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The relationship between autonomous and controlled motivation and eating behaviors: examining the roles of self-regulating eating quality and quantity

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Abstract
The goal of this study was to examine whether strategies such as planning and self-monitoring the quality/quantity of eating can explain the relationships between autonomous and controlled motivation and eating in undergraduate female students. Study 1 (n = 456) examined whether the strategies could account for additional variance in eating outcomes beyond the influence of motivation, and whether the strategies mediated the relationships between motivation and eating. Study 2 (n = 979) replicated the results within structural equation models. Autonomous motivation was positively associated with planning and self-monitoring eating quality, and these strategies were then positively and negatively associated with healthy and unhealthy eating, respectively. In contrast, controlled motivation was positively associated with planning and self-monitoring eating quantity, and these strategies were then positively associated with bulimic symptoms. Findings provide insight into the mechanisms by which different motivations relate to distinct eating outcomes and suggest that promoting eating quality may be more beneficial for adopting healthy eating behaviors.

Keywords Motivation · Self-regulation strategies · Quality and quantity · Eating behaviors

Introduction

The regulation of eating behaviors is not a simple task for most individuals. It is now widely recognized that the types and amount of food that people consume are strongly influenced by their environment. As indicated by the World Health Organization (2000), the primary cause of the rapid increase in obesity within recent decades lies in the environmental and societal transitions that the Western world has undergone. Specifically, the industrialization of food production in conjunction with an economy based on trade has contributed to an increase in the availability of cheaper, bigger, and tastier foods, high in energy but poor in nutrients (Chandon & Wansink, 2012). Since the production of unhealthy commodities (e.g., processed foods high in fat, sugar and salt) is more profitable that the production of healthy commodities (e.g., fruits and vegetables that are easily perishable), global food companies have high economic incentives to market and sell such products (Stuckler et al., 2012). These changes in the food system have contributed to the emergence of a food environment that favors the consumption of unhealthy foods at the expense of population health.

As obesity rates escalated, the developed world also witnessed a shift in attitudes towards body shape and weight, especially towards women. While a "plump" body was previously considered desirable, thinness among women became a dominant cultural ideal during the twentieth century (Garner et al., 1980). According to the sociocultural model of eating pathology (Stice, 1994, 2001), the portrayal of the "thin ideal" in the media has led many women to perceive and endorse society's beliefs about thinness and obesity and consequently, to become dissatisfied with their bodies and to develop eating disorders.

Fortunately, although the current food environment fosters conditions that are conducive to eating regulation failure, not everyone falls victim of their environment to the same extent. According to the Self-Determination Theory

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(SDT; Ryan & Deci, 2017), one of the leading theories of human motivation, people have the potential to be active agents of their eating behaviors, instead of passively influenced by the social world. Indeed, central to the SDT is the concept of *internalization*, which is defined as an internal psychological process through which behaviors regulated by external forces are transformed into behaviors regulated by the self. This process can be viewed along a continuum depicting the behavioral regulations that go from the least to the most internalized.

The self-determination continuum

The behavioral regulations proposed by the SDT can be categorized into two broad types of motivation: intrinsic and extrinsic motivation. Intrinsic motivation encompasses behaviors that are enacted out of volition and pure enjoyment. These behaviors represent an expression of the self and contribute to personal development and growth (Ryan, & Deci, 2017). Behaviors that fall under the category of extrinsic motivation represent a means to an end and are performed in order to satisfy external and/or internal demands. Within the SDT, extrinsic motivation is divided into four types of behavioral regulations, which differ in their degree of internalization. External regulation is the least internalized form of extrinsic motivation and represents behaviors that are initiated in order to receive a reward and/or to avoid social punishment. Introjected regulation marks the beginning of the internalization process, but is only considered partial, as behaviors regulated by introjection are not yet operating from an integrated sense of volition (Ryan & Deci, 2017). At this point in the process, an individual has taken in external controls but has not yet fully accepted them as one's own. With identified regulation, behaviors have been internalized within the self, as individuals recognize the significance in performing the behavior. Finally, integrated regulation is the most internalized form of extrinsic motivation. People who behave out of integration have succeeded in bringing an action that was formally external to the self in congruence with other aspects of one's value system.

According to the SDT, intrinsic and extrinsic motivation can be further categorized into the dimensions of autonomous and controlled motivation. Autonomous motivation encompasses the behavioral regulations that reflect individuals' volition to engage in a behavior (i.e., intrinsic motivation, and integrated and identified regulations), whereas controlled motivation encompasses the behavioral regulations that reflect internal and external pressures to act a certain way (i.e., introjected and external regulations). The SDT postulates that the more autonomous the motivational form, the more positive the affective, cognitive, and behavioral outcomes will be (Ryan & Deci, 2017). This has been supported by many studies in the eating domain which have demonstrated the benefits of autonomous motivation not only for the adoption of healthier eating behaviors, but also for decreasing the likelihood of developing eating disorders such as bulimic symptoms (Verstuyf, Patrick, Vansteenkiste, & Teixeira, 2012, for a review). For instance, Pelletier, Dion, Slovinec-D'Angelo and Reid (2004a; study 2) demonstrated that autonomous motivation was positively associated with healthy eating and negatively associated with bulimic symptoms, whereas controlled motivation was positively associated with bulimic symptoms and negatively associated with healthy eating. Pelletier, Dion, and Lévesque (2004b) and Pelletier and Dion (2007) also showed that global autonomy in life buffered against sociocultural pressures about body image and the internalization of the "thin ideal", which reduced women's likelihood of experiencing body dissatisfaction and bulimic symptoms.

Recent studies (e.g., Guertin et al., 2018; Guertin, Barbeau, Pelletier, & Martinelli, 2017; Guertin et al., 2020) have also shown that autonomous motivation was positively associated with healthy eating and negatively associated with unhealthy eating, whereas controlled motivation was positively associated with unhealthy eating and negatively associated with healthy eating as defined by Canada's Food Guide. In Guertin and colleagues' (2020) study, it was also found that stages of change moderated the relationship between autonomous motivation and healthy and unhealthy eating, with individuals showing stronger relationships between motivation and eating as they scored higher on stages of change. Specifically, the authors reported that women in earlier stages of change—that is, stages in which people are considering changing their eating behaviors or have begun to implement changes—reported higher levels of controlled motivation and lower levels of autonomous motivation, as well as a higher consumption of unhealthy foods and a lower consumption of healthy foods. However, women in later stages of change—that is, stages in which people are trying to maintain or have been maintaining changes in their eating behaviors—reported higher levels of autonomous motivation and lower levels of controlled motivation, as well as a higher consumption of healthy foods and a lower consumption of unhealthy foods.

Together, these studies indicate that when people regulate their eating behaviours for autonomous, relative to controlled reasons, they are much more successful in navigating the current food environment. Although only a few studies have examined the mechanisms by which autonomous and controlled motivations are associated with different types of eating behaviors, there is some evidence that individuals approach the regulation of their eating behaviors in different ways depending on their motivation which, in turn, leads to different consequences in terms of their eating behaviors. For instance, in Otis and Pelletier's (2008) study, it was found that approach food planning (i.e., planning *what* to

eat) partially mediated the relationship between autonomous motivation and healthy eating behaviors, whereas avoidance food planning (i.e., planning *what not* to eat) partially mediated the relationship between controlled motivation and bulimic symptoms. Furthermore, Hagger et al. (2006) showed that higher levels of autonomy was associated with positive attitudes and perceived behavioral control over dieting, which was further associated with intentions to diet and dieting behaviors.

Pelletier and colleagues (2004a; study 2) also found that women who reported higher levels of autonomous motivation were more concerned over the *quality* of the food they ate, whereas women who reported higher levels of controlled motivation were more concerned over the *quantity* of the food they ate. Although these researchers did not examine the dietary outcomes associated with these two types of approaches, they hypothesized that an emphasis on the quantity (versus the quality) of eating may put some individuals at greater risk of eating regulation failure, as controlled motivation was also found to be associated with bulimic symptoms. In line with this hypothesis, Guertin and Pelletier (2020) recently showed that individuals self-regulate their eating behaviors by planning and self-monitoring the quality (i.e., nutrient intake) and the quantity (i.e., calories and portion sizes) of their eating behaviors, and that eating quality strategies were positively associated with healthy eating and negatively associated with unhealthy eating behaviors, whereas eating quantity strategies were positively associated with bulimic symptoms and BMI. Although planning and self-monitoring have been recognized as beneficial strategies for engaging in healthy eating (e.g., Adriaanse et al., 2011; Harkin et al., 2016), the goal of Guertin and Pelletier's (2020) study was to demonstrate that individuals engage in these strategies in qualitatively distinct ways, and that planning and self-monitoring in terms of quality versus quantity can have differential effects on eating behaviors.

The present research

The purpose of the present research was to build upon the studies of Pelletier and colleagues (2004a) and Guertin and Pelletier (2020) in order to further knowledge on the mechanisms by which different types of motivation are associated with different eating outcomes. Specifically, this research examined whether planning and self-monitoring the quality versus the quantity of eating could help explain the relationships between autonomous and controlled motivation, and healthy and unhealthy eating behaviors and bulimic symptoms. According to Guertin and Pelletier (2020), food *quality* refers to the types of food consumed in terms of nutritional value, for example, by focusing on the daily intake of nutrients (e.g., protein, fat, carbohydrates, vitamins and minerals) and whether or not a person is consuming healthy foods according to Canada's Food Guide throughout the day,whereas food *quantity* refers to the amount of food consumed in terms of calories and portion sizes. Guertin and Pelletier (2020) distinguish between calories and portion sizes because national dietary guidelines often recommend paying attention to both calories and portion sizes when making food choices.

This objective was achieved through two studies. First, as a preliminary step, Study 1 examined if the different self-regulation strategies could account for additional variance in eating outcomes over and above the influence of motivation, using hierarchical multiple regressions. In cases where motivation and the strategies are both significantly associated with eating behaviors, mediation analyses were then carried out to examine if the strategies mediated the relationship between motivation and eating. Study 2 replicated the mediation results found in Study 1 within structural equation models (SEM).

Since Guertin and Pelletier (2020) found that BMI was positively associated with eating quantity strategies exclusively, which were also positively associated with bulimic symptoms, BMI was controlled for in both studies. Theoretically, autonomous motivation has been negatively associated with BMI, whereas controlled motivation has been positively associated with BMI (Gettens et al., 2018; Pelletier et al., 2004a, 2004b), suggesting that BMI covaries with autonomous and controlled motivation. Such relationships could be explained by the sociocultural model of eating pathology (Stice, 1994, 2001). This model suggests that the internalization of beliefs about thinness and obesity has an impact on a person's perception of their appearance and leads them to develop different levels of body dissatisfaction. This, in turn, make them more likely to develop eating disorders since this process is experienced as a weight control process. However, according to Pelletier and Dion (2007), although individuals motivated by autonomous and controlled motivation both experience some body dissatisfaction, these individuals manage body image differently. Individuals with autonomous motivation are more likely to engage in healthy behavioral strategies (such as choosing healthy foods, focusing on food quality), whereas individuals with controlled motivation are more likely to engage in unhealthy or dysfunctional behavioral strategies (such as avoiding unhealthy foods, focusing on food quantity; Guertin & Pelletier, 2020; Otis & Pelletier, 2008).

Methodologically, BMI could be viewed both as a determinant of regulatory processes and as a consequence from the use of different regulatory processes. In the following two studies, our design was cross-sectional, making it difficult to establish with certainty the direction of causality between BMI, motivation, and regulatory strategies. We estimated that participants' BMI preceded their study participation and questionnaire completion, making it a factor more

likely to be an exogenous variable correlated with autonomous and controlled motivation, and a factor more likely to be a determinant of the regulatory processes examined in the present studies. In our analyses, we allowed all three exogenous variables (BMI, autonomous and controlled motivation) to be correlated to reduce the contribution of error to the overall fit of the model. Although this may limit the possibility to generalize our results to the general population, we decided to examine these processes within undergraduate female students because eating regulation, and the problems associated with it, represent topics of great interest for this population.

Study 1

The purpose of Study 1 was to examine if planning and self-monitoring the quality and quantity of eating play a role in the prediction of eating outcomes over and above the effects of motivation, while controlling for BMI. Mediation analyses were also conducted to examine if the strategies could partly explain the relationship between motivation and eating. In line with Pelletier et al., (2004a, study 2) and Guertin and Pelletier (2020), it was expected that eating quality strategies would contribute to predicting healthy and unhealthy eating behaviors over and above autonomous motivation and that akin to autonomous motivation, the strategies would be positively associated with healthy eating and negatively associated with unhealthy eating behaviors. In comparison, it was expected that eating quantity strategies would contribute to predicting bulimic symptoms over and above controlled motivation, and that akin to controlled motivation, the strategies would be positively associated with bulimic symptoms. For the control variable, it was also expected that BMI would be non-significantly associated with healthy and unhealthy eating behaviors and positively associated with bulimic symptoms. Finally, in terms of mediation analyses, it was anticipated that eating quality strategies would, in part, explain the effects of autonomous motivation on healthy and unhealthy eating behaviors, whereas eating quantity strategies would, in part, explain the effects of controlled motivation on bulimic symptoms.

Method

Participants

The sample consisted of 467 undergraduate female students were who recruited from a Canadian University's research participation pool. Participants were aged between 16 and 40 years, with a mean age of 19.37 ($SD = 2.81$). They identified as Non-Hispanic white or European-American (54.7%), Black, Afro-Caribbean, or African American (11.6%), East Asian or Asian American (6.9%), Middle Eastern or Arab American (6.4%), South Asian or Indian American (6.2%), Latino or Hispanic American (2.4%), Native American or Alaskan Native (1.1%), or other (8.8%; 1.9% preferred not to disclose). According to the Centers for Disease Control and Prevention guidelines, 7.5% of the sample was considered underweight (≤ 18.49), 68.1% in the normal range (18.50–24.99), 17.5% overweight (25–29.99), and 6.9% obese (≥ 30). The average BMI was 23.22 ($SD = 4.54$; range 15.62 to 48.76), which falls within the healthy BMI category. The study protocols were approved by the institutions' research ethics board and electronic informed consent was obtained from each participant prior to their participation. Students were compensated with partial course credit for participating in this study.

Measures

The measures below were completed by the participants through an online questionnaire.

Body mass index

BMI (Kg/m^2) was calculated by using the participants' self-reported height and weight.

Autonomous and controlled motivation

The Regulation of Eating Behaviors Scale (REBS; Pelletier et al., 2004a) was used to evaluate individual differences in autonomous and controlled motivation within the eating regulation domain. In this scale, individuals were asked to respond to 20 items, which assessed the different types of behavioral regulations—intrinsic, integrated, identified, introjected and extrinsic regulations—proposed by the SDT (i.e., 4 items per subscale; Ryan & Deci, 2017). Using a scale going from 1 (*Does not correspond at all*) to 7 (*Correspond exactly*), participants were asked to indicate the extent to which each item corresponded to their personal reasons for regulating their eating behaviors (e.g., "I take pleasure in fixing healthy meals," "other people close to me will be upset if I don't"). Composite scores for autonomous and controlled motivation were created by calculating an average score of all items that corresponded to the two different types of motivation. In the validation study of the REBS (Pelletier et al., 2004a), exploratory and confirmatory factor analyses supported the factorial structure of the scale. Construct validity was also established by demonstrating the relationships between autonomous and controlled motivation and other constructs related to the regulation of eating behaviors. In this study, Cronbach's alpha was 0.91 for autonomous motivation (intrinsic $\alpha = 0.88$; integrated

α = 0.89; identified α = 0.75) and 0.85 for controlled motivation (introjected α = 0.85; extrinsic α = 0.85).

Planning and self-monitoring the quality and quantity of eating

The Planning and Self-Monitoring the Quality and Quantity Scale (PMQQS; Guertin & Pelletier, accepted) was administered to the participants in order to measure the extent to which they generally plan and self-monitor the quality (i.e., nutrient intake) and the quantity (i.e., calories and portions) of their eating behaviors. In this 18-item scale (three items per subscale), individuals were asked to rate each item using a scale going from 1 (*Never*) to 7 (*Always*) by using the stems "When I plan my meals" and "When I monitor my food intake." Examples of items include: "I think in advance about the *quality* of the food I am going to eat, "I think about the calorie content of the food I am going to eat" (planning calories); I focus on whether or not I ate healthily throughout the day" (monitoring quality) and "I ask myself whether or not my portion sizes were too big (monitoring portions). In the validation study of the PMQQS (Guertin & Pelletier, accepted), confirmatory factor analyses provided support for the 6-factor structure of the scale and the PMQQS showed good internal consistency and strong convergent and discriminant validity. In this study, the Cronbach's alpha was 0.86 for planning nutrient intake, 0.87 for planning calories and 0.79 for planning portion sizes; and 0.80 for self-monitoring nutrient intake, 0.93 for self-monitoring calories, and 0.88 for self-monitoring portion sizes.

Healthy and unhealthy eating behaviors

The Healthy and Unhealthy Eating Behaviors Scale (HUEBS; Guertin et al., 2020) was used to measure individuals' general consumption of healthy and unhealthy food items. The HUEBS is a 22-item scale that identifies 11 food items that are considered to be healthy [e.g., "I eat fruits," I eat whole grains (e.g., brown rice, buckwheat, quinoa, oats),"] and 11 food items that should be consumed in moderation [e.g., "I eat refined grains (e.g.., white rice, white bread, white flour)," "I eat processed meats, such as sausages, bacon, and/or cold-cuts"] according to Canada's Food Guide. Participants were asked to indicate the extent to which they generally consume each food item using a scale going from 1 (*Never*) to 7 (*Always*). Composite scores for healthy and unhealthy eating behaviors were created by averaging the respective items of the two subscales. In the validation study of the HUEBS (Guertin et al., 2020), principal component analyses produced a 2-factor structure, with reliability coefficients that ranged from 0.80 to 0.81 for healthy eating and 0.77 to 0.82 for unhealthy eating behaviors. In this study, the reliability coefficients were 0.79 and 0.76 for healthy and unhealthy eating behaviors, respectively.

Bulimic symptoms

Participants completed the Bulimia subscale of the Eating Disorder Inventory (EDI-2; Garner et al., 1983) in order to evaluate their engagement in dysfunctional eating behaviors such as bingeing (e.g., "I have gone on eating binges where I have felt that I could not stop") and purging (e.g., "I have the thought of trying to vomit in order to lose weight"). This scale includes seven items in total, which were all rated on a scale going from 1 (*Never*) to 7 (*Very often*). The composite score for bulimic symptoms was created by averaging all items of the scale into one single score. Although the original validation study of the EDI-2 was conducted within clinical samples, test–retest reliability and internal consistency for the EDI-2 has also been confirmed within non-clinical samples (Garner, 1991). In this sample, Cronbach's alpha for bulimic symptoms was 0.89.

Analyses and results

Preliminary analyses

All analyses were conducted using IBM SPSS, version 26. Before proceeding with the main analyses, the data was screened and cleaned following the guidelines recommended by Tabachnick and Fidell (2013). A missing data analysis was first conducted and revealed that missing values were not missing completely at random (Little's MCAR test, $\chi^2 = 3997.83$, $df = 3744$, $p = 0.002$). Since no variable had more than 5% of missing data, the values were replaced using the expectation maximization (EM) algorithm. Next, univariate outliers were dealt with by identifying standardized scores that were above or below the normal distribution of ± 3.29. Outliers were recoded using the next most extreme value that was still within the normal range. Mahalanobis distances were then calculated and eight multivariate outliers were identified and excluded from further analyses. Three participants were also removed from the data, as they had missing values on their height and/or weight, which prevented us from calculating their BMI. The final sample included 456 participants. Finally, all variables showed normal distributions as none of the absolute values of skewness and kurtosis were above or below 3.00 for skewness and 10.00 for kurtosis (skewness range: − 0.490–1.438; kurtosis range: − 1.138–3.344; Kline, 2011).

The data was also screened to ensure compliance with the basic assumptions of the analyses that were conducted. The examination of scatterplots did not suggest violation of the assumptions for normality and linearity; however, the data

Table 1 Studies 1 and 2: Means, standard deviations and correlations between autonomous and controlled motivation, planning and self-monitoring the quality and quantity of eating, eating outcomes, and BMI

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
Study 1														
1. Autonomous	4.79	1.16	–	.12*	.60**	.28**	.40**	.49**	.25**	.28**	.43**	−.27**	−.04	−.11*
2. Controlled	3.38	1.28		–	.06	.38**	.32**	.21**	.40**	.36**	.02	.02	.45**	.20**
3. Plan quality	4.74	1.45			–	.36**	.52**	.62**	.29**	.37**	.46**	−.37**	−.03	−.10*
4. Plan calories	3.30	1.64				–	.63**	.57**	.85**	.59**	.19**	−.19**	.28**	.09
5. Plan portions	4.06	1.42					–	.58**	.60**	.67**	.22**	−.20**	.13**	.02
6. Monitor quality	4.31	1.51						–	.61**	.62**	.37**	−.27**	.09*	−.07
7. Monitor calories	3.48	1.89							–	.69**	.16**	−.11*	.31**	.11*
8. Monitor portions	4.37	1.60								–	.18**	−.12*	.22**	.14**
9. Healthy eating	4.35	1.09									–	.03	−.02	−.06
10. Unhealthy eating	3.01	1.05										–	.06	.03
11. Bulimic symptoms	2.86	1.36											–	.27**
12. BMI	23.07	4.13												–
Study 2														
1. Autonomous	4.85	1.13	–	.06	.61**	.28**	.34**	.52**	.23**	.26**	.40**	−.29**	−.07	−.08*
2. Controlled	3.40	1.26		–	−.03	.36**	.29**	.17**	.40**	.35**	.006	.04	.45**	.16**
3. Plan quality	4.71	1.46			–	.32**	.47**	.63**	.25**	.34**	.41**	−.38**	−.09**	−.07*
4. Plan calories	3.38	1.68				–	.63**	.54**	.85**	.61**	.17**	−.17**	.32**	.13**
5. Plan portions	4.12	1.43					–	.54**	.58**	.69**	.20**	−.19**	.20**	.06*
6. Monitor quality	4.33	1.51						–	.58**	.63**	.33**	−.31**	.10**	.003
7. Monitor calories	3.58	1.91							–	.70**	.15**	−.12**	.36**	.17**
8. Monitor portions	4.39	1.58								–	.18**	−.16**	.29**	.12**
9. Healthy eating	4.54	1.04									–	.05	−.05	−.03
10. Unhealthy eating	3.20	1.08										–	.11**	.05
11. Bulimic symptoms	2.87	1.41											–	.25**
12. BMI	22.96	4.19												–

Study 1: $N = 456$. Study 2: $N = 979$. ** $p < .01$; * $p < .05$

did violate the assumption of homoscedasticity when examining unhealthy eating and bulimic symptoms as outcome variables (Breusch-Pagan test: $p = 0.04$ for unhealthy eating and $p < 0.001$ for bulimic symptoms). When we applied a square root transformation to unhealthy eating and a logarithmic transformation to bulimic symptoms, however, there was no longer indication of heteroscedasticity in the data (Breusch-Pagan test: $p = 0.09$ for the square root transformation of unhealthy eating and $p = 0.90$ for the logarithmic transformation of bulimic symptoms). The transformed variables were used in all subsequent analyses. No multicollinearity was found between the variables in the sample.

Table 2 Hierarchical multiple regression models examining eating outcomes from motivation and strategies, while controlling for BMI

Variables	Healthy eating			Unhealthy eating			Bulimic symptoms		
	β	t	R^2 change	β	t	R^2 change	β	t	R^2 change
Step 1			.18***			.08***			.23***
Autonomous	.43	10.00***		−29	−6.34***		−.07	−1.63	
Controlled	−03	−0.74		.06	1.36		.43	9.98***	
BMI	−01	−0.26		−01	−0.26		.15	3.47**	
Plan quality									
Step 2									
Autonomous	.24	4.70***	.06***	−.10	−1.73	.07***	−.08	−1.47	.000
Controlled	−.03	−0.72		.06	.06		.43	9.97***	
BMI	.001	.03		−.03	−.03		.15	3.48**	
Plan quality	.31	6.12***		−.33	-.33***		.01	0.27	
Plan calories									
Step 2									
Autonomous	.41	9.10***	.008	−.25	−5.25***	.02**	−.11	−2.46**	.02**
Controlled	−.07	−1.43		.12	2.50**		.37	8.31***	
BMI	−.02	−0.37		−.004	−.08		.14	3.33**	
Plan calories	.10	2.10		−.17	−3.47***		.15	3.26**	
Plan portions									
Step 2									
Autonomous	.40	8.67***	.004	−.24	−4.90***	.01**	−.08	−1.77	.001
Controlled	−.05	−1.16		.10	2.07		.42	0.34***	
BMI	−.01	−0.27		−.01	−0.24		.15	3.46**	
Plan portions	.08	1.56		−.13	−.13**		.03	0.69	
Monitor quality									
Step 2									
Autonomous	.33	6.81***	.04***	−.20	−3.89***	.03***	−.10	−2.13*	.004
Controlled	−.07	−1.57		.09	2.03		.41	9.56***	
BMI	.001	0.02		−.02	−0.49		.15	3.56***	
Monitor quality	.22	4.56***		−.19	−3.71***		.07	1.46	
Monitor calories									
Step 2									
Autonomous	.41	9.35***	.005	−.27	−5.80***	.005	−.11	−2.49**	.02***
Controlled	−.06	−1.30		.09	1.85		.36	8.04***	
BMI	−.02	−0.38		−.007	−0.14		.14	3.24**	
Monitor calories	.08	1.67		−.08	−1.59		.17	3.78***	
Monitor portions									
Step 2									
Autonomous	.41	9.12***	.007	−.27	−5.74***	.004	−.09	−2.08*	.006
Controlled	−.06	−1.34		.09	1.73		.40	8.88***	
BMI	−.02	−0.49		−.004	−0.09		.14	3.24**	
Monitor portions	.09	1.99		−.07	−1.38		.09	1.87	

N = 456. *** $p < .001$; ** $p < .01$

Table 1 presents the means, standard deviations and correlations between the variables. On average, participants reported higher scores on autonomous motivation than on controlled motivation. The means were similar between strategies, although the means were higher for planning and self-monitoring nutrient intake and portion sizes. Participants reported higher scores for healthy eating, followed by unhealthy eating and bulimic symptoms, respectively. In terms of the correlations, autonomous and controlled motivation were positively associated with all strategies, except for controlled motivation that was non-significantly associated with planning quality. The relationships were stronger between autonomous motivation and the eating quality strategies, and between controlled motivation and eating quantity strategies. Furthermore, autonomous motivation was positively associated with healthy eating, negatively associated with unhealthy eating and BMI, and non-significantly associated with bulimic symptoms, whereas controlled motivation was positively associated with bulimic symptoms and BMI. All strategies were positively associated with healthy eating and negatively associated with unhealthy eating, and only the eating quantity strategies were positively associated with bulimic symptoms. A significant positive correlation was also found between self-monitoring the quality of eating and bulimic symptoms, although this relationship was weak. Finally, planning quality was negatively associated with BMI, whereas self-monitoring calories and portion sizes were positively associated with BMI.

Main analyses

In total, 18 hierarchical multiple regression models were tested. In all models, autonomous and controlled motivation, as well as BMI as a control variable, were entered at Step 1. The strategies were then entered in separate models at Step 2. This allowed us to examine the influence of each strategy on the outcome variables. Since it is possible that individuals may only use one of the strategies or a different combination of the strategies to regulate their eating behaviors, it was considered more appropriate to examine the strategies individually, rather than in combination. Table 2 shows the results from the 18 hierarchical multiple regression analyses that were conducted.

When examining healthy eating as the outcome variable, only autonomous motivation significantly positively contributed to the model in Step 1. The variables included in the first step accounted for 18% of healthy eating variance [$F_{(3, 452)} = 34.20$, $p < 0.001$]. When individually entering the strategies in Step 2, it was found that only planning and self-monitoring the quality of eating provided additional variance to healthy eating over and above the influence of motivation and BMI. For these strategies, we examined whether they mediated the relationship between autonomous motivation and healthy eating. All mediation analyses were tested using the PROCESS macro in SPSS (model 4; Hayes, 2013), with indirect effects that were estimated using bootstrapping (samples = 5,000). In the model that examined planning quality as the mediator, it was found that autonomous motivation was positively associated with planning quality (b = 0.76, $t = 16.12$, $p < 0.001$) and that both autonomous motivation (b = 0.23, t = 4.67, $p < 0.001$) and planning quality (b = 0.24, t = 6.15, $p < 0.001$) were positively associated with healthy eating. The indirect effect was also significant and positive [b = 0.18, BootCI (0.12, 0.24)], which suggested that partial mediation was achieved. Similar results were obtained in the model examining self-monitoring quality: autonomous motivation was positively associated with self-monitoring quality (b = 0.65, t = 12.12, $p < 0.001$) and both autonomous motivation (b = 0.31, t = 6.81, $p < 0.001$) and self-monitoring quality (b = 0.15, t = 4.36, $p < 0.001$) were positively associated with healthy eating, with an indirect effect that was significant and positive [b = 0.10, BootCI (0.05, 0.15)]. Again, it was concluded that partial mediation had occurred.

When examining unhealthy eating as the outcome variable, it was found that autonomous motivation was significantly negatively associated with unhealthy eating, whereas controlled motivation and BMI were non-significantly associated with unhealthy eating at Step 1. Together, the two different types of motivation and BMI accounted for 8% of the variance in unhealthy eating [$F_{(3, 452)} = 13.62$, $p < 0.001$]. All strategies except for self-monitoring calories and portion sizes were significantly negatively associated with unhealthy eating at Step 2. In the mediation analyses that followed, results revealed that the direct effect from autonomous motivation to unhealthy eating was significant and negative (b = -0.08, t = -6.25, $p < 0.001$). However, when planning quality was added as a mediator in the model, the relationship between autonomous motivation and unhealthy eating became non-significant (b = − 0.02, t = − 1.57, $p = 0.12$). Planning quality was significantly negatively associated with unhealthy eating (b = − 0.07, t = − 5.96, $p < 0.001$). Since the indirect effect was also significant (b = -0.05, BootCI (− 0.07, -0.03), it was concluded that in this case, full mediation had occurred. The results also revealed that the indirect effects of planning calories [b = − 0.01, BootCI (− 0.02, − 0.003)] and self-monitoring quality [b = − 0.02, BootCI (− 0.04, − 0.008)] were significant. Partial mediation was achieved in both cases, as both autonomous motivation (b = − 0.06, t = − 5.24, $p < 0.001$ in the model examining planning calories; and b = − 0.05, t = − 3.82, $p < 0.001$ in the model examining monitoring quality) and the strategies (b = − 0.02, t = − 2.73, $p < 0.01$ for planning calories; and b = − 0.04, t = − 3.38, $p < 0.001$ for monitoring quality) were significantly negatively associated with unhealthy eating. The indirect effect for planning portion sizes was

non-significant [b = − 0.01, BootCI (− 0.02, 0.000)], which suggested that planning portion sizes was not a significant mediator of the relationship between autonomous motivation and unhealthy eating.

Finally, in the model examining bulimic symptoms as the outcome variable, both controlled motivation and BMI were significantly positively associated with bulimic symptoms at Step 1. The variables included in the first step of the regression models accounted for 22% of the variance in bulimic symptoms [$F_{(3, 452)} = 44.23$, $p < 0.001$]. At Step 2, only planning and self-monitoring calories provided additional variance to bulimic symptoms over and above the effects of motivation and BMI. Since BMI was associated with bulimic symptoms in Step 1, BMI was controlled for in the mediation analyses. In the model that examined planning calories as the mediator, controlled motivation was positively associated with planning calories (b = 0.49, t = 8.55, $p < 0.001$) and both controlled motivation (b = 0.06, t = 8.18, $p < 0.001$) and planning calories (b = 0.02, t = 2.69, $p < 0.01$) were positively associated with bulimic symptoms. The indirect effect was also significant and positive [b = 0.007, BootCI (0.002, 0.01)], thereby suggesting partial mediation. Similarly, controlled motivation was positively associated with self-monitoring calories (b = 0.58, t = 8.94, $p < 0.001$). Furthermore, both controlled motivation (b = 0.06, t = 7.89, $p < 0.001$) and self-monitoring calories (b = 0.02, t = 3.27, $p < 0.001$) were positively associated with bulimic symptoms and the indirect effect was significant and positive [b = 0.009, BootCI (0.004, 0.02)], which confirmed that self-monitoring calories partially mediated the relationship between controlled motivation and bulimic symptoms.

Discussion

The goal of Study 1 was to examine if the strategies proposed by Guertin and Pelletier (2020) could account for additional variance in eating outcomes over and above the effects of motivation, while controlling for BMI. Mediation analyses were also conducted to examine if the strategies mediated the relationship between motivation and eating. As expected, it was found that planning and self-monitoring the quality of eating provided additional variance to autonomous motivation in the models examining healthy and unhealthy eating behaviors as outcome variables. Like autonomous motivation, positive relationships were found between the strategies and healthy eating, and negative relationships were found between the strategies and unhealthy eating. Planning calories and portion sizes also provided additional variance to autonomous motivation in the models examining unhealthy eating as the outcome variable; however, the negative relationships were not as strong as the ones found for the eating quality strategies. Furthermore, planning and self-monitoring calories provided additional variance to controlled motivation in the models examining bulimic symptoms as the outcome variable. Like controlled motivation, positive relationships were found between the strategies and bulimic symptoms. Contrary to our hypotheses, planning and self-monitoring portion sizes were not significantly associated with bulimic symptoms.

In terms of mediation analyses, results suggested that planning and self-monitoring the quality of eating partially mediated the relationship between autonomous motivation and healthy eating; that planning quality fully mediated and that planning calories and self-monitoring quality partially mediated the relationship between autonomous motivation and unhealthy eating; and that planning and self-monitoring calories partially mediated the relationship between controlled motivation and bulimic symptoms. Finally, as expected, BMI was significantly associated with bulimic symptoms in the regression and mediation models.

Study 2

The purpose of Study 2 was to examine whether the mediation results found in Study 1 could be replicated within SEM. We chose to apply SEM in Study 2 as it allowed us to examine the relationships between the variables of interest while including all outcome variables in the same model; to reduce the contamination attributed to measurement error by representing constructs as latent (versus observed) variables; and finally, to assess the tenability of the proposed models by obtaining model fit indices.

Based on Study 1, it was anticipated that autonomous motivation would be more strongly and positively associated with eating quality strategies, whereas controlled motivation would be more strongly and positively associated with eating quantity strategies. It was also expected that the eating quality strategies would be more positively and negatively associated with healthy and unhealthy eating behaviors respectively, and that they would partly or fully explain the relationships between autonomous motivation and healthy and unhealthy eating. In opposition, it was expected that eating quantity strategies would be positively associated with bulimic symptoms and that they would partly or fully explain the relationship between controlled motivation and bulimic symptoms. Although no significant relationship was found between planning and self-monitoring portion sizes and bulimic symptoms in Study 1, this hypothesis was based on the significant and positive relationships that were found between these strategies and bulimic symptoms in Guertin and Pelletier (2020). Finally, it was expected that BMI would be positively associated with variables associated with the more dysfunctional processes of eating, such

as with controlled motivation, eating quantity strategies and bulimic symptoms.

Method

Participants

The sample comprised of 1020 undergraduate female students aged between 16 and 49 ($M = 19.44$; $SD = 3.26$) years. Participants identified with the following ethnic backgrounds: Non-Hispanic white or European-American (51.6%); Black, Afro-Caribbean or African American (10.1%); East Asian or Asian American (8.9%); Middle Eastern or Arab American (8.1%); South Asian or Indian American (6.4%); Latino or Hispanic American (2.4%); Native American or Alaskan Native (0.8%); or other (9%; 2.7% preferred not to disclose). The average BMI ($M = 23.00$; $SD = 4.33$) of the sample was within the healthy BMI category according to Centers for Disease Control and Prevention guidelines. As in Study 1, participants were recruited using a Canadian University's research participation pool in exchange for partial course credit. The study procedures were obtained from the institutions' research ethics board prior to conducting the study. Electronic informed consent was obtained from each participant.

Measures

The same measures as in Study 1 were used in Study 2. All subscales demonstrated good internal consistency ($\alpha \geq 0.77$). Composite variables were created for each subscale of the REBS to represent autonomous and controlled motivation in the model. The respective individual items of the PMQQS were used to represent the strategies. For healthy and unhealthy eating behaviors and bulimic symptoms, parcels were created using the item-to-construct balance strategy – a strategy that consists of creating composite scores by balancing individual scale items with the highest and lowest factor loadings between parcels. This strategy has been shown to perform well when creating parcels for unidimensional constructs (Little, Rhemtulla, Gibson, & Schoemann, 2013). Based on Little et al.'s (2013) recommendations, three parcels were created for each variable. Finally, BMI was calculated using the same formula as in Study 1.

Data analysis

Preliminary analyses were conducted using IBM SPSS version 26 and SEM was performed using Mplus version 7. Six models were tested in total, in which each strategy was examined separately as a mediator in the models. The models were tested using the two steps proposed by Kline (2011). First, we conducted measurement model analyses to determine if the observed variables loaded appropriately onto their latent factors and to determine whether the proposed structure provided a good fit to the data. Second, the structural models exploring the relationships between motivation, the strategies, and eating behaviors were examined. When testing the structural models, bootstrapping procedure (samples = 5000) with bias-corrected confidence intervals was applied to estimate the significances of the indirect effects. The following fit indices were used to assess the adequacy of the measurement and structural models: the chi-square (χ^2) and the Standardized Root Mean Square Residual (SRMR) as absolute fit indices; the Tucker-Lewis Index (TLI) as a relative fix index; and the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA) with its' confidence intervals as noncentrality-based indices. According to Hooper, Coughlan, and Mullen (2008), values below 0.08 indicate adequate fit and values below 0.06 indicate excellent fit for the SRMR and RMSEA; and values above 0.90 represent adequate fit and values above 0.95 represent excellent fit for the CFI and TLI.

Analyses and results

Preliminary analyses

Data screening and cleaning procedures were the same as in Study 1. Little's MCAR test was significant ($\chi^2 = 699$ 8.02, $df = 6718$, $p = 0.008$), which suggested that missing values were not missing completely at random. Since missing values were less than 5% on each individual item, the EM algorithm was used to replace the missing values. For univariate outliers, cases that showed standardized scores that were above or below 3.29 were modified so that their values fell within the normal range. In total, 35 multivariate outliers were identified using Mahalanobis distances and were removed from the subsequent analyses. Six participants were also removed from the dataset as they had missing values on their height and/or weight and consequently, on their BMI. The final sample included data from 979 participants. According to guidelines proposed by Kline (2011), univariate normality did not show to be problematic as none of the absolute values of skewness exceeded ± 3.00 and none of the absolute values of kurtosis exceeded ± 10.00 (skewness range: -0.683 to 1.175; kurtosis range: -1.273 to 4.987).

The means, standard deviations and correlations between the study variables can be found in Table 1. In this study, the mean of autonomous motivation was higher than the mean of controlled motivation. The means of planning and self-monitoring quality and portion sizes were also higher than the means of planning and self-monitoring caloric intake.

Table 3 Fit Indices for the Measurement and Structural Models

Strategies	χ^2 (*df*), *p* value	CFI	TLI	RMSEA (90% CI)	SRMR
Measurement models					
Plan quality	410.56 (104), $p < .001$	.96	.95	.06 (0.049, 0.061)	.05
Plan calories	433.09 (104), $p < .001$	.96	.95	.06 (0.051, 0.062)	.05
Plan portions	451.85 (104), $p < .001$	.95	.94	.06 (0.053, 0.064)	.05
Monitor quality	443.34 (104), $p < .001$	.95	.94	.06 (0.052, 0.063)	.05
Monitor calories	423.17 (104), $p < .001$	.96	.95	.06 (0.050, 0.062)	.05
Monitor portions	447.95 (104), $p < .001$	.95	.94	.06 (0.053, 0.064)	.05
Structural models					
Plan quality	460.99 (115), $p < .001$	.96	.94	.06 (0.050, 0.061)	.05
Plan calories	487.23 (115), $p < .001$	.95	.94	.06 (0.052, 0.063)	.05
Plan portions	505.59 (115), $p < .001$	.95	.93	.06 (0.054, 0.064)	.05
Monitor quality	491.48 (115), $p < .001$	.95	.93	.06 (0.053, 0.063)	.05
Monitor calories	472.46 (115), $p < .001$	.96	.95	.06 (0.051, 0.062)	.05
Monitor portions	496.55 (115), $p < .001$	.95	.93	.06 (0.053, 0.064)	.05

N = 979. χ^2 = Chi-square; *df* degrees of freedom, *CFA* comparative fix index, *TLI* Tuker Lewis index, *RMSEA* root mean square of approximation, *CI* confidence intervals, *SRMR* standardized root mean square residual

In terms of eating behaviors, the mean for healthy eating was higher than the mean for unhealthy eating, followed by the mean of bulimic symptoms. For the correlations, it was found that autonomous and controlled motivation were significantly positively associated with all strategies, except for controlled motivation that was non-significantly associated with planning quality. As in Study 1, autonomous motivation was more strongly and positively associated with eating quality strategies, whereas controlled motivation was more strongly and positively associated with eating quantity strategies. Furthermore, autonomous motivation was significantly positively correlated with healthy eating and significantly negatively correlated with unhealthy eating and BMI. Controlled motivation was significantly positively correlated with bulimic symptoms and BMI. All strategies were significantly positively and negatively associated with healthy and unhealthy eating respectively, and significantly positively associated with bulimic symptoms, except for planning quality that was significantly negatively associated with bulimic symptoms. Planning quality was significantly negatively associated with BMI and self-monitoring quality was non-significantly associated with BMI, whereas all

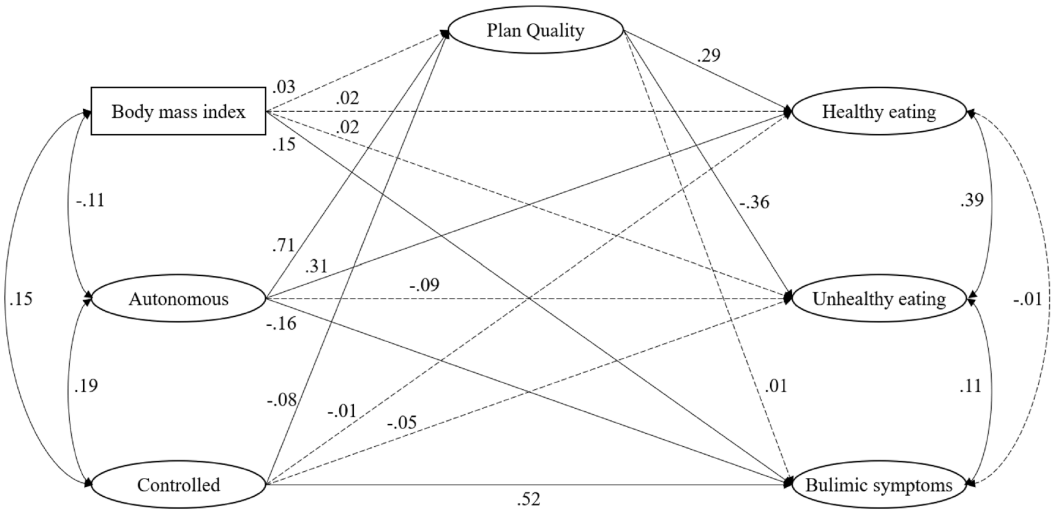

Fig. 1 The hypothesized model for the regulation of eating where planning quality is examined as a mediator of the relationships between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines $p < .01$. Doted lines = *ns*

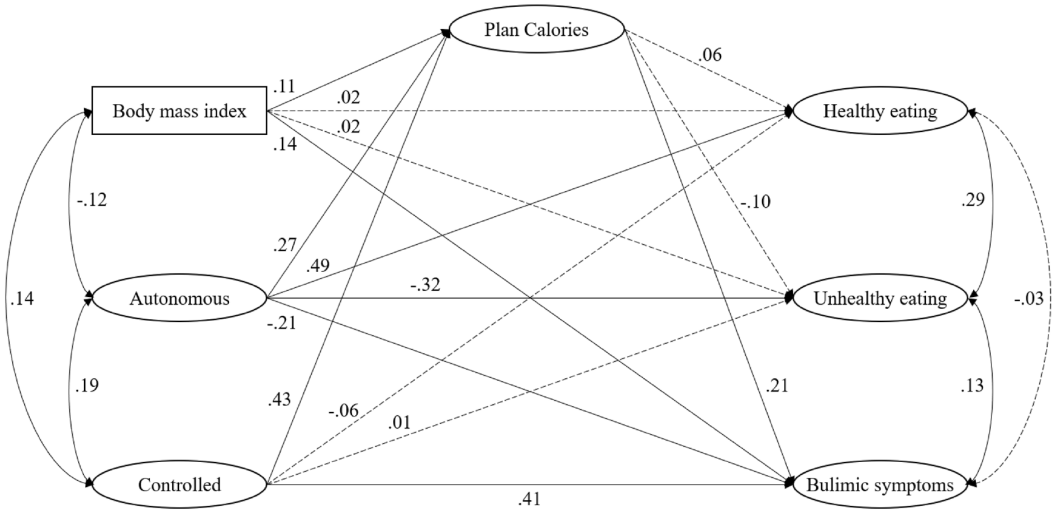

Fig. 2 The hypothesized model for the regulation of eating where planning calories is examined as a mediator of the relationship between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines = $p < .01$. Doted lines = *ns*

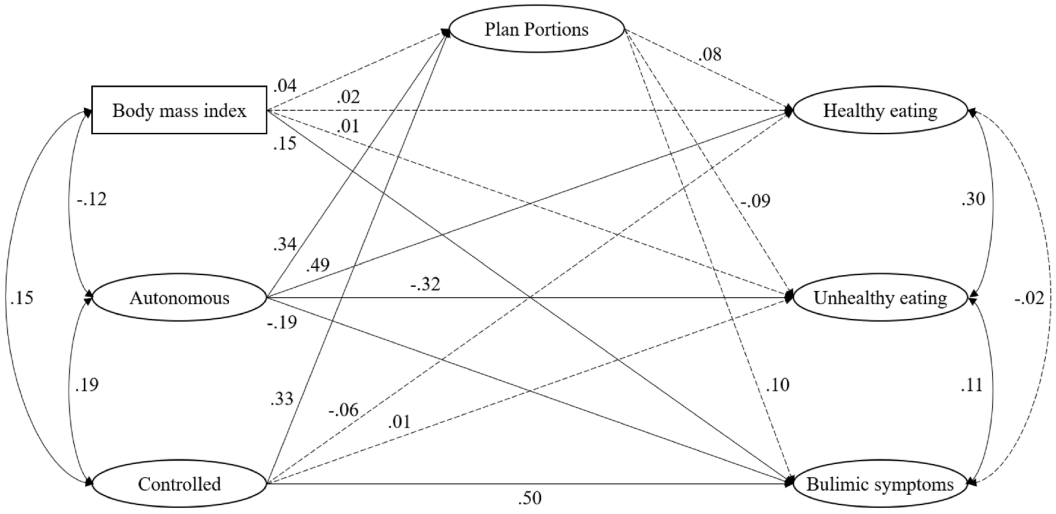

Fig. 3 The hypothesized model for the regulation of eating where planning portions is examined as a mediator of the relationship between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines = $p < .01$. Doted lines = *ns*

eating quantity strategies were significantly positively associated with BMI. Finally, a significant positive correlation was found between bulimic symptoms and BMI. Neither healthy nor unhealthy eating were significantly associated with BMI.

Main Analyses

Measurement models

All models that were tested included six latent variables and one observed variable. The latent variables were: (1) autonomous motivation (three indicators); (2) controlled motivation (two indicators); (3) the strategies (three indicators); (4) healthy eating (three parcels); (5) unhealthy eating

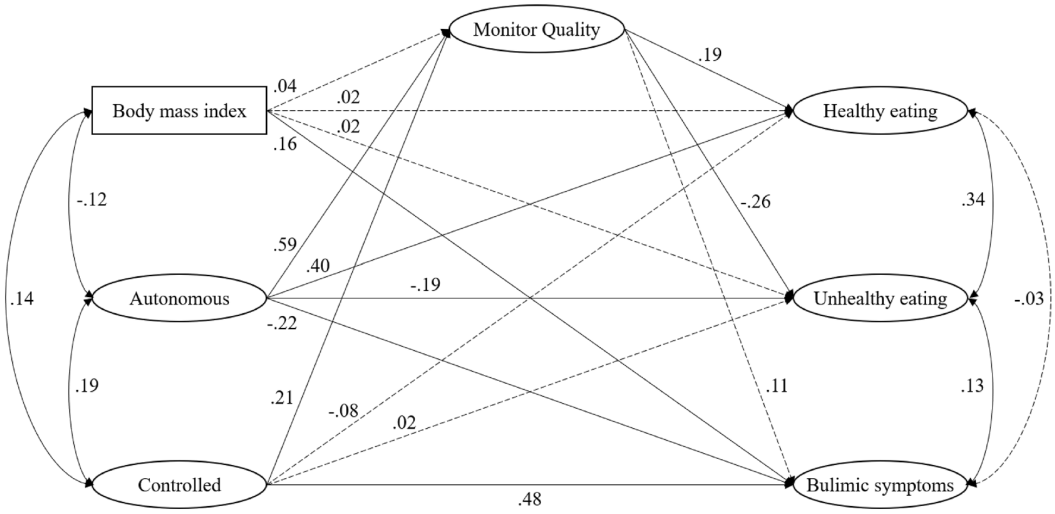

Fig. 4 The hypothesized model for the regulation of eating where self-monitoring quality is examined as a mediator of the relationship between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines = $p < .01$. Doted lines = *ns*

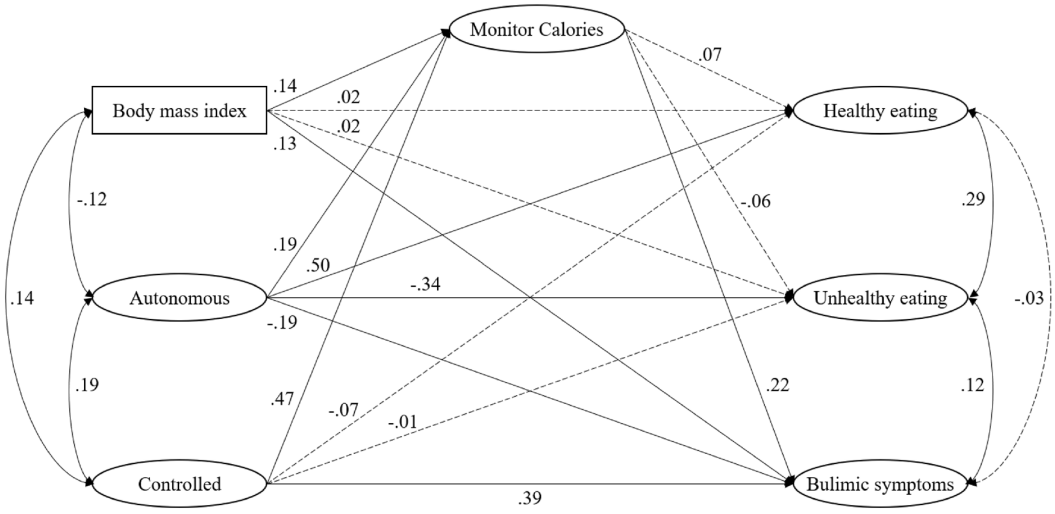

Fig. 5 The hypothesized model for the regulation of eating where self-monitoring calories is examined as a mediator of the relationship between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines = $p < .01$. Doted lines = *ns*

(three parcels); and (6) bulimic symptoms (three parcels). The observed variable was BMI, which served as a control variable in the models. When testing the measurement models, all latent factors were free to correlate. As demonstrated in Table 3, all measurement models showed adequate fit.

Structural models

The fit indices of the structural models presented in Table 3 showed that all six models presented a good fit with the data. The final hypothesized models with standardized coefficients can be found in Figs. 1, 2, 3, 4, 5, and 6. As demonstrated in the figures, autonomous and controlled motivation were significantly associated with all strategies except for controlled motivation that was negatively associated with planning

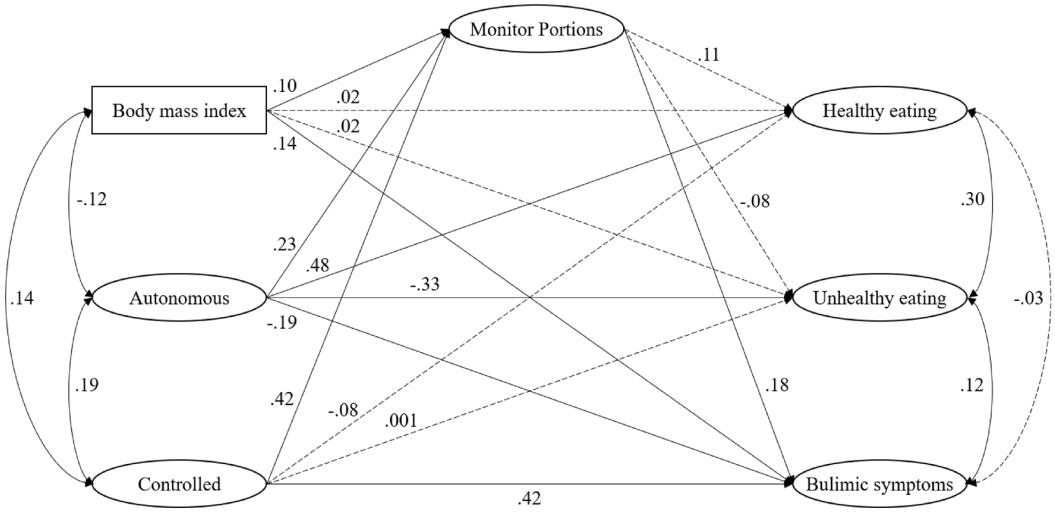

Fig. 6 The hypothesized model for the regulation of eating where self-monitoring portions is examined as a mediator of the relationship between motivation and eating. Note: unidirectional arrows represent hypothesized paths; bidirectional arrows represent correlations. Solid lines = $p < .01$. Doted lines = *ns*

quality. Autonomous motivation was also more strongly and positively associated with eating quality strategies, whereas controlled motivation was more strongly and positively associated with eating quantity strategies. The only exception was the relationship between autonomous motivation and planning portion sizes, which was similar in magnitude to the relationship between controlled motivation and planning portion sizes.

In terms of the relationships between the strategies and eating, the same relationships were found as in Study 1. The eating quality strategies were associated with a higher consumption of healthy foods and a lower consumption of unhealthy foods, whereas the eating quantity strategies were associated with bulimic symptoms. Contrary to Study 1, in this study it was also found that the relationships between planning calories and portion sizes were non-significantly associated with unhealthy eating, and a significant positive relationship was found between self-monitoring portion sizes and bulimic symptoms. In all models, BMI was positively correlated with controlled motivation and bulimic symptoms, and negatively correlated with autonomous motivation. BMI was also positively associated with planning calories, as well as self-monitoring calories and portion sizes.

Tests of indirect effects

The indirect effects of motivation on eating behaviors through the strategies were also examined to determine whether the strategies significantly mediated the relationships between motivation and eating. In total, 12 indirect effects were found to be significant. In the model that examined planning quality as the mediator, it was found that autonomous motivation was indirectly associated with healthy eating ($b = 0.21$, $SE = 0.04$, $p < 0.001$) and unhealthy eating ($b = -0.26$, $SE = 0.04$, $p < 0.001$). In the model that examined planning calories as the mediator, it was found that both autonomous and controlled motivation were indirectly associated with bulimic symptoms (autonomous motivation: $b = 0.06$, $SE = 0.02$, $p = 0.002$; controlled motivation: $b = 0.09$, $SE = 0.02$, $p < 0.001$). No indirect effect was found in the model examining planning portion sizes as the mediator.

Four significant indirect effects were also found in the model examining self-monitoring quality as the mediator. Both autonomous and controlled motivation were indirectly associated with healthy eating (autonomous motivation: $b = 0.11$, $SE = 0.04$, $p = 0.002$; controlled motivation: $b = 0.04$, $SE = 0.01$, $p = 0.007$) and with unhealthy eating (autonomous motivation: $b = -0.15$, $SE = 0.04$, $p < 0.001$; controlled motivation: $b = -0.05$, $SE = 0.02$, $p = 0.001$). In the model that examined self-monitoring calories as the mediator, indirect effects of autonomous and controlled motivation on bulimic symptoms were both significant (autonomous motivation: $b = 0.04$, $SE = 0.01$, $p = 0.003$; controlled motivation: $b = 0.10$, $SE = 0.02$, $p < 0.001$). Finally, in the model that examined self-monitoring portion sizes as the mediator, it was found that both autonomous and controlled motivation were indirectly associated with bulimic symptoms (autonomous motivation: $b = 0.05$, $SE = 0.02$, $p = 0.01$; controlled motivation: $b = 0.07$, $SE = 0.02$, $p = 0.001$).

Alternative models

Although the SDT suggests that motivation dictates the different approaches people take to regulate their eating behaviors (e.g., Verstuyf et al., 2012), alternative models were tested in which the roles of strategies and motivation were reversed. Specifically, in these models, strategies were examined as the independent variables, whereas the two types of motivation were examined as mediators. The fit indices for the measurement and structural alternative models can be found in "Introduction" of the supplementary material, and the final alternative models with standardized coefficients can be found in "Study 1" of the supplementary material. All models presented a good fit with the data and overall, the fit of the models was almost the same as in the hypothesized models. The relationships between strategies, motivation and eating behaviors were also similar to the results obtained in the hypothesized models in terms of direction and magnitude.

In the alternative models, a total of 15 indirect effects were significant. In the model that examined planning quality as the independent variable, it was found that the strategy was indirectly associated with healthy eating through autonomous motivation ($b = 0.22$, $SE = 0.04$, $p = 0.000$). In the model that examined planning calories at the independent variable, it was found that the strategy was indirectly associated with healthy eating through autonomous motivation ($b = 0.18$, $SE = 0.02$, $p = 0.000$), unhealthy eating through autonomous motivation ($b = -0.11$, $SE = 0.03$, $p = 0.001$), and bulimic symptoms through autonomous ($b = -0.07$, $SE = 0.05$, $p = 0.003$), and controlled motivation ($b = 0.21$, $SE = 0.04$, $p = 0.000$). Finally, in the model that examined planning portions as the independent variable, the strategy was found to be indirectly associated with healthy eating through autonomous motivation ($b = 0.20$, $SE = 0.02$, $p = 0.000$), unhealthy eating through autonomous motivation ($b = -0.13$, $SE = 0.02$, $p = 0.000$), and bulimic symptoms through autonomous ($b = -0.07$, $SE = 0.02$, $p = 0.000$), and controlled motivation ($b = 0.20$, $SE = 0.04$, $p = 0.000$).

In relation to monitoring strategies, in the model that examined monitoring quality as the independent variable, the strategy was indirectly associated with both healthy eating ($b = 0.25$, $SE = 0.03$, $p = 0.000$) and unhealthy eating ($b = -0.12$, $SE = 0.03$, $p = 0.000$) through autonomous motivation. Monitoring calories was indirectly associated with healthy eating ($b = 0.15$, $SE = 0.02$, $p = 0.000$) and unhealthy eating ($b = -0.10$, $SE = 0.03$, $p = 0.002$) through autonomous motivation, and with bulimic symptoms through autonomous ($b = -0.06$, $SE = 0.01$, $p = 0.000$) and controlled ($b = 0.21$, $SE = 0.04$, $p = 0.000$) motivation. Similarly, monitoring portions was associated with healthy eating ($b = 0.16$, $SE = 0.02$, $p = 0.000$) and unhealthy eating ($b = -0.11$, $SE = 0.02$, $p = 0.000$) through autonomous motivation, and with bulimic symptoms through autonomous ($b = -0.06$, $SE = 0.01$, $p = 0.000$), and controlled motivation ($b = 0.21$, $SE = 0.04$, $p = 0.000$).

Discussion

The goal of Study 2 was to replicate the mediation results found in Study 1 within SEM. As expected, autonomous motivation was more strongly and positively associated with planning and self-monitoring the quality of eating, whereas controlled motivation was more strongly and positively associated with planning and self-monitoring the quantity of eating. Results also showed that the eating quality strategies were more strongly and positively associated with healthy eating and more strongly and negatively associated with unhealthy eating, whereas the eating quantity strategies—except for planning portion sizes—were more strongly and positively associated with bulimic symptoms. In all models, it was also found that BMI was significantly positively associated with controlled motivation and bulimic symptoms and that BMI was significantly and positively associated with eating quantity strategies, except for planning portion sizes.

Results also supported the hypotheses regarding the mediation effects. We found support for the indirect effects of autonomous motivation on healthy and unhealthy eating through planning and self-monitoring the quality of eating. The indirect effects of controlled motivation on bulimic symptoms through planning and self-monitoring calories, and through self-monitoring portion sizes were also significant. Although the following results were unexpected, we also found support for the indirect effects of autonomous motivation on bulimic symptoms through planning and self-monitoring calories and through self-monitoring portion sizes, as well as for the indirect effect of controlled motivation on healthy and unhealthy eating behaviors through self-monitoring quality. It should be noted, however, that these indirect effects were smaller and lower in magnitude than the indirect effects that were anticipated. Alternative models were also examined in which the strategies were examined as independent variables and the two types of motivation as mediators between the strategies and eating behaviors.

General discussion

The purpose of this research was to further knowledge on the mechanisms by which different types of motivation are associated with distinct eating outcomes. Building on the work of Pelletier and colleagues (2004a; study 2) and Guertin and Pelletier (2020), it was examined whether planning and self-monitoring the quality and quantity of eating could provide some explanation for the associations between autonomous and controlled motivation and healthy and unhealthy

eating behaviors and bulimic symptoms. As a preliminary step, Study 1 examined if the strategies could account for additional variance in eating outcomes over and above the influence of autonomous and controlled motivation while controlling for BMI, and whether the strategies significantly mediated the relationships between motivation and eating. Study 2 examined if the mediation results of Study 1 could be replicated within SEM. Alternative models were also tested in which the two types of motivation were examined as mediators between the strategies and eating behaviors.

Overall, most of the results supported the hypotheses. In Study 1, hierarchical multiple regressions showed that the eating quality strategies provided additional variance to autonomous motivation in the models examining healthy and unhealthy eating as outcome variables, with positive relationships that were found between autonomous motivation and the strategies and healthy eating, and negative relationships that were found between autonomous motivation and the strategies and unhealthy eating. Planning and self-monitoring calories also provided additional variance to controlled motivation in the models examining bulimic symptoms as the outcome variable, with positive relationships that were found between controlled motivation and the strategies and bulimic symptoms. Contrary to our hypotheses, planning and self-monitoring portion sizes were not associated with bulimic symptoms.

In line with Pelletier and colleagues (2004a; study 2) and Guertin and Pelletier (2020), Study 2 also demonstrated that autonomous motivation was more strongly and positively associated with eating quality strategies which, in turn, were positively associated with healthy eating and negatively associated with unhealthy eating behaviors. In opposition, controlled motivation was more strongly and positively associated with eating quantity strategies which, in turn, were positively associated with bulimic symptoms. In both studies, it was also found that planning and self-monitoring the quality of eating mediated the relationships between autonomous motivation and healthy and unhealthy eating behaviors, and that planning and self-monitoring calories mediated the relationship between controlled motivation and bulimic symptoms. Although it was expected that planning and self-monitoring portion sizes would also mediate the relationship between controlled motivation and bulimic symptoms, the only indirect effect that was significant was controlled motivation on bulimic symptoms through self-monitoring portion sizes in Study 2.

These results suggest that individuals may succeed or fail in the regulation of their eating behaviors when they adopt different strategies based on their motivation. As previously mentioned, Otis and Pelletier (2008) found that autonomous motivation was mainly associated with approach food planning, whereas controlled motivation was mainly associated with avoidance food planning. Although the quality/quantity dimension is distinct from the approach/avoidance dimension, they may be connected in that individuals who focus on the quality of their eating behaviors may be more likely to engage in behaviors that move them toward desired objectives such as eating healthy, whereas individuals who focus on the quantity of their eating behaviors may be more likely to move away from undesired objectives such as not exceeding a specific number of calories and/or not eating too much. Indeed, Verstuyf and colleagues (2012) suggested that processes of dietary restraint are more closely related to a controlled (versus an autonomous) pattern of eating regulation. According to the dietary restraint model (Polivy & Herman, 1985), increased attention to food intake can lead to excessive indulgence after violating self-imposed cognitive rules regarding food intake, such as the consumption of a specific number of calories per day. Future research would benefit from examining how eating quantity strategies are associated with constructs such as avoidance tendencies and/or dietary restraint in order to better understand the relationships that were found between the eating quantity strategies and bulimic symptoms.

While the SDT suggests that autonomous and controlled motivation affect eating behaviours through different approaches to eating regulation, such as focusing on eating quality versus quantity (Verstuyf et al., 2012), the alternative models have shown that it is also possible that strategies influence individuals' motivations for eating regulation. The models showed that the relationships are bidirectional, such that motivation is related to strategies and strategies to motivation. Unfortunately, the cross-sectional design of this study does not allow for causal relationships to be established between the variables; however, the results allow for the conclusion of reciprocity between the variables. Longitudinal models would be needed in order to better understand how the relationships between these variables unfold over time and how they truly influence each other.

The use of a longitudinal model would also be particularly useful to examine the role played by BMI in our models. For example, BMI may be considered a variable that could precede motivation and the use of self-regulatory strategies, as participants may be inclined to regulate their eating behaviors to maintain or change their weight. Alternatively, BMI may change over time due to different motivations to regulate eating and the use of different self-regulatory strategies. In the present research, participants' BMI was a factor that preceded their completion of the surveys. Using BMI as a consequence would have created an awkward situation where we would be using motivation and self-regulatory strategies to predict an outcome that was present before participants completed the survey. However, given that motivation and self-regulatory strategies can potentially affect participants' BMI, we believe that this issue could be addressed in a longitudinal design where BMI is measured

at the beginning of the study and again several weeks after participants have used the different strategies.

From a SDT perspective, it is also possible that the dimensions of eating quality and quantity may be associated with different eating behaviors as they offer different experiences in terms of satisfying basic psychological needs for autonomy, competence, and relatedness. As suggested by Verstuyf and colleagues (2012), a focus on the quality of eating may yield more need-satisfying experiences, in that individuals who mainly focus on their nutrient intake feel that they have choices in the regulation of their eating behaviors, they feel competent in their abilities to succeed, and/or they feel supported in their decisions. On the contrary, a focus on the quantity of eating may yield more need-thwarting experiences, in that individuals who mainly focus on their caloric intake and/or portion sizes feel pressured in the regulation of their eating behaviors, they feel unable to meet certain demands, and/or they feel unsupported by others. These different experiences may also explain why planning and self-monitoring portion sizes were not related to bulimic symptoms to the same extent as planning and self-monitoring caloric intake. Whereas planning and self-monitoring calories significantly mediated the relationship between controlled motivation and bulimic symptoms in both studies, the results were not as clear for planning and self-monitoring portion sizes. It could be that focusing on portion sizes may be less need-thwarting than focusing on caloric intake. Furthermore, since planning portion sizes was non-significantly associated with bulimic symptoms whereas self-monitoring portion sizes was significantly associated with bulimic symptoms in Study 2, self-monitoring may serve as a more controlling strategy than planning when it comes to regulating portion sizes.

Although the results should be replicated in order to confirm their validity, this research may have important implications for health interventions. The classic SDT approach to increase motivation quality consists of supporting basic psychological needs (Ryan & Deci, 2017). When social contexts foster choices (autonomy support), provide information that increase levels of self-efficacy (competence support), and promote a sense of belongingness (relatedness support), individuals are more likely to become autonomously motivated in the regulation of their eating behaviors and, consequently, to achieve healthy eating outcomes (Verstuyf et al., 2012). Since this research also identified strategies as mediators of the relationships between motivation and eating, health professionals could also intervene at this level of intervention. While health professionals may find it logical to encourage individuals to focus on the quantity of their eating behaviors given that weight gain results from an energy imbalance, this advice may have backfiring effects for individuals motivated by external factors. Instead, encouraging individuals to mainly focus on the quality of their eating behaviors may have more beneficial effects for health. In fact, previous research (Mozaffarian et al., 2011) has shown that dietary quality influences dietary quantity, in that consuming higher quality foods such as fruits and vegetables reduces total number of calories consumed which, in turn, leads to less weight gain over time. That said, although the present research did not examine how strategies related to the quality and quantity of eating interact, it is possible that advising people to focus on the quality of their eating behaviors would have the same desired effects as advising people to focus on the quantity of their eating behaviors.

Limitations

Although this research advances knowledge on the mechanisms by which different types of motivation are associated with distinct eating outcomes, they also have their limitations. First, a cross-sectional design was used in both studies and therefore, causation cannot be established. Since mediation analyses have been shown to be highly misleading in correlational designs (Maxwell & Cole, 2007), future research should replicate the proposed relationships using a longitudinal design. Second, self-reported measures were used in both studies, which may have biased the results in terms of social desirability. For instance, since the HUEBS is based on national eating guidelines, it is possible that individuals overreported intake of healthy foods and underreported intake of unhealthy foods. Third, BMI was examined as a determinant rather than a consequence of eating behaviors. Since calories and portion sizes can influence energy balance, future research should examine how the proposed strategies affect physical indicators such as weight and/or BMI over time. Fourth, the sample was not representative of the general population, as participants were undergraduate female students, and most were Caucasian. Fifth, participants also displayed healthy eating behaviors and low unhealthy eating behaviors and bulimic symptoms, and BMI was mostly within the normal range in both studies. Future research may wish to examine how the results manifest in more diverse and clinical samples of individuals who meet the diagnostic criteria for an eating disorder, and/or for overweight or obese individuals who are trying to lose weight. This type of investigation would be useful since positive relationships were found between BMI and controlled motivation, eating quantity strategies, and bulimic symptoms.

Finally, although the present research suggest that motivational orientations may be associated with the use of different strategies, it remains unclear how individuals develop and use planning and self-monitoring strategies in terms of quality and quantity over time. As previously mentioned, Guertin et al. (2020) demonstrated that women in earlier stages of change reported higher levels of controlled

motivation and lower levels of autonomous motivation, as well as a higher consumption of unhealthy foods and a lower consumption of healthy foods, whereas the reverse was true for women in later stages of change. It may therefore be possible that eating quantity strategies would be more prominent in earlier stages of change, whereas eating quality strategies would be more prominent in later stages of change. Furthermore, whereas self-monitoring may be required in every stage of the behavior change process as it is nearly impossible to self-regulate a behavior without keeping track of it (Baumeister & Vohs, 2007), planning may only begin to play a role once individuals are ready to implement changes to their eating behaviors. An interesting avenue for future research would be to extend the results of Guertin and Pelletier (2020) and examine if people also report different levels of strategy use in terms of quality and quantity, depending on their stage of change.

Conclusion

In summary, this research suggests that people who regulate their eating behaviors for autonomous reasons engage in healthier eating behaviors since they tend to focus more on the quality of their food intake. On the contrary, people who regulate their eating behaviors for controlled reasons engage in dysfunctional eating behaviors, since they tend to focus more on the quantity of their food intake. Health professionals could benefit from future research examining why a focus on the quality (versus the quantity) of eating is associated with heathier eating behaviors. This would provide a better understanding of why eating quality strategies may be more beneficial to promote than eating quantity strategies, in individuals who feel more controlled in the regulation of their eating behaviors.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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Informed consent Informed consent was obtained from all individual participants included in the studies.

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