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Healthy eating in daily life: the role of relative autonomous motivation when it is difficult

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Abstract

Most people try to eat healthy, but the temptation of unhealthy foods (among other factors) can make it difficult. Despite these difficulties, some people still achieve their healthy eating goals. Following self-determination theory (SDT; Ryan & Deci, 2000), we propose that relative autonomous motivation (RAM) can foster people's effort in pursuing health goals. In two daily diary studies, we tested the hypothesis that RAM predicts attainment of healthy eating goals, especially when it is difficult. In Study 1, we focused on difficulties associated with trying to eat certain foods while avoiding others, whereas in Study 2, we focused on difficulties associated with the availability of unhealthy and healthy foods. Multilevel analyses provided some support our hypothesis, and highlighted the role of RAM for eating (vs. skipping) lunch and packing a lunch– two approach-based healthy eating strategies. We discuss these findings in relation to SDT and propose directions for future research on within-person changes in motivation and other sources of difficulty.

Keywords Relative autonomous motivation · Self-determination theory · Self-regulation · Eating behavior

Most people want to eat healthy because of the benefits for their physical and mental health (e.g., Tohill et al., 2004; White et al., 2013). Yet, many people struggle to meet their healthy eating goals. In Canada, this is evidenced by poor eating habits, high rates of obesity, and a growing weight loss and dieting industry (Statistics Canada, 2019a, 2019b). People often overeat, choose unhealthy foods, and fail to get enough vitamins and essential nutrients. Researchers have studied various causes of unhealthy eating, including the availability and salience of certain foods (Sobal & Wansink, 2007), social norms and influence (Cruwys et al., 2015), and lapses in self-control (Hofmann et al., 2014).

Despite a number of challenges for people trying to make healthy food choices, some people are still able to eat healthy. Self-determination theory (SDT; Ryan & Deci, 2000) posits that the quality of a person's motivation could explain the effort, persistence, and success in attaining such goals. Specifically, autonomous forms of motivation are associated with more positive outcomes than controlled forms of motivation (e.g., Ng et al., 2012; Williams et al.,

2006). Under the SDT framework, the purpose of the current research is to examine the role of autonomous (vs. controlled) motivation (aka Relative Autonomous Motivation, RAM) for healthy eating, especially when it is difficult.

Why do people eat healthy?

Many people are motivated to eat healthy for different reasons. For example, some people enjoy choosing healthy foods, or eat healthy because it is good for their health, whereas others eat healthy to avoid feeling guilty or to assent to social expectations. Self-determination theory (SDT; Ryan & Deci, 2000) proposes that these reasons could reflect different types of behavior regulation that lie on a continuum ranging from more autonomous (i.e., self-determined) forms of motivation to more controlled forms of motivation. Autonomous forms of motivation are characterized by inherent enjoyment for the behavior (i.e., intrinsic motivation), congruence between the behavior and personally meaningful goals and values (i.e., integrated regulation), and/or personal valuation of the outcome (i.e., identified regulation). In contrast, behavior arising from controlled forms of motivation involves internal pressures, guilt, shame, and contingent self-worth (i.e., introjected regulation), compliance with external

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pressures or expectations, and/or striving to obtain a reward or avoid punishment (i.e., external regulation).

Compared to controlled motivation, autonomous motivation has been linked to more positive outcomes in a range of contexts, such as education (Wang, 2008), work (Gagne & Deci, 2005), responsible alcohol consumption (Pavey & Sparks, 2009), and physical activity (Teixeira et al., 2012). In a healthy eating context, Pelletier et al (2004) found that autonomous motivation was associated with healthy eating and dieting success, whereas controlled motivation was associated with dysfunctional eating patterns (e.g., binge eating). Likewise, Hagger et al (2006) found that greater autonomous than controlled motivation (i.e., relative autonomous motivation) was positively related to attitudes, intentions, and actual healthy eating behaviors. Taken together, these findings are consistent with a meta-analysis showing that autonomous motivation predicts engagement for a large range of health behaviors (Ng et al., 2012).

The role of relative autonomous motivation when healthy eating is difficult

Trying to eat healthy often means managing temptations and overcoming challenges (e.g., resisting unhealthy foods, preparing meals, eating a balanced diet). Autonomous (vs. controlled) motivation can be an important factor in this endeavor. Indeed, in a pro-environmental context, Green-Demers et al (1997) found that while most people engage in relatively easy behaviors (e.g., recycling), autonomous motivation is a stronger predictor of engagement in more difficult behaviors (e.g., buying eco-friendly products) compared to controlled forms of motivation. This finding has been replicated in a recent study on eco-friendly transportation (Aitken et al., 2016). Likewise, Ntoumanis et al (2014) found that autonomous motivation (but not controlled motivation) was positively related to effort and performance during a progressively difficult exercise session.

According to SDT, autonomous motivation involves behaving in ways that are consistent with one's interests and values. This type of motivation is proposed to require less energy than controlled forms of motivation. For example, it takes less energy to clean one's house when an individual wants to do it (autonomous motivation) than when they feel obligated to do so (controlled motivation). Therefore, higher levels of autonomous motivation than controlled motivation (i.e., higher relative autonomous motivation or RAM) might be associated with greater persistence in the face of difficulties because the individual does not feel their actions require as much effort as when the behavior arises from controlled forms of regulation. Recent findings from Milyavskaya et al (2015) provide support for this view, showing that greater autonomous motivation (but not controlled motivation) is

associated with perceiving fewer temptations and obstacles to one's goal pursuit (see also Werner et al., 2016).

What makes healthy eating difficult?

Part of what makes healthy eating difficult is having to both avoid tempting unhealthy foods (e.g., junk foods) and approach nutritious foods (e.g., fruits and vegetables). This distinction reflects the concept of approach-avoidance motivation, defined as the energization by and direction of behavior toward [away] from positive [negative] stimuli (Elliot, 2006). Approach-avoidance motivation manifests as the framing of goals, means, or strategies moving towards desired end-states (e.g., eating two servings of whole grains) or away from undesired end-states (e.g., limiting consumption of sugar). However, most of the time people tend to focus on approaching healthy food *or* avoiding unhealthy food, with mixed results.

A focus on eating healthy foods may satisfy one's hunger, subsequently reducing cravings, temptations, and the likelihood of eating unhealthy foods (Steel et al., 2006). Approaching healthy food may also be a relatively simple goal to enact, involving a specific endpoint, measurable goal progress, and clearly defined means to attain the goal (e.g., eat two servings of whole grains). In contrast, research on restraint theory suggests that focusing on limiting or avoiding certain foods is more challenging (Herman & Mack, 1975; Polivy et al., 2005). Trying not to eat certain foods may indeed increase desires and cravings for them, making them even more difficult to avoid (Jansen et al., 2007; Pham et al., 2016). Also, avoidance eating goals only involve undesired end-states (i.e., "anti-goals"), and do not specify a direction for action. For example, trying to avoid sugary foods does not tell the person what to eat, nor how long to avoid sugar. Therefore, goal progress may be difficult to interpret and any actions required to attain a goal may be unclear (Carver & Scheier, 2012).

Consistent with this view, researchers have found that avoidance goals may be more difficult than approach goals. For example, Mor and Cervone (2002) found that people report fewer means for attaining their avoidance goals than for their approach goals. Accordingly, Sullivan and Rothman (2008) found that participants who tried to eat fewer unhealthy snacks (i.e., avoidance) ate less healthy and benefitted more from planning than did participants who tried to eat more healthy snacks (i.e., approach). These findings echo Elliot et al (1999), showing that students with more avoidance-based studying goals were more "disorganized" and performed worse on exams than those with approach-based goals. Together, these findings suggest that part of the difficulty of avoidance goals is identifying when and how to work towards them. Furthermore, Henson et al (2010)

showed in a survey of over one thousand people that dietary recommendations framed as avoidance are rated as more difficult than those framed in an approach manner.

The current studies

Previous research has shown that greater (relative) autonomous motivation predicts engagement and persistence when difficulties arise.[1] In two daily diary studies, we tested the hypothesis that relative autonomous motivation (RAM) predicts healthy eating when it is difficult.[2] To this aim, we used idiographic diary designs that set this research apart from studies requiring participants to focus on predetermined food categories such as vegetables and junk food (e.g., White et al., 2013), and previous research using cross-sectional designs (e.g., Harrison et al., 2011; Pelletier et al., 2004). Although studying motivation and eating behavior in daily life provides little control over extraneous variables, it allowed us to observe these phenomena as they naturally occur, and to contribute to a growing body of research on self-regulation in everyday life (e.g., Hofmann et al., 2014; Wilkowski et al., 2018).

Study 1

The aim of this first daily diary study was to examine the role of RAM when trying to eat healthy foods and avoid unhealthy foods. We invited participants to set three approach food goals and three avoidance food goals, and then to report their food consumption each day for 3 weeks, with the possibility of setting new daily food goals. Based on the above literature that trying to avoid unhealthy foods is more difficult than trying to eat healthy foods, we hypothesized that RAM is more strongly associated with meeting avoidance goals (i.e., trying to limit or not eat certain foods) than with meeting approach goals (i.e., trying to eat more of certain foods). We expected the effect of RAM on goal

outcomes would be the same for both shorter-term (i.e., daily) and longer-term (i.e., 3 week) food goals.

Method

Participants

In Fall 2016, we recruited 156 undergraduate psychology students from a Canadian university through a research participant pool in exchange for course credits.[3] The sample included 88% female students and 93% of participants were under 24 years of age ($M = 20$, $SD = 2.83$). Data from one participant was not used for the analyses because they did not complete any daily surveys.

Procedure

After providing informed consent to participate, participants were first invited to complete a series of demographic questions and a measure of autonomous and controlled motivation for regulating eating behavior.[4] They were also asked to set three approach food goals and three avoidance food goals for the next 3 weeks. Then, during the daily diary phase, participants received an email each morning at 6:00 A.M. inviting them to complete a daily survey before 1:00 P.M. In this survey, they were first asked to report their previous day consumption of the six foods they listed as approach and avoidance food goals (i.e., 3-Week Goals). Second, they were presented with the six food goals they set at the beginning of the study and asked to select three approach and three avoidance food goals for the current day (i.e., Daily Goals), which could include any of the goals they initially set or additional goals they had for that day. For example, a participant may have initially listed "salad" as an approach food goal, but may not have the intention to eat salad on a given day. Participants who added a new food goal were asked to report on their consumption of these foods the following day. The median number of diary surveys completed by a participant was 19 (out of 21; $M = 17.90$, $Min = 3$, $Max = 21$), and data from 155 participants were included in the analyses (see Table 1 for descriptive statistics).

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[1] Notably, researchers have used a range of approaches to operationalize self-determined motivation (e.g., examining separate behaviour regulation, focusing on profiles of motivation types, focusing on both autonomous and controlled motivation; Hagger et al., 2006; Sheldon et al., 2017). For the purposes of the current research we focus on relative autonomous motivation towards healthy eating, as this reflects the extent that a person may be more or less autonomous (vs. controlled) in their behaviour.

[2] We recognize that healthy eating could involve a number of factors, such as the quantity, frequency, types, and manner in which foods are eaten. For the purpose of this research, we take an idiographic approach and view healthy eating as attaining one's own goals to eat or avoid certain foods, both for short-term.

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[3] Our aim was to recruit a sample of 150 participants for 3 weeks of observations, which we based on final samples in published studies involving a similar methodology and an expected attrition rate of 15–20%. Given the multitude of sources of variability in a diary study and the novelty of this study design, it seemed impractical to derive the required estimates for a power calculation (Bolger et al., 2012).

[4] Given our focus on approach and avoidance goals, we also included the Behavioral Inhibition Scale/Behavioral Activation Scale (BIS/BAS; Carver & White, 1994). However, the inclusion of this variable in the analyses did not make any significant difference (see *Supplemental Material* for details).

Table 1 Descriptive statistics for Study 1

	Three-week goals	Daily goals
Number of goal outcomes	15,754	10,453
Number of days	2769	2347
Approach goals		
Mean success rate	48.8%	59.5%
$ICC_{Person-level}$	.21	.17
$ICC_{Day-level}$	.03	.04
Avoidance goals		
Mean success rate	85.6%	84.6%
$ICC_{Person-level}$	.26	.27
$ICC_{Day-level}$	.12	.12

ICC intraclass correlation coefficient

Measures

Relative autonomous motivation to eat healthy

The Regulation of Eating Behavior Scale (Pelletier et al., 2004) was used to assess RAM for regulating one's eating behaviors. Participants were asked why they regulate their eating behaviors, which they answered through 24 statements assessing intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation using a 7-point scale (from 1 = "Does not correspond at all" to 7 = "Corresponds exactly"). None of the items demonstrated skewness scores exceeding |3| and only the amotivation subscale items demonstrated kurtosis scores exceeding |3|, and the 6-factor structure demonstrated good fit to the data, $\chi^2(237) = 361.68$, $p < 0.001$, CFI = 0.940, SRMR = 0.073, RMSEA = 0.056 [90% CI 0.043, 0.067].

We calculated RAM scores for regulating eating behaviors by subtracting average scores on controlled motivation subscales (i.e., introjected regulation and external regulation, Cronbach's $\alpha = 0.82$) from autonomous motivation scores (i.e., intrinsic motivation and the average of integrated and identified regulation scores, Cronbach's $\alpha = 0.91$).[5] RAM scores ranged from -4.38 to 15.75 ($M = 6.54$, $SD = 4.31$) with higher scores reflecting higher autonomous than controlled motivation.

Approach and avoidance eating goals

For the 3-Week Goals, participants were asked to list three foods that they intended to eat "some or a lot of" (i.e., approach goals) and three foods that they intended "to limit or avoid" (i.e., avoidance goals) over the course of the next 3 weeks.[6] Participants could also add additional approach and avoidance food goals (i.e., Daily Goals) during the 3 week span of the study. Most participants (78.2%) listed at least one additional eating goal ($M = 6.2$, $Mdn = 4$, $Range = 0$–41). In addition, participants were asked to select which of their initial food goals they endorsed for the current day. On average, participants endorsed four food goals per day ($M = 3.5$, $Mdn = 4$, $SD = 2.02$). Most commonly, participants listed vegetables (14.7%), fruit (14.1%), and salad (5.1%) as approach food goals, and chocolate (7.7%), chips (7.2%), and candy (5.6%) as avoidance food goals.

Eating goal success versus failure

For the initial three approach and three avoidance goals (i.e., 3-week Goals) and any additional food goals listed on the previous day (i.e., Daily Goals), participants were asked how much of each of the foods they ate using an 8-point Likert-type scale: (1) "I didn't eat any", (2) "Ate much less than intended", (3) "Ate less than intended", (4) "Ate slightly less than intended", (5) "Ate as much as intended", (6) "Ate slightly more than intended", (7) "Ate more than intended", or (8) "Ate much more than intended". Food goals were presented to participants in a random order. To assess goal success versus failure, the responses were recoded differently for approach and avoidance food goals. For Approach Food Goals, ratings ranging from (5) "Ate as much as intended" to (8) "Ate much more than intended" were coded (+ 1) for success, while ratings ranging from (1) "I didn't eat any" to (4) "Ate slightly less than intended" were coded (0) for failure. For Avoidance Food Goals, ratings ranging from (1) "I didn't eat any" to (5) "Ate as much as intended" were coded (+ 1) for success, while ratings from (6) "Ate slightly more than intended" to (8) "Ate much more than intended" were coded (0) for failure. Although we coded all food goals as success or failure, we used the 8-point scale of food consumption to minimize demand characteristics and to make it easier for participants to record their eating behavior. Since participants set goals both at the beginning of the study (i.e., 3-Week Goals) and during the diary phase (i.e., Daily Goals), we examined both goal timeframes.

Goal specificity

To allow us to examine the impact of goal specificity on goal success/failure (e.g., it may be more challenging to pursue the specific goal of eating more carrots than the broad goal of trying to eat more vegetables), the level of specificity of each food goal was coded by ten trained coders. Each coder

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[5] We did not include amotivation in the calculation of RAM as it signifies an absence of intention to act and not necessarily a degree of autonomous motivation.

[6] Despite instructions to list "food" goals, some participants set goals that involved drinks. Data for these goals (n = 47 goals, 5% of all observations) was not used in the analyses.

rated half or all the participants' goals, such that each goal was rated by six independent coders. To create a Goal Specificity score, each food goal was rated as (− 2) "Specific food content", (− 1) "Specific food type", (0) "Food type", (+ 1) "Category", or (+ 2) "Very broad category". For example, an apple would be coded as (0) "Food type", fruit would be coded as (+ 1) "Category", and fruits and vegetables would be coded as (+ 2) "Very broad category", whereas red apples would be coded as (− 1) "Specific food type" and sugar from apples would be coded as (− 2) "Specific food content". To create a single Goal Specificity score for each food goal, any discrepancies in coding were resolved through discussion among all coders (mean weighted Cohen's κ = 0.46 prior to discussion). Goal Specificity was person-mean centered when used as a predictor for multilevel analyses to examine within-person associations with goal success/failure.

Results

Perceived difficulty of approach versus avoidance goals

We first tested the assumption that Avoidance Food Goals are more difficult than Approach Food Goals.[7] To avoid any effect of asking participants to rate the difficulty of their goals on their responses during the diary study (and to reduce the burden on participants), we asked to an independent sample of undergraduate students from the same university and participant pool (n = 103, 95% female, 94% under 24 years of age, M = 21.32) to rate the perceived difficulty of the approach and avoidance eating goals set by participants in this daily diary study (n = 518 distinct food goals). Participants were asked, "How difficult would it have been to…", with response options ranging from (1) "Not at all difficult" to (5) "Very difficult".[8] There were also options to indicate if the participant do not know what a certain food was, or if they do not eat that type of food due to dietary restrictions.

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[7] All analyses reported in this manuscript were conducted using the "psych" (Revelle, 2018) and "lme4" packages inR (Bates, et al., 2015).

[8] Due to reduction of in-person classes as a result of the Covid-19 pandemic, we asked these students to provide difficulty ratings retrospectively, thinking back to how difficult it would have been to pursue each goal while taking courses on the university campus (e.g., "How difficult would it have been to limit or not eat chocolate for 3 weeks?"). Responses from participants who reported to not have attended university before COVID-19 pandemic (i.e., n = 15 first-year students) were not included in the sample description and the analyses. Because of the high number of different food goals (n = 518 goals) and to minimize participants burden, we split the goals into two halves and only one half of the goals were presented to each independent rater, although some participants (n = 33) rated all the food goals by participating in two sessions of the study. Of the 518 food goals, 317 were approach goals and 201 were avoidance goals.

Using hierarchical linear models with maximum likelihood estimation and random intercepts (Level-1 = Goal-level, Level-2 = Person-level) to predict Goal Difficulty, we found that Avoidance Food Goals (coded + 1) were rated as more difficult than Approach Food Goals (coded -1), $B = 0.27$ [95% CI 0.25, 0.29], $p < 0.001$, with Goal Type accounting for 4.8% of Level-1 variance in Goal Difficulty.

These independent raters also completed the REBS (Pelletier et al., 2004),[9] which allowed us to examine whether RAM could predict ratings of Goal Difficulty. The inclusion of RAM and the RAM x Goal Type interaction in a model with Goal Type as a predictor significantly improved fit, $\chi^2(2) = 14.15$, $p < 0.001$, and accounted for 16% of the Person-level variance in Goal Difficulty. Specifically, higher RAM was associated with lower ratings of food goal difficulty, $B = − 0.12$ [95% CI − 0.05, -0.13], $p < 0.001$. The interaction was marginally significant, $B = − 0.01$ [95% CI 0.00, − 0.03], $p = 0.053$, with simple effects suggesting a stronger effect of RAM for avoidance goals, $B = − 0.14$ [95% CI − 0.04, − 0.24], $p = 0.010$, than for approach goals, $B = − 0.11$ [95% CI − 0.03, − 0.19], $p = 0.010$.

RAM and the effect of goal type on goal success

To predict goal success/failure during the diary study, we fit a series of three-level generalized linear models with maximum likelihood estimation and random intercepts (Level-1 = Goal-level, Level-2 = Day-level, and Level-3 = Person-level). We found higher success rates for Avoidance Goals (coded + 1) than Approach Goals (coded -1), both for 3-Week Goals and Daily Goals, $OR = 2.23$ [95% CI 2.14, 2.32], $p < 0.001$, and $OR = 1.71$ [95% CI 1.63, 1.80], $p < 0.001$, respectively. Building on these models, the inclusion of RAM and the cross-level Goal Type x RAM interaction term significantly improved model fit for 3-week goals, $\chi^2(2) = 12.07$, $p = 0.002$. Accordingly, the interaction between RAM and Goal Type was significant, $OR = 0.98$ [95% CI 0.96, 0.99], $p = 0.001$. As depicted in Fig. 1, simple effect analysis showed a marginal positive relationship between RAM and goal success for approach food goals, $OR = 1.05$ [95% CI 0.99, 1.11], $p = 0.081$, but not for avoidance food goals, $OR = 1.02$ [95% CI 0.86, 1.21], $p = 0.820$. However, for Daily Goals, the inclusion of RAM and the RAM x Goal Type interaction did not significantly improve model fit, $\chi^2(2) = 2.29$, $p = 0.318$. As shown in Table 2, RAM and the associated interaction term were non-significant, $OR = 1.03$ [95% CI 0.99, 1.07], $p = 0.198$, and $OR = 0.99$ [95% CI 0.97, 1.01], $p = 0.494$, respectively.

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[9] For this independent sample of raters, we found reasonable fit for the 6-factor structure of the scale, $\chi^2(237) = 470.30$, p < .001, CFI = .90, SRMR = .090, RMSEA = .087 [90% CI .076, .099], and good reliability for the both autonomous and controlled motivation subscales (Cronbach's α = 0.94 and α = 0.86, respectively).

Fig. 1 Daily- and 3 week approach and avoidance goal success as a function of relative autonomous motivation (mean and ± 1 and 2 standard deviations) for Study 1
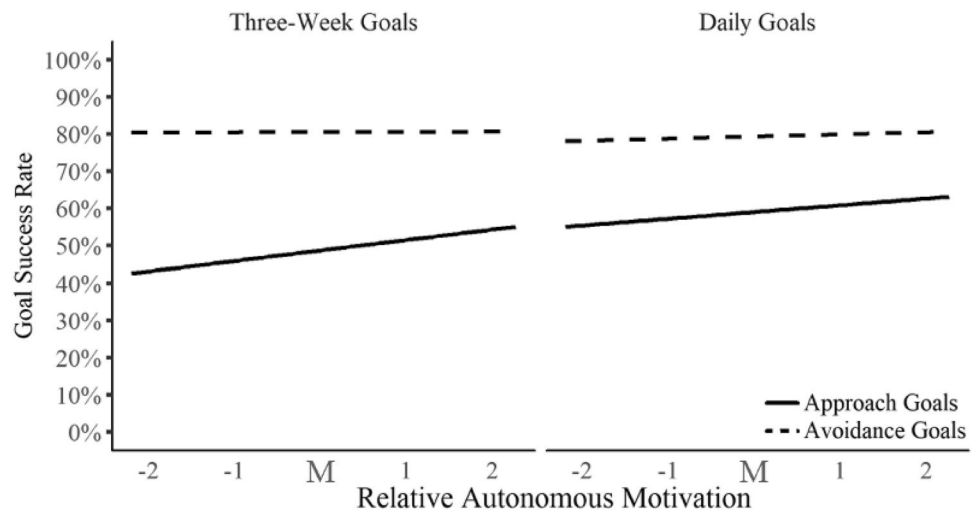

Table 2 Goal success/failure as a function of ram and goal type for study 1

	Three-week goals		Daily goals	
Intercept	0.76 [0.05]**	0.76 [0.05]***	0.96 [0.06]***	0.96 [0.06]***
Goal type	0.80 [0.02]**	0.80 [0.02]**	0.54 [0.02]**	0.54 [0.02]**
RAM		0.02 [0.02]		0.03 [0.02]
RAM x goal type		− 0.02 [0.01]**		− 0.01 [0.01]
Simple effects				
Approach goals				
RAM		0.05 [0.03]†		
Avoidance goals				
RAM		0.01 [0.03]		
χ^2 model comparison (df)	12.07 (2)**		2.29 (2)	
BIC	17,251.5	17,258.6	11,318.1	11,334.2
Marginal R^2	.146	.148	.071	.072
Δ Person-level variance	− 1.9%		− 1.7%	
Δ Day-level variance	+ 1.6%		+ 0.2%	

Unstandardized coefficients and standard errors reported; Dependent variable is Goal Success (+ 1) versus Failure (0); Goal Type coded − 1 for Approach and + 1 for Avoidance; Marginal R^2 represents the variance accounted for by fixed effects following recommendations from Nakagawa and Schielzeth (2013); The level-1 (residual) variance in generalized hierarchical linear models with a binomial distribution is always defined as $\pi^2/3$, so we only report changes in variance at Level-2 (day) and Level-3 (person; for a discussion, see Austin & Merlo, 2017)

RAM = Relative Autonomous Motivation

†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

RAM and the effect of goal specificity on goal success (post-hoc analysis)

To further understand the relationship between goal type and goal difficulty, we modeled the effects of goal specificity (as a proxy for goal difficulty) on goal success/failure. We expected that broader avoidance goals would be more difficult than specific avoidance goals (e.g., more difficult to avoid "junk food" than "chocolate cake") and that the reverse would be true for approach goals (e.g., more difficult to try to eat "kale" than "fruits and vegetables"). Indeed, we found that the broader the approach food goals were coded by research assistants, the easier they were rated by the independent student raters, $r = -0.34$, $p < 0.001$, whereas broader avoidance goals were rated as being more difficult than more specific avoidance goals, $r = 0.58$, $p < 0.001$.

For 3-Week Goals, the interaction between Goal Type and Goal Specificity (person-mean centered) was significant, $OR = 0.74$ [95% CI 0.70, 0.79], $p < 0.001$, with simple effects analysis showing that success rates were higher when approach food goals were broader, $OR = 1.52$ [95% CI 1.38, 1.67], $p < 0.001$, and lower when avoidance food goals were
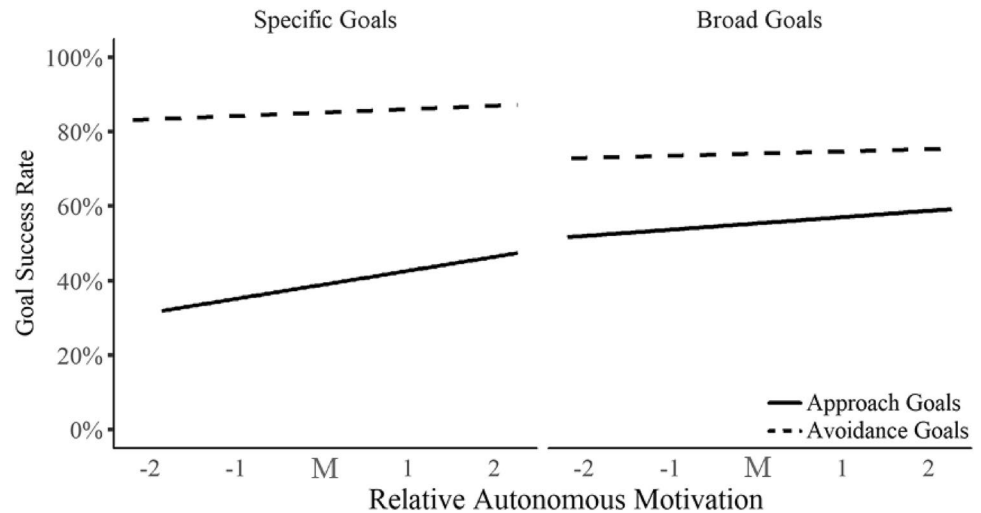
broader, $OR = 0.79$ [95% CI 0.73, 0.87], $p < 0.001$. Adding RAM and all associated interactions significantly improved model fit, $\chi^2(4) = 23.22$, $p < 0.001$. For approach food goals, there was a significant RAM x Goal Specificity interaction, $OR = 0.81$ [95% CI 0.74, 0.89], $p < 0.001$, indicating that, as depicted in Fig. 2, RAM was a better predictor of approach goal success for more specific (coded – 2, – 1, or 0) goals, $OR = 1.08$ [95% CI 0.99, 1.16], $p = 0.063$, than broader goals (coded + 1 or + 2), $OR = 1.04$ [95% CI 0.87, 1.24], $p = 0.680$. For avoidance goals, the RAM x Goal Specificity interaction was non-significant, $OR = 1.01$ [95% CI 0.95, 1.08], $p = 0.444$.

For Daily Goals, a model with Goal Type and Goal Specificity (person-mean centered) showed a significant interaction, $OR = 0.82$ [95% CI 0.76, 0.88], $p < 0.001$. As expected, simple effects analysis showed higher success rates for more broad approach goals, $OR = 1.17$ [95% CI 1.04, 1.31], $p = 0.006$, and for more specific avoidance goals, $OR = 0.74$ [95% CI 0.67, 0.83], $p < 0.001$. However, including RAM and all associated interaction terms did not improve model fit, $\chi^2(4) = 4.47$, $p = 0.347$ (see Table 3).

We conducted additional post-hoc analyses to further understand the role of RAM in relationships between goal specificity, goal type, and endorsement of 3-Week Goals on a given day. Details of these analyses are provided in *Supplemental Materials*. In sum, RAM was unrelated to setting more or less specific goals, and was unrelated to the number of goals participants set during the study. Also, endorsing a 3-Week Goal on a given day was positively associated with success rates only for approach goals, and success rates for avoidance goals were higher on days when participants were also successful at their approach goals.

Brief discussion

Study 1 provided some support for the hypothesis that RAM predicts healthy eating when it is difficult. Consistent with previous research (e.g., Milyavskaya et al., 2015), post-hoc analyses showed that higher RAM was also associated with lower perceptions of food goal difficulty. However, despite higher ratings of difficulty for avoidance goals than approach goals, we observed a higher success rate for avoidance goals than for approach goals. We believe that this finding may be partly explained by food availability because many avoided foods might have been unavailable, which would lead to goal success but not necessarily represent a source of difficulty. This could also create a ceiling effect that may account for the absence of a relationship between motivation and avoidance goal success/failure. Furthermore, food availability could be considered an important source of difficulty in itself.

Study 2

We conducted a second daily diary study to further test the hypothesis that RAM predicts healthy eating when it is difficult, taking into consideration the difficulties associated with trying to eat healthy foods when they are not yet prepared or easily accessible, and avoiding unhealthy foods when they are readily available. Food environments with many junk and convenience foods are often referred to as "toxic" or "obesogenic" and have been partly blamed for increases in obesity rates (Swinburn, et al., 1999). When unhealthy foods are more available, salient, and ready-to-eat, people may perceive fewer costs involved in eating these foods (e.g., preparation, time, effort), making it difficult to avoid or limit consumption. The opposite is true when trying

Table 3 Goal success/failure as a function of ram, goal type, and goal specificity for study 1

	Three-week goals		Daily goals	
Intercept	0.75 [0.06]***	0.63 [0.09]***	0.95 [0.06]***	0.83 [0.10]***
Goal type	0.81 [0.02]***	0.91 [0.04]***	0.54 [0.02]***	0.55 [0.04]***
Goal specificity	0.01 [0.03]	0.13 [0.05]**	− 0.12 [0.03]***	− 0.20 [0.06]**
RAM		0.03 [0.02]****		0.03 [0.02]****
Goal type x Specificity	− 0.30 [0.03]***	− 0.42 [0.06]***	− 0.20 [0.03]***	− 0.16 [0.07]*
RAM x goal type		− 0.02 [0.01]**		− 0.01 [0.01]
RAM x specificity		− 0.03 [0.01]**		0.02 [0.01]
RAM x GT x specificity		0.03 [0.01]*		− 0.01 [0.01]
Simple effects				
Approach goals				
Specificity		0.77 [0.10]***		0.16 [0.06]**
RAM		0.06 [0.03]*		
RAM x specificity		− 0.08 [0.02]***		
Avoidance goals				
Specificity		− 0.19 [0.06]**		− 0.30 [0.05]***
RAM		0.02 [0.03]		
RAM x specificity		− 0.01 [0.01]		
BIC	17,019.6	16,958.8	11,190.9	11,223.2
Marginal R^2	.159	.161	.081	.082
χ^2 model comparison (df)	23.22 (4)***		4.47 (4)	
Δ Person-level variance	− 1.2%		− 2.3%	
Δ Day-level variance	+ 2.9%		+ 0.6%	

Unstandardized coefficients and standard errors reported; Dependent variable is Goal Success (+ 1) versus Failure (0); Goal Type coded − 1 for Approach and + 1 for Avoidance; Goal specificity is person-mean centered and higher values indicate broader goals; Marginal R^2 represents the variance accounted for by fixed effects following recommendations from Nakagawa and Schielzeth (2013); The level-1 (residual) variance in generalized hierarchical linear models with a binomial distribution is always defined as $\pi^2/3$, so we only report changes in variance at Level-2 (day) and Level-3 (person; for a discussion, see Austin & Merlo, 2017)

RAM = Relative Autonomous Motivation

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

to eat healthy foods because eating them is easier and more likely when they are more available and ready-to-eat (Kroese et al., 2015). Therefore, when there is more preparation or time required to eat healthy foods, people perceive greater difficulty in doing so. The difficulties associated with food availability exist at multiple levels, highlighting the role of geography (Inagami et al., 2006), kitchen and dining environments (Stroebele & de Castro, 2004), time pressure and convenience foods (Celnik et al., 2012) and portion size (Fisher et al., 2003). In contrast to Study 1, we chose to focus on eating behavior during lunches in Study 2 because it would be difficult for participants to report on the availability of a food across an entire day, and because students often eat lunch on the university campus where unhealthy foods may be readily available.

Method

Participants

During Fall 2017, we recruited 139 undergraduate psychology students from a Canadian university through a research participant pool in exchange of course credits.[10] The sample included 89% female students and 89% of participants were under 24 years of age ($M = 21$, $SD = 4.59$). Data from four participants were not included in the analyses because three did not complete any daily diaries and one did not complete the measure of RAM.

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[10] To determine sample size for this study, we used the "simr" package in R to conduct simulation-based power estimates (Green & MacLeod, 2016). These simulations indicated that a sample of 130 participants would be needed to provide power of .80, assuming the same effect size and response rate observed in Study 1.

Procedure

We used a similar 3 week diary design as in Study 1, but simplified the design by only focusing on Three-Week Goals. After providing informed consent to participate, we invited participants to complete the same measures as in Study 1[11] and asked them to set three approach food goals and three avoidance food goals for lunches. During the diary phase, participants received a daily email inviting them to complete the diary after lunch, between 12:00 P.M. and 8:00 P.M. The diary involved questions about the availability and consumption of the foods specified by the participant, as well as several questions about participants' experiences during lunch (e.g., time, location). The median number of diary surveys that participants completed was 17 (out of 21; $M = 15.90\ Min = 2,\ Max = 20$).

Measures

Relative autonomous motivation to eat healthy

We measured RAM with the Regulation of Eating Behavior Scale (Pelletier et al., 2004). The 6-factor structure demonstrated adequate fit in our sample, $\chi^2(237) = 430.02$, $p < 0.001$, CFI = 0.90, SRMR = 0.094, RMSEA = 0.077 [90% CI 0.065, 0.089], and good reliability for the autonomous (Cronbach's $\alpha = 0.93$) and controlled (Cronbach's $\alpha = 0.80$) subscales. We calculated RAM scores using the same approach as in Study 1, which ranged from − 4.25 to 10.38 ($M = 3.43$, $SD = 2.85$).

Approach-avoidance eating goals

Participants were asked to list three foods that they intended to eat "some or a lot of" (i.e., approach food goals) during lunches and three foods that they intended to "limit or avoid" (i.e., avoidance food goals) during lunches for the next 3 weeks.[12] Fruit (9.5%), vegetables (8.2%), and salad (8.2%) were the most common approach goals, whereas chips (5.2%), pizza (4.4%), and chocolate (4.4%) were the most common avoidance goals.

Goal specificity

Using the same approach as in Study 1, each food goal was coded by a group of eight trained coders to indicate how broad or specific it was. Each coder rated at least half of the participants' goals, so that each goal was rated by six independent coders. Any discrepancies among coders were resolved through discussion (mean weighted Cohen's $\kappa = 0.57$ prior to discussion), and goal specificity was person-mean centered.

Eating goal success vs. failure

We assessed goal success versus failure using the same food consumption measure and coding procedure as in Study 1.

Food availability

Food availability was assessed with three questions. First, we asked participants for each of their six food goals: "Was this food available to you at lunch?" Response options were (1) "No, this food was not available", (2) "Yes, but I had to purchase ingredients to prepare and/or cook it", (3) "Yes, but some preparation and/or cooking was required, or I had to purchase it already prepared (e.g., grocery, restaurant, cafeteria)", and (4) "Yes it was readily available (e.g., already prepared or purchased)". Second, we asked participants how much it cost, or would have cost them to get each food at lunch (1 = "No cost", 5 = "Very expensive"). Third, we asked participants how long it took, or would have taken them to prepare, cook, or purchase each food (1 = "No time at all", 5 = "A long time"). For these last two questions, there was also a response option for "I was unable to purchase this food when I decided to eat lunch today", which was coded as missing data. All food availability items were person-mean centered to examine within-person associations.

Lunch context

To further understand participants' experiences during lunches, we first asked them to indicate where they were when they decided to eat lunch, with response options being "At home", "On campus in a place where food could be purchased (e.g., cafeteria)", "On campus in a place food could not be purchased (e.g., outside, in a classroom)", "At work", "In transit (e.g., walking, in a car)", "Off campus in a place where food could be purchased (e.g., café, restaurant, market)", "In a location not listed here", and "I did not eat anything for lunch today". Second, we asked them what time it was when they decided to eat lunch, with response options ranging from "Before 11 A.M." to "After 2 P.M.", with 30 min intervals in between. We finally asked them

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[11] This included the BIS/BAS (Carver & White, 1994) but we did not find any significant differences by including these variables in the analyses.

[12] Despite instructions to list "foods," some participants set goals that involved drinks. Data from these goals were not included in the analyses ($n = 25$ goals, 3% of all observations).

whether they had brought their own lunch (coded + 1) or not (coded 0).

Results

Perceived difficulty of approach versus avoidance goals

Using the same approach as in Study 1, we verified that the reported avoidance goals are more difficult than reported approach goals by asking an independent sample of undergraduate students from the same university and participant pool ($n = 72$ including 41 raters who also rated food goals from Study 1; 92% female, 96% under 24 years of age, $M = 21.06$) to rate the difficulty of the food goals that were set by participants in this diary study (n = 352 distinct food goals).[13] As predicted, avoidance goals were rated as more difficult than approach goals, $B = 0.23$ [95% CI 0.22, 0.24], $p < 0.001$, with Goal Type accounting for 3.7% of Level-1 variance in Goal Difficulty.

We also examined whether RAM (as measured by REBS; Pelletier et al., 2004)[14] predicted ratings of Goal Difficulty in this independent sample of raters. The inclusion of RAM and the RAM x Goal Type interaction improved fit over a model with only Goal Type as a predictor, $\chi^2(2) = 192.28$, $p < 0.001$, and accounted for 8.1% of the Person-level variance in Goal Difficulty. Specifically, higher RAM was associated with lower ratings of food goal difficulty, $B = -0.11$ [95% CI − 0.02, -0.19], $p = 0.021$. However, the interaction was also significant, $B = 0.06$ [95% CI 0.05, 0.07], $p < 0.001$, with simple effects showing the effect was only present for approach goals, $B = -0.16$ [95% CI − 0.07, − 0.26], $p < 0.001$, and not for avoidance goals, $B = -0.04$ [95% CI − 0.17, 0.09], $p = 0.525$.

RAM and the effect of food availability on goal success

To examine the role of RAM in the relation between food availability and goal outcomes, we first fit a three-level generalized linear model (Level-1 = Goal-level,

Level-2 = Day-level, and Level-3 = Person-level) with random intercepts and Goal Success/Failure as the dependent variable, and included both Goal Type (Approach Goal = − 1; Avoidance Goal = + 1) and Food Availability (person-mean centered) as Level-1 predictors. Results showed that avoidance goals had higher success rates than approach goals, $OR = 13.38$ [95% CI 12.00, 14.92], $p < 0.001$. The Goal Type x Food Availability interaction was significant, $OR = 0.30$ [95% CI 0.28, 0.33], $p < 0.001$, and simple effects showed success rates were higher when approached foods were more available, $OR = 4.91$ [95% CI 4.35, 5.56], $p < 0.001$, and when avoided foods were less available, $OR = 0.26$ [95% CI 0.22, 0.31], $p < 0.001$. Then, we added RAM scores as a Level-3 predictor, and the corresponding cross-level interaction which significantly improved model fit, $\chi^2(4) = 12.022$, $p = 0.018$. The two-way interaction was significant, $OR = 0.97$ [95% CI 0.95, 1.00], $p = 0.033$, but simple effects analysis showed the RAM x Food Availability interaction was not significant for either approach, $OR = 1.02$ [95% CI 0.98, 1.05], $p = 0.367$, or avoidance goals, $OR = 0.97$ [95% CI 0.92, 1.03], $p = 0.340$.

However, the above analyses included all observations, which included some observations where participants did not eat lunch. By definition, not eating lunch means successfully avoiding certain foods and failing to eat others. Therefore, we re-analyzed the data that included only observations where participants did not eat lunch (24.5% of observations; see Table 4 for descriptive statistics) and used this reduced dataset for all subsequent analyses. Building on a model with only Goal Type and Food Availability as predictors, including RAM and all corresponding interactions

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[13] Due to shift to online classes as a result of the Covid-19 pandemic and campus lock down, we asked these raters to provide difficulty ratings retrospectively, thinking back to how difficult it would have been to pursue each goal while taking courses on the university campus. Of the 352 food goals, there were 182 approach goals and 170 avoidance goals.

[14] When combining raters of food goals from Study 1 and Study 2 ($n = 134$), we found good fit for the 6-factor structure of the scale, $\chi2(237) = 359.01$, $p < .001$, CFI = .90, SRMR = .083, RMSEA = .091 [90% CI .071, .110], and good reliability for the both autonomous and controlled motivation subscales (Cronbach's $\alpha = 0.94$ and $\alpha = 0.82$, respectively).

Table 4 Descriptive statistics for study 2

	All observations	Only when lunch was eaten
Number of goal outcomes	12,365	9,342
Number of days	2,123	1,614
Approach goals		
Mean goal success rate	21.3%	31.5%
ICC$_{Person-level}$	.28	.13
ICC$_{Day-level}$	.09	.001
Avoidance goals		
Mean goal success rate	96.5%	91.6%
ICC$_{Person-level}$	.45	.09
ICC$_{Day-level}$	.18	.04
Food availability		
Mean (SD)	2.25 (1.27)	2.39 (1.29)
Median	2	3
ICC$_{Person-level}$	.19	.18
ICC$_{Day-level}$	.13	.06

ICC = intraclass correlation coefficient

Table 5 Goal success/failure as a function of goal type, food availability and ram for study 2

	All observations		Only when lunch was eaten	
Intercept	0.77 [0.08]***	0.64 [0.13]***	0.83 [0.09]***	0.72 [0.14]***
Goal type	2.59 [0.05]***	2.62 [0.08]***	2.18 [0.05]***	2.02 [0.07]***
Food availability	0.13 [0.04]***	0.15 [0.05]**	0.12 [0.04] ***	0.15 [0.06]**
RAM		0.03 [0.03]		0.03 [0.03]
Goal Type X food avail	− 1.19 [0.04]***	− 1.10 [0.05]***	− 1.10 [0.04]***	− 0.93 [0.06]***
RAM x goal type		− 0.01 [0.02]		0.05 [0.02]**
RAM x food avail		− 0.01 [0.01]		− 0.01 [0.01]
RAM x GT x food avail		− 0.02 [0.01]*		− 0.05 [0.01]*
Simple effects				
Approach goals				
Food availability		1.56 [0.08]***		1.37 [0.09]***
RAM		0.05 [0.05]		− 0.02 [0.05]
RAM x food availability		0.02 [0.02]		0.03 [0.02]
Avoidance goals				
Food availability		− 1.28 [0.12]***		− 1.08 [0.13]***
RAM		− 0.01 [0.06]		0.08 [0.06]
RAM x food availability		− 0.03 [0.03]		− 0.05 [0.03]†
χ^2 model comparison (df)		12.02 (4)*		16.63 (4)**
BIC	7,914.3	7,939.9	6,754.1	6,774.0
Marginal R^2	.663	.666	.605	.615
Δ Person-level variance		− 2.6%		+1.4%
Δ Day− level variance		− 0.3%		− 1.3%

Unstandardized coefficients and standard errors reported; Outcome variable is Goal Success (+1) versus Failure (0); Goal Type coded -1for Approach and + 1 for voidance; Food Availability is person-mean centered; Marginal R2 represents the variance accounted for by fixed effects following recommendations from Nakagawa and Schielzeth (2013); The level-1 (residual) variance at Level-2 (day) and Level-3 (person; for a discussion, see Austin & Merlo, 2017)

RAM = Relative Autonomous Motivation

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

significantly improved fit according to the likelihood ratio test, $\chi^2(4) = 16.63$, $p = 0.002$, (see Table 5 and Fig. 3). The RAM x Goal Type and two-way interactions were significant, $OR = 1.05$ [95% CI = 1.02, 1.09], $p = 0.002$, and $OR = 0.95$ [95% CI = 0.92, 0.97], $p < 0.001$, respectively. Accordingly, the RAM x Food Availability interaction neared significance for avoidance goals, $OR = 0.95$ [95% CI 0.89, 1.00], $p = 0.064$, but not for approach goals, $OR = 1.03$ [95% CI 0.99, 1.07], $p = 0.113$. Simple effects analysis showed the negative effects of Food Availability on avoidance goal success were slightly higher for those with high RAM scores (i.e., + 1 SD), $OR = 0.32$ [95% CI 0.22, 0.46], $p < 0.001$, than those with low RAM scores (i.e., − 1 SD), $OR = 0.40$ [95% CI 0.30, 0.55], $p < 0.001$.

We then examined the role of RAM and food costs for approach and avoidance goal success. In a model with Goal Type (coded − 1 for Approach and + 1 for Avoidance), Food Costs (person-mean centered), and the associated interaction, the Goal Type x Food Costs interaction was significant, $OR = 0.86$ [95% CI 0.79, 0.94], $p < 0.001$. Unexpectedly, higher food costs were associated with higher approach

goal success, $OR = 1.24$ [95% CI 1.14, 1.36], $p < 0.001$, and unrelated to lower avoidance goal success, $OR = 0.88$ [95% CI 0.75, 1.03], $p = 0.103$. Including RAM and all associated interactions significantly improved model fit, $\chi^2(4) = 14.71$, $p = 0.005$, and the two-way interaction was significant, $OR = 1.04$ [95% CI 1.01, 1.08], $p = 0.005$. Analysis of simple effects indicated that the RAM x Food Cost interaction was significant for both approach goals, $OR = 0.95$ [95% CI 0.93, 0.98], $p = 0.003$, and neared significance for avoidance goals, $OR = 1.05$ [95% CI 1.00, 1.11], $p = 0.064$. For approach goals, food cost was unrelated to goal success for those high (+ 1 SD) in RAM, $OR = 0.94$ [95% CI 0.76, 1.14], $p = 0.504$, but positively related for those low (− 1 SD) in RAM, $OR = 1.41$ [95% CI 1.18, 1.68], $p < 0.001$.

Finally, we examined the role of RAM and time required to prepare or get food for approach and avoidance goal success. In a model with Goal Type, Required Time (person-mean centered), and the associated interaction, the Goal Type x Required Time interaction was significant, $OR = 0.91$ [95% CI .83, 0.99], $p = 0.032$. Unexpectedly, Required Time was positively associated with approach goal success,
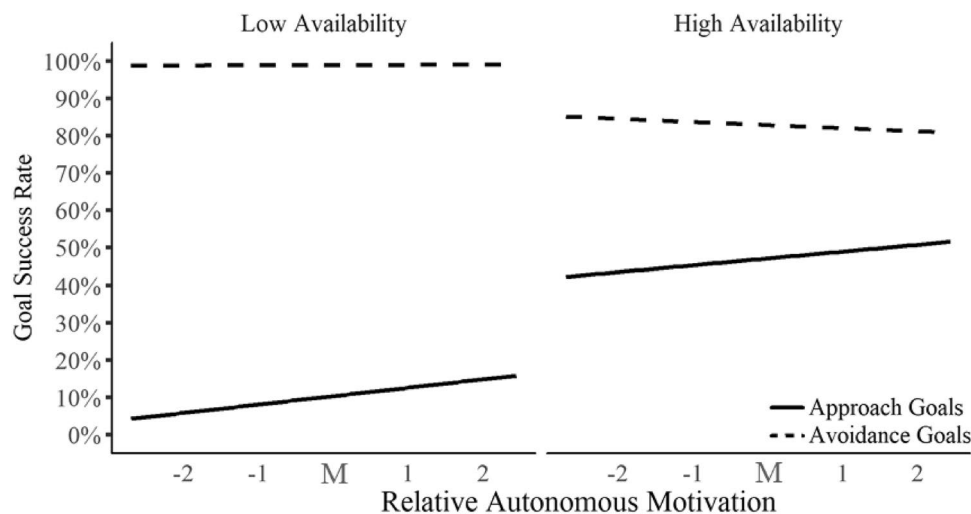
Fig. 3 Approach and avoidance goal success as a function of relative autonomous motivation (mean and ± 1 and 2 standard deviations) and food availability for Study 2. Low availability comprised of responses for (1) "No, this food was not available" and (2) "Yes, but I had to purchase ingredients to prepare and/or cook it", and high availability of (3) "Yes, but some preparation and/or cooking was required, or I had to purchase it already prepared (e.g., grocery, restaurant, cafeteria)" and (4) "Yes it was readily available (e.g., already prepared or purchased)". Includes only observations where lunch was eaten

$OR = 1.20$ [95% CI 1.10, 1.32], $p < 0.001$, and unrelated to avoidance goal success, $OR = 0.99$ [95% CI 0.84, 1.17], $p = 0.911$. Including RAM and all associated interactions marginally improved model fit, $\chi^2(4) = 7.88$, $p = 0.096$, although the two-way interaction was non-significant, $OR = 1.02$ [95% CI 0.99, 1.06], $p = 0.171$. The Food Cost x RAM interaction, $OR = 0.99$ [95% CI 0.096, 1.02], $p = 0.490$, but the effect of RAM neared significance, $OR = 1.05$ [95% CI 0.099, 1.10], $p = 0.079$.[15]

RAM and perceived food availability (post-hoc analysis)

In order to examine whether participants' RAM may have influenced perceptions of food availability, we fit a three-level hierarchical linear model with Food Availability as the dependent variable. The effect of Goal Type was significant, indicating that approached foods were perceived as more available than avoided foods, $OR = 0.87$ [95% CI 0.85, 0.89],

$p < 0.001$. Including RAM and the associated interaction in this model improved fit, $\chi^2(2) = 34.58$, $p < 0.001$. The main effect of RAM was non-significant, $OR = 0.99$ [95% CI 0.90, 1.10], $p = 0.870$, but the interaction was significant, $OR = 0.93$ [95% CI 0.91, 0.96], $p < 0.001$. As illustrated in Fig. 4, simple effects analysis showed a crossover interaction. Participants with high RAM scores (+ 1 SD) viewed approached foods as more available and avoided foods as less available, $OR = 0.90$ [95% CI 0.85, 0.96], $p < 0.001$ when compared to those with low RAM scores (− 1 SD), $OR = 1.07$ [95% CI 1.00, 1.14], $p = 0.056$.

RAM as a predictor of eating versus skipping lunch (post-hoc analysis)

Noticing that not all participants did eat lunch, we examined whether this behavior was related to RAM. We fit a two-level generalized hierarchical linear model with a random intercept for each participant, eating lunch (No coded "0", Yes coded "1") as the outcome and RAM as a predictor. The main effect of RAM was significant, $OR = 1.21$ [95% CI 1.10, 1.34], $p < 0.001$, indicating that higher RAM was associated with greater likelihood to eat lunch (see Table 6).

RAM and the relation between goal specificity and goal success (post-hoc analysis)

We also examined the relations between RAM and goal specificity. Details of these post-hoc analyses are in *Supplemental Materials*. In short, RAM was unrelated to setting more or less specific goals, but RAM was positively
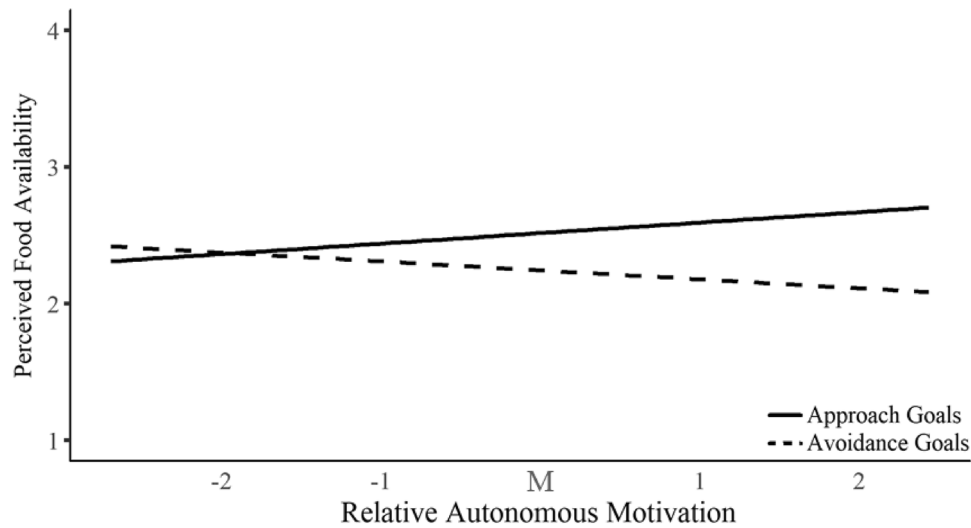
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[15] We conducted additional analyses to understand the unexpected relationships between food costs, required time, and goal success/failure. These analyses are detailed in the *Supplemental Materials*. Despite instructions to participants, it seems that they interpreted these two questions in a different way than anticipated. Ostensibly, participants reported their required time and costs if they ate the foods, but often selected response options for no cost or time if they did not. In other words, foods may have been available, but participants often reported no costs or time (because they spent no time or money) rather than using the response option to indicate an inability to purchase or prepare the food. Therefore, we cannot be confident in the validity of these two items. We still report the associated findings, but any interpretation should be made with caution.

Fig. 4 Perceived food availability as a function of relative autonomous motivation (mean and ±1 and 2 standard deviations) for Study 2 for observations where lunch was consumed. To measure food availability, participants were asked "Was this food available to you at lunch?" for each of their food goals, and asked to respond either (1) "No, this food was not available", (2) "Yes, but I had to purchase ingredients to prepare and/or cook it", (3) "Yes, but some preparation and/or cooking was required, or I had to purchase it already prepared (e.g., grocery, restaurant, cafeteria)", or (4) "Yes it was readily available (e.g., already prepared or purchased)"

Table 6 Perceived food availability, the likelihood of eating lunch, and the likelihood of packing lunch as a function of RAM

	Perceived food availability		Likelihood of eating lunch		Likelihood of packing lunch	
Intercept	− 0.02 [0.05]	− 0.03 [0.05]	1.46 [0.14]***	1.47 [0.14]***	− 1.48 [0.20]***	− 1.48 [0.20]***
Goal type	− 0.14 [0.01]***	− 0.14 [0.01]***				
RAM	− 0.01 [0.02]			0.19 [0.05]***		0.14 [0.07]*
RAM x goal type		− 0.02 [0.01]***				
Simple effects						
Approach goals						
RAM		0.02 [0.02]				
Avoidance goals						
RAM		− 0.02 [0.02]				
χ^2 model comparison (df)	34.58 (2)***		16.20 (1)***		4.57 (1)*	
BIC	28,966.3	28,950.0	2116.1	2107.6	1309.8	1312.4
Marginal R^2	.012	.015	–	.057	–	.023
Δ Person-level variance	− 0.1%		− 14.6%		− 4.2%	
Δ Day-level variance	+ 0.9%					
Δ Goal-level variance	− 0.5%					

Unstandardized coefficients and standard errors reported; Food Availability modeled with a three-level hierarchical linear model; Likelihood of eating lunch (No = 0, Yes = 1) and packing lunch (No = 0, Yes = 1) modeled with a two-level generalized hierarchical linear model; Likelihood of packing lunch only involves observations where participants were on campus or in a place where food could be purchased; Goal Type coded -1 for Approach and +1 for Avoidance; Marginal R^2 represents the variance accounted for by fixed effects following recommendations from Nakagawa and Schielzeth (2013)

RAM = Relative Autonomous Motivation

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

associated with achievement of broader approach goals. Moreover, when participants were more successful at their approach goals on a given day, they were more successful at their avoidance goals that day.

The role of the lunch context (post-hoc analysis)

Lastly, we conducted analyses to further understand participants' experiences during lunches. Most of the time participants ate lunch between 11:30 A.M. and 1:30 P.M. (68.6%) and ate lunch either at home (43.3%) or on campus (38.4%). Participants packed a lunch on 39.2% of days when they ate lunch on campus. We expect it is easier for students to meet their healthy eating goals when eating lunch at home than on campus or somewhere where food could be bought (e.g., café, restaurant), since unhealthy foods are often present and preparing healthy foods may not be possible. Likewise, we expect that it is easier for students to meet their healthy eating goals on campus when they pack their own lunch. To test these predictions, we fit several additional models, which are detailed in *Supplemental Materials*. For both approach and avoidance goals, success rates were higher when eating lunch at home (vs. on campus or in places where food was available for purchase), and when participants packed a lunch to eat on campus. Finally, RAM was unrelated to where students ate lunch, but more autonomously motivated individuals were more likely to pack a lunch when on campus.

Brief discussion

Study 2 provided mixed evidence for our hypothesis. We did not find evidence that the difficulties associated with food availability were more likely to be overcome with greater RAM. However, post-hoc analyses showed that RAM was related to perceptions of food availability, and to perceived difficulty. Further, we found that RAM is linked to the strategies people use to eat healthy (e.g., eating vs. skipping lunch, packing lunch).

General discussion

The purpose of this research was to test the hypothesis that RAM predicts healthy eating when it is difficult. Specifically, we focused on difficulties involved when trying to eat certain foods and avoid others (Study 1) and when these foods are more or less available (Study 2). Both studies provided some evidence for our hypothesis. In Study 1, RAM was associated with success for 3 week approach goals, and especially for specific approach goals that were the most difficult. Yet, this effect was not present for daily goals. In

Study 2, RAM did not predict healthy eating when availability of certain foods could make it more challenging. However, the effect of RAM on perceived food availability may partly explain this finding. Similarly, post-hoc analyses in both studies demonstrated that individuals with higher RAM rated healthy eating goals as being less difficult. In Study 2, post-hoc analyses also showed that RAM was associated with the likelihood of eating lunch, and of packing a lunch when on campus – two potential healthy eating strategies. Finally, in both studies success in approaching healthy food was positively related to success in avoiding unhealthy food. Below, we discuss these findings by first addressing the unexpected findings and then we discuss the evidence regarding our initial hypothesis. Finally, we interpret the findings regarding healthy eating strategies and the role of RAM.

Difficulty of approaching versus avoiding foods

As expected, the approach goals that participants identified in both Study 1 and 2 were rated by an independent sample of similar individuals (i.e., undergraduate students) as being easier to attain than avoidance goals. However, we observed that avoidance goals had higher success rates than approach goals, which could be explained by the complexity of approach and avoidance goals. Indeed, the difference between approach and avoidance food goals is more complex than the activation-inhibition dichotomy. For avoidance goals, individuals can *try to limit* (moderate consumption) or *not eat* (abstain from eating) foods, which likely differs in terms of endorsement, strategies, goal persistence, and goal difficulty. For example, trying to not eat meat may require very different tactics than trying to eat less meat, which could be more or less challenging. Similarly, for approach goals, individuals could try to eat *some* or *a lot of* food, but it may be more difficult to achieve the relatively intense goal of eating *a lot of* carrots than the more modest goal of eating *a few* carrots. In addition, we asked participants to set both approach and avoidance goals in our studies, as opposed to selecting a type of goal to pursue (e.g., Sullivan & Rothman, 2008). While this allowed us to examine both approach and avoidance goal pursuit for each participant, it seems plausible that participants may have been more committed to some of their goals than to others. Without assessing varying degrees and commitment to approach and avoidance goals, it is difficult to know whether this could be a source of bias in the current studies.

However, findings on the prevalence of skipped lunches (Study 2) may suggest that participants were more likely to set avoidance goals involving abstinence than moderation. In addition, the North American focus on diets and weight maintenance often includes a focus on abstinence (Yaemsiri et al., 2011), which could promote higher success

rates if abstinence goals are more clear and measurable to pursue. Of course, research on restraint theory (Herman & Mack, 1975) suggests that an abstinence-based approach could be more challenging than moderation. Although we did not measure participants' level of restrained eating in our studies, future research connecting RAM, restrained eating, and the degree of people's approach and avoidance could provide valuable insights in setting and attaining healthy eating goals.

The role of RAM when healthy eating is difficult

Based on previous research (e.g., Green-Demers et al., 1997; Ntoumanis et al., 2014), we hypothesized that greater RAM would promote healthy eating because it involves greater persistence when difficulties arise. Study 1 provided some support for this hypothesis, but the effects were only present for 3 week approach goals and not for daily goals or 3 week avoidance goals. This could be explained by the fact that daily goals are more salient, and thus easier, than 3-week goals that required participants to stick to the long-term goals, making it more difficult. In Study 2, we found no effect of RAM on goal success when food availability made eating healthy more difficult. However, post-hoc analyses showed that RAM influenced perceptions of food availability, which is consistent with other research (e.g., Milyavskaya et al., 2015). Indeed, we found that people with higher (vs. lower) RAM perceived healthy foods as being easier to access, and unhealthy foods as less available.

Our findings also showed that RAM could help explain the achievement of difficult goals in a different way. Indeed, although we found no relationship between RAM and goal specificity or goal endorsement, it is plausible that RAM influenced the level of difficulty of participants' goals. For example, RAM to eat healthy often involves an interest and enjoyment in healthy eating, which may have led individuals with higher RAM to set more challenging healthy eating goals. Indeed, post-hoc analyses in both studies showed that RAM was negatively related to ratings of food goal difficulties, so peoples' RAM may influence the difficulty of goals they set, perhaps as part of a general strategy to eat healthy.

RAM and strategies for eating healthy

Further analyses highlighted unexpected findings on daily eating behaviors and the role of RAM in adopting different healthy eating strategies. In Study 2, post-hoc analyses showed that RAM was related to packing a lunch to eat on campus, which led to higher goal success rates. We also found that RAM predicted the likelihood of eating lunch, and that achieving approach goals on a given day increased the likelihood of attaining avoidance goals as well. Consistent with these findings, Pelletier et al (2004) found that

autonomous motivation was associated with greater concern for the quality of one's diet (i.e., what to eat), whereas controlled motivation was related to the quantity of food (i.e., how much to eat). Then, Otis and Pelletier (2008) found that autonomous motivation was related to the use of approach strategies, whereas controlled motivation was related to avoidance strategies. Therefore, it is not surprising to see RAM associated with the use of two approach strategies: eating (or not skipping) lunch and packing one's own lunch when away from home. Conversely, not eating lunch could be viewed as an avoidance strategy when motivation was predominantly controlled (or less autonomous). Skipping lunch is a way to eat fewer foods, but eating lunch can also be a means to consume more healthy foods. Notably, the fact that RAM predicted approach goal success could be interpreted as an effective use of approach strategies.

In addition, autonomous motivation is related to a preference for food variety (Otis & Pelletier, 2008) and creativity (e.g., Sheldon, 1995), so individuals higher in RAM may have been more likely to meet their personal healthy eating goals through alternative means not measured in this study. For example, eating other healthy foods (and avoiding other unhealthy foods) not listed as food goals still involves eating healthy, and missing this possibility in the diary study could have resulted in finding reduced estimates of the impact of RAM on eating goal success/failure. It also seems likely that the benefits of higher RAM extend beyond goal attainment, such as experiencing greater positive affect when striving towards healthy eating goals (e.g., Lee et al., 2003). This could provide an interesting direction for future research to examine the dynamic influence of affect and well-being on efforts and motivation towards difficult healthy eating goals.

Across both studies, we also found that individuals who were more successful at their approach goals were also more successful at their avoidance goals. It seems that eating healthy foods may have made it easier to avoid unhealthy foods. This could be the result of satisfying hunger with healthy foods (Steel et al., 2006) or motivational spillover (e.g., Silva et al., 2011). Regardless, this finding contributes to the existing literature on healthy eating strategies (e.g., Adriaanse et al., 2011; Sullivan & Rothman, 2008).

Limitations

Because of the complexity of these studies, the findings are limited at different levels. First, there is much variability and unpredictability involved in studying eating behavior in daily life. As a result, the effects that are detected using daily diary designs are often smaller than those manipulated or isolated in controlled settings. Nonetheless, these effects should be more robust to contextual factors and replicable across samples (Maner, 2016). In a

healthy eating context, this trade-off between ecological and internal validity should always be considered. While lab-based studies provide insight into specific aspects of eating behavior (e.g., Wansink et al., 2005), daily diary designs provide rich observations of people's day-to-day eating patterns, contexts, and challenges (e.g., Conner et al., 2015). However, we found very little variance in goal success/failure at the person-level (around 20%). It was thus more challenging to observe an effect of RAM on goal success/failure.

Second, we measured RAM at the contextual-level (i.e., healthy eating context) whereas motivation at the situational-level might be a better moderator as suggested in Vallerand's (1997) hierarchical model. People might be more likely to engage in behaviors that are more difficult when their situational RAM was high, independently from their general RAM for eating. Similarly, 3 weeks is only a brief period to observe eating behaviours, and it seems plausible that RAM influences eating behaviours on a longer timescale, such as the extent that students may persist with (vs. disengage from) their healthy eating goals across a semester or academic year. Further research should consider other contexts, challenges, and timelines, such as the presence of friends and family (Cruwys et al., 2015), and eating at night or after a demanding day (e.g., Wichianson et al., 2009).

Third, the samples we recruited in each study limit the generalizability of these findings. Each sample was comprised of students who were mostly female. Although we expect similar findings would emerge among non-students and males, replications of this study among these populations are needed to support this prediction. It may be especially important to test these hypotheses among populations who struggle with eating behaviour, such as those experiencing an eating disorder or who are overweight/obese.

Another limitation is the possibility of measurement reactivity. By setting their own healthy eating goals, participants may have found themselves in a form of intervention during the diary studies. During the participants' debriefing, they often reporting seeing this 3 week phase as a challenge, holding themselves more accountable and enhancing their self-awareness of their eating behavior. Measurement reactivity could introduce a bias in the findings, such that participants' eating behavior may have been healthier than normal. In Study 1, we even observed an increase in goal success rates over the 3 week phase, which provides some evidence of measurement reactivity, but is promising for healthy eating interventions and for the development of self-regulation applications and programs. Measurement reactivity and bias are common issues in psychological research (Borsboom, 2006; Shrout et al., 2018), and using more intensive or objective measures of food consumption (e.g., multiple

24 h dietary recalls; Jonnalgadda et al., 2000) would not necessarily solve these problems.

Conclusion

Overall, two daily diary studies provide some evidence that RAM leads to healthy eating when it is difficult. Most importantly, we found that RAM is associated with perceiving fewer difficulties, and with the use of more approach-based healthy eating strategies. These findings help to explain why some people are more likely to meet their healthy eating goals than others, and contribute to a growing literature on the role of RAM for engaging in and maintaining various health behaviors.

Declarations

Conflict of interest The authors have no conflicts of interest to declare regarding the content of this article.

Ethical approval Approval was obtained from the Human Research Ethics Board at the University of Victoria (Ethics approval number: 16-321).

Consent to participate Informed consent was obtained from all individual participants included in the study.

References

Adriaanse, M. A., Vinkers, C. D., De Ridder, D. T., Hox, J. J., & De Wit, J. B. (2011). Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite, 56*, 183–193.

Aitken, N. M., Pelletier, L. G., & Baxter, D. E. (2016). Doing the difficult stuff: Influence of self-determined motivation toward the environment on transportation proenvironmental behavior. *Ecopsychology, 8*, 153–162.

Austin, P. C., & Merlo, J. (2017). Intermediate and advanced topics in multilevel logistic regression analysis. *Statistics in Medicine, 36*, 3257–3277.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using "lme4." *Journal of Statistical Software, 67*, 1–48.

Bolger, N., Stadler, G., & Laurenceau, J.-P. (2012). Power analysis for intensive longitudinal studies. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 285–301). The guilford press.

Borsboom, D. (2006). When does measurement invariance matter? *Medical Care, 44*(11), S176–S181.

Carver, C. S., & Scheier, M. F. (2012). Cybernetic control processes and the self-regulation of behavior. In R. M. Ryan (Ed.), *Oxford Handbook of Human Motivation* (pp. 28–42). New York: Oxford University Press.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*, 319–333.

Celnik, D., Gillespie, L., & Lean, M. E. J. (2012). Time-scarcity, ready-meals, ill-health and the obesity epidemic. *Trends in Food Science & Technology, 27*, 4–11.

Conner, T. S., Brookie, K. L., Richardson, A. C., & Polak, M. A. (2015). On carrots and curiosity: Eating fruit and vegetables is associated with greater flourishing in daily life. *British Journal of Health Psychology, 20*, 413–427.

Cruwys, T., Bevelander, K. E., & Hermans, R. C. (2015). Social modeling of eating: A review of when and why social influence affects food intake and choice. *Appetite, 86*, 3–18.

Elliot, A. J. (2006). The hierarchical model of approach-avoidance motivation. *Motivation and Emotion, 30*, 111–116.

Elliot, A. J., McGregor, H. A., & Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology, 91*, 549–563.

Fisher, J., Rolls, B. J., & Birch, L. L. (2003). Children's bite size and intake of an entree are greater with large portions than with age-appropriate or self-selected portions. *American Journal of Clinical Nutrition, 77*, 1164–1170.

Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior, 26*, 331–362.

Green, P., & MacLeod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution, 7*, 493–498.

Green-Demers, I., Pelletier, L. G., & Menard, S. (1997). The impact of behavioral difficulty on the saliency of the association between self-determined motivation and environmental behaviors. *Canadian Journal of Behavioral Science, 29*, 157–166.

Hagger, M. S., Chatzisarantis, N. L., & Harris, J. (2006). The process by which relative autonomous motivation affects intentional behavior: Comparing effects across dieting and exercise behaviors. *Motivation and Emotion, 30*, 306–320.

Harrison, A., Treasure, J., & Smillie, L. D. (2011). Approach and avoidance motivation in eating disorders. *Psychiatry Research, 188*, 396–401.

Henson, S., Blandon, J., & Cranfield, J. (2010). Difficulty of healthy eating: A Rasch model approach. *Social Science & Medicine, 70*, 1574–1580.

Herman, C. P., & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality, 43*, 647–660.

Hofmann, W., Adriaanse, M., Vohs, K. D., & Baumeister, R. F. (2014). Dieting and the self-control of eating in everyday environments: An experience sampling study. *British Journal of Health Psychology, 19*, 523–539.

Inagami, S., Cohen, D. A., Finch, B. K., & Asch, S. M. (2006). You are where you shop: Grocery store locations, weight, and neighborhoods. *American Journal of Preventive Medicine, 31*, 10–17.

Jansen, E., Mulkens, S., & Jansen, A. (2007). Do not eat the red food!: Prohibition of snacks leads to their relatively higher consumption in children. *Appetite, 49*, 572–577.

Jonnalagadda, S. S., Mitchell, D. C., Smiciklas-Wright, H., Meaker, K. B., Van Heel, N., Karmally, W., Ershow, A. G., & Kris-Etherton, P. M. (2000). Accuracy of energy intake data estimated by a multiple-pass, 24 hour dietary recall technique. *Journal of the American Dietetic Association, 100*, 303–311.

Kroese, F. M., Marchiori, D. R., & de Ridder, D. T. (2015). Nudging healthy food choices: A field experiment at the train station. *Journal of Public Health, 38*(2), e133–e137.

Lee, F. K., Sheldon, K. M., & Turban, D. B. (2003). Personality and the goal-striving process: The influence of achievement goal patterns, goal level, and mental focus on performance and enjoyment. *Journal of Applied Psychology, 88*, 256–265.

Maner, J. K. (2016). Into the wild: Field research can increase both replicability and real-world impact. *Journal of Experimental Social Psychology, 66*, 100–106.

Milyavskaya, M., Inzlicht, M., Hope, N., & Koestner, R. (2015). Saying "no" to temptation: Want-to motivation improves self-regulation by reducing temptation rather than by increasing self-control. *Journal of Personality and Social Psychology, 109*, 677–693.

Mor, N., & Cervone, D. (2002). *Approach and avoidance goals and sub goals*. Poster presented at the annual meeting of the Society for Personality and Social Psychology, Savannah.

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R^2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution, 4*, 133–142.

Ng, J. Y. Y., Ntoumanis, N., Thogersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-determination theory applied to health contexts: A meta-analysis. *Perspectives on Psychological Science, 7*, 325–340.

Ntoumanis, N., Healy, L. C., Sedikides, C., Duda, J., Stewart, B., Smith, A., & Bond, J. (2014). When the going gets tough: The "why" of goal striving matters. *Journal of Personality, 82*, 225–236.

Otis, N., & Pelletier, L. G. (2008). Women's regulation styles for eating behaviors and outcomes: The mediating role of approach and avoidance food planning. *Motivation and Emotion, 32*, 55–67.

Pavey, L., & Sparks, P. (2009). Reactance, autonomy and paths to persuasion: Examining perceptions of threats to freedom and informational value. *Motivation and Emotion, 33*, 277–290.

Pham, N., Mandel, N., & Morales, A. C. (2016). Messages from the food police: How food-related warnings backfire among dieters. *Journal of the Association for Consumer Research, 1*, 175–190.

Polivy, J., Coleman, J., & Herman, C. P. (2005). The effect of deprivation on food cravings and eating behavior in restrained and unrestrained eaters. *International Journal of Eating Disorders, 38*, 301–309.

Wang, F. (2008). Motivation and English achievement: An exploratory and confirmatory factor analysis of a new measure for Chinese students of english learning. *North American Journal of Psychology, 10*, 633–646.

Revelle, W. (2018) psych: Procedures for Personality and Psychological Research. Northwestern University, Evanston https://CRAN.R-project.org/package=psych Version 1.8.12.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.

Sheldon, K. M. (1995). Creativity and self-determination in personality. *Creativity Research Journal, 8*, 25–36.

Sheldon, K. M., Osin, E. N., Gordeeva, T. O., Suchkov, D. D., & Sychev, O. A. (2017). Evaluating the dimensionality of self-determination theory's relative autonomy continuum. *Personality and Social Psychology Bulletin, 43*, 1215–1238.

Shrout, P. E., Stadler, G., Lane, S. P., McClure, M. J., Jackson, G. L., Clavél, F. D., Iida, M., Gleason, M. E. J., Xu, J. H., & Bolger, N.

(2018). Initial elevation bias in subjective reports. *Proceedings of the National Academy of Sciences, 115*(1), e15–e23.

Silva, M. N., Markland, D., Carraça, E. V., Vieira, P. N., Coutinho, S. R., Minderico, C. S., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2011). Exercise autonomous motivation predicts 3-yr weight loss in women. *Medicine & Science in Sports & Exercise, 43*, 728–737.

Sobal, J., & Wansink, B. (2007). Kitchenscapes, tablescapes, platescapes, and foodscapes: Influences of microscale built environments on food intake. *Environment and Behavior, 39*, 124–142.

Statistics Canada. (2019a). *Fruit and vegetable consumption, 2017*. Retrieved from https://www150.statcan.gc.ca/n1/pub/82-625-x/2019a001/article/00004-eng.htm

Statistics Canada. (2019b). *Overweight and obese adults, 2018*. Retrieved from https://www150.statcan.gc.ca/n1/pub/82-625-x/2019b001/article/00005-eng.htm

Steel, D., Kemps, E., & Tiggemann, M. (2006). Effects of hunger and visuo-spatial interference on imagery-induced food cravings. *Appetite, 46*, 36–40.

Stroebele, N., & De Castro, J. M. (2004). Effect of ambience on food intake and food choice. *Nutrition, 20*, 821–838.

Sullivan, H. W., & Rothman, A. J. (2008). When planning is needed: Implementation intentions and attainment of approach versus avoidance health goals. *Health Psychology, 27*, 438–444.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), e78.

Tohill, B. C., Seymour, J., Serdula, M., Kettel-khan, L., & Rolls, B. J. (2004). What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. *Nutrition Reviews, 62*, 365–374.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 29, pp. 271–360). Academic Press.

Pelletier, L. G., Dion, S. C., Slovinec-D'Angelo, M., & Reid, R. (2004). Why do you regulate what you eat? Relationships between forms of regulation, eating behaviors, sustained dietary behavior change, and psychological adjustment. *Motivationand emotion, 28*, 245–277.

Wansink, B., Painter, J. E., & North, J. (2005). Bottomless bowls: Why visual cues of portion size may influence intake. *Obesity Research, 13*, 93–100.

Werner, K. M., Milyavskaya, M., Foxen-Craft, E., & Koestner, R. (2016). Some goals just feel easier: Self-concordance leads to goal progress through subjective ease, not effort. *Personality and Individual Differences, 96*, 237–242.

White, B. A., Horwath, C. C., & Conner, T. S. (2013). Many apples a day keep the blues away: Daily experiences of negative and positive affect and food consumption in young adults. *British Journal of Health Psychology, 18*, 782–798.

Wichianson, J. R., Bughi, S. A., Unger, J. B., Spruijt-Metz, D., & Nguyen-Rodriguez, S. T. (2009). Perceived stress, coping and night-eating in college students. *Stress and Health: Journal of the International Society for the Investigation of Stress, 25*, 235–240.

Williams, G. C., McGregor, H., Sharp, D., Kouides, R. W., Lévesque, C. S., Ryan, R. M., & Deci, E. L. (2006). A self-determination multiple risk intervention trial to improve smokers' health. *Journal of General Internal Medicine, 21*, 1288–1294.

Wilkowski, B. M., Ferguson, E. L., Williamson, L. Z., & Lappi, S. K. (2018). (How) does initial self-control undermine later self-control in daily life? *Personality and Social Psychology Bulletin, 44*(9), 1315–1329.

Yaemsiri, S., Slining, M. M., & Agarwal, S. K. (2011). Perceived weight status, overweight diagnosis, and weight control among US adults: The NHANES 2003–2008 Study. *International Journal of Obesity, 35*, 1063–1070.