Relationship between impulsivity, uncontrolled eating and body mass index: a hierarchical model

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Abstract

Background

Impulsivity increases the risk for obesity and weight gain. However, the precise role of impulsivity in the aetiology of overeating behavior and obesity is currently unknown. Here we examined the relationships between personality-related measures of impulsivity, Uncontrolled Eating, BMI, and longitudinal weight changes. Additionally, we analyzed the associations between general impulsivity domains and brain cortical thickness to elucidate brain vulnerability factors related to weight gain.

Methods

Students in their first year of university - a risky period for weight gain - completed questionnaire measures of impulsivity and eating behavior at the beginning (N = 2318) of the school year. We also collected their weight at the end of the term (N = 1197). Impulsivity was divided into factors stress reactivity, reward sensitivity and lack of self-control. Using structural equation models, we tested the plausibility of a hierarchical relationship, in which impulsivity traits were associated with Uncontrolled Eating, which in turn predicted BMI and weight change. 71 participants underwent T1-weighted MRI to investigate the correlation between impulsivity and cortical thickness.

Results

Impulsivity traits showed positive correlations with Uncontrolled Eating. Higher scores in Uncontrolled Eating were in turn associated with higher BMI. None of the impulsivity-related measurements nor Uncontrolled Eating were correlated with longitudinal weight gain. Higher stress sensitivity was associated with increased cortical thickness in the superior temporal gyrus. Lack of self-control was positively associated with increased thickness in the superior medial

frontal gyrus. Finally, higher reward sensitivity was associated with lower thickness in the inferior frontal gyrus.

Conclusion

The present study provides a comprehensive characterization of the relationships between different facets of impulsivity and obesity. We show that differences in impulsivity domains might be associated with BMI via Uncontrolled Eating. Our results might inform future clinical strategies aimed at fostering self-control abilities to prevent and/or treat unhealthy weight gain.

Introduction

The increase in the incidence of obesity in the past 50 years can be attributed to overeating in response to abundant and inexpensive calories (1). Obesity is also heritable, and most of the implicated genes appear to be expressed in the central nervous system (2). As such, obesity can be thought of as resulting from an interaction between a brain-based endophenotype and a disease-promoting environment (3). Endophenotypes are intermediate phenotypes that link latent biological processes to observable outcomes (4,5). The neurobehavioral endophenotypes associated with obesity can be broadly categorized as domain-general and eating-specific (6).

One domain-general endophenotype is impulsivity (7), the tendency to act without full consideration of the consequences (8). It can be subdivided into three domains that align with personality factors: 1) low *conscientiousness*, reflecting self-control, or, in other terms, premeditation and perseverance ; 2) *neuroticism*, a reflection of an individual's sensitivity to stress and aversive events, also referred to as negative urgency, or the tendency to act impulsively when distressed, and 3) *extraversion*, reflecting sensitivity to rewards and sensation seeking (8–10). Enhanced impulsivity is characteristic of different neuropsychiatric conditions, such as pathological gambling, substance abuse and attention deficit hyperactivity disorder (11,12). Additionally, it might constitute a risk factor for obesity and overeating patterns (13–15).

Meta-analytic studies have shown that impulsivity shows weak positive correlations with BMI across independent studies (16). The effects of impulsivity on BMI, however, seem to be largely heterogeneous (16). One of the reasons for this heterogeneity could be explained by different impulsivity measures and domains used across studies (6). Another possibility is that the relation between personality measures of impulsivity and BMI might be mediated by individually-varying eating-specific impulsivity characteristics (17). In terms of brain correlates of impulsivity, it seems

93 that they overlap with brain correlates of high BMI, which suggests that there is a relationship
94 between obesity and impulsivity that might stem from the brain. For example, both high
95 impulsivity and BMI are positively related to the volume of the striatum (18,19), or negatively
96 related to the volume of the prefrontal and orbitofrontal cortex (20,21).
97
98 Eating-specific constructs associated with a high BMI include emotional eating (22), disinhibited
99 eating (23), and power of food (24). Scores on all these questionnaires consistently and strongly
100 correlate with BMI (25) and with each other (26). For this reason, in previous research we have
101 proposed that different eating behavior questionnaires depict a common underlying latent factor,
102 labelled uncontrolled eating (25,27). Preliminary results show that uncontrolled eating is
103 associated with brain alterations from functional MRI studies, specifically higher brain activity in
104 response to food cues or at rest in the cerebellum, and lower brain activity in the prefrontal cortex
105 (28). While both impulsivity traits and uncontrolled eating have been linked to increased BMI
106 (17), the relationships between different impulsivity domains, uncontrolled eating and obesity
107 remain to be tested. A hypothesis here is that some impulsivity traits might be associated with
108 eating behaviors, which in turn will be linked to BMI (17). However, comprehensive models have
109 not been built for different impulsivity domains and eating questionnaires and have not been
110 applied to the prediction of weight changes yet.
111 So far, most analyses have been conducted on cross-sectional datasets making it difficult to say if
112 impulsivity is a risk factor or a consequence of obesity (28). The freshman year of university is an
113 ideal time period to test these hypotheses both cross-sectionally and longitudinally. During this
114 time, students transition into a new environment with access to similar food and exercise options,
115 allowing underlying vulnerability to express itself. Weight gain often happens in this short period

116 of time and affects approximately 50-60% of students (29,30). Eating specific behaviors that
117 revolve around the concept of impulsivity have been most commonly studied as risk factors for
118 weight gain. The results, however, have been contradictory (31–33).
119 In the brain, a high BMI has been associated with lower gray matter volume and cortical thickness
120 in areas such as the medial prefrontal cortex extending to the orbitofrontal cortex, and temporal
121 pole (21,34,35). However, it is possible that other brain structures involved in processes like
122 impulsivity might be indirectly associated with weight gain. Identifying those regions might pave
123 the way for new studies to investigate links between brain function and maladaptive eating
124 patterns.
125 In the current study, we present a comprehensive examination of the relationships between
126 impulsivity, uncontrolled eating, BMI and weight changes. We tested the hypothesis that the
127 relations between general impulsivity, uncontrolled eating, BMI and longitudinal weight changes
128 might be plausibly represented in a hierarchical structural equation model (SEM). In a sub-sample
129 of participants, we additionally examined the relationship between domain-general impulsivity
130 variables and brain structure. This post-hoc analysis was performed in order to extend our
131 behavioral findings and identify new brain structures that might be relevant to weight status in an
132 indirect manner.
133
134 **Methods and Materials**
135 Participants
136 Participants were first year McGill university students, at least 18 years of age, recruited via an
137 advertisement sent to the incoming class electronic mailing list. Participants provided their consent
138 online and data were collected using the online survey tool LimeSurvey

139 (https://www.limesurvey.org) over three consecutive years. The study was approved by the
140 Montreal Neurological Institute Research Ethics Board. Participants for the brain imaging
141 experiment gave additional written consent before participating.
142
143 Questionnaires
144 Participants filled out the following online questionnaires in the fall semester: "Big Five"
145 personality dimensions (Openness/ Imagination, Conscientiousness, Agreeableness, Extraversion,
146 and Neuroticism) from the International Personality Item Pool (IPIP) (36), two subscales (lack of
147 perseverance and sensation seeking) of the UPPS Impulsive Behavior Scale (37), Cohen's
148 Perceived Stress Scale (PSS) (38), and Rosenberg Self Esteem Scale (39), as well as eating specific
149 questionnaires such as the disinhibition subscale of Three-Factor Eating Questionnaire (TFEQ)
150 (23), emotional eating subscale of Dutch Eating Behavior Questionnaires (DEBQ) (22), and all
151 subscales of Power of Food Scale (PFS) (24) (Table 1). Participants also reported their height and
152 weight at two timepoints – together with online questionnaires during the initial assessment in the
153 fall semester, and during a follow-up in the spring semester. Only a subset of participants reported
154 their height and weight during the follow-up (N=1145). Our questionnaires included two "catch"
155 questions and three "catch-match" questions as a measure of the level of participants' attention in
156 completing the survey. Participants with total catch scores above three were excluded, resulting in
157 a sample of 2318 participants (Males N= 750; Females N= 1538). After completion of the
158 questionnaires during the initial assessment and after the follow-up, a subset of participants were
159 asked to visit our laboratory to have their BMI measured. Height and weight were measured from
160 333 participants in the fall, and from 209 participants in the spring semester (N =115 overlap with
161 the fall group) using a medical scale and a stadiometer. Self-reported BMI was highly correlated

162 with measured BMI in the fall ($r = 0.91$, $p<10^{-5}$) and in the spring ($r = 0.92$, $p<10^{-5}$). We replaced
163 the reported BMI with measured BMI in the analyses for higher accuracy. BMI was further
164 residualized for age, sex and a covariate to account for whether it was derived from self-report or
165 measured. Brain imaging was conducted on a subset of participants selected from this sample in
166 the fall (N=71 participants, N=69 of them were included in the cortical thickness analysis, see
167 below).
168
169 Structural Equation Models
170 We performed a series of SEMs to analyze the relationships between Uncontrolled Eating, the
171 three impulsivity traits defined above, and weight gain. First, we tested the hypothesis that
172 Uncontrolled Eating, stress reactivity, lack of self-control and reward sensitivity can be considered
173 separable latent constructs. We built a four-dimension model (Model 1, Figure 1A), with
174 Uncontrolled Eating, stress reactivity, lack of self-control and reward sensitivity modelled as latent
175 constructs. Uncontrolled Eating (UE) was defined by the scores in Disinhibition, Power of Food
176 and Emotional Eating, following previous work from our group (27,28). Stress reactivity was the
177 latent variable that resulted from Perceived Stress Scale (PSS), Rosenberg self-esteem
178 questionnaire and Neuroticism (IPIP). Lack of Self Control was a latent factor emerging from the
179 observable variables Lack of Perseverance (UPPS) and Conscientiousness (IPIP). Finally, reward
180 Sensitivity was formed by Extraversion (IPIP) and Sensation Seeking (UPPS). This model was
181 compared to a simpler one-dimension model (Model 2, Figure 1B), where all the observable
182 factors were fit into a single latent variable.
183 We also built a hierarchical version of the four-dimension model (Model 3, Figure 1C), where we
184 examined the plausibility of a layered model structure, inspired by the watershed model of mental

185 illness endophenotypes (5,40). In this model, stress reactivity, lack of self-control, and reward
186 sensitivity were assumed to each contribute to the Uncontrolled Eating phenotype.
187 Finally, we examined the relationships between Uncontrolled Eating, the impulsivity traits, BMI
188 and longitudinal changes in BMI in a hierarchical four-dimension model (Model 4, Figure 1D).
189 We tested whether BMI and longitudinal change in BMI (delta BMI) were predicted by
190 Uncontrolled Eating, stress reactivity, lack of self-control and reward sensitivity.
191 We used the Lavaan package in R version 3.3. (41) to perform SEM. Model fit was assessed with
192 the chi-square test (X^2), the Comparative Fit index (CFI), Root Mean Square Error of
193 Approximation (RMSEA) and the standardized root mean squared residuals (SRMR). The
194 following guidelines were utilized for judging good fit: RMSEA (acceptable fit < 0.08, good fit <
195 0.05), CFI (acceptable fit 0.95-0.97, good fit > 0.97), SRMR (acceptable fit 0.05-0.10, good fit <
196 0.05) (42).
197 To test for the robustness of the preferred hierarchical SEM model (model 3, Figure 1C), we
198 repeated the analysis by randomly splitting the sample in half. Age and sex were regressed out of
199 all the observable variables in the models. To account for the multiple models performed, we set
200 a stringent p value threshold ($p<0.005$).
201
202 Magnetic Resonance Imaging parameters and preprocessing
203 High-resolution T1-weighted anatomical images with voxel size = 1x1x1 mm were obtained (TR
204 = 2.3 s; TE = 2.98 ms; FOV phase=93.8°; FOV = 256mm) with a Siemens Magnetom Trio 3T
205 MRI scanner at the Montreal Neurological Institute (MNI).
206

207 Pre-processing of T1-weighted MRIs included denoising using optimized non-local means
208 filtering (43), correction for intensity inhomogeneity (44) and linear intensity scaling using
209 histogram matching to the ICBM-MNI152 template. The images were linearly registered to the
210 ICBM-MNI152 template (9 parameter registration) (45). A mask of the brain was generated using
211 BEaST, a nonlocal segmentation method applied to the linearly registered images in stereotaxic
212 space (46).
213
214 Cortical Thickness
215 All T1-weighted MRI images were processed using the CIVET pipeline (version 2.1;
216 http://www.bic.mni.mcgill.ca/ServicesSoftware/CIVET). Native T1-weighted MRI scans were
217 first corrected using the N3 algorithm, underwent brain masking, and registration to ICBM-
218 MNI152 template. Images were then segmented into gray and white matter, cerebrospinal fluid
219 and background with a neural net classifier. The white matter (inner) and gray matter (outer)
220 cortical surfaces were generated using the Constrained Laplacian-based Automated Segmentation
221 with Proximities algorithm. These surfaces were resampled to a stereotaxic surface template to
222 allow vertex-based measurement of cortical thickness. All resulting images went through a
223 stringent quality control by two inspectors in which 69 of 71 images were accepted for further
224 analysis. Cortical thickness in MNI space was defined as the linked distance between the two
225 surfaces across vertices.
226
227 Post-hoc brain-impulsivity analysis
228 We performed a post-hoc exploratory analysis to test which brain regions are associated with the
229 three general-impulsivity domains. We extracted the latent individual scores for stress reactivity,

230 lack of self-control and reward sensitivity of the participants with an available MRI. Next, using
231 the SurfStat software package (http://www.math.mcgill.ca/keith/surfstat/), we computed three
232 separate linear regression models to test for the associations between the three latent impulsivity
233 scores and cortical thickness. The models were analyzed with random field theory with a threshold
234 of $p<0.05$ corrected for multiple comparisons over the entire surface (47). Results are reported
235 cluster- and vertex-wise corrected. Total surface area was included as covariate. Age and sex were
236 already regressed out of the observable variables forming the latent scores (see Structural Equation
237 Models above). For this reason, these confounding variables were not included in the analyses.
238 Moreover, since the latent scores were obtained from a SEM model that includes the 3 general
239 impulsivity variables as latent variables, each latent score "accounts" for the other two.
240

241 **Results**

242 Participants' characteristics are listed in Table 1.

243

244 **Uncontrolled Eating and general impulsivity traits can be considered independent latent**
245 **variables (Models 1 and 2)**

246 A four-dimension model, with Uncontrolled Eating, stress reactivity, lack of self-control and
247 reward sensitivity as latent variables provided an acceptable fit ($\chi^2_{(29)} = 322.40$; RMSEA = 0.068;
248 CFI= 0.956; SRMR = 0.037). The first latent factor, Uncontrolled Eating, had positive loadings
249 from Disinhibited Eating, Power of Food, and Emotional Eating. The latent factor stress reactivity
250 had a negative loading from the Rosenberg self-esteem questionnaire and positive loadings from
251 Neuroticism and the Perceived Stress Scale. Lack of self-control, the third latent factor had a
252 positive loading from Lack of Perseverance and a negative loading from Conscientiousness.
253 Reward sensitivity was characterized by positive loadings from the Extraversion and Sensation

Seeking (UPPS) subscales. This model provided a better fit than an alternative single-dimension model, where all the observable variables were fit into a single latent score (difference in $\chi^2_{(6)}$ = 2770.5; p=2.2e-16).

A four-dimensional hierarchical model, where general impulsivity traits predict Uncontrolled Eating, is plausible (Model 3)

We tested the plausibility of a four-dimension hierarchical model. In this model, the latent variables stress reactivity, lack of self-control and reward sensitivity were characterized as predictors of Uncontrolled Eating. All the paths were significant. Note that the fit parameters are the same as Model 2, since sample size and degrees of freedom did not change and provided an acceptable fit (Figure 2A).

Relationship between Uncontrolled Eating, BMI and longitudinal weight change (Model 4)

Finally, we tested the relationship between Uncontrolled Eating, general impulsivity, BMI and longitudinal changes in BMI in the hierarchical four-dimension model. From these additional regression paths, the only one that was significant was the association between BMI and Uncontrolled Eating (B=0.38; SE=0.05; Beta=0.09; p<0.001). This model provided an acceptable fit ($\chi^2_{(41)}$ = 198.52; RMSEA = 0.055; CFI= 0.956; SRMR = 0.032) (Figure 2B).

Validation of Model 4 in the half split dataset

All the previously observed relationships in Model 4 remained equivalent in the two subsamples. Fit parameters in the first half of the sample (N=601 observation) were as follows: ($\chi^2_{(41)}$ = 102.97; RMSEA = 0.050; CFI= 0.965; SRMR = 0.032). The same model in the second half of the sample

(N=600 observations) had the following fit parameters ($\chi^2_{(41)}$ = 142.72; RMSEA = 0.064; CFI= 0.939; SRMR = 0.039).

Post-hoc correlations between cortical thickness and general impulsivity scores

Higher stress sensitivity was associated with greater cortical thickness in the right temporoparietal junction extending to superior temporal gyrus. Lack of self-control was positively associated with greater thickness in the right superior frontal gyrus extending to midcingulate cortex. Finally, higher scores in reward sensitivity were associated with lower thickness in the bilateral inferior frontal gyrus (Figure 3).

Discussion

The purpose of the current study was to provide a comprehensive examination of the relationship between domain-general (personality-related facets of impulsivity) and eating-specific obesity endophenotypes (Uncontrolled Eating), BMI, and weight changes. To do so, we tested a series of structural equation models in a large sample size (N>2300) of first-year students and accounted for the multidimensional nature of impulsivity. A final SEM model, which depicted a hierarchical relationship between general impulsivity, Uncontrolled Eating, BMI and weight gain, was developed in the first split-half of the sample and replicated in the second. In a follow-up analysis we also investigated neural correlates of different facets of impulsivity. We found that cortical thickness in parts of the frontal, cingulate and temporoparietal cortex were correlated with impulsivity and hence are potentially related to BMI via Uncontrolled Eating.

299 Following previous work, we first stratified impulsivity into three general latent variables: stress
300 sensitivity, lack of self-control and reward sensitivity (8,10). A fourth latent variable, Uncontrolled
301 Eating, was considered an eating-specific form of impulsivity. In line with previous publications
302 (27), Uncontrolled Eating was defined using the total scores of relevant eating questionnaires. We
303 showed that an SEM that separated these 4 latent factors was significantly better than a model in
304 which all the observable variables were loaded into a single latent score. Moreover, a hierarchical
305 relationship, in which the three general impulsivity domains were considered predictors of
306 Uncontrolled Eating, was found to be plausible. Each general impulsivity domain had an
307 independent and positive correlation with Uncontrolled Eating. We also found that higher scores
308 in Uncontrolled Eating were positively associated with BMI, as demonstrated previously (27,28).
309 However, none of the relations between general impulsivity domains and BMI were significant in
310 the model that also included Uncontrolled Eating. The SEM model therefore suggests that the
311 association between impulsivity and BMI is indirect, with impulsivity factors predicting
312 Uncontrolled Eating, and Uncontrolled Eating predicting BMI.
313
314 Finally, we tested the hypothesis that Uncontrolled Eating underlies vulnerability for weight gain
315 during the first year of university. We utilized the transition period into university because it is
316 associated with a high risk of weight gain. In our sample, the average weight gain was small (0.52
317 kg over 10 months), but significant, and was similar to previous reports (29). However, in this
318 sample we did not find evidence that Uncontrolled Eating can longitudinally predict weight gain.
319 This could be due to limited duration of the study. Moreover, we cannot exclude the possibility of
320 seasonal weight gain (48), which would not necessarily be related to Uncontrolled Eating. The
321 existence of bidirectional relationships between Uncontrolled Eating and BMI might also mask a

322 relationship, since changes in body weight might lead to longitudinal variations in eating-specific
323 impulsivity (49). For instance, scores in different Uncontrolled Eating scales decrease after
324 bariatric surgery (50) or voluntary weight loss (51).
325
326 Our results support a model in which BMI is associated with Uncontrolled Eating, which in turn
327 is derived from general impulsivity. Impulsivity could compromise the maintenance of behaviors
328 that promote healthy weight. High scores on conscientiousness have been consistently linked to a
329 lower risk of having and developing obesity across independent samples (52,53). These results are
330 generally derived from sample populations with a higher mean age than ours, suggesting that self-
331 control deficits may be more associated with BMI as individuals age and start making their own
332 food decision. Nonetheless, our findings point to reduced conscientiousness (lack of self-control)
333 as a risk factor for overeating behaviors in adolescent and young adult populations.
334 In a subset of the sample, we performed additional post-hoc correlations between cortical thickness
335 and impulsivity in all three tested domains. We found that the temporoparietal junction, superior
336 frontal gyrus/midcingulate cortex and inferior frontal gyrus were associated with stress sensitivity,
337 lack of self-control and reward sensitivity, respectively. These results are consistent with previous
338 reports showing brain correlates of impulsivity (19,20,54) and partially overlap with obesity-
339 related brain regions (21,55). Paralleled by our SEM results, these findings show that cortical
340 thickness differences might indirectly influence BMI via Uncontrolled Eating. In the future we
341 would like to update our SEM model to test the hypothesis that brain differences can act as
342 independent predictors of impulsivity, which in turn are significant predictors of Uncontrolled
343 Eating, and hence BMI. This hierarchy of relationships can be depicted as a watershed model (40),
344 which will allow to test the hypothesis that the temporoparietal junction, midcingulate cortex and

345 inferior frontal gyrus are indirectly involved in BMI, via their association with impulsivity.
346 Unfortunately, due to low imaging sample size, this was not possible in this study.
347
348 The results of our study should be considered with regards to its limitations. Although we had a
349 large sample group, whereby we were able to detect and replicate results from meta-analyses, most
350 of our measures were self-reported. In addition, brain imaging was conducted with a small subset
351 of the total sample.
352

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359

360 **Competing interests**

361 IGG, SN, FM, MD, YY, SGS, YZ, NS, DLC, UV, AD report no financial interests or potential
362 conflicts of interest.
363

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Figures

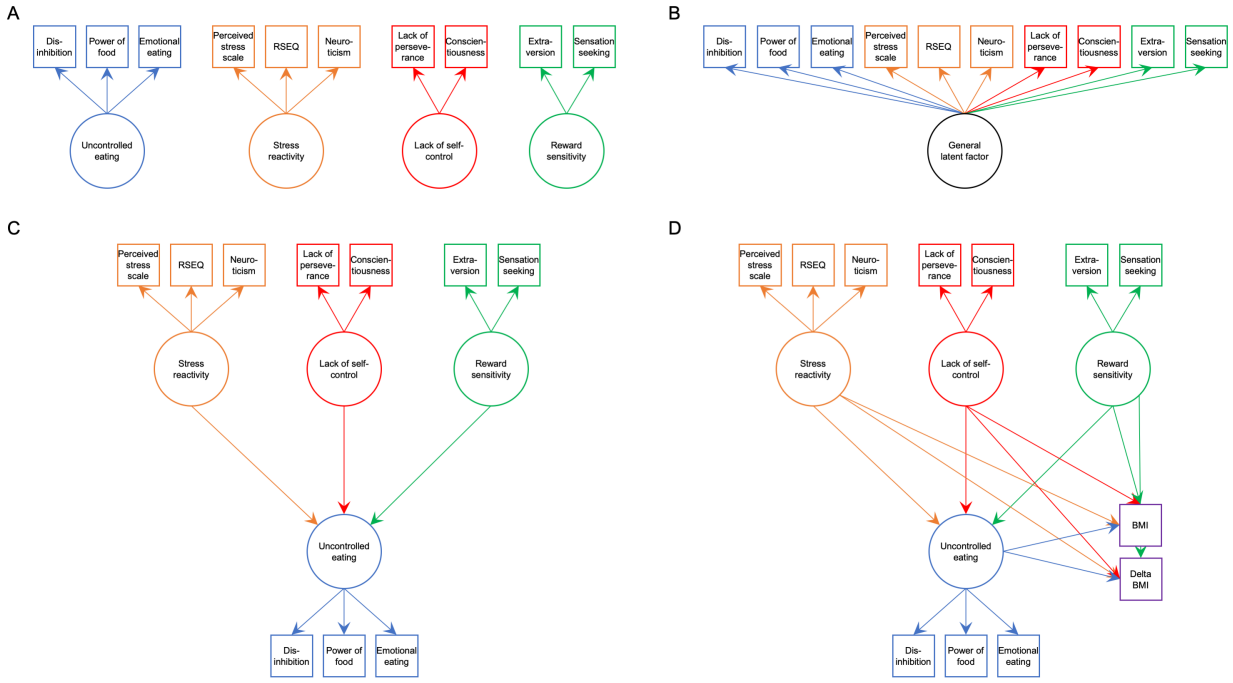

Figure 1 Structural equation models used in the study. **A** Model 1 representing 4 distinct latent variables; **B** Model 2 pooling all measures into 1 latent variable; **C** Model 3 representing a hierarchical model where stress reactivity, lack of self-control and reward sensitivity all influence Uncontrolled Eating; **D** Model 4 where all 4 latent variables influence BMI and BMI change. RSEQ – Rosenberg self-esteem questionnaire. BMI – body mass index.

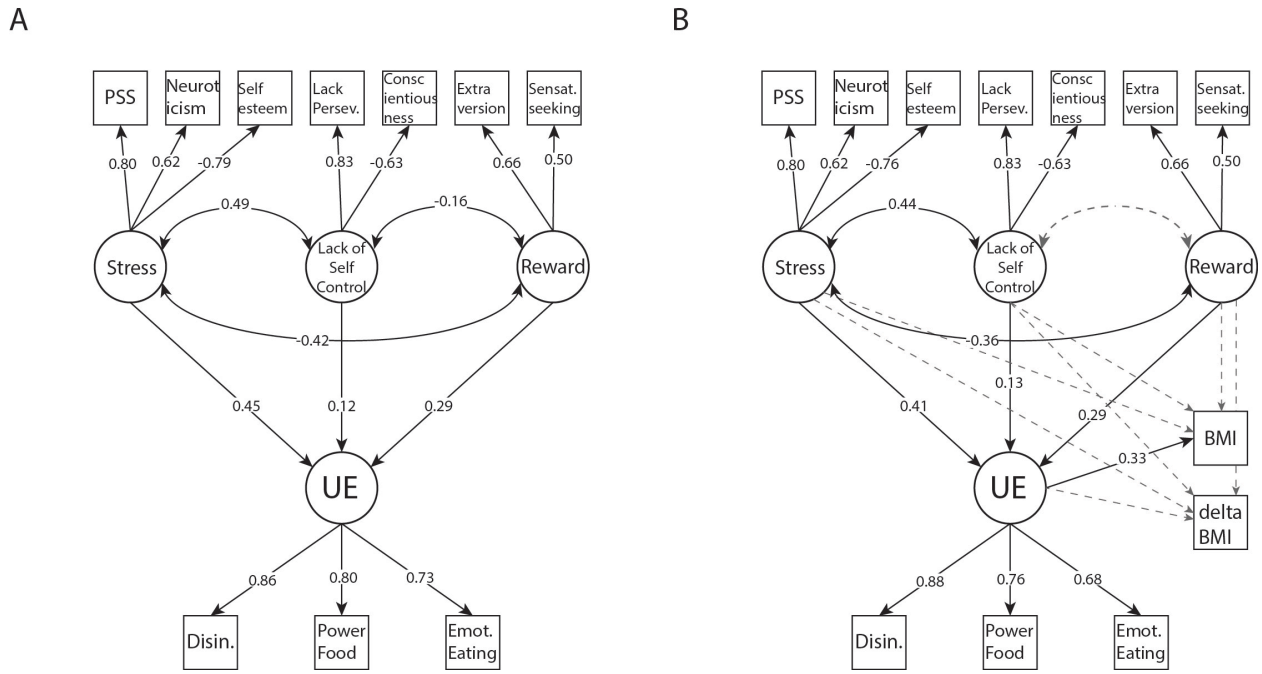

Figure 2. SEM representing: A) Model 3 (n=2318), the relationships between Uncontrolled Eating (UE) and the general impulsivity-related variables stress reactivity, lack of self-control and reward sensitivity. B) Model 4 (n=1197), a model that additionally includes the associations between UE, general impulsivity-related variables, BMI and 6-month longitudinal change in BMI (delta BMI) are added. Numeric values are standardized beta weights (all of them $p<0.005$). Dashed gray lines depict non-significant associations. PSS – perceived stress scale. UE – Uncontrolled Eating. BMI – body mass index. Stress – stress reactivity. Reward – reward sensitivity. Disinh. – disinhibition. Emot. Eating – emotional eating. Lack Persev. – lack of perseverance. Sensat. seeking – sensation seeking.

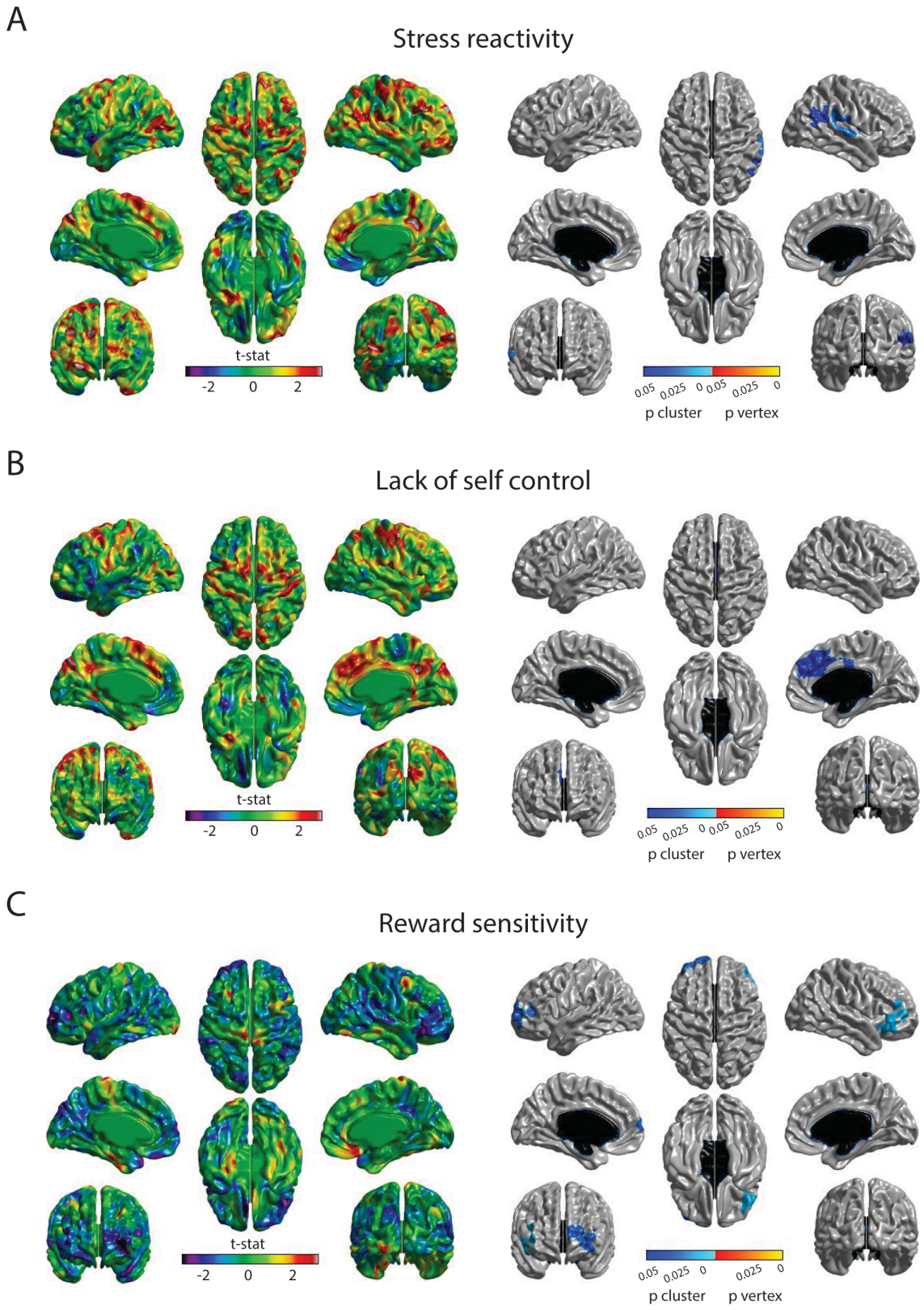

Figure 3 Correlations between latent factors of impulsivity and cortical thickness.

545 **Table**

546 **Table 1.** Descriptive statistics of the study variables. Numbers in parentheses indicate standard

547 deviation.

Variables	Full sample (n=2318)	Subsample with longitudinal BMI (n=1197)	Subsample with MRI (n=71)
Age	19.34 (4.35)	19.40 (4.07)	18.24 (0.80)
Sex	780 males	347 males	18 males
	1538 females	830 females	53 females
Baseline (autumn) BMI (kg/m^2)	22.24 (3.57)	22.21 (3.44)	22.38 (2.54)
Follow-up (spring) BMI (kg/m^2)		22.36 (4.25)	22.48 (2.63)
Change in weight in first year (kg)		0.52 (3.35)	1.39 (2.67)
Disinhibition (Three-Factor Eating Questionnaire)	6.38 (3.34)	6.38 (3.42)	6.24 (3.47)
Emotional Eating (Dutch Eating Behavior Questionnaire)	2.45 (0.74)	2.42 (0.77)	2.36 (0.70)
Power of Food (PFS)	12.42 (3.65)	12.47 (3.84)	12.40 (3.72)
Lack of Perseverance (the UPPS Impulsive Behavior Scale)	1.91 (0.45)	1.91 (0.47)	1.97 (0.49)
Sensation Seeking (the UPPS Impulsive Behavior Scale)	2.81 (0.56)	2.91 (0.59)	2.87 (0.55)
Rosenberg Self Esteem Scale	29.85 (4.96)	29.66 (5.30)	28.92 (5.86)
Cohen's Perceived Stress Scale	24.57 (7.17)	24.82 (7.35)	24.48 (7.79)
Neuroticism (International Personality Item Pool)	11.63 (2.93)	11.59 (3.17)	11.69 (3.08)
Agreeableness (International Personality Item Pool)	15.60 (2.80)	15.67 (3.01)	15.73 (2.86)
Imagination (International Personality Item Pool)	15.15 (2.75)	15.16 (2.90)	15.73 (2.86)
Conscientiousness (International Personality Item Pool)	13.97 (2.93)	13.98 (3.18)	13.46 (3.13)
Extraversion (International Personality Item Pool)	12.04 (3.48)	11.86 (3.66)	11.77 (4.13)

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