



Connecting to our future, healthier selves: Associations between self-continuity measures and eating behaviors in daily life

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ABSTRACT

In the pursuit of healthy eating, as with many other health goals, most benefits for one's health are not realized immediately, but instead occur after a person engages in consistent patterns of healthy eating across many weeks, months, and years. Thus, being able to represent temporally distant benefits when making seemingly trivial daily eating decisions (e.g., choosing fruit salad rather than ice cream for dessert) should be a key determinant of healthy eating. Here, we tested a priori, preregistered hypotheses in a large online sample of adults ($N = 360$) by examining the role of self-continuity in people's daily eating behaviors, as well as the relationship between self-continuity and motivational factors behind people's decisions to eat healthy. We also examined the moderating influence of self-continuity on training in self-regulatory strategies intended to promote healthy eating. Overall, we garnered support for our hypotheses, as there were links between self-continuity measures, autonomous motivation levels, and daily eating of healthy and unhealthy foods, with participants' ability to consider future consequences associated with unhealthy eating measures, and participants' connectedness to their future selves associated with healthy eating measures. Taken together, the present findings suggest that continuity with one's future self is an important factor underlying daily eating decisions and successful goal pursuit in the eating domain.

Introduction

Individuals who maintain a healthy diet have a lower risk of developing numerous noncommunicable diseases, such as diabetes, heart disease, and certain cancers. Although many nations have established guidelines to encourage and support healthy eating (e.g., eating five portions of fruit and vegetables per day), individuals living in these societies consistently fall short of these targets (GBD 2015 Obesity Collaborators et al., 2017). One challenge in the pursuit of healthy eating, as with many other health goals, is that the most significant benefits of healthy eating for morbidity and mortality are not realized immediately upon consumption, but instead occur after a person engages in sustained healthy eating throughout the course of their life. Thus, being able to adequately represent and value temporally distant, and often uncertain, benefits during everyday behaviors (e.g., choosing fruit salad rather than ice cream for dessert) is a crucial determinant of

healthy eating.

Considerations of future outcomes, however, come more naturally to some people than others. While some individuals see their future self as a smooth continuation of their present self, others identify much more strongly with their present self while seeing their future self as a more detached and distant other. As the benefits of healthy eating are often distal rather than proximal, low levels of self-continuity might predispose an individual to favor gratifying foods in the moment that pose a risk to the development of ill-health. Here, we first explored if feeling more connected to one's future self predicts healthier eating during everyday life. It is furthermore crucial to not only understand *if* individuals with high self-continuity make healthier dietary choices, but also *why* and *how* they engage these behaviors. To this end, we assessed whether self-continuity was associated with differences in two important aspects of dietary self-regulation: one focused on the quality of motivations towards eating behaviors, and a second on the type of self-

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regulatory strategies used to promote healthy eating or discourage unhealthy eating.

Self-continuity and healthy eating

Understanding what drives healthy eating is complex, including a wide range of personal and situational factors associated with the selection of healthy options. Healthier food choices are often limited by socioeconomic inequalities (Darmon and Drewnowski, 2015), and are also partially related to environmental factors associated with food accessibility (Allan and Powell, 2020; Allan et al., 2017; Hawkes et al., 2015). In addition to these external factors, dietary choices are driven by psychological processes that are internal to the individual. For many of us, selecting between one food option and another might generate conflict between the long-term goal of being healthy and the short-term desire to eat something immediately rewarding and delicious. Such goal-desire conflicts are a hallmark feature of self-control dilemmas (Kotabe and Hofmann, 2015), where an individual might be motivated to overcome a short-term impulse to select an option that favors long-term health. This self-control process is often fallible, arising in part from people's tendency to discount future benefits in favor of immediate gratification (Kable and Glimcher, 2007; Mischel, 1974).

While it is well documented that individuals undervalue temporally distal rewards on average, some individuals are better able to consider and value delayed positive outcomes. Having a strong sense of connection with one's future self may facilitate additional processing of personal, long-term consequences of immediate behaviors. Self-continuity, a construct that captures the extent to which individuals experience a sense of personal connection to (or overlap with) their future self (e.g., Adelman et al., 2017; Ersner-Hershfield et al., 2009b), is one potentially important factor to consider when trying to encourage behaviors that align with higher-order, long-term goals (see Sedikides et al., 2022 for a review). This is consistent with studies showing that appealing to a connection with one's future self helps to overcome immediate temptations (Hershfield, 2019; Stephan et al., 2018; Strathman et al., 1994; Van Gelder et al., 2013). These empirical findings also cohere with suggestions that individuals do not necessarily view themselves as a single consistent entity over time, but instead that the self is composed of multiple identities (or selves) over time (e.g., Higgins, 1987; Markus and Nurius, 1986; McConnell, 2011; Roberts and Donahue, 1994).

Much of the empirical evidence indicating the benefits of self-continuity has focused on intertemporal choice, particularly in the realm of financial decision making (Bartels and Rips, 2010; Bartels and Urminsky, 2011; Ersner-Hershfield et al., 2009a, 2009b; Hershfield, 2011; Macrae et al., 2017). Furthermore, lower self-continuity has also been associated with unethical decisions and criminality (Van Gelder et al., 2013; van Gelder et al., 2015), smoking (Zhao et al., 2022), lack of adherence to COVID-19 restrictions (Simić et al., 2021), and less exercise (Rutchick et al., 2018). Low self-continuity, therefore, might be accompanied by actions resulting in choices that favor the present self, almost as if the future self were a stranger (Hershfield, 2019; Pronin et al., 2008; Pronin and Ross, 2006; Tausen et al., 2018). Thus, a strong sense of self-continuity might help individuals overcome the desire for immediate gratification in service of personal future gains.

Self-continuity, consideration of future consequences, and healthy eating

Despite promising empirical and theoretical evidence, relatively little research has examined the association between a sense of connectedness to one's future self and healthy eating behaviors. On the other hand, Consideration of Future Consequences, a conceptually related construct (Strathman et al., 1994), has been associated with a myriad of health-related behaviors including exercise (Adams and Nettle, 2009; Ouellette et al., 2005) and intentions to eat healthy or control one's diet (Joireman et al., 2006; Piko and Brassai, 2009). As the name implies,

Consideration for Future Consequences captures the extent to which individuals appreciate the long-term impact of current decisions (e.g., "Often I engage in a particular behavior in order to achieve outcomes that may not result for many years"). Questions also probe the goal-desire conflict assessing whether more value is placed on current or future experiences (e.g., "I only act to satisfy immediate concerns, figuring the future will take care of itself"). Contrasted with future self-continuity measures, which emphasize a psychologically cohesive identity over time, Consideration for Future Consequences is more directly oriented towards behavior.

While it might be expected that the same individuals who experience a strong sense of connectedness to their future selves will also be particularly attentive to the future consequences of their present behavior, the empirical overlap of Consideration of Future Consequences and self-continuity has yet to be thoroughly investigated. One related study demonstrated that Consideration of Future Consequences mediates the impact of self-continuity on unethical decision making (Hershfield et al., 2012). Investigating interaction effects, another study identified that individuals who score high on Consideration of Future Consequences are more likely to exercise after imagining an ideal version of themselves (Ouellette et al., 2005). Though this study did not directly measure self-continuity, seeing one's self (mentally or virtually) can enhance a sense of self-continuity (Hershfield, 2011; Macrae et al., 2017; Tausen et al., 2020b) and reduce consumption of high calorie foods (Christian et al., 2016; Kuo et al., 2016). Considering the theoretical and empirical overlap and the potential utility of self-continuity manipulations, direct investigations of the relationship between daily food consumption, Consideration of Future Consequences, and self-continuity are important to explore.

Self-continuity and self-regulation

Self-regulation is a multifaceted concept that involves processes related to goal setting (e.g., why do I pursue healthy eating?) and goal striving (i.e., how will I pursue my healthy eating goal?; Inzlicht et al., 2020; Mann et al., 2013). Thus, an analysis of the components of self-regulation might not only allow us to establish if self-continuity predicts healthy eating behaviors (an empirical question), but also why (i.e., goal motives) and how (i.e., self-regulation strategies) individuals with high self-continuity make healthy choices (a process question). Here, we explored if self-continuity promotes healthy eating, either by motivating the long-term goal to eat healthily, or by facilitating deployment of self-control strategies that are known to down-regulate impulses (Duckworth et al., 2016; Milyavskaya et al., 2021), including impulses to eat (Lopez et al., 2021), or both.

According to self-determination theory, a person is more likely to achieve a goal if they are autonomously motivated. This might occur because the individual finds the means of achieving the goal inherently interesting and satisfying (i.e., intrinsic motivation), or because they see achieving the goal as being congruent with their life values and beliefs (i.e., integrated regulation), or when a person individually identifies an unrewarding action as being instrumental in achieving an outcome that is personally significant and meaningful (i.e., identified regulation; Deci and Ryan, 2000; Ryan and Deci, 2017). These three factors commonly form a composite measure of autonomous (or "want-to") motivation (Milyavskaya et al., 2015). Internal motivation is distinguished from motives that have an external locus of motivation, where individuals perform actions due to guilt, shame, or anxiety derived from seeking approval from others or from the self in service of maintaining positive self-worth (i.e., introjection), or where individuals are compelled to perform to achieve extrinsic rewards or escape punishment (external regulation; Deci and Ryan, 2000). Individuals with high self-continuity see little difference between their current and future self. Thus, motives to act in line with both longer-term goals and proximal goals are equally likely to become internalized for individuals with high levels of self-continuity. In contrast, for individuals who experience weaker

connections to their future self, they may be less likely to internalize distal goals, and thereby become less autonomously motivated to pursue those goals.

Beyond these goal-level considerations, a substantial body of research has identified self-control strategies that can promote the consumption of healthy foods and/or reduce the unhealthy eating. These strategies resolve conflicts between immediate temptations and another option, which, although less tempting, is better aligned with long-term goals. Multiple strategies can be identified to target different stages of a developing temptation (Duckworth et al., 2016; Giuliani and Berkman, 2015; Metcalfe and Mischel, 1999; Mischel and Baker, 1975). First, a person might proactively avoid self-control conflicts by avoiding tempting situations (*situation selection*), or by altering or restructuring their immediate environment to make temptations less salient (*situation modification*). Other *intrapsychic* self-control strategies involve actively countering a temptation as it develops, either by selectively moving attention away from the object of desire (*attention deployment*), rethinking the temptation in a way that makes it less appealing (*cognitive change*), or by acting to override or inhibit behaviors that enact temptations (*response modulation*). Such strategies have demonstrable efficacy in reducing food related cravings in the lab (Giuliani et al., 2013; Mischel and Baker, 1975) and in everyday life (Lopez et al., 2021; Milyavskaya et al., 2021).

A critical extension of this growing body of research is the exploration of the interactions between self-control strategies and individual differences. Interactions with a personal sense of future self-continuity might be important to study in the context of self-control for at least two reasons. First, those higher in future self-continuity may already be making healthier food choices and leading healthier lives, and thus might not need nor benefit as much from self-regulation training. Alternatively, it is possible that considering the future self does not entirely sidestep the need for self-control, but instead changes the types of strategies that an individual uses. A person who does not readily represent or identify with their future self might be less likely to use self-control in order to pursue distant, less identified goals over immediate gratification. In contrast, a closer connection with your distant self might motivate an individual to use self-control in service of choices with delayed payoffs. Individuals with a deep connection to the future may also be more adept at utilizing specific strategies such as those to select or alter the environment because of the level of planning that they require. This might be achieved by avoiding environments with goal conflicting temptations (e.g., by not frequenting restaurants with unhealthy options, or by stocking cabinets with healthy rather than unhealthy foods). Situational strategies can be particularly effective in preventing goal incongruent behavior because they are implemented early in the process of craving generation, often before the craving even occurs (Duckworth et al., 2016). While alternative strategies are necessary once face-to-face with a temptation, it seems likely that those who are more future focused would be better equipped to anticipate, and thus avoid, temptation altogether.

Current study and hypotheses

To explore the relationship between self-continuity and eating behaviors, we analyzed data from a large-scale online self-regulation training study to probe the relationship between self-continuity and daily eating behaviors. We had three primary outcomes of interest: craving strength, resistance, and consumption, as these are commonly assessed together using Ecological Momentary Assessment (EMA) and daily diaries of self-regulation of eating, with craving and resistance as important drivers of subsequent consumption (e.g., Hofmann et al., 2012); craving has also been robustly associated with eating and weight gain over time, as demonstrated in a meta-analysis (Boswell and Kober, 2016).

As a secondary goal of the present work, we examined whether individual differences in self-continuity would interact with self-

regulation strategies to promote healthy eating. This was motivated because previous research has not explored whether self-continuity moderates the effectiveness of self-control interventions. Considering the robust relationship between self-continuity and intertemporal choice (Bartels and Urminsky, 2011; Hershfield, 2011; Parfit, 1971, 1984; Stephan et al., 2018; Thaler and Shefrin, 1981), those high in future self-continuity may already demonstrate healthy eating behaviors and, thus, may benefit less from self-control interventions.

We set out to test the following a priori hypotheses: (H1) Self-continuity will be positively correlated with healthy eating behaviors (greater craving and consumption of healthy foods and/or less craving and consumption of unhealthy foods); (H2) Self-continuity will be positively correlated to eating decisions that represent “who one is and what they value most in life” (reflecting autonomous motivation) and negatively correlated with eating decisions based on “feeling ashamed, guilty or anxious” (reflecting extrinsic/controlled motivation); (H3) Self-continuity will moderate the effectiveness of the self-regulation strategies, such that people low in self-continuity may particularly benefit from self-regulation strategy training, whereas people high in self-continuity would experience fewer benefits from strategy training; and (H4) Those high in self-continuity will have greater success with the situation selection strategy compared to those low in self-continuity, given the future planning that is involved in situation selection and other proactive regulatory strategies (Duckworth et al., 2016). These hypotheses, along with our study design and analyses, were pre-registered on the Open Science Framework (<https://osf.io/zvqc7>).

Method

Participants and procedure

All participants were recruited from the Prolific community and enrolled in a longitudinal self-regulation training study, the primary hypotheses and analyses of which are noted elsewhere (<https://osf.io/7hvda/>). Participants were eligible to participate if they met the following inclusion criteria: (1) Not currently pregnant; (2) Reported at least moderate levels of overall motivation to eat healthy (a response of at least 50 on a 0–100 visual analog scale where 0=*not at all motivated*, 50=*moderately motivated*, and 100=*extremely motivated*); (3) Not diagnosed with any eating disorders or syndromes (“No” responses for Anorexia Nervosa, Bulimia Nervosa, Binge Eating Disorder, Prader-Willi Syndrome, and other non-specified feeding or eating disorder); and (4) No significant impact of mental health conditions on daily functioning (a “No” response to the question, “Do you have any diagnosed mental health condition that is uncontrolled [by medication or intervention] and which has a significant impact on your daily life / activities?”). In total, there were 360 participants (190 Women; $M_{age} = 27.0$; $SD_{age} = 9.28$; range = 18–65) who met these eligibility criteria and whose data were included in the present analyses. All participants gave informed consent according to guidelines set by the Institutional Review Board at Bard College, and upon completion of the study were debriefed on the study’s overall aim to enhance self-control of daily eating behaviors.

In an initial session, participants first completed a baseline survey that consisted of a series of questionnaires capturing different psychological traits and dispositions, including measures of interest reflecting self-continuity and motivation (see below for more details on each measure). Participants also were randomly assigned to learn and practice different self-regulatory strategies to promote healthy eating (or, as a control, some received no training). There were three conditions total: control (no training), cognitive reappraisal (directed toward healthy or unhealthy foods), and situation selection/modification (directed toward healthy or unhealthy foods). This self-regulation training procedure closely followed that of Boswell and colleagues (2018), which reliably altered food craving and consumption across multiple samples (Boswell et al., 2018). See our other preregistration that directly tests the

effectiveness of the regulatory strategies participants were trained to employ (<https://osf.io/7hvda/>).

Self-continuity and motivation measures

We administered two measures of self-continuity. The first was a 12-item scale assessing inter-individual differences in Consideration of Future Consequences (Strathman et al., 1994), where participants rated items such as “I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years” on a 1–5 Likert scale, where 1=*extremely uncharacteristic (of me)* and 5=*extremely characteristic (of me)*. Sum scores were calculated based on responses to all items (possible range of 12–60). Participants also completed an assessment of similarity and connectedness to one’s future self, adapted from Ersner-Hershfield and colleagues’ 2009 study (Ersner-Hershfield et al., 2009b); specifically, participants selected one set of overlapping circles representing their current and future self in response to the following two items: (1) “Which of the following circle pairs best represents how *connected* you feel to your future self?” and (2) “Which of the following circle pairs best represents how *similar* you feel to your future self?”. The sets of circles mapped onto a Likert scale ranging from 1 (no overlap; circles do not touch at all) to 7 (a lot of overlap; circles almost entirely overlaid on each other). We averaged responses from these two questions to estimate participants’ level of overall connectedness to their future selves.

To assess participants’ baseline level of motivation, we administered a brief survey capturing internal and external sources of motivation to pursue healthy eating goals (adapted from Milyavskaya et al., 2015); “Because [the goal] represents who I am and reflects what I value most in life” is an item reflecting internal motivation, whereas “Because someone else (e.g., parent, professor, friend) wants me to, or because I’ll get something from someone if I do” is an item reflecting external motivation. We re-administered two of these items to capture participants’ daily motivation levels to pursue their healthy eating goals, with participants using a slider scale to indicate agreement with the statement “In general today, I made eating decisions that represent who I am and reflect what I value most in life” (0=*strongly disagree*; 50=*neither agree nor disagree*; 100=*strongly agree*) to reflect their internal motivation, as well as agreement with the statement “In general today, I made eating decisions in order to avoid feeling ashamed, guilty, or anxious” (0=*strongly disagree*; 50=*neither agree nor disagree*; 100=*strongly agree*) to reflect their external motivation.

Assessment of daily eating behaviors

During the daily diary portion of the study, participants completed surveys that assessed craving for, resistance to, and consumption of the following food categories; sweets (e.g., ice cream, chocolate, doughnuts, cookies, cake, candy, etc.); starches (e.g., white bread, potatoes, rolls, pasta, rice, etc.); salty snacks (e.g., chips, pretzels, and crackers); fatty foods (e.g., steak, bacon, hamburgers, cheeseburgers, pizza, French fries, etc.); fresh vegetables (e.g., leafy greens, carrots, broccoli, cauliflower, etc.); fresh fruits (e.g., apples, oranges, bananas, berries, etc.); and lean proteins (e.g., fish, poultry, eggs, nuts, low-fat dairy products, etc.). Craving ratings for the above categories were made using a slider scale (0=*very weak craving*; 50=*moderate craving*; 100=*very strong craving*), as were resistance ratings (0=*did not resist at all*; 50=*resisted somewhat*; 100=*resisted very strongly*), and ratings for amount consumed (0=*none*; 50=*a moderate amount (average portion)*; 100=*a very large quantity*). We averaged responses to these measures to create healthy and unhealthy food composite measures for craving, resistance, and amount eaten, respectively, with unhealthy measures comprised of responses from the sweets, salty snacks, and fatty foods categories, and healthy measures comprised of responses from the fresh vegetables, fresh fruits, and lean proteins categories.

Power and effect size considerations

An a priori power analysis was originally conducted based on the design of the self-regulation training study that yielded the present data. This involved a series of simulations that suggested that a total sample size of approximately 300–350 would be sufficient to attain statistical power of around 80–85% to detect effects of interest for the parent study. We also computed a separate set of a priori power calculations to test hypotheses in the present analyses; these indicated that we would need at least 260 participants to achieve 90% statistical power, assuming an alpha rate of 0.05 and small-to-medium effect sizes (i.e., $|r| \geq 0.20$) for zero-order correlations of interest. Given the final sample size was over 350, we are confident that we achieved sufficient statistical power to detect all effects of interest.

Statistical analyses and model specifications

Preregistered (primary) analyses

To test H1 (positive correlations between self-continuity measures and patterns of healthy eating) and H2 (positive/negative correlations between self-continuity measures and intrinsic/extrinsic motivation), we ran a series of bivariate correlations in the whole sample. To test H3 (self-continuity moderates self-regulation strategy effectiveness), we conducted moderated regression models in which we specified interactions between self-continuity and strategy type to predict our outcomes of interest (craving, resistance, and amount eaten for healthy and unhealthy foods, respectively). To test H4 (positive relationship between self-continuity measures and healthy eating in the situation selection/modification group), we looked at the subset of participants who learned the situation selection/modification strategy and ran bivariate correlations between the self-continuity measures and the daily eating measures.

Exploratory analyses

As an extension of H1 (positive correlations between self-continuity measures and patterns of healthy eating) and H2 (positive/negative correlations between self-continuity measures and intrinsic/extrinsic motivation), we conducted exploratory analyses that incorporated the same variables of interest (i.e., self-continuity measures, motivational factors, and eating behaviors). Given the role of autonomous motivation in health-promoting self-regulatory behaviors (Cosme and Berkman, 2020), we tested whether any direct associations between self-continuity measures and eating behaviors might be mediated by autonomous motivation. To do this, we first inspected correlations testing direct links between these variables (H1 and H2), and if they were statistically significant, we proceeded to specify mediation models in which self-continuity measures served as the predictor (X), autonomous motivation served as the mediator (M), and eating behaviors were the outcome measure (Y).¹

Results

Descriptives

Means and standard deviations for all variables of interest are listed in Table 1.

¹ Although none of these variables were experimentally manipulated, they were assessed longitudinally, with self-continuity assessed first, followed by daily motivation levels and eating behaviors, which is an appropriate model specification, especially when examining individual differences (Selig & Preacher, 2009).

Table 1

Summary statistics for demographic variables and all a priori variables of interest (i.e., measures of self-continuity, daily eating behaviors, and daily motivation levels). For continuous variables, means and standard deviations are reported in the summary statistic column; for categorical variables, counts and proportions are reported.

Variable	Summary Statistic
Age in years (SD)	27.0 (9.28)
Sex	
Different identity (coded as 1) (%)	1 (0.27)
Female (coded as 2) (%)	189 (52.5)
Male (coded as 3) (%)	169 (46.9)
Trans female / trans woman (coded as 4) (%)	1 (0.27)
Measures of self-continuity	
Future Self-connectedness (total possible range: 1–7) (SD)	3.84 (1.37)
Consideration of Future Consequences (total possible range: 12–60) (SD)	41.3 (6.56)
Daily eating behaviors (total possible range: 0–100)	
Unhealthy foods–craving strength (SD)	28.5 (14.6)
Unhealthy foods–resistance (SD)	54.4 (24.0)
Unhealthy foods–amount eaten (SD)	18.9 (12.2)
Healthy foods–craving strength (SD)	34.0 (18.8)
Healthy foods–resistance (SD)	29.7 (24.9)
Healthy foods–amount eaten (SD)	34.8 (18.1)
Daily motivation levels (total possible range: 0–100)	
Autonomous motivation (SD)	52.9 (19.7)
Controlled motivation (SD)	34.4 (23.1)

Preregistered (primary) analyses

Before proceeding with our primary analyses, we conducted two initial checks following Note 1 and Note 2 in the preregistration. First, we calculated the correlation between the two self-continuity measures (Future Self-connectedness and Consideration of Future Consequences) and found them to be weakly correlated ($r=0.13$), which is consistent with previous work (e.g., Hershfield et al., 2012), so we decided to conduct subsequent analyses separately for each measure. Next, we incorporated time (week-level data) into models that tested H3 (self-continuity moderates self-regulation strategy effectiveness), and we only inspected the three-way interaction terms. None were significant, so as per Note 2, we averaged values for daily eating measures reflecting general eating patterns over the course of two weeks following the initial (baseline) survey.

First, in support of H1 (positive correlations between self-continuity measures and patterns of healthy eating), those scoring higher on the Consideration of Future Consequences scale tended to report weaker cravings for unhealthy foods, $r(358) = -0.16$ (95% CI: $-0.26, -0.06$), $p = .002$, and consumed less unhealthy foods, $r(358) = -0.26$ (95% CI: $-0.35, -0.16$), $p < .001$ (see Table 2). Additionally, those with higher Future Self-connectedness scores reported stronger cravings for healthy foods, $r(358) = 0.18$ (95% CI: $0.08, 0.28$), $p < .001$, and consumed more healthy foods, $r(358) = 0.15$ (95% CI: $0.04, 0.25$), $p = .006$ (see Table 2).

Next, we observed some associations in support of H2 (positive/negative correlations between self-continuity measures and intrinsic/extrinsic motivation), with significant positive correlations between participants' daily autonomous motivation to eat healthy and both measures of self-continuity. Specifically, those with higher scores on the Consideration of Future Consequences scale also reported greater autonomous motivation, $r(358) = 0.16$ (95% CI: $0.06, 0.26$), $p = .002$, and those with higher Future Self-connectedness also reported more autonomous motivation, $r(358) = 0.21$ (95% CI: $0.11, 0.31$), $p < .001$ (see Table 2). Lastly, with respect to H2, those with higher scores on the Consideration of Future Consequences scale tended to report lower levels of extrinsic motivation at baseline, $r(358) = -0.21$ (95% CI: $-0.31, -0.11$), $p < .001$.

Next, in support of H3 (self-continuity moderates self-regulation strategy effectiveness), there was a significant interaction effect

between scores on the Consideration of Future Consequences scale and strategy type when predicting craving for unhealthy foods, $F(2, 354) = 5.97$, $p = .003$. Simple slope analyses qualified this interaction effect, indicating that those in the cognitive reappraisal and control groups saw a negative relationship between Consideration of Future Consequences scores and craving strength ($b_{\text{cog}} = -0.70$, $p < .001$; $b_{\text{control}} = -0.60$, $p = .002$), but this was not the case in the group that received training in situation selection/modification ($b_{\text{sit}} = 0.20$, $p = .33$) (see Fig. 1).

Following our fourth preregistered hypothesis, we conducted follow-up analyses to H3 by inspecting relationships between self-continuity measures and healthy eating in the situation selection/modification group specifically. Those with higher Consideration of Future Consequences scores tended to report greater resistance to unhealthy foods, $r(124) = 0.19$ (95% CI: $0.02, 0.36$), $p = .03$, while those with higher Future Self-connectedness tended to report stronger cravings for healthy foods, $r(124) = 0.20$ (95% CI: $0.03, 0.36$), $p = .02$. For the sake of thoroughness and to compare with the above correlations testing H4 in the situation selection/modification group, we also examined relationships between self-continuity measures and healthy eating in the cognitive reappraisal group. There were robust negative correlations between participants' scores on the Consideration of Future Consequences scale and cravings for unhealthy foods, $r(115) = -0.29$ (95% CI: $-0.45, -0.12$), $p = .001$, and amount of unhealthy food consumed, $r(115) = -0.23$ (95% CI: $-0.40, -0.05$), $p = .01$.

Exploratory analyses

As an extension of H1 and H2, and as mentioned above in the method section, we employed structural equation modeling with bootstrapped estimates to examine indirect associations between self-continuity measures and daily eating patterns, via participants' daily autonomous (intrinsic) motivation. First, we observed a significant indirect path between Future Self-connectedness and amount of healthy food eaten, such that higher Future Self-connectedness was associated with greater autonomous motivation, $b=3.05$ (95% bootstrapped² CI: $1.59, 4.52$), $p < .001$, which was associated with greater consumption of healthy foods, $b=0.31$ (95% bootstrapped CI: $0.20, 0.42$), $p < .001$ (indirect effect: $b=0.94$ (95% bootstrapped CI: $0.44, 1.54$), $p < .001$, 48.8% partial mediation).

Replicating the above indirect path, there was also a significant indirect effect between Consideration of Future Consequences scores and amount of healthy foods consumed via autonomous motivation, such that higher Consideration of Future Consequences scores were associated with greater autonomous motivation, $b=0.49$ (95% bootstrapped CI: $0.17, 0.80$), $p = .002$, which was associated with greater consumption of healthy foods, $b=0.32$ (95% bootstrapped CI: $0.21, 0.44$), $p < .001$ (indirect effect: $b=0.16$ (95% bootstrapped CI: $0.05, 0.29$), $p = .012$, 96.3% partial mediation). See Fig. 2 for path diagram depicting direct and indirect paths from the above two mediation models.

Lastly, with respect to unhealthy eating, there was a significant indirect effect between Future Self-Connectedness and amount of unhealthy foods consumed via autonomous motivation, such that higher Future Self-connectedness was associated with greater autonomous motivation, $b=3.05$ (95% bootstrapped CI: $1.61, 4.53$), $p < .001$, which was associated with less consumption of unhealthy foods, $b = -0.08$ (95% bootstrapped CI: $-0.14, -0.02$), $p = .015$ (indirect effect: $b = -0.23$ (95% bootstrapped CI: $-0.46, -0.04$), $p = .033$, 62.1% partial mediation). In an alternate model specification with Consideration of Future Consequences as the predictor, there was no such indirect effect, $b = -0.02$ (95% bootstrapped CI: $-0.06, 0.01$), $p = .162$.

² All confidence intervals in mediation models were estimated from 10,000 re-samplings of the data.

Table 2

Pairwise correlations between all variables of interest (CFC = Consideration of Future Consequences; FSC = Future Self-connectedness; Auto. Motivation = average daily autonomous motivation levels).

	CFC	FSC	Auto. motivation	Craving _{healthy}	Resist _{healthy}	Amount _{healthy}	Craving _{unhealthy}	Resist _{unhealthy}
CFC	—							
FSC	0.128*	—						
Auto. motivation	0.162**	0.212***	—					
Craving _{healthy}	-0.030	0.179***	0.289***	—				
Resist _{healthy}	-0.077	-0.013	-0.054	-0.156**	—			
Amount _{healthy}	0.055	0.145**	0.350***	0.774***	-0.211***	—		
Craving _{unhealthy}	-0.164**	0.015	-0.072	0.088	0.237***	0.019	—	
Resist _{unhealthy}	0.073	-0.013	0.174***	0.283***	0.403***	0.292***	-0.028	—
Amount _{unhealthy}	-0.257***	-0.010	-0.118*	0.027	0.286***	-0.011	0.682***	-0.208***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

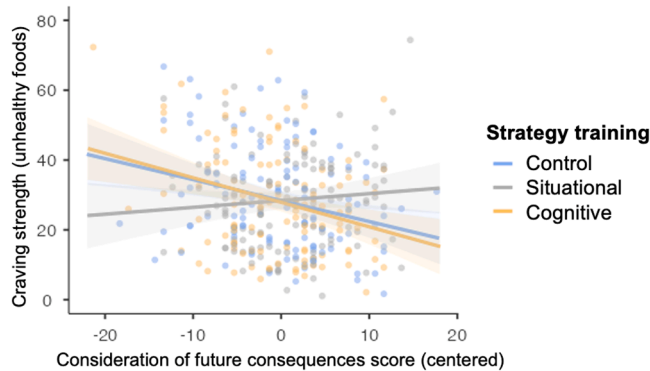


Fig. 1. Interaction plot showing relationships between Consideration of Future Consequences scores and craving strength for unhealthy foods, as a function of self-regulatory strategy training (indicated by differing line colors). Shaded regions indicate 95% confidence bands around the simple slope estimates.

the effectiveness of self-regulation strategies (H3), and that those high in self-continuity would have greater success with the situation selection strategy (H4).

Consistent with our hypotheses, Future Self Continuity and Consideration for Future Consequences were both predictive of eating behaviors measured over a two-week period (H1). We also demonstrated partial support for H2, such that autonomous motivation was reliably associated with both Future Self-Connectedness and Consideration of Future Consequences when measured concurrently with eating behaviors. Results demonstrated less consistent support for moderation of different self-regulation strategies (H3 & H4), though there was some evidence to suggest that Consideration of Future Consequences was predictive of craving for those in the control and cognitive reappraisal, but not the situation selection group. Finally, exploratory analyses also revealed that both Future Self-Connectedness and Consideration of Future Consequences were associated with autonomous motivation, associations that drove indirect effects of future-oriented measures on some (but not all) eating behaviors. The theoretical connections and practical implications of these findings are discussed in detail below.

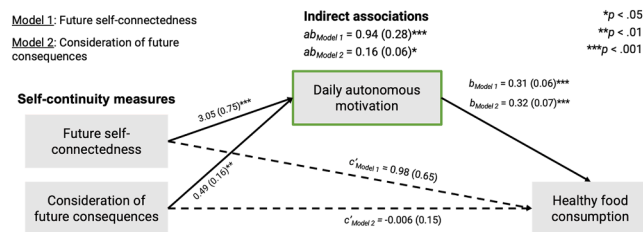


Fig. 2. Path diagram depicting all direct and indirect paths represented by two mediation models predicting healthy food consumption as a function of self-continuity measures (predictors) and daily autonomous motivation levels (mediator). Estimates of indirect associations are designated by *ab*. Dashed lines indicate direct paths between the predictor and the outcome measures. All numbers indicate unstandardized path coefficients, with estimates of standard error in parentheses.

Self-Continuity and future self consequences

In line with past work on the value of Future Self-Connectedness for goal-oriented behaviors (Ersner-Hershfield et al., 2009a, 2009b; Hershfield, 2019; Stephan et al., 2018; Strathman et al., 1994; Van Gelder et al., 2013), we hypothesized that self-continuity measures would be positively associated with healthy eating (H1). Given empirical and theoretical overlap between Consideration of Future Consequences and Future Self-Connectedness, we did not have predictions about each construct individually. The constructs were weakly correlated ($r=0.13$), and we investigated them separately (see above re: Note 1 from our preregistration). This afforded a unique look at how these future-oriented individual difference measures were differentially associated with eating behavior. Corroborating and extending past work on eating intentions (Joireman et al., 2012; Piko and Brassai, 2009), Future Self-Connectedness was more strongly associated with measures related to healthy foods whereas Consideration of Future Consequences was more strongly associated with measures related to unhealthy foods. Put simply, those who had a strong sense of connection to their future selves demonstrated more approach-related behaviors such that they both craved and consumed more healthy foods. Those who had a strong appreciation of future consequences, on the other hand, exhibited more avoidant behaviors such that they reported less craving and consumption of unhealthy foods.

While more recent work has begun to demonstrate connections between Future Self-Connectedness and health behaviors (Rutchick et al., 2018), our findings are among the first to demonstrate that these measures connect to actual consumption of healthy and unhealthy foods over time. To our knowledge, we are also the first to demonstrate that Consideration of Future Consequences and Future Self-Connectedness measures have unique value when predicting approach and avoid

Discussion

The wide-ranging consequences of unhealthy eating behaviors are well established, yet many individuals struggle to align their actions with their intentions to eat more healthily. We explored the possibility that individuals who are more deeply connected to their future selves would exhibit healthier eating behaviors and benefit most from self-control interventions that required future-planning. Additionally, we probed the motivation associated with self-continuity and the extent to which the effects of self-continuity on eating behaviors could be explained by motivation. We hypothesized that self-continuity measures would be positively correlated with general healthy eating behaviors (H1) and autonomous (but negatively correlated with controlled) motivations (H2). We also expected that self-continuity would moderate

behaviors. Examining the nuances of self-control dilemmas may help explain why prior work has not shown such distinctions. Specifically, eating may be distinct from other self-control tasks that have been investigated in the context of Future Self-Connectedness, because when pursuing healthy eating there are relatively clear avoidance (e.g., *don't eat the donut*) and approach (e.g., *do eat the spinach*) components. Approach components are less clear in prior investigations (e.g., smoking, spending) which might help explain the predictive overlap of Consideration of Future Consequences and Future Self-Connectedness. It is important, then, to consider that strategies and individual differences in service of prevention (do not buy the car) and promotion (do invest in the stock market) behaviors may be different, even if they are two sides of the same self-control coin. Future explorations of goal-oriented behaviors that require both clear approach and avoid behaviors might be useful to shed light on the value of measuring, and potentially cultivating, Consideration of Future Consequences and Future Self-Connectedness. This work may also benefit from leveraging a two-factor model of Consideration of Future Consequences which could help distinguish between promotion (approach) and prevention (avoidance) orientations (Joireman et al., 2012) in order to more effectively personalize goals and interventions.

The self and self-regulation

Elsewhere, conceptually related work has demonstrated clear connections between conceptualizations of the self and eating behavior. Individuals with an interdependent (vs. independent) self-construal, for example, demonstrate more self-regulatory behaviors (Steinmetz and Mussweiler, 2017). Beyond related definitions, which suggest an overlap either with one's future self or with other people, the resonance of these two constructs is clearly captured in similar measurement approaches (Aron et al., 1992; Markus and Kitayama, 1991). Interestingly, Steinmetz and Mussweiler (2017) postulated that the effect of self-construal on eating behavior is likely grounded in an ability to appreciate the compounding consequences of individual indulgences (Steinmetz and Mussweiler, 2017). If this is the case, then individuals with an interdependent self-construal would likely also score high in Consideration of Future Consequences and we might expect that Consideration of Future Consequences would mediate the relationship between self-construal and self-regulatory behaviors. While future work will be necessary to untangle the complex connections of self-construal as it pertains to others and one's future self, conceptualizations of the self have clear implications for goal pursuit and regulating one's own behaviors.

A substantive body of work has also demonstrated the impact of self-awareness on self-regulation. Research in this domain has focused on two distinct aspects of awareness - awareness of one's internal sensory experience, and also visual awareness of one's physical body and appearance. Both have implications for self-regulation. Interventions to improve financial decisions have leveraged face aging technology to show individuals pictures of what their future older selves would look like - an intervention that enhances the connection between one's current and future self (Hershfield, 2011). Likewise, imagining one's self from a third person perspective enhances body awareness and in turn one's intentions to save (Macrae et al., 2017). In the eating domain, body awareness (e.g., being in front of a mirror) reduces consumption, as does third-person mental imagery (Christian et al., 2016). Imagining one's self from an outside perspective and related interventions to increase psychological distance (Tausen et al., 2020b; Trope and Liberman, 2010) may be particularly effective as they not only enhance body awareness, but also strip simulations of their embodied sensory components (Christian et al., 2016; Tausen et al., 2020a). In so doing, sensory-driven temptations can be minimized while potentially amplifying avoidance motivations, particularly for individuals who are not satisfied with their physical appearance. How these aspects of self-awareness map onto the pursuit of healthy foods and intersect with autonomous vs. controlled motivation remains an important area for

future research.

Distinctions in self-construal and awareness are useful to consider in the current context because different goals and motivations may lend themselves more to Consideration of Future Consequences vs. Future Self-Connectedness manipulations. Although the current research is limited by its correlational nature, we suspect that efforts to enhance Future Self-Connectedness or Consideration of Future Consequences will benefit from considering the goal/self-construal fit. While there are many reasons to eat more healthily, the largely visual nature of Future Self-Connectedness manipulations makes focusing on physique changes the most construct-congruent. Other motivations (e.g., avoid heart disease, etc.) that are harder to visualize may lend themselves more to manipulations that enhance Consideration of Future Consequences. Of course, a baseline level of Consideration of Future Consequences and Future Self-Connectedness may be necessary for the success of any intervention. Someone may appreciate the future consequences but feel so disconnected from their future selves that they do not imagine *they* will be the one experiencing the consequences. Alternatively, someone may have a deep sense of connection to their future self but lack awareness of the consequences of compounded behaviors. Thus, interventions may benefit from assessing individual differences in Consideration of Future Consequences and Future Self-Connectedness and tailoring goals to match individual strengths. When goals are fixed or cannot be reframed, folks might benefit most from interventions aimed at enhancing the future orientation (either Consideration of Future Consequences or Future Self-Connectedness) in which they are the weakest.

Self-control motivations

Counter to our predictions, Future Self-Connectedness and Consideration of Future Consequences did not moderate the efficacy of cognitive training strategies on consumption of healthy or unhealthy foods in the current study (though there was some evidence that Consideration of Future Consequences moderated the relationship between strategies and reported craving). What this suggests is that certain training strategies may not favor individuals high in future self-continuity or awareness of future consequences. This is not to say, however, that Future Self-Connectedness and Consideration of Future Consequences are irrelevant factors. Beyond being independently predictive of consumption, Future Self-Connectedness and Consideration of Future Consequences were positively correlated with daily measures of autonomous motivation. Put simply, a connection to one's future self and an appreciation for future consequences of current behaviors were associated with the extent to which people reported decisions that were aligned with "who one is and what they value most in life". These findings are noteworthy in light of self-determination theory, which emphasizes the value of autonomous motivation to sustain goal-consistent behaviors (Milyavskaya et al., 2015). Those in the study (knowing their consumption was being monitored) may have been able to "power through" and modify their behaviors for a short period, but when autonomous motivation is driving food choices, individuals are considerably more likely to maintain goal-congruent behaviors over a longer duration of time and without external monitoring. As such, it is possible that individuals high in Future Self-Connectedness and Consideration of Future Consequences would benefit more from training strategies over time, but that the external monitoring and time-limited nature of our study design precluded our ability to detect any moderation effects.

To further unpack the relationship between Future Self-Connectedness and autonomous motivation, it is worth noting that in the current study Future Self-Connectedness correlated with daily (but not baseline) autonomous motivation. While speculative, this raises the possibility that when goals become relevant or activated, those who are high in Future Self-Connectedness and Consideration of Future Consequences are more readily able to internalize those goals as personal

(Deci and Ryan, 2000; Ryan and Deci, 2017). This line of thinking is consistent with results from our exploratory analyses that probed the indirect effects of Future Self-Connectedness on consumption via autonomous motivation. At face value, Future Self-Connectedness was only associated with the consumption of healthy foods. When probing indirect effects, however, exploratory analyses suggest that Future Self-Connectedness did have a significant indirect effect on consumption of both healthy and unhealthy foods via autonomous motivation. Consideration of Future Consequences similarly had an indirect impact on consumption of healthy foods via autonomous motivation. What these findings suggest is that decisions related to who one is and what one values (autonomous motivations) are connected to both approach and avoid behaviors (healthy and unhealthy eating). Importantly, however, autonomous motivations did not explain the connection between Consideration of Future Consequences and reduced consumption of unhealthy food, suggesting that Consideration of Future Consequences is a meaningful predictor above and beyond making identity-consistent decisions. Curiously, controlled motivations did not explain this connection either. While future research will be necessary to probe other potential mechanisms, practically speaking, a strong appreciation for future consequences may help curb consumption of unhealthy foods above and beyond what can be accounted for with autonomous or controlled motivation. A similar pattern of results might be expected for other self-regulation tasks that require both approach and avoid motivations.

Practical & theoretical implications for future self-connectedness and consideration of future consequences

Despite clear practical and theoretical overlap, research investigations of Consideration of Future Consequences and Future Self Continuity have been largely siloed. That the two constructs were only weakly correlated in the current study may help to shed some light on the bifurcation in the published literature. Additionally, our findings suggest that each of these constructs might be uniquely valuable when considering self-control dilemmas that require modification of both approach and avoidance behaviors. While we explored Consideration of Future Consequences and Future Self-Connectedness as individual difference measures, past research has demonstrated that these constructs can be developed (Chandler, 1994; Ersner-Hershfield et al., 2009b), increasing the likelihood that they could be leveraged to improve self-control. Such interventions would likely benefit from targeting both Future Self-Connectedness and Consideration of Future Consequences. When individuals have both a strong connection to their future selves and a clear appreciation for the consequences of individual actions, they may be most likely to engage in both the consumption of nutrient dense, low-calorie foods and the avoidance of nutrient poor high calorie foods that are ultimately necessary to create a healthier current and future self.

Limitations & future directions

Notwithstanding the insight afforded by the current work, there are a few limitations that warrant caution when interpreting the results. Most notably, our findings are limited by the correlational nature of our study. While there is some evidence to suggest directionality (Future Self-Connectedness did not correlate with baseline autonomous motivation but did correlate with daily autonomous motivation after the training periods), future research that manipulates Consideration of Future Consequences and Future Self-Connectedness will be important to better understand the potential for these constructs to meaningfully and sustainably improve eating behaviors. It will also be important for future work to explore the possibility that Future Self-Connectedness is a more meaningful approach-oriented individual difference measure whereas Consideration of Future Consequences may be more avoidant oriented. At face value, our 2-item Future Self-Connectedness measure emphasized a connection with and similarity to one's future self, whereas the

more detailed Consideration of Future Consequences measure included a mixture of items representing approach oriented (e.g., "Often I engage in a particular behavior in order to achieve outcomes that may not result for many years") and avoidant oriented (e.g., "I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years") states. One of the strengths of our work compared to conceptually related investigations is the use of daily diaries, which have been shown to provide reliable estimates of food intake compared to other self-report measures (Day et al., 2001). Notwithstanding the contributions of this approach, it is still prone to biases in self-report, and we recommend that future studies administer additional, objective measures of consumption (e.g., calorie intake, changes in body mass index or adiposity) to establish convergent validity of the daily diary measures used here. Additionally, being monitored over a two-week period may artificially alter eating behavior through added awareness, accountability, or perceptions of being judged (Touré-Tillery et al., 2022).

Finally, it is worth noting that the selection criteria in the current study were intentionally broad regarding the personal importance of (and motivations for) healthy eating, resulting in participants who ranged significantly in a variety of health-related measures. This broader inclusion criteria also means that our results have the potential to generalize to a wider spectrum of the population. Future research could explore current health as a moderator or focus more exclusively on individuals in poorer health to determine how Future Self-Connectedness and Consideration of Future Consequences predict eating behaviors for those who are most likely to be targeted for and benefit from self-control interventions. While our study had relatively broad inclusion criteria, our sample was not deliberately constructed to be nationally representative, and, as such, might not generalize across the entire population. Indeed, it has been demonstrated that temporal orientation might differ quite systematically across socioeconomic levels (Pepper and Nettle, 2017) and between cultures (Ji et al., 2019). An important focus for future research will be to explore the relationships between self-continuity, self-regulation, and healthy eating across known moderators of future connectedness.

Conclusion

Consequences of unhealthy eating patterns are wide ranging, and although the problem is multi-faceted and will require insight from multiple disciplines, psychologically informed research can contribute to the solution by developing a deeper understanding of individual differences and interventions that contribute to enhanced self-control in the eating domain. In the current study, we demonstrated that Future Self Continuity and Consideration of Future Consequences are useful predictors of eating behavior and autonomous motivation. Put simply, the extent to which people feel a strong sense of continuity to their future selves and appreciate the personal consequences of their behaviors, they are more likely to make decisions in line with this future self in the domain of healthy eating, and this relationship is mediated by autonomous motivation. While future work is necessary to explore causal connections, our research suggests that both Future Self-Connectedness and Consideration of Future Consequences are important factors to consider when investigating goal-congruent and internally motivated behaviors that promote the healthiest versions of one's future self.

Data availability statement

All data have been made publicly available on the Open Science Framework (OSF) and can be accessed at: <https://osf.io/kbeq2/>.

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.

Data availability

Data are available on the Open Science Framework here: <https://osf.io/kbeq2/>.

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