

Moderating Role of Thin-ideal Internalization in the Relationship between Negative Affect and Eating: An Ecological Momentary Assessment Study

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Eating has been regarded as a regulatory behavior in coping with negative affect. However, individual differences in the relationship between negative affect and eating behavior remain relatively unexplored. This study aims to investigate this association while examining the role of potential moderators, namely thin-ideal internalization and impulse control difficulties using ecological momentary assessment (EMA) methodology. Female participants ($N=72$) aged 18 to 29 years completed a 7-day EMA protocol and questionnaires. Daily EMA measures included negative affect (NA) and caloric intake. Hierarchical linear modeling was applied to analyze the data. NA did not significantly predict caloric intake at the within-person level. However, the non-significant association between NA and caloric intake was negatively moderated by thin-ideal internalization on the between-person level. The moderating role of impulse control difficulties was not significant. These findings extend prior research on risk factors of emotional undereating and they highlight the importance of further research. The limitations of this study and suggestions for future research have been discussed.

Keywords: ecological momentary assessment (EMA), negative affect, eating behavior, thin-ideal internalization, emotional undereating

Introduction

The Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5; American Psychiatric Association, 2013) defines a range of eating disorders (ED) such as anorexia nervosa, bulimia nervosa and binge eating disorder which are known to afflict 1-4% of the population (Smink, Van Hoeken, & Hoek, 2012). Although the DSM-5 and most ED-related empirical evidence concern full-blown ED symptoms, problematic or disordered eating behaviors affect the emotional and physical health of individuals of all shapes

and sizes (Schaumberg et al., 2017). According to an 8-year longitudinal study, over 12% of adolescent females had experienced partial or sub-threshold ED symptoms (Stice, Marti, Shaw, & Jaconis, 2009). Moreover, it has been repeatedly suggested that ED symptoms may remain largely unidentified, and thus may be significantly underrepresented in epidemiological data (Ali et al., 2020; Mond, Myers, Crosby, Hay, & Mitchell, 2010; Whitehouse, Cooper, Vize, Hill, & Vogel, 1992). The pervasiveness of eating problems and the current knowledge gap underscore the importance of elucidating the underlying mechanism of disordered eating, regardless of one's diagnostic or weight status.

Dysregulated affect is one of the transdiagnostic risk factors that contribute to the onset and maintenance of EDs (Fairburn, Cooper, & Shafran, 2003). In other words, individuals with ED have difficulty processing intense affective states such that they attempt to distract from or gain control of such emotions by engaging in dis-

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ordered eating, be it undereating or overeating. A substantial body of literature has indicated that overeating is a means to regulate emotional states. Early clinical models such as the psychosomatic theory postulate that individuals overeat by confusing emotional arousal with hunger, seeking comfort or distraction by eating (Kaplan & Kaplan, 1957). By the same token, the affect regulation model proposes that intense negative emotions provoke binge eating which temporarily alleviates negative affect (Hawkins & Clement, 1984). On the other hand, a more recent line of research shed light on restrictive eating or undereating that may serve an emotion regulatory function as can be seen in individuals with anorexia nervosa, especially those classified as the restricting subtype (Brockmeyer et al., 2014; Meule et al., 2019). Previous studies, however, were obtained from predominantly clinical or obese samples. Research on emotion-induced eating behaviors in non-clinical population is still lacking and producing mixed results (Heron, Scott, Sliwinski, & Smyth, 2014).

Taken together, eating is intrinsically associated with affect, while the nature and strength of the relationship depends on individual predispositions (Greeno & Wing, 1994; Macht, 2008; Polivy & Herman, 2005; Vogeley & Gibson, 2010). To account for the effect of negative affect on eating behaviors, Greeno and Wing (1994) formulated the individual-difference model. The model presupposes that individual differences in learning history, attitude and biology lead to differential reactivity to negative affect in terms of eating more or less than usual. Previously studied predictors which moderate the association between negative affect and eating include body mass index (BMI) or weight status, gender and intentional dietary restraint. Put differently, females, individuals with higher BMI and those who had engaged in restrained eating are more likely to cope with stress by eating more than usual.

Socioenvironmental factors are also known to shape how individuals react to intense emotions. Internalization of the thin ideal or the extent to which an individual “buys into socially defined ideals of attractiveness” is another trait that could explain such individual differences (Heinberg, Thompson, & Stormer, 1995; Thompson & Stice, 2001). Body image literature has formulated that women who have internalized socially defined body ideals make conscious efforts to maintain their body shape or weight (Stice, 2001). When faced with negative affect, the level of control

they normally try to exert over food consumption may likely be disrupted, resulting in greater reactivity to cravings, food cues and subsequent disinhibited eating (Greeno & Wing, 1994; Hawks, Madanat, & Christley, 2008). Consistent with this view, a recent diary study found that poor body image or body shame predicted high caloric consumption over 7 days in a normal-weight community sample (Troop, 2016). Thus, it is expected that individuals who endorse the thin-ideal to a greater extent are more likely to react to negative affect by overeating relative to those who do not endorse such socially defined body image.

Impulse control may be another potential moderator of the relationship between momentary negative affect and eating. It refers to the ability to respond adaptively to one's emotional states by refraining from impulsive, even self-destructive behaviors (Gratz & Roemer, 2004). In order to understand the role of impulse control, it is important to recognize that eating is essentially a rewarding experience, as with other hedonic behaviors, followed by immediate relief of hunger and dopamine release (Vogeley & Gibson, 2010). High impulse control difficulties could be thought of as a disposition favoring immediate rewards over delay of gratification (Pearson, Riley, Davis, & Smith, 2014). In this respect, individuals with high impulsivity are known to be more reactive to food stimuli and subsequent overeating (Dawe & Loxton, 2004). Therefore, it can be inferred that individuals who have difficulty controlling impulsive behaviors may respond to negative affect by consuming more calories.

Although thin-ideal internalization and impulse control difficulties have been found to be associated with increased eating in response to negative affect (Pearson et al., 2014; Stice, 2016), previous research has heavily relied on cross-sectional design and retrospective self-report. Unfortunately, extant empirical evidence suggests that individuals may not be able to accurately recall past experiences which are frequent, mundane and irregular (Bradburn, Rips, & Shevell, 1987). In this regard, eating behaviors and affective states are particularly vulnerable to recall bias which traditional data collection methods inevitably entail (A. Stone, Shiffman, Atienza, & Nebeling, 2007).

Ecological momentary assessment (EMA), a methodology that repeatedly measures participants' real-time momentary state and behavior in the natural environment, serves as a viable alternative

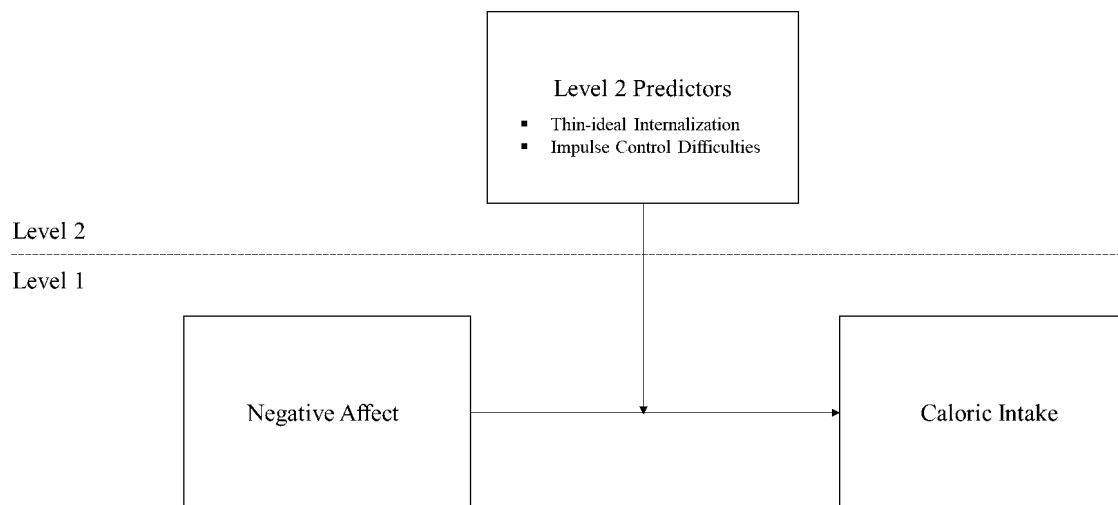


Figure 1. Research hypothesis.

to traditional research methodology (A. Stone & Shiffman, 1994). Recent meta-analyses have empirically supported the feasibility and ecological validity of EMA methodology in affect and eating behavior research (Mason, Do, Wang, & Dunton, 2020; Smyth et al., 2001; A. Stone et al., 2007). In addition, another source of recall bias of prior research is related to the operationalization of eating behavior, where most studies assessed participants' retrospective self-reported eating behavior as opposed to measuring the actual amount of consumption and real-time affective state. Thus, it is expected that the use of EMA methodology and operationalization of eating in terms of caloric count, as well as measuring real-time affective state will minimize recall bias and secure ecological validity of the findings.

The present study thus aims to observe the moderating role of thin-ideal internalization and impulse control difficulties in the association between affective states and eating behaviors using both EMA and self-report survey method. We expected that women with higher degree of thin-ideal internalization and impulse control difficulties would report increased caloric intake when they experience negative affect. Figure 1 illustrates the research model.

Methods

Participants

Participants were recruited from the community via online study recruitment advertisements posted on websites frequently visited

by young adults. Inclusion criteria were as follows: a) identify oneself as female, b) fully understand the Korean language, c) be between the age of 18 and 29 and d) neither have been diagnosed with a psychological disorder based on the DSM-5 nor have received any form of treatment for psychological difficulties within the last 12 months. A total of 109 participants registered for the study and 83 participants started the EMA protocol. During the EMA data collection period, 6 participants were dropped due to low compliance rate (< 57%). Among those who completed the EMA protocol, 5 individuals did not complete the necessary demographic and person-level questionnaires, hence were not included in data analysis.

Thus, a total of 72 participants were included in the final data analysis. Their age ranged from 18 to 29 years with a mean of 22.03 ($SD = 2.44$), with all participants reporting that they were single. Participants' mean body mass index (BMI) was 20.90 ($SD = 3.07$; range: 17.21–36.05). Based on the recommendations of the Korean Society for the Study of Obesity (Seo et al., 2019), 51 participants (70.83%; BMI range: 18.5–22.9) were within normal range, 12 individuals were classified as underweight (16.67%; BMI range: < 18.5), 3 fell into the pre-obese range (4.16%; BMI range: 23–25) and 6 participants were identified as obese (8.33%; BMI range: > 25). The mean BMI of participants was slightly lower than the national mean of the same age range group ($M = 21.80$, $SD = .21$) according to the National Health and Examination Survey (Ministry of Health and Welfare, 2020).

Procedure

Following approval of the institutional review board of the researchers' university, participants completed an online registration form including confirmation of eligibility and informed consent. The registration form also included a scheduler through which they designated seven consecutive days to arrange individual EMA protocol. In order to maximize the generalizability of the findings, it was required that participants' designated EMA phase (a) does not overlap with menstrual, pregnancy or intended weight loss period, (b) does not include or proximately precede any examination or job interview in the academic or professional domain, (c) does not coincide with personal vacations and trips, and (d) is not closely spaced with anticipated major life events such as interpersonal conflict, job loss, relocation or marriage. A user manual was provided in electronic format to instruct participants on how to download and operate the mobile calorie tracker application designated by the researcher.

Participants then started the 7-day EMA protocol beginning on the day they had designated. Participants used their personal mobile devices to answer questions concerning negative affect they are currently experiencing, which was delivered via email at a random time between 09:00 a.m. and 18:00 p.m. once a day. They were required to turn on email notification and fill out the questionnaire as soon as it was received. Responses submitted past the midnight-deadline were not allowed and resulted in missing values. Concurrent with answering questionnaires on negative affect, participants tracked their caloric intake of main meals and snacks. While it was recommended to log caloric intake 'on the spot', participants were also allowed to retrospectively enter the data. If an individual's caloric intake record indicated more than two consecutive main meals were skipped, the researcher contacted the participant within 2 days of the completion of the EMA protocol, to ask whether it was omitted intentionally or if the participant had forgotten to enter the information. As a result, 10 participants were contacted by the researcher and asked to either confirm whether they had skipped more than two consecutive meals or retrospectively report their caloric intake. Prior to the 7-day experience sampling, participants were provided with the researcher's email address and phone number to forward any inquiries or technological issues.

Within one or two days of the completion of the 7-day experience

sampling, participants were sent a link to an online self-report questionnaire battery. Participants were given payment for their participation ranging from 5,000 to 25,000 Korean won depending on their individual compliance rate. For instance, participants who replied to 4 out of 7 daily negative affect surveys and logged in 4 out of 7 days of caloric intake received the minimum compensation (5,000 Korean won) whereas those who demonstrated a 100% compliance rate received 25,000 Korean won.

Measures

Ecological Momentary Assessment Measures (Level 1 Variables)

Negative Affect

Participants' state-level negative affect was measured via the 10-item negative affect subscale of the Korean version of the Positive Affect and Negative Affect Schedule (PANAS; Park & Lee, 2016; Watson et al., 1988). This subscale consists of items that represent different facets of negative affect (e.g., upset, afraid, nervous). Items (e.g., "How upset are you feeling right now?") are rated on a 1 (not at all) to 5 (extreme) Likert-type scale and summed to create a total score. Higher sum score implies the individual experienced higher level of negative affect.

Daily Caloric Intake

To measure caloric intake, a calorie counter application named 'Diet Camera AI' (<http://www.doinglab.com/>) was employed. The application supports two modes of data entry, either by manually searching the name of food from its nutrition database or by taking or uploading images of the food from which the application's food recognition algorithm produces the name of the food. Once the food name is identified and verified by the participants, the amount of food consumed (e.g., a bowl of white rice) was entered. Participants also indicated whether it was consumed as a main meal or a snack. Daily caloric intake was calculated by adding up overall calorie consumption within a 24-hour span, including both main meals and snacks.

Person-level Psychological Characteristics Measures (Level 2 Variables)

Thin-ideal Internalization

Thin-ideal internalization was assessed using the eight-item inter-

nalization subscale of the Sociocultural Attitudes Toward Appearance Questionnaire (SATAQ; Heinberg et al., 1995), which measures one's degree of awareness and internalization of socially defined standards of beauty. Each item (e.g., "Women who appear in TV shows and movies project the type of appearance that I see as my goal.") is rated on a scale ranging from 1 (completely disagree) to 5 (completely agree). Higher sum score indicates the respondent have internalized sociocultural standards of beauty and imposed them onto herself to a greater extent. In this study the Korean version of SATAQ, translated and validated by Lee and Oh (2003) was used. In the current study, Cronbach's alpha of the Internalization subscale and the entire scale was .71 and .81, respectively.

Impulse Control Difficulties

To measure impulse control difficulties, the 5-item subscale of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) was used. The DERS assesses emotional dysregulation comprehensively, encompassing six interconnected low-order dimensions of emotion regulation including (a) emotional awareness, (b) emotional clarity (c) acceptance of emotions, (d) ability to control impulsive behaviors, (e) ability to behave in accordance with desired goals when experiencing negative emotions, and (e) ability to use situationally appropriate emotion regulation strategies. Each item (e.g., "When I am upset I have difficulty controlling my behaviors.") is rated on a five-point scale ranging from 1 (almost never, 0-10%) to 5 (almost always, 91-100%). Higher sum scores indicate greater difficulties in controlling impulsive behaviors when experiencing negative affect. The Korean version of DERS (K-DERS; Cho, 2007) was used to assess impulse control difficulties of participants. In the current study, Cronbach's alpha was .89 for the Impulse Control Difficulties subscale and .95 for the entire scale.

Analytic Strategy

Hierarchical linear models (HLM) were applied using the software HLM8 (Raudenbush, Bryk, & Congdon, 2019) due to the nested structure of the data where repeated measures of state-level negative affect and caloric intake (Level 1) were nested within participants' person-level measures (Level 2). Following Enders & Tofighi's guidelines on centering decisions (Enders & Tofighi, 2007), Level 1 vari-

ables were person-mean centered and Level 2 variables were grand-mean centered. Missing values of Level 1 recordings (22 out of 504 recordings; 4.37%) were not imputed. Intercepts-and-Slopes-as-Outcomes model was formulated whereby intercepts and slopes were allowed to vary across participants. Given the relatively modest Level-2 sample size, the restricted maximum likelihood (REML) method was employed to minimize small sample bias (Bolker et al., 2009; McNeish, 2017).

At Level 1, daily caloric intake was regressed on negative affect. This modeling allowed us to examine whether an individual's negative affect predicted the amount of calorie consumption of the same day (within-person effect). Level 1 model is expressed by the following equation:

$$\text{Level 1 Model: } \text{Caloric Intake}_{it} = \pi_{0i} + \pi_{1i} * (\text{Negative Affect}_{it}) + e_{it}$$

At Level 2, person-level predictors were separately entered as predictors of means and slopes. This set of multilevel regression analyses allowed for an examination of a) whether Level 2 predictors predispose individuals to cope with negative affect by eating more or less quantity of food and b) how strong the association is. The multilevel equations are presented below with the example of thin-ideal internalization entered as the Level 2 predictor.

Level-2 Model:

$$\begin{aligned} \pi_{0i} &= \beta_{00} + \beta_{01} * (\text{Thin-ideal Internalization}_i) + \beta_{02} * (\text{BMI}_i) + r_{0i} \\ \pi_{1i} &= \beta_{10} + \beta_{11} * (\text{Thin-ideal Internalization}_i) + \beta_{12} * (\text{BMI}_i) + r_{1i} \end{aligned}$$

At Level 2, the intercept β_{00} and β_{10} respectively represents the mean level of caloric intake and negative affect when participants reported average level of thin-ideal internalization and BMI, which was grand-mean centered. β_{01} reflects the regression coefficient, or the strength of the association between thin-ideal internalization and caloric intake. β_{11} stands for the regression coefficient of the slope between thin-ideal internalization and negative affect. To statistically control for the main and moderation effect of BMI on HLM analysis results, grand-mean centered BMI was entered as simultaneous predictor of means and slopes (β_{02} , β_{12}). The thin-ideal internalization variable was then exchanged for impulse control difficulties.

Results

Preliminary Analysis

Participants submitted 503 and 483 recordings of daily caloric intake and negative affect, respectively over the 7-day span. On average, participants reported consuming approximately 17 main meals ($M = 16.81$; $SD = 3.58$) and 4 snacks ($M = 4.36$; $SD = 3.35$) during the 7-day period. Further descriptive statistics of participants' caloric intake can be found in the Appendix A of this article. With regards to daily negative affect surveys, participants completed 95% ($SD = .09$) of their daily entries (range: 57%–100%), reflecting overall good compliance rate. Intraclass correlation (ICC) of the dependent variable was 0.37. Put differently, 37% of the total variance in participants' caloric consumption was due to the mean difference between participants. This ICC estimate falls within the typical ICC range (.20–.40) reported from previous EMA studies (Bolger & Laurenceau, 2013).

Descriptive statistics and correlations for study variables are presented in Table 1. Grand means, standard deviations and correlation coefficients of Level 1 variables were obtained by entering person-level means of the variable over the 7-day EMA period. In terms of daily caloric intake, the grand mean of 72 participants was 1,292.49 kcal. This estimate is lower by approximately 370 kcal than the average caloric intake ($M = 1,661.10$) obtained from a national sample of females according to the 2018 Korea National Health and Nutrition Examination Survey (Ministry of Health and Welfare, 2020). The person-level mean of negative affect over the 7-day experience sampling period significantly correlated with impulse

control difficulties ($r = .30$, $p < .05$). Participants' person-mean of caloric intake negatively correlated with thin-ideal internalization ($r = -.24$, $p < .05$).

Hierarchical Linear Modeling Analysis

Within-person (Level 1) effects analysis revealed that the degree of negative affect participants experienced did not significantly predict the number of calories consumed on the same day ($t = .17$, *ns.*). Even after controlling for the potential impact of BMI, the main effect of negative affect on caloric intake was not statistically significant ($t = -1.05$, *ns.*).

In the opposite direction from our hypothesis, HLM analysis (Level 2) showed that thin-ideal internalization moderated the non-significant association between negative affect and caloric intake ($\beta_{11} = -58.66$, $t = -2.07$, $p = .04$). In other words, participants who reported having internalized socially defined standards of beauty to a greater extent showed significant decrease in caloric intake on days when they experienced negative affect. Meanwhile, the main effect of thin-ideal internalization was not significant ($\beta_{01} = -1.58$, $t = .13$, *ns.*), suggesting that the strength of thin-ideal internalization did not predict the average amount of calories they consumed over the 7-day EMA period. Figure 2 provides an illustration of the moderation effect of thin-ideal internalization between negative affect and caloric intake.

Contrary to the study hypothesis, the second set of HLM analysis revealed that impulse control difficulties did not exert a significant moderating effect on the association between negative affect and caloric intake ($\beta_{11} = -8.90$, $t = -.50$, *ns.*). In addition, impulse

Table 1. Descriptive Statistics and Correlations for Study Variables ($N = 72$)

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
Level 1 variables									
1. Negative affect	16.37	4.55	-	-.00	-.03	-.18	.01	.20	.30*
2. Caloric intake (kcal)	1,292.49	337.80	-	-	.35**	.51**	-.17	-.24*	-.18
3. Meal frequency	2.40	.51	-	-	-	-.04	-.25*	-.09	-.10
4. Snacking frequency	.62	.48	-	-	-	-	-.24*	-.20	-.22
Level 2 variables									
5. BMI	20.90	3.07	-	-	-	-	-	-.06	.12
6. TII	24.68	4.92	-	-	-	-	-	-	.24*
7. ICD	11.18	4.34	-	-	-	-	-	-	-

Note. For all Level 1 variables, grand mean of person-level means over the 7-day EMA protocol period was calculated.

BMI = Body Mass Index; TII = Thin-ideal Internalization; ICD = Impulse Control Difficulties.

* $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed.

control difficulties did not predict the mean level of caloric intake ($\beta_{01} = -12.67$, $t = -.95$, *ns.*). Put differently, individuals with high impulse control difficulties neither consumed more calories on average nor reported increased food intake when they experienced negative affect. Further results pertaining to the Level-2 analysis can be found in Table 2.

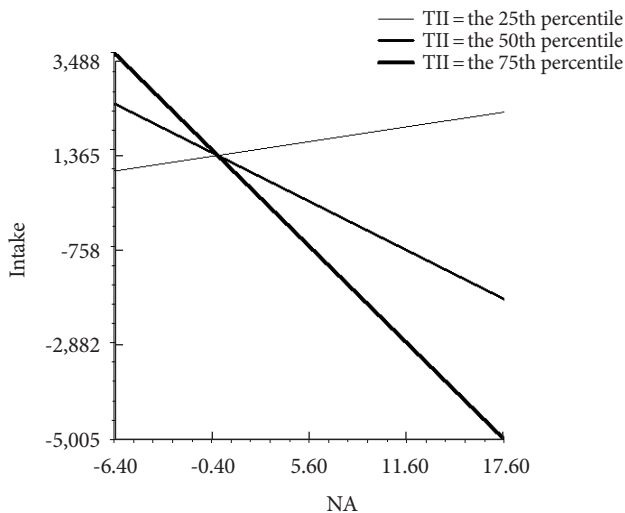


Figure 2. The relationship between negative affect and caloric intake (Level 1) being moderated by thin-ideal internalization (Level 2).

Discussion

The purpose of this EMA study was to investigate the moderating role of person-level variables on the relationship between state-level negative affect and caloric intake in young females. On a within-person level, negative affect did not predict the number of calories consumed on the same day. The non-significant association between negative affect and caloric intake could be explained by comparatively examining the individual-difference model as opposed to the general effect model (Greeno & Wing, 1994), a physiologically-oriented explanation that negative affect induces overeating. Whereas the general effect model has received modest empirical support in animal studies employing tail-pinching or electric shock paradigms, it does not take into account individual differences in learning history, attitudes and biology which might increase or reduce one's physiological vulnerability to negative affect (Greeno & Wing, 1994). Therefore, it is plausible that variability in person-level characteristics across participants could have cancelled out the general effect, or the physiological reactivity to overeat when experiencing negative affect.

In the opposite direction to our hypothesis, thin-ideal internal-

Table 2. Random effects from Hierarchical Linear Modeling: Predicting Caloric Intake from Negative Affect (Level-1) with Level-2 Predictors Entered as Moderators ($N = 72$)

Predictor		Random Effect			<i>p</i> -value	95% CI	
		Estimates	<i>SE</i>	<i>t</i> -ratio		Lower	Upper
TII	Means as outcomes						
	Intercept, β_{00}	1,231.74	66.80	18.44	< .001***	1,100.81	1,362.67
	TII, β_{01}	-1.58	12.12	-.13	.89	-25.34	22.18
	BMI, β_{02}	9.00	59.89	.15	.88	-108.38	126.38
	Slopes as outcomes						
	Intercept, β_{10}	-121.25	80.88	-1.50	.14	-279.78	37.27
	TII*NA, β_{11}	-58.66	28.26	-2.07	.04*	-114.05	-3.27
ICD	Means as outcomes						
	Intercept, β_{00}	1,225.61	68.29	17.95	< .001***	1,091.76	1,359.46
	ICD, β_{01}	-12.67	13.35	-.95	.35	-38.84	13.50
	BMI, β_{02}	15.20	59.60	.26	.80	-101.62	132.02
	Slopes as outcomes						
	Intercept, β_{10}	-266.73	139.53	-1.91	.06	-540.21	6.75
	ICD*NA, β_{11}	-8.90	17.94	-.50	.62	-44.06	26.26
	BMI*NA, β_{12}	-141.84	89.38	-1.58	.12	-317.03	33.34

Note. BMI = Body Mass Index; NA = Negative Affect; TII = Thin-ideal Internalization; ICD = Impulse Control Difficulties.

* $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed.

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ization significantly heightened participants' undereating tendencies on days they experienced negative affect. Correlation analysis also revealed that thin-ideal internalization was associated with lower person-level mean of caloric intake over the 7-day EMA period. These findings are at odds with past body image literature demonstrating the risk of thin-ideal internalization on bulimic symptoms (Stice, 2016). A number of reasons may have contributed to such contradictory findings. First, present results were obtained using an EMA design observing the moderating role of thin-ideal internalization on state-level eating behavior over a relatively short span of time. On the other hand, a majority of well-established body image studies employed longitudinal survey methods with the aim of examining the risk of poor body image on the onset of an ED over the course of several years. Also, the current study operationalized eating behavior in terms of numeric caloric intake while past research utilized diagnostic status of an ED or a wide range of self-report questionnaires measuring ED pathology or eating behaviors such as the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien et al., 1986), Emotional Eating Scale (EES; Arnow, Kenardy, & Agras, 1995) or Eating Disorders Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994). Last but not least, participants' weight status could have led to such differing results. For instance, Troop (2016) found that participants' baseline level of body shame predicted higher caloric intake over the next 7 days despite sharing a number of commonalities with the current study in terms of research design (a 7-day diary study), independent variable (body shame) and operationalization of the outcome variable (caloric intake). We speculate this discrepancy may have been due to the overall difference in participants' weight status between the two studies where Troop (2016) reported a mean BMI of 23.4 whereas participants' mean BMI was 20.90 in present study.

With the study-specific characteristics in mind, one possible explanation for such findings is that undereating in and of itself serves as a coping strategy to attenuate aversive affective states. While most prior works have tested the "emotional undereating" hypothesis in children or individuals diagnosed with anorexia nervosa (Bjorklund, Wichstrøm, Llewellyn, & Steinsbekk, 2019; Brockmeyer et al., 2012; Herle, Fildes, Steinsbekk, Rijdsdijk, & Llewellyn, 2017; Jansen et al., 2012), mounting evidence suggests that it is not limited to clinical populations or certain diagnostic entities (Haynos, Wang, & Frusz-

zetti, 2018; Murray, Anorenius, & Avena, 2015). Even though our study inclusion criteria precluded the clinical ED population and dieters, present results call attention to potential contributing role of negative body image on emotional undereating. Given recent findings that emotional undereating may be a premorbid risk factor of anorexia nervosa as well as bulimia nervosa, further research on young females' restricted eating is warranted, especially in view of the fact that there exist limited theories on emotional undereating (Bjorklund et al., 2019; Kim, Heo, Kang, Song, & Treasure, 2010; Meule et al., 2019; Stice, Gau, Rohde, & Shaw, 2017).

Contrary to the research hypothesis, the interaction effect between impulse control difficulties and negative affect proved insignificant. We speculate that this result may have been due to the sample characteristic marked by emotional over-control rather than under-control. Thus, it is hypothesized that participants may have adopted undereating behaviors in an effort to gain a sense of control in face of negative affect, which is functionally similar to comfort eating or binge eating in relatively less inhibited individuals (Haynos et al., 2018). This interpretation implies differential contribution of specific subtypes of emotion dysregulation in the eating behavior spectrum. For instance, impulse control difficulties are thought to be linked to binge eating or overeating, as evidenced by a recent EMA study demonstrating the moderating role of impulse control difficulties in binge eating in female college students who identified themselves as emotional eaters (Yoon & Shim, 2019). On the other hand, other subtypes of emotion regulation difficulties (e.g., deficits in emotion awareness, acceptance or clarity) may be more relevant in predicting restrictive eating behaviors. Future research is warranted to investigate the association between specific emotion regulation difficulties and emotional over- or undereating.

This study contributes to the previous literature by adopting the EMA methodology including both behavioral and psychological measures, thereby reinforcing the ecological validity of the findings. Specifically, this study demonstrated a cross-level interaction between person-level psychological characteristics and state-level affect and eating behaviors. Another strength of this study lies in the operationalization of eating, where calorie counting was employed instead of self-reported dietary recall. This approach holds particular importance for future studies including samples with

significantly greater body dissatisfaction who are known to demonstrate low self-reporting accuracy in dietary recall tasks (Taren et al., 1999).

It should be noted that current study bears several limitations. First, although EMA methodology has been known to maximize ecological validity of research findings it does not directly examine causal relationship between two variables. Relatedly, this study did not establish temporal precedence nor causal effect of negative affect in that it tested the association between caloric intake measured over the course of a day and negative affect assessed once at a random time during the same day. In addition, the Level 2 variables were assessed after the completion of the 7-day EMA protocol, the course of which may have influenced participants' body image or perceived emotion regulation tendencies. Therefore, neither a causal link nor a moderation effect can be confirmed. Meanwhile, it is noteworthy that the bi-directionality of affect and eating has been suggested in recent EMA studies (Engel et al., 2013; Schaefer et al., 2020). In other words, what individuals eat and/or how much they eat may influence how one feels afterwards (Polivy & Herman, 2005). From this standpoint, future EMA studies are encouraged to sample data at a higher frequency and establish a temporal order of study variables in an effort to unravel the bidirectional link between affect and eating. For additional analysis of the reversed association between affect and eating in the present study, readers are referred to Appendix B.

Secondly, the observer effect or the tendency to modify one's behavior in response to their awareness of being observed (Landsberger, 1958), may have influenced participants' food consumption because the calorie tracker application used in current study allowed its users to view their present and past records of food intake. Although past research has indicated that EMA reactivity in eating behavior domain is at most "a minimal concern" (Fitzsimmons-Craft et al., 2016), it is still inconclusive since this study did not directly examine participants' EMA reactivity.

Lastly, the impact of the novel coronavirus disease (COVID-19) should be taken into account when interpreting or replicating the results. The data collection stage of current study (January to June 2020) directly coincided with the outbreak and early transmission phase of COVID-19 in South Korea. Emerging evidence suggests that COVID-19 and subsequent preventative measures

such as social distancing may have caused emotional distress beyond the fear of infection (Taylor et al., 2020; Weissman, Bauer, & Thomas, 2020). With regards to eating behaviors, both restrained eating (27.6%) and binge eating behaviors (34.6%) were reported to have increased in undiagnosed populations since the COVID-19 pandemic (Phillipou et al., 2020). Although inconclusive, the economic, emotional and health-related sequelae of the pandemic could have influenced the overall level of negative affect and subsequent undereating behaviors in participants with poor body image.

Author contributions statement

JYJ, graduate student in the Department of Psychology of Yonsei University, designed the study, conducted data collection and analysis, and drafted the manuscript. SHP, associate professor in the Department of Psychology of Yonsei University, supervised the research design, data collection and analysis process. All authors provided critical feedback, participated in the revision of the manuscript and approved the final submission.

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Appendix A. *Descriptive Statistics for Person-level Caloric Intake over 7-day EMA protocol (N = 72)*

Variable	Range	<i>M</i>	<i>SD</i>
Total caloric intake (kcal)	501.14–2,173.57	1,292.49	337.80
Snack (kcal)	0–564.86	166.62	142.19
Main meals (kcal)	370.28–1,934.14	1,123.40	301.11
Calories consumed as main meals (%) ^a	44.42–100	87.29	10.50
Main meal frequency (times)	0.57–3	2.40	.51
Snacking frequency	0–2.14	.62	.48

Note. For all variables, grand mean and standard deviation of person-level means over the 7-day EMA protocol period were calculated.

^aPercentage of calories consumed as main meals was calculated using the following equation: (person-level mean of caloric intake from main meals) ÷ (person-level mean of caloric intake from snacks) × 100.

Appendix B.

Additional Hierarchical Linear Modeling Analysis

In addition to our initial hypotheses, negative affect was regressed on person-mean centered caloric intake (Level 1) to examine whether the amount of caloric intake predicts negative affect on the same day. Within-person (Level 1) effects analysis showed that caloric intake did not significantly predict negative affect on the same day ($t = .08$, *ns.*). In the Intercepts-and-Slopes-as outcome model, thin-ideal internalization and impulse control difficulties were separately entered as Level 2 predictor of the relationship between caloric intake and negative affect. BMI was entered as a simultaneous predictor to statistically control for its potential impact. Thin-ideal internalization did not show a statistically significant interaction effect ($\beta_{11} = .00$, $t = .82$, *ns.*) nor did impulse control difficulties ($\beta_{11} = .00$, $t = -.82$, *ns.*). Further results of the HLM analysis can be found in Table B1.

Table B1. Random effects from Hierarchical Linear Modeling: Predicting Negative Affect from Caloric Intake (Level-1) with Level-2 Predictors Entered as Moderators ($N = 72$)

Predictor		Random Effect			<i>p</i> -value	95% CI	
		Estimates	SE	t-ratio		Lower	Upper
TII	Means as outcomes						
	Intercept, β_{00}	16.16	.81	20.00	< .001***	14.57	17.75
	TII, β_{01}	-.02	.16	-.14	.89	-.33	.29
	BMI, β_{02}	.65	.61	1.08	.29	-.55	1.85
	Slopes as outcomes						
	Intercept, β_{10}	.01	.00	2.50	.02*	.01	.01
	TII*CI, β_{11}	.00	.00	.82	.42	.00	.00
	BMI*CI, β_{12}	.01	.00	1.81	.08	.01	.01
ICD	Means as outcomes						
	Intercept, β_{00}	16.15	.81	20.02	< .001***	14.56	17.74
	ICD, β_{01}	.03	.18	.15	.89	-.32	.38
	BMI, β_{02}	.63	.61	1.04	.30	-.57	1.83
	Slopes as outcomes						
	Intercept, β_{10}	.01	.00	2.54	.01**	.01	.01
	ICD*CI, β_{11}	-.00	.00	-.82	.42	.00	.00
	BMI*CI, β_{12}	.00	.00	1.74	.09	.00	.00

Note. BMI = Body Mass Index, CI = Caloric Intake, TII = Thin-ideal Internalization, ICD = Impulse Control Difficulties.

* $p < .05$, ** $p < .01$, *** $p < .001$, two-tailed.