinguishing between- and within-person variability that can capture both the trait differences between individuals, in terms of cross-situational consistencies, and the state differences within individuals, in terms of cross-situational variability (Fournier, Moskowitz, & Zuroff, 2008). A previous diary study that focused on situational CHBs did not account for these two levels (Kronick et al., 2011). Therefore, we applied an intensive longitudinal design to distinguish the effects of state and trait CHBs on unhealthy snack consumption in daily life at the between- and within-person level. First, at the within-person level, we hypothesized that when people report higher state CHBs than usual, they eat more unhealthy snacks (H1). Further, we hypothesized that people who report higher state CHBs across time eat more unhealthy snacks than people who report lower state CHBs across time (H2). Last, we hypothesized that people with higher trait CHBs eat more unhealthy snacks than people with lower trait CHBs (H3).

Method

Design

This study was part of a larger project investigating between-person and within-person intention-behavior relations for snack consumption using an intensive longitudinal study design in everyday life (Inauen, Shrout, Bolger, Stadler, & Scholz, 2016). The study included five measurement points daily for seven consecutive days, resulting in 35 measurement points for each participant. This allowed testing hypotheses at the within- and between-person level (Bolger & Laurenceau, 2013). Further, the study included a diary and a panel condition with baseline and follow-up measurement only. As we were interested in daily associations between CHBs and unhealthy snack consumption, we only included the diary group in the analysis. The project was approved by the institutional review board of the University of Konstanz.

Procedure and participants

First, all students of the University of Konstanz (Germany) and the University of Applied Sciences Konstanz (Germany) received an e-mail with an invitation for this study. This contained a link to a brief online questionnaire that assessed eligibility criteria. To be included in the study, participants had to meet the following criteria: a) asserting that they generally intended to avoid unhealthy snacks and admitting to occasionally eating unhealthy snacks (i.e. indicating a motivational conflict), each assessed by a yes/no question; b) having a routine of eating two or more regular meals a day; c) having access to a smartphone during the study; and d) being fluent in reading and writing German. For further details about recruitment and study procedure, please see Inauen et al. (2016).

People who met the criteria were randomly assigned to one of the two assessment conditions (diary or panel). Afterwards, people were contacted by the experimenters to make an appointment at the lab. At this appointment, all participants included in the study provided written informed consent, answered an online questionnaire (T1), and participants' weight and height were measured. Participants in the diary condition received the information that they would receive text messages with a link to the online survey at 11 a.m. (first time point of day), 2 p.m., 5 p.m., 8 p.m., and 11 p.m. (last time point of day) for the next 7 days, starting the next day. After the diary phase, all participants returned to the lab, answered the last online questionnaire (T2) and were debriefed. The incentive for study participation was taking part in a lottery of four vouchers worth EUR 150 each (approximately $ 167) or course credit (see further information in Inauen et al., 2016).

The final sample (N = 45) included 30 women (66.7%) with an overall mean age of 21.9 years (range: 18-26 years) and a mean body mass index (BMI) of 23.1 (range: 18.4-29.7). Participants indicated at T1 that they had a rather high intention to avoid unhealthy snacks (M=6.07, SD=1.76, scale ranged from 1-9. Participants answered 1460 (93%) of in total 1575 possible diary entries.

Measures

All item examples were translated from German.

Unhealthy snack consumption was assessed in the diary. First, participants had to indicate how often and when (e.g. 8pm) they had snacked (= any food that is consumed between main meals) since the last questionnaire. Then, participants were asked to check the 15 categories of core (= healthy) and non-core foods (= unhealthy snacks, adapted from Kelly, King, Bauman, Smith, & Flood, 2007) they had snacked from across all indicated snacking events since the last survey. The healthy categories were: 1) fruits, 2) vegetables, 3) milk and milk products (incl. ice cream or frozen yoghurt with < 5% fat content), 4) meat, fish, chicken, eggs, nuts, 5) bread, grain, rice, pasta (incl. low-fat biscuits and sweet corn snacks), 6) vegetable juice and pasta sauces with < 10% fat content. The unhealthy categories were: 7) sweets (e.g. chocolate, jelly bears etc.), 8) dishes from fast-food restaurants, 9) cakes, cookies, muesli bars (but not low-fat biscuits), 10) Chips and savory snacks (but not low-fat corn snacks), 11) sauces (but not pasta sauces with < 10% fat content, 12) sugared beverages and fruit juices (also tea and coffee with sugar and/or milk), 13) ice cream and frozen yoghurt with >5% fat content, 14) sandwich spreads with high amount of sugar or fat, 15) fried potato products. In addition, for each category checked, participants were asked to write down the exact snack that they had consumed (e.g. Mars chocolate bar). The final behavioral measure was the count of all unhealthy snacks consumed since the last questionnaire.

State CHBs were assessed in the diary and referred to a specific snack (Radtke et al., 2014). Only when participants had indicated that they had eaten at least one snack, the following item was asked: "To what extent did you think that you would compensate your snack, for example, by a subsequent sport session or with eating less the next time?" (adapted from Kronick et al., 2011). Response format ranged from (1) "not at all" to (9) "very much".

Trait CHBs were assessed at T1 and T2 by nine eating-related CHB items (adapted from Kaklamanou, Armitage, & Jones, 2013; Radtke et al., 2014). Six items measured eating-related CHBs that referred to the belief that unhealthy eating can be compensated for by eating healthily or less ($\text{CHBs}_{\text{eating}}$). For example, "It is alright to eat energy dense snacks such as cake or peanuts if I eat less during the main meals." Three items referred to the belief that unhealthy snacking can be compensated for by engaging in physical activity ($\text{CHBs}_{\text{physical activity}}$). For example, "As long as I am being physically active, I can eat any energy dense snack such as cake or peanuts." Response options ranged from (1) "not at all true" to (9) "completely true". There is evidence that CHBs in regards to different compensatory behaviors represent distinct factors and differ in their prediction of unhealthy eating (Radtke et al., 2014). Thus, an exploratory factor analysis was performed to select the best items and define the factor structure. Three of nine items were excluded as they had small factor loadings (< 0.4). A final factor analysis with the remaining six items was conducted with maximum likelihood extraction and varimax rotation resulting in two factors. Table 1 gives an overview of all items included in the analysis and shows Cronbach's alphas for each factor. Both factors (CHBs $_{eating}$ and CHBs $_{physical\ activity}$) were included in the analysis.

Hunger was assessed in the diary with the item "How hungry are you right now?" with the response format ranged from (1) "not at all" to (9) "very much". This was included as a covariate in the sensitivity analyses as it is likely to be related to unhealthy eating behavior (Jasinska et al., 2012).

Participant characteristics such as gender and age were assessed at T1. After the questionnaire, participants' weight and height (to calculate BMI) were measured. They were included as covariates in the sensitivity analysis.

Restrained eating has been shown to be related to CHBs and unhealthy eating behavior (Sim & Cheon, 2019; van Strien, Frijeters, Bergers, & Defares, 1986). Thus, it was included as a covariate in the sensitivity analysis. Restrained eating was assessed at T1 with 10 items using the restrained subscale of the German translation of the Dutch Eating Behavior Questionnaire (Grunert, 1989; van Strien et al., 1986). Cronbach's alpha of all 10 items was good (.89).

Data Analysis

In this study, repeated assessments of behavior and predictors (Level 1) were nested within participants (Level 2). Therefore, we applied general estimating equations (GEE) in R 3.6.0 (R Core Team, 2017), using the gee function from the CRAN package. GEE adjusts the model coefficients and standard errors for the interdependence between measurements. Because unhealthy snack consumption had a skewed distribution, we specified a poisson distribution and a log link function (Gardner, Mulvey, & Shaw, 1995). The effect sizes for these models are rate ratios (*RR*) and are interpreted as the percentage increase (values > 1) or decrease (values < 1) in snacking for a unit increase in the predictor (Atkins, Baldwin, Zheng, Gallop, & Neighbors, 2013).

When data is collected at multiple points in time from multiple individuals, it is suggested to disaggregate the between- and the within-person effect, as the associations can differ between levels (Raudenbush & Bryk, 2002). Thus, we included a within- and a between-person variable of state CHBs. To obtain between-person variable (= mean state CHBs), the grand-mean that represents the mean score across subjects and time points was subtracted from the mean score of each individual. Second, a within-person variable for state CHBs was generated (Bolger & Laurenceau, 2013). Here, the mean score of each individual was subtracted from the daily raw score of each individual. Thus, the within variable of state CHBs indicates the deviation of the momentary state CHBs from the personal state CHBs-mean score. To model linear effects over time, a time variable for all 35 measurement points in the diary was computed: 0 = first measurement point, 34 = last measurement point (Bolger & Laurenceau, 2013).

Intra-class correlations (ICCs) are the recommended index to estimate test–retest reliability for self-reported health-related outcomes (Polit, 2014; Yen & Lo, 2002). To compute the test-retest reliability of the trait CHBs scale, the ICC (=ICC_{Rel}) with two-way mixed effects and absolute agreement was calculated in SPSS (Koo & Li, 2016).

To examine the amount of variability at both within- and between-person level, the ICC (=ICC_{Var}) in R with the ‘multilevel’ package was calculated. The ICC_{Var} represents the amount of within-person variance that can be "explained" by individuals (Hoffman & Stawski, 2009).

As a sensitivity analysis, the model was re-run, adjusting for age (0 = average age), gender, BMI (0 = average BMI), restrained eating, weekend, and time of day (0 = first time point; 4 = last time point). Based on the principle of parsimony (Tabachnick, Fidell, & Ullman, 2007), all variables that were not significantly associated with the outcome variable were excluded from the model.

Results

Preliminary Analyses

Table 2 gives an overview of all within-person variables. In 476 (30.2%) out of 1441 diary entries, people reported having eating at least one snack. Unhealthy snack consumption ranged from zero to four unhealthy snacks eaten during the previous three hours with an average of 0.9 unhealthy snacks eaten during each interval. The average score of state CHBs in the diary was rather low with 3.24 (*SD*=2.47) on a scale ranging from 1-9. The ICC_{Var} (= amount of variability at both levels) for the main variables in the diary varied from 0.11 to 0.37 (see Table 2). 85% of the total variance in unhealthy snack consumption and 63% of the total variance in state CHBs was attributable to within-person differences. Figure 1 illustrates that some people used state CHBs occasionally, whereas others used them often when indulging in unhealthy snacks.

Table 3 gives an overview of all between-person variables. Bivariate correlations showed a significant positive correlation between the restrained eating scale and $CHBs_{eating}$ (.44) and a significant negative correlation between the restrained eating scale and $CHBs_{physical\ activity}$ (-.33). Further, the ICC_{Rel} (=test-retest reliability) for trait $CHBs_{eating}$ was lower (0.36) than the ICC_{Rel} for trait $CHBs_{physical\ activity}$ (0.74). This indicates that participants answered items in the scale for trait $CHBs_{eating}$ quite differently at T2 compared to T1.

State and trait CHBs in relation with unhealthy snack consumption

Table 4 shows the results of the generalized estimating equation model testing within- and between-person effects of state and trait CHBs on unhealthy snack consumption. The model adjusted for changes in unhealthy snack consumption over the study period, and BMI was included as covariate. The intercept of *RR* = 0.74 represents the average unhealthy snack consumption, when all other variables are 0. The estimate for time was not significant, indicating that participants' snack consumption did not change over the 35 measurement points. In line with hypothesis 1, state CHBs at the within-person level were positively related to unhealthy snacking (*RR*=1.04). This indicates that at times, when participants reported one point higher state CHBs than usual, they ate on average 4% more unhealthy snacks. Across one week, people with one point higher state CHBs than usual ate 1.0 more unhealthy snacks, on average. Contrary to our second hypothesis, no significant effect for the mean score of state CHBs appeared at the between-person level. This indicates that people, who reported one point higher mean state CHBs than the average person, did not eat more unhealthy snacks across time. Concerning our third hypothesis, no effect for trait CHBs $_{\text{eating}}$ (*RR* = 1.01), but a significant effect for trait CHBs $_{\text{physical activity}}$ emerged (*RR* = 1.05) at the between-person level. People with one point higher trait CHBs $_{\text{physical activity}}$ ate 5% more unhealthy snacks than persons with lower trait CHBs, resulting in 1.3 more unhealthy snacks eaten in one week, on average. In addition, a significant effect emerged for BMI (*RR* = 1.04) indicating that people with a one point higher BMI ate 4% more unhealthy snacks, again resulting in 1 more unhealthy snack eaten in one week, on average. The model results remained substantively unchanged after inclusion of the following covariates: Age, time of day (0-4), restrained eating, gender, hunger of previous time point and weekend. Based on the principle of parsimony, these variables were therefore not included in the final analysis.

Discussion

This study, for the first time, investigated both state and trait CHBs with ecological momentary assessment at the within- and between-person level and showed that both are positively associated with unhealthy snack consumption in daily life. The results held when adjusting for different eating-related covariates such as BMI and restrained eating.

This study showed at the within-person level that state CHBs varied over time within individuals, and people ate more unhealthy snacks when reporting higher state CHBs than usual (H1; Kronick et al., 2011; Radtke et al., 2014). These findings strongly contribute to the accumulating knowledge that CHBs relate to unhealthy eating behavior during the day in daily life. Although we adjusted for different situational factors (time of day, hunger), future studies should investigate possible moderators at the trait level (e.g. weight status, nutrition knowledge) and state level (e.g. perceived availability or healthiness of the snack; Petersen et al., 2019; Ruddock, Field, Jones, & Hardman, 2018). Such situational factors may influence the likelihood that individuals will employ CHBs, for example, by experiencing a stronger desire (see CHB-model; Rabiau et al., 2006). In addition, future studies should explicitly measure different strategies that make the unhealthy behavior acceptable to oneself. For example, the concept of self-licensing implies that people can use a justification (e.g. feeling of success) that allow them to eat unhealthily in a specific moment without feeling bad about it (De Witt Huberts, Evers, & De Ridder, 2014; Prinsen, Evers, & Ridder, 2019). Some individuals may use different strategies to indulge in unhealthy snacks depending on the situation. Although there have been attempts to distinguish between such licensing and compensatory effects between different health behaviors (Dohle & Hofmann, 2019), future studies should focus on the moment when an unhealthy snack was eaten and explicitly ask people which strategy they choose to overcome a motivational conflict, e.g. using an event-based ecological momentary study design.

At the between-person level, the mean score of situational state CHBs across time was unrelated to unhealthy snack consumption in daily life (H2). This indicates that people with higher state CHBs across seven days did not eat more unhealthy snacks compared to people with lower state CHBs. This is the first study that measured situational state CHBs as a mean across time to investigate associations at the between-person level. However, as the sample size was rather small at the between-person level (N = 45), replication studies with more participants are needed to confirm this null effect of state CHBs across time on unhealthy behavior at the between-person level. In addition, seven days may be too short to detect differences between individuals as people may not have experienced many motivational conflicts during this time. Future studies could test different time aggregations, that means the aggregation of CHBs across meaningful time units, to detect interindividual differences of state CHBs (Scholz, 2019).

In line with Radtke et al. (2014), trait CHBs were significantly associated with unhealthy snack consumption when they referred to the compensation of unhealthy eating with physical activity, but not when they referred to prospective healthy or reduced eating (H3). A possible explanation for this is that a higher educated sample such as students may see the compensation with physical activity as more realistic, as education status is positively related to physical activity (see Radtke et al., 2014; Kantomaa et al., 2016). In line with this, people in our study indicated higher trait CHBs $_{\text{physical activity}}$ (M = 5.59; SD = 2.10) than trait CHBs $_{\text{eating}}$ (M = 4.19; SD = 1.86), $t(44) = 3.6$, $p = .001$).

Interestingly, the mean score of state CHBs was unrelated to CHBs $_{\text{physical activity}}$ (r = -.05, n.s.) while a significant correlation emerged between the mean score of state CHBs and the trait CHBs $_{\text{eating}}$ (r = .38, p = .009). Importantly, the item formulation of state CHBs referred to a general compensation (= “compensation with other health behaviors”) that could include, for example, eating healthily or being physically active. We used this single item capturing any compensatory behavior to keep participant burden low in this intensive diary. However, the item formulation of trait CHBs explicitly distinguished between different compensatory behaviors. Thus, to investigate whether this is a true trait-state difference or whether the difference resulted from the different formulations, future studies should include a set of items assessing state CHBs separately for the compensation within eating behavior and with physical activity to examine the association between trait and state eating-related CHBs for different compensatory behaviors.

In line with previous research (Amrein et al., 2017; Kaklamanou et al., 2013; Radtke et al., 2014), we found no significant correlation between BMI and either of the trait CHBs scales, but BMI was a significant predictor for unhealthy snack consumption. This indicates that CHBs can serve as justifications to eat unhealthily for both normal weight and obese people. Further, we found a significant positive relation between restrained eating and trait CHBs $_{eating}$. This is in line with a previous study showing a positive correlation between restrained eating and CHBs regarding eating behavior (Hartmann, Keller, & Siegrist, 2016). However, as both restrained eating and trait CHBs $_{eating}$ were unrelated to unhealthy snack consumption, future studies could explore whether these constructs are related with other eating behavior assessment, e.g. calorie intake (Zambrowicz et al., 2019).

The present study has important theoretical implications, as it is the first to demonstrate the distinct associations between state and trait CHBs with unhealthy snack consumption in real life. This contributes to the ecological validity of both, trait and state CHBs, and provides support for the association between CHBs and unhealthy behavior proposed by the CHB-model (Knäuper et al., 2004; Rabiau et al., 2006). An avenue for future studies is to clarify the interplay between trait and state CHBs and subsequent compensation. For example, people with higher trait CHBs may have higher state CHBs that can lead to greater unhealthy snack consumption. Alternatively, people who do not endorse CHBs might use state CHBs as justifications in moments of indulgence. Such interaction effects could contribute to the knowledge of the variability in people's behavior and beliefs across different situations.

Although this study applied an ecological momentary assessment design, the assumption of the CHB model that CHBs are activated right in the moment of a motivational conflict could not be tested. Future studies will need to try capturing these reactions to motivational conflicts by using an event-based assessment in an EMA-design instead of a time-based as was done in the present study to allow testing the assumptions of the CHB model on the activation of CHBs.

Further, to analyze the associations between CHBs, an unhealthy behavior and a compensatory behavior, future studies are needed that can examine such compensatory effects, especially within the same health behavior. This could be done, e.g., by assessing the unhealthy and compensatory behaviors within the same time interval and explicitly asking people about a compensatory intention after the unhealthy behavior (e.g. “Are you planning to compensate this snack?”) and/or after the compensatory behavior (e.g. “Did you avoid eating unhealthy snacks because you intended to compensate your unhealthy snack consumption from before?”). As no study so far analyzed such associations, this would be an avenue for future research.

Some limitations need to be acknowledged. First, main variables were based on self-reports. To avoid retrospective bias, unhealthy snack consumption was measured with different categories (e.g. candy, fruits, bread) that helped participants classify their consumption into unhealthy or healthy foods (Kelly et al., 2007). Second, the main outcome was measured as the count of how many unhealthy snacks participants consumed since the last time point of measurement to test the hypothesis, for example, whether unhealthy snack consumption is related to state CHBs. Future studies may investigate the effect of CHBs on other eating measures, for example, the self-reported portion size of meals that are closely related to clinically relevant outcomes such as obesity (Berg et al., 2009). Third, the study comprised a small number of participants that predominately consisted of female students, making it difficult to draw conclusions for the general population. Last, state CHBs and eating behavior were assessed at the same time. It is impossible to establish causality with this research design. For example, it cannot be determined whether participants justified their unhealthy snack consumption in the moment of indulgence or only retrospectively.

To conclude, these findings showed that trait and state CHBs explain distinct variance in unhealthy snack consumption in daily life. Our findings on trait CHBs indicate that people with higher trait CHBs may benefit from interventions that aim to improve individuals' ability to regulate motivational conflicts resulting from encountering unhealthy eating options. Our findings on state CHBs indicate that such interventions should focus on specific situations when people indulge and justify the unhealthy behavior with CHBs in their daily lives. Future studies should further elaborate, in which situations people use state CHBs and investigate possible moderation effects, such self-efficacy as proposed by the CHB-model. In sum, the findings provide directions for future studies to help people reduce unhealthy eating behavior in daily life.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards The authors Melanie Alexandra Amrein, Urte Scholz and Jennifer Inauen declare that they have no conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Reference

Amrein, M. A., Rackow, P., Inauen, J., Radtke, T., & Scholz, U. (2017). The role of Compensatory Health Beliefs in eating behavior change: A mixed method study. *Appetite, 116*, 1–10. https://doi.org/10.1016/j.appet.2017.04.016

Atkins, D. C., Baldwin, S. A., Zheng, C., Gallop, R. J., & Neighbors, C. (2013). A tutorial on count regression and zero-altered count models for longitudinal substance use data. *Psychology of Addictive Behaviors, 27,* 166–177. https://doi.org/10.1037/a0029508

Berg, C., Lappas, G., Wolk, A., Strandhagen, E., Torén, K., Rosengren, A., . . . Lissner, L. (2009). Eating patterns and portion size associated with obesity in a Swedish population. *Appetite, 52*(1), 21–26. https://doi.org/10.1016/j.appet.2008.07.008

Bolger, N., & Laurenceau, J.□P. (2013). *Intensive longitudinal methods: An introduction to diary and experience samplng research*. New York, NY: The Guilford Press.

De Ridder, D., Kroese, F., Evers, C., Adriaanse, M., & Gillebaart, M. (2017). Healthy diet: Health impact, prevalence, correlates, and interventions. *Psychology & Health, 32*(8), 907–941. https://doi.org/10.1080/08870446.2017.1316849

De Witt Huberts, J., Evers, C., & De Ridder, D. (2014). "Because I Am Worth It": A Theoretical Framework and Empirical Review of a Justification-Based Account of Self-Regulation Failure. *Personality and Social Psychology Review*, *18*(2), 119–138. https://doi.org/10.1177/1088868313507533

Dohle, S., & Hofmann, W. (2019). Consistency and Balancing in Everyday Health Behaviour: An Ecological Momentary Assessment Approach. *Applied Psychology. Health and Well-Being*, *11*(1), 148–169. https://doi.org/10.1111/aphw.12148

Fleig, L., Kerschreiter, R., Schwarzer, R., Pomp, S., & Lippke, S. (2014). Sticking to a healthy diet is easier for me when I exercise regularly: Cognitive transfer between physical exercise and healthy nutrition. *Psychology & Health*, *29*, 1361–1372. https://doi.org/10.1080/08870446.2014.930146

Fournier, M. A., Moskowitz, D. S., & Zuroff, D. C. (2008). Integrating dispositions, signatures, and the interpersonal domain. *Journal of Personality and Social Psychology*, *94*(3), 531–545. https://doi.org/10.1037/0022-3514.94.3.531

Gardner, W., Mulvey, P., & Shaw, E. (1995). Regression analyses of counts and rates: poisson, overdispersed poisson, and negative binomial models. *Psychological Bulletin*. (118), 392.

Grunert, S. C. (1989). Ein Inventar zur Erfassung von Selbstaussagen zum Ernährungsverhalten [An inventory for determination of eating behaviors through self-reporting]. *Diagnostica*, *35*, 167–179.

Hartmann, C., Keller, C., & Siegrist, M. (2016). Compensatory beliefs, nutrition knowledge and eating styles of users and non-users of meal replacement products. *Appetite*, *105*, 775–781. https://doi.org/10.1016/j.appet.2016.07.013

Hoffman, L., & Stawski, R. S. (2009). Persons as Contexts: Evaluating Between-Person and Within-Person Effects in Longitudinal Analysis. *Research in Human Development*, *6*, 97–120. https://doi.org/10.1080/15427600902911189

Inauen, J., Shrout, P. E., Bolger, N., Stadler, G., & Scholz, U. (2016). Mind the gap? An intensive longitudinal study of between-person and within-person intention-behavior relations. *Annals of Behavioral Medicine*, *50*, 516–522. https://doi.org/10.1007/s12160-016-9776-x

Jasinska, A. J., Yasuda, M., Burant, C. F., Gregor, N., Khatri, S., Sweet, M., & Falk, E. B. (2012). Impulsivity and inhibitory control deficits are associated with unhealthy eating in young adults. *Appetite*, *59*(3), 738–747. https://doi.org/10.1016/j.appet.2012.08.001

Kaklamanou, D., Armitage, C. J., & Jones, C. R. (2013). A further look into compensatory health beliefs: A think aloud study. *British Journal of Health Psychology*, *18*, 139–154. https://doi.org/10.1111/j.2044-8287.2012.02097.x

Kantomaa, M. T., Tikanmäki, M., Kankaanpää, A., Vääräsmäki, M., Sipola-Leppänen, M., Ekelund, U., . . . Tammelin, T. H. (2016). Accelerometer-Measured Physical Activity and Sedentary Time Differ According to Education Level in Young Adults. *PloS One*, *11*(7), e0158902. https://doi.org/10.1371/journal.pone.0158902

Kelly, B., King, L., Bauman, A., Smith, B. J., & Flood, V. (2007). The effects of different regulation systems on television food advertising to children. *Australian and New Zealand Journal of Public Health*, *31*(4), 340–343. https://doi.org/10.1111/j.1753-6405.2007.00083.x

Knäuper, B., Rabiau, M., Cohen, O., & Patriciu, N. (2004). Compensatory health beliefs: Scale development and psychometric properties. *Psychology & Health*, *19*, 607–624. https://doi.org/10.1080/0887044042000196737

Koo, T. K., & Li, M. Y. (2016). A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *Journal of Chiropractic Medicine*, *15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Kronick, I., Auerbach, R. P., Stich, C., & Knäuper, B. (2011). Compensatory beliefs and intentions contribute to the prediction of caloric intake in dieters. *Appetite*, *57*, 435–438. https://doi.org/10.1016/j.appet.2011.05.306

Matley, F. A. I., & Davies, E. L. (2018). Resisting temptation: Alcohol specific self-efficacy mediates the impacts of compensatory health beliefs and behaviours on alcohol consumption. *Psychology, Health & Medicine*, *23*, 259–269. https://doi.org/10.1080/13548506.2017.1363395

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., . . . Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980â€“2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. (384), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Petersen, J. M., Prichard, I., Kemps, E., & Tiggemann, M. (2019). The effect of snack consumption on physical activity: A test of the compensatory health beliefs model. *Appetite*, *141*, 1–6. https://doi.org/10.1016/j.appet.2019.104342

Poelman, M. P., Vermeer, W. M., Vyth, E. L., & Steenhuis, I. H. M. (2013). 'I don't have to go to the gym because I ate very healthy today': The development of a scale to assess diet-related compensatory health beliefs. *Public Health Nutrition*, *16*, 267–273. https://doi.org/10.1017/S1368980012002650

Polit, D. F. (2014). Getting serious about test-retest reliability: A critique of retest research and some recommendations. *Quality of Life Research*, *23*(6), 1713–1720. https://doi.org/10.1007/s11136-014-0632-9

Prinsen, S., Evers, C., & Ridder, D. T. D. de (2019). Justified indulgence: Self-licensing effects on caloric consumption. *Psychology & Health*, *34*, 24–43. https://doi.org/10.1080/08870446.2018.1508683

R Core Team (2017). R: A language and environment for statistical computing. Retrieved from https://www.R-project.org/

Rabiau, M., Knäuper, B., & Miquelon, P. (2006). The eternal quest for optimal balance between maximizing pleasure and minimizing harm: The compensatory health beliefs model. *British Journal of Health Psychology*, *11*, 139–153. https://doi.org/10.1348/135910705X52237

Radtke, T., Inauen, J., Rennie, L., Orbell, S., & Scholz, U. (2014). Trait versus state: Effects of dispositional and situational compensatory health beliefs on high-calorie snack consumption. *Zeitschrift Für Gesundheitspsychologie*, *22*, 156–164. https://doi.org/10.1026/0943-8149/a000125

Radtke, T., Scholz, U., Keller, R., & Hornung, R. (2011). Smoking is ok as long as I eat healthily: Compensatory health beliefs and their role for intentions and smoking within the health action process approach. *Psychology & Health*, *27*, 91–107. https://doi.org/10.1080/08870446.2011.603422

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaksm, CA: Sage.

Ruddock, H. K., Field, M., Jones, A., & Hardman, C. A. (2018). State and trait influences on attentional bias to food-cues: The role of hunger, expectancy, and self-perceived food addiction. *Appetite, 131*, 139–147. https://doi.org/10.1016/j.appet.2018.08.038

Scholz, U. (2019). It's Time to Think about Time in Health Psychology. *Applied Psychology: Health and Well-Being.* Advance online publication. https://doi.org/10.1111/aphw.12156

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological Momentary Assessment. *Annual Review of Clinical Psychology*, *4*(1), 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Sim, A. Y., & Cheon, B. K. (2019). Influence of impending healthy food consumption on snacking: Nudging vs. compensatory behaviour. *Physiology & Behavior*, *198,* 48–56. https://doi.org/10.1016/j.physbeh.2018.10.010

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics (Vol. 5).* Bosten, MA: Pearson.

Van Strien, T., Frijeters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders*, *5*(2), 295–315.

Wadhera, D., & Capaldi-Phillips, E. D. (2014). A review of visual cues associated with food on food acceptance and consumption. *Eating Behaviors*, *15*(1), 132–143. https://doi.org/10.1016/j.eatbeh.2013.11.003

WHO (2018). World health statistics 2018: monitoring health for the SDGs, sustainable development goals. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf

Yen, M., & Lo, L.□H. (2002). Examining test-retest reliability: An intra-class correlation approach. *Nursing Research*, *1*(51), 59–62.

Zambrowicz, R., Schebendach, J., Sysko, R., Mayer, L. E. S., Walsh, B. T., & Steinglass, J. E. (2019). Relationship between three factor eating questionnaire-restraint subscale and food intake. *The International Journal of Eating Disorders*, *52*(3), 255–260. https://doi.org/10.1002/eat.23014

Table 1. Factor structure of eating-related CHBs (varimax rotation)

		Rotated factor loadings	
Factor	Item	1	2
CHBs $_{eating}$ Cronbach's alpha = .742	It is fine to eat energy dense snacks such as cake or peanuts, if I eat less during the main meals.	**.61**	.20
	It is fine to eat energy dense snacks occasionally (e.g. cake or peanuts), if I eat less in general.	**.91**	.03
	If I do not eat anything during the day, it is fine to eat an energy dense snack such as cake or peanuts.	**.72**	-.17
	It is fine not sticking to my diet for a day, if I carry on with my diet the next day.	**.40**	.14
CHBs $_{physical\ activity}$ Cronbach's alpha = .763	As long as I am physically active, I can eat any energy dense snacks such as cake or peanuts.	.11	**.99**
	If I am physically active, I can eat whatever I want.	.04	**.62**

Note: N =45; Loadings ≥.40 are bold.

Table 2 Descriptive statistics for within-person variables.

Level 1 variables (when at least one snack was consumed)	*n*	*M*	*SD*	Range	ICC_{Var}
Number of unhealthy snacks	476	0.89	0.77	0 - 4	0.15
State CHBs	476	3.24	2.47	1 - 9	0.37
Hunger	474	3.36	2.33	1 - 9	0.11

Note: N = 45, n = number of available diary entries when at least one snack was consumed.

ICC_{Var} = Intra-class correlation, calculated as the proportion of the between-person of the total variance.

Table 3. Correlations and descriptive statistics for between-person variables.

Level 2 variables	1	2	3	4
1. Trait CHBs $_{eating}$	-			
2. Trait CHBs $_{physical\ activity}$	.16	-		
3. BMI	.09	.02	-	
4. Restrained Eating	.44**	-.33*	.17	-
N	45	45	44	45
Mean	4.19	5.59	23.07	2.80
SD	1.86	2.10	2.66	2.90
Range	1 - 9	1 - 9	18.4 – 29.7	1 - 5

Note: ** $p < .01$, * $p < .05$; CHBs = Compensatory health beliefs; BMI = Body mass index; CHBs $_{eating}$ = CHBs in regard to the compensation with eating behavior; CHBs $_{physical\ activity}$ = CHBs in regard to the compensation with physical activity.

Table 4 Parameter estimates for the generalized estimating equation model of unhealthy snack consumption as a function of time, state and trait CHBs and BMI.

Fixed effects	*B*	SE	*RR*	*p*
Intercept	-0.30	.14	0.74	0.102
Time	< 0.00	.00	1.00	0.136
State CHBs (within-person)	0.04	.02	1.04	0.043
Mean state CHBs (between-person)	-0.05	.03	0.95	0.172
Trait CHBs $_{\text{eating}}$	0.01	.02	1.01	0.682
Trait CHBs $_{\text{physical activity}}$	0.05	.02	1.05	0.021
BMI	0.04	.02	1.04	0.028

Note: N = 44, number of observation = 454, estimated scale parameter = 0.62, number of iterations = 1, B = unstandardized regression coefficients, RR = rate ratio; CHBs = Compensatory health beliefs; BMI = Body mass index.

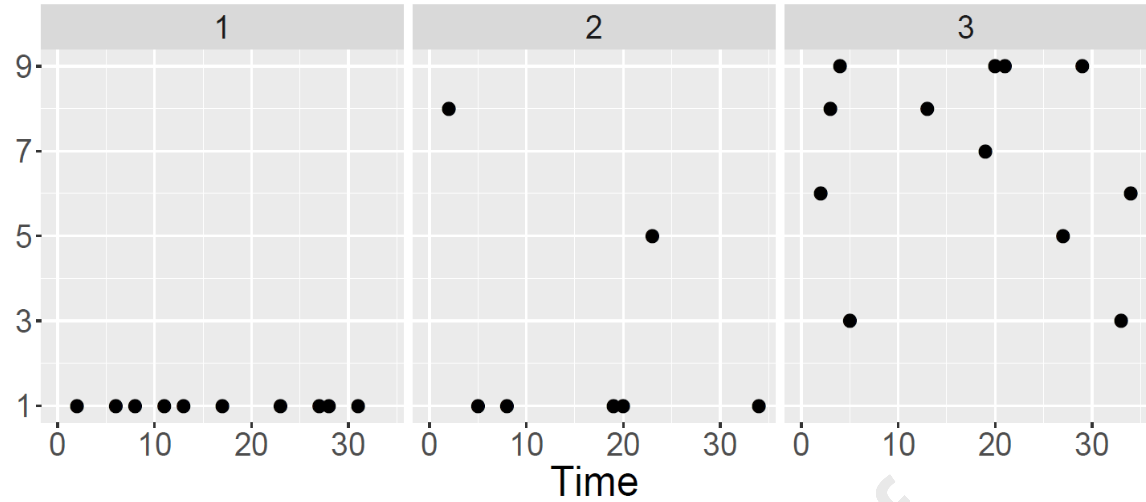

Figure 1. Variation of state compensatory health beliefs over 35 measurement points when snacks were eaten for three sample individuals.

Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards The authors Melanie Alexandra Amrein, Urte Scholz and Jennifer Inauen declare that they have no conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.