Examining relationships among thin-ideal internalization, eating pathology, and motivational reactions to high- and low-calorie food

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Abstract

Motivational responses to food stimuli are relevant for eating disorders (EDs). Research examining reactions to food in EDs has been mixed, with some studies reporting enhanced appetitive responses, and others observing defensive responses, to food. Thin-ideal internalization, a socio-cognitive factor implicated in EDs, may relate to these mixed findings, as individuals with eating pathology may experience food as a threat to internalized ideals of thinness, despite its inherently appetitive qualities. In the present study, physiological reflexes measuring defensive (startle blink reflex) and appetitive (postauricular reflex) responding as well as self-report ratings were recorded while 88 women with and without eating pathology viewed images of high- and low-calorie food. Greater global eating pathology, but not thin-ideal internalization, was associated with negative self-report valence ratings and lower craving ratings of high-calorie food. In contrast, greater thin-ideal internalization and eating pathology both related to more positive self-report valence ratings of low-calorie food, with thin-ideal internalization accounting for some of the shared variance between low-calorie food ratings and eating pathology. Overall, thin-ideal internalization may represent a higher-order factor that may contribute to the relationship between conscious reactions to food and disordered eating.

Keywords: thin-ideal internalization; food; motivation; startle blink reflex; postauricular reflex

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1. Introduction

Thin-ideal internalization refers to the degree to which an individual subscribes to socially reinforced ideals of weight and shape (Thompson et al., 1999; Thompson & Stice, 2001). Thin-ideal internalization is a central component of the dual-pathway model (Stice, 1994). This etiological model of eating disorders (EDs) posits that pressure to conform to the thin-ideal, and pursuit of this ideal, elicit body dissatisfaction, which increases risk for dietary restraint and, subsequently, binge eating and the use of compensatory behaviours (Stice, 1994). There is extensive empirical support for the dual-pathway model and, specifically, the role of thin-ideal internalization as a risk factor for the development of EDs in women (for a review, see Keel & Forney, 2013). In line with this model, sociocultural factors increase risk for thin-ideal internalization (for reviews, see Lopez-Guimera et al., 2011; Mingoia et al., 2017), and thin-ideal internalization relates strongly to body dissatisfaction in women (for a review, see Paterna et al., 2021). Fortunately, interventions exist to directly target thin-ideal internalization; for example, dissonance-based prevention programs have been shown to effectively reduce ED risk factors and symptoms through exercises aimed at challenging the thin-ideal and demonstrating how its pursuit is at odds with personal values (for a review, see Stice et al., 2019). Taken together, thin-ideal internalization has been established as both a prospective risk factor for EDs as well as an effective target for intervention, highlighting the critical importance of continuing to refine our understanding of this construct and its relationship with EDs.

By definition, thin-ideal internalization equates thinness with what is ideal and implies that being overweight is perceived as a negative characteristic. It has been argued that the

positive valence accorded to thinness can result in approach motivation toward thin bodies, whereas fatness can prompt avoidance of overweight bodies due to its negative valence (see Dondzilo et al., 2019 for a discussion). Indeed, several studies have reported that greater thin-ideal internalization is associated with both a stronger approach response toward thin bodies (Dondzilo et al., 2019) and an increased avoidant response to overweight bodies (Woud et al., 2011), as assessed by computerized tasks requiring participants to move a figure towards or away from the presented body image. Furthermore, Mussap (2007) found that relationships between both self-reported sensitivity to reward and punishment (indicative of general approach and avoidance motivation, respectively) and eating pathology were partly explained by thin-ideal internalization. These studies suggest that ED behaviours may be motivated by a desire to move toward thinness and/or away from a feared overweight body and show that this association may be related to thin-ideal internalization. While thin-ideal internalization has been found to contribute to the relationship between approach and avoidance motivation to body stimuli and eating pathology, the potential impact of this construct in the relationship between reactions to food and ED symptoms has not been examined. Thin-ideal internalization may be related to evaluations of food due to associations between weight gain with high-calorie food and weight loss with low-calorie food.

Similar to the literature examining reactions to bodies, both appetitive and defensive motivational responses to food have been observed in individuals with eating pathology. Though food is a universally appetitive stimulus, some evidence suggests that food may be particularly rewarding for individuals with binge-type eating pathology (Bodell & Keel, 2015; Racine et al., 2018; Simon et al., 2016). Conversely, many studies have also reported enhanced defensive reactions to food stimuli in people with EDs and disordered eating behaviours (Erdur et al.,

2017; Rodriguez et al., 2007; Soussignan et al., 2010). In line with the motivational conflict hypothesis, there is evidence to suggest that food elicits both positive and negative emotional reactions in individuals with eating pathology, particularly those who experience binge eating (for a review, see Burmester et al., 2021).

Evidence from laboratory-based studies indirectly supports a link between thin-ideal internalization and reactions to food. Indeed, thin-ideal exposure either elicits an increase (Durkin et al., 2013; Mills et al., 2002; Monro & Huon, 2006; Seddon & Berry, 1996; Strauss et al., 1994; Warren et al., 2005) or a decrease (Anschutz et al., 2008; Anschutz et al., 2009; Stampfli & Brunner, 2016) in food intake depending on the sample examined. Thus, it is possible that thin-ideal internalization may be implicated in the relationship between motivational responding to food and eating behaviour. Support for this notion comes from an evaluative conditioning study conducted in a non-clinical sample of women; food stimuli (even foods that were initially rated positively) were rated more negatively after repeated pairing with images of obese women (Lascelles et al., 2003). Based on these results, the authors suggested that the negative valence attributed to overweight bodies might transfer to food (Lascelles et al., 2003). Taken together, research suggests that there is a relationship between both food intake and evaluations of food with exposure to thin and overweight bodies. These findings suggest that appetitive and defensive reactions to food may also be associated with a desire to attain a thin body (or avoid having an overweight body).

Despite its appetitive qualities, food may be viewed as a threat to the attainment or maintenance of internalized ideals of thinness. More specifically, if the idealized thin body and feared overweight body are thought of in terms of approach and avoidance goals, respectively (Elliot, 1999), defensive responses to high-calorie food and appetitive responses to low-calorie

food may represent an approach response toward attainment of a thin body. Thin-ideal internalization, conceptualized as part of an appearance schema (Cash, 2011; see Yamamiya et al., 2005 for a discussion), can be activated in response to external stimuli. Low-calorie food, with its association with dieting and weight loss, may represent a form of salient stimuli that activates the appearance schema. Associated with weight gain, high-calorie food may also activate this schema as a threat to attainment of the thin ideal. It is therefore possible that exposure to high- and low-calorie food may increase the salience of thin-ideal internalization.

The current study used a multi-method paradigm to examine the association between motivational reactions to food and thin-ideal internalization and to investigate whether thin-ideal internalization may contribute to the relationships between these motivational reactions and eating pathology. Participants viewed images of both high- and low-calorie foods and provided self-report ratings of valence, arousal, and craving for each food image. Reflexive psychophysiology measures were used as implicit indices of appetitive and defensive motivation to food; the startle blink reflex is potentiated during aversive stimuli, relative to neutral stimuli, while the postauricular reflex (PAR) is potentiated during pleasant stimuli, relative to neutral stimuli (Lang et al., 1998; Benning, et al., 2004). Importantly, these reflexes are uncorrelated, which allows for a simultaneous assessment of each motivational system (appetitive and defensive) and (theoretically) the ability to capture motivational conflict towards stimuli, something that is not possible with other common measures of approach and avoidance (e.g., Stimulus Response Compatibility Task; see Racine et al., 2021 for a discussion). Furthermore, previous studies have found associations between these physiological measures and self-report ratings of emotional stimuli (e.g., Lang et al., 1993; Suissa-Rocheleau et al., 2019).

Socially and culturally prescribed values relating to the importance of thinness may be

especially salient in response to food and subsequently relate to eating pathology. Accordingly, it was hypothesized that greater thin-ideal internalization would be associated with enhanced startle blink and more negative self-report ratings in response to high-calorie food as well as with enhanced PAR and more positive ratings in response to low-calorie food. Given previous studies that have reported that thin-ideal internalization mediates the relationship between exposure to thin-ideal media and both ED symptoms (Stice et al., 1994) and body dissatisfaction (Arroyo, 2015), it was also hypothesized that at least some of the shared variance between both physiological and self-report reactions to food and global eating pathology would be attributable to thin-ideal internalization. Understanding factors that underlie differences in responses to food in individuals with eating pathology is important, as affective and motivational reactions to stimuli are linked to subsequent behaviour (Boswell & Kober, 2016). Furthermore, research of this kind may help to identify another area in which interventions targeting thin-ideal internalization may be effective (Stice et al., 2019).

2. Method

2.1 Participants

Eighty-eight women (*M* age = 23.19, *SD* = 9.55; *M* BMI = 25.27, *SD* = 5.39; 89.02% White) participated in the current study. Participants with and without binge eating and/or dietary restriction were recruited from a Midwestern United States university and the surrounding community via posted advertisements, mass emails, and social media. Participants completed an online screening questionnaire prior to enrolling in the study to assess the following exclusion criteria: 1) uncorrected visual impairment, 2) auditory impairment, 3) current use of psychotropic medication, 4) use of sleeping aids or sedatives in the 24 hours prior to study participation, and 5) history of concussion lasting longer than 30 minutes. The presence versus absence of binge

eating and dietary restriction in the past 3 months was assessed via the online screener and confirmed during an in-person clinical interview using a modified version of the Eating Disorders Examination (EDE; Fairburn, 2008). Based on the interview, 22 participants reported objective binge eating episodes only, 20 participants reported dietary restriction only, 27 participants endorsed both behaviours, 17 participants endorsed neither behaviour, and two participants were missing clinical interview data. More details about study methods are described in Racine et al., 2021, which describes the parent study aims to examine implicit and explicit motivational responses to high- and low-calorie food in women with different forms of eating pathology.

2.2 Images

Images of high- and low-calorie foods were selected from the Open Library of Affective Foods (OLAF; Miccoli et al., 2014; 2016) and the internet. The OLAF includes 96 ecologically valid images and was created to be used in conjunction with the International Affective Picture System (IAPS) and the Self-Assessment Manikin (SAM) rating system (see below). The OLAF was designed to include foods that are unambiguously high-calorie or low-calorie, rather than to represent the entire spectrum of foods (Miccoli et al., 2014). High-calorie foods are further divided into those that are sweet (e.g., ice cream) versus savoury (e.g., French fries), whereas low-calorie foods include fruits and vegetables. The OLAF has been validated in large community samples of adolescents and adults, and normative ratings are available for valence, arousal, and craving ratings (Miccoli et al., 2014; 2016). As the OLAF image set was created in Spain, some of the images do not reflect foods that are commonly consumed in North America. As such, additional food images were selected from the internet. Images eliciting the highest valence, arousal, and craving ratings in an undergraduate sample (Racine, 2018) were included in

the current study. In total, participants were presented with 12 high-calorie (6 sweet; 6 savoury) and 12 low-calorie (6 fruits, 6 vegetables) food images.

Emotional images were drawn from the International Affective Picture System (IAPS; Lang et al., 2008), a database of ~1000 images for which normative data for valence and arousal has been collected in large community samples (Lang et al., 2008). As part of the larger study, 12 pleasant (6 nurturant, 6 erotic), 12 aversive (6 threat, 6 mutilation/disgust), and 12 neutral (6 people, 6 objects) images were presented to participants. For the present study, responses to the neutral images were used as an anchor point from which to compare physiological responses to food images.

2.3 Measures

2.3.1 Sociocultural Attitudes Towards Appearance Questionnaire-4 (SATAQ-4; Schaefer et al., 2015).

The SATAQ-4 is a 22-item self-report measure. The present study examined the 'Internalization: Thin/Low Body Fat' subscale, which assesses internalization of an idealized thin body type. This subscale is comprised of five items rated on a five-point Likert scale ranging from 'definitely disagree' to 'definitely agree'. This subscale has demonstrated strong convergent validity and good-to-excellent internal consistency in samples of women from the United States (α's ranging from .82-.87) and other countries (α = .91; Schaefer et al., 2015), as well as in the present sample (α = .86).

2.3.2 Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994).

The EDE-Q is a self-report measure assessing eating symptomatology over the previous 28 days. The EDE-Q includes four subscales: restraint, eating concern, shape concern, and weight concern. The Global Score represents the average of the four subscale scores. The items included in these subscales are rated using a seven-point Likert scale. Due to an oversight when

entering this measure into the online survey software, item 6 belonging to the EDE-Q Shape Concern subscale was not included in the study; thus, the mean for this subscale was calculated based on seven rather than eight items. Internal consistency of the EDE-Q Global Score has previously been found to be excellent (Berg et al., 2012) and this was also true in the present sample (α = .95). Test-retest reliability and temporal stability have been found to range from good-to-excellent for the EDE-Q, which has also been found to correlate highly with scores on the EDE interview as well as other measures of eating pathology (for a review, see Berg et al., 2012).

2.3.3 Inventory of Depression and Anxiety Symptoms – II (IDAS-II; Watson et al., 2012). The IDAS-II is a 99-item self-report measure assessing symptoms of mental health conditions across 18 subscales. A 'general depression' subscale can be calculated by combining the 'dysphoria' subscale in its entirety with two items from each of the following subscales: 'appetite loss', 'insomnia', 'lassitude', 'suicidality', and 'well-being'. Due to ethics concerns, items from the 'suicidality' subscale were omitted in the present study. The 'general depression' subscale has been found to have excellent internal consistency in clinical (α = .87) and non-clinical samples (α = .91; Irak & Albayrak, 2020), and this was the case in the current sample as well (α = .90). The IDAS-II 'general depression' subscale was used in the present study to control for the effects of depression on appetitive responses to food.

2.3.4 Self-Assessment Manikin (SAM; Bradley & Lang, 1994). The SAM is a pictorial rating scale originally designed for rating the IAPS images and more recently has been used to rate OLAF images as well. In the present study, we included two of the original SAM scales measuring valence on a scale from 1 (happy) to 9 (unhappy) and arousal on a scale from 1 (excited) to 9 (calm). We also included the SAM craving scale, which measures level of craving

on a scale from 1 (strong desire to eat) to 9 (no desire to eat). The SAM craving scale, originally developed for use in addiction research, has been validated for use with OLAF images (Miccoli et al., 2014).

2.3.5 Body Mass Index (BMI). Participants were weighed using a digital scale, and their height was measured using a wall-mounted ruler. The standard formula was used to calculate BMI. As it has been previously associated with self-reported and physiological responses to food (Batterink et al., 2010; Ferreira de Sa et al., 2014; Johnson et al., 2014; Kilgore et al., 2005), BMI was included as a covariate in the current study.

2.4 Procedure

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ohio University Institutional Research Board (16-X-142). All participants gave informed consent prior to study participation.

2.4.1 Startle paradigm. Participants were instructed to eat a meal two hours prior to testing and to avoid eating, smoking, or drinking caffeinated beverages in the hour prior to assessment (Altman et al., 2013; Racine et al., 2016). Participants were seated in a lounge chair facing a 24-inch monitor. Participants were randomly assigned to view images in one of four run orders. No two images of the same content category (e.g., nurturant) and no more than two images of the same valence (e.g., pleasant) were ever presented consecutively in any of the run orders.

Participants were first presented with five test images to familiarize them with the procedure (i.e., startle probes, rating scales, etc.). Participants then viewed 60 images (36 emotional images and 24 food images) and immediately rated each using the three SAM scales described above. Consistent with previous studies (e.g., Benning & Ait Oumeziane, 2017),

images were presented for 6s followed by a 3s inter-trial-interval (ITI) during which participants viewed a black screen. On 84% of the trials, an auditory startle probe (50 ms 95dB burst of white noise with near instantaneous rise and fall time) occurred at 3, 4, or 5 seconds post-image onset (Benning & Ait Oumeziane, 2017). A startle probe went off during the ITI on an additional 8% of the trials to enhance the unpredictability of the startle probes (Benning & Ait Oumeziane, 2017).

2.4.2 Psychophysiology data collection and reduction. Participants' skin was cleaned at the sensor application sites using alcohol wipes and NuPrep (Medline Industries Inc.) to remove makeup and dead skin cells. Two sintered 4mm Ag/AgCl electrodes filled with Signa electrode gel (Parker Laboratories Inc.) were attached to the lower left orbicularis oculi muscle under the left eye to measure the startle blink response (Blumenthal et al., 2005). To locate the postauricular muscle, each ear was pulled back to reveal the fibrous strip that connects the ear to the scalp; one electrode was placed next to the tendon on the ear and the other was placed on the scalp over the muscle (Benning et al., 2004). An electrode was also placed in the middle of the forehead to act as a ground.

The data were collected using a MindWare Bionex system. The sampling rate was 1000 Hz with a gain of 5000. A 60 Hz notch filter was applied during processing of startle blink and PAR electromyographic signals (EMGs) using MindWare EMG software. For startle blink data, a 28-500 Hz bandpass filter was also applied and a rolling filter of 10 samples was used to smooth the rectified data. Startle blink responses were scored as the peak activity 30-120 ms after startle probe onset minus mean baseline activity 50 ms pre-probe (Blumenthal et al., 2005). PAR EMGs were filtered with a 50/60 Hz notch filter and an 8-500 Hz bandpass filter. As PAR is a micro-reflex (Hackley et al., 1987), trials were aggregated across images of the same type.

The aggregate PAR waveforms were scored as the peak activity 8-35 ms after startle probe onset minus mean baseline activity 50 ms pre-probe (Racine et al., 2018). During data analysis of the PAR, the peaks were averaged across both ears (when data were available for both).

Each startle blink and PAR aggregate waveform was evaluated to determine the presence of a response. Trials for which it was impossible to determine if there was a response due to 'noise' (i.e., responses indistinguishable from baseline) were excluded from analyses. Trials without a response were included in the analyses but were coded as '0'. Startle blink reflex data were unusable for six participants and PAR data were unusable for seven participants due to unstable baseline activity or mean responses less than 2 uV. Startle blink reflex and PAR magnitudes were within-subject z-scored to correct for inter-individual differences in reflex magnitudes. These scores were subsequently calculated relative to neutral images (e.g., startle blink response to high-calorie food images minus startle blink response to neutral images).

2.5 Statistical Approach

The analyses described in this manuscript are secondary analyses conducted on data collected as part of a larger study (Racine et al., 2021). The hypotheses tested were specified before conducting these analyses. All statistical analyses were conducted in SPSS version 21. A critical false positive rate (or α level) of .05 was used in all analyses. A natural log transformation was used for BMI given the kurtosis (3.92) of the distribution of scores. Pearson correlations were used to examine the relationships among all study variables. Indirect effects analyses were conducted using the PROCESS macro, version 4 (Hayes, 2022) using 5000 bootstrapped samples and 95% confidence intervals around coefficients.

3. Results

3.1 Differences in Image Ratings, Startle Blink, and PAR by Picture Type

As reported elsewhere (Racine et al., 2021), valence, arousal, and craving ratings differed by picture type, as expected. High-calorie and low-calorie food images were rated similarly on valence, with ratings falling in between those for pleasant and neutral images. Arousal ratings for high-calorie food images were significantly greater than for low-calorie food images and similar to those for pleasant and aversive images. Craving ratings were also significantly higher for high- vs. low-calorie food images. There also were significant differences in startle blink magnitude and PAR by picture type. Startle blink magnitude was attenuated to pleasant, high-calorie food, and low-calorie food images, and enhanced to aversive images, relative to neutral images. PAR magnitude was enhanced to pleasant, high-calorie, and low-calorie images, relative to neutral images, with pleasant and high-calorie images also having larger average PAR magnitudes than low-calorie images. High- and low-calorie food images did not differ on startle blink or PAR magnitude. Thus, the following results can be interpreted in the context of an established effect of picture type on self-report ratings as well as startle blink and PAR magnitudes.

3.2 Descriptive Statistics

Means and standard deviations for the variables of interest are presented in Table 1. Mean scores for the EDE-Q Global Score in the present sample (M = 2.70; SD = 1.37) were approximately one standard deviation above community norms (M = 1.554; SD = 1.213; Fairburn et al., 2008), which would be expected given our recruitment of individuals with eating pathology. Mean SATAQ-4 Thin/Low Body Fat Internalization scores in the present sample (M = 3.65; SD = 1.11) were similar to those from samples of undergraduate women from the United States (M = 3.41, SD = .92; Schaefer et al., 2015).

3.3 Correlations

Correlations are presented in Table 1. SAM valence, arousal, and craving ratings of high-calorie food images were significantly correlated (*r*s = .62 - .67, $p < .001$). SAM ratings were also significantly correlated for low-calorie food images (*r*s = .57 - .72, $p < .001$). Further, SAM ratings of high- and low-calorie food images were significantly correlated (valence ratings: $r = .29$, $p = .006$; arousal ratings: $r = .76$, $p < .001$; craving ratings: $r = .60$, $p < .001$). SAM ratings of high- and low-calorie foods did not correlate with startle blink reflex or PAR during either food type (*r*s < .15, *p*s > .17).

Regarding associations with thin-ideal internalization and ED symptomatology, SAM valence ratings of low-calorie food images were negatively correlated with thin-ideal internalization ($r = -.26$, $p = .016$) and ED symptomatology ($r = -.21$, $p = .049$). These negative correlations indicate that rating low-calorie food images as *more pleasant* was associated with greater thin-ideal internalization and eating pathology. SAM valence ($r = .23$, $p = .033$) and craving ($r = .23$, $p = .031$) ratings of high-calorie food images were positively correlated with EDE-Q scores, meaning that rating high-calorie food images as *less pleasant* and *lower on craving* was associated with greater ED symptoms. SAM ratings of high-calorie foods were not significantly correlated with thin-ideal internalization (*r*s < .19, *p*s > .07). Neither startle blink reflexes nor PAR during high- and low-calorie foods, compared to neutral images, were related to thin-ideal internalization or ED symptomatology (*r*s < .08, *p*s > .46). As SAM valence ratings of low-calorie food was the only measure of response to food that was significantly correlated with thin-ideal internalization, a single indirect effects analysis was conducted using this as the independent variable.

3.4 Indirect Effects Analysis

An indirect effects analysis was conducted, with self-reported valence ratings of low-calorie food as the independent variable and the EDE-Q Global Score as the dependent variable. Thin-ideal internalization was entered as the intermediate variable. The 'general depression' subscale of the IDAS-II and BMI were entered as covariates. Results of this analysis suggested that some of the shared variance between self-reported valence ratings of low-calorie food and EDE-Q Global score was attributable to thin-ideal internalization (standardized indirect effect = -.11, SE = .05, 95% CI [-0.23, -0.02]; see Figure 1). This was true after accounting for the significant effects of both depression (β = .33, $t(81) = 3.97$, p = .0002, 95% CI [0.02, 0.05]) and BMI (β = .18, $t(81) = 2.19$, p = .03, 95% CI [0.12, 2.45]) on EDE-Q Global Score.

As a sensitivity analysis, a second indirect effects analysis was conducted with thin-ideal internalization as the independent variable, self-reported valence ratings of low-calorie food as the intermediate variable, and EDE-Q Global Score as the dependent variable. The indirect effect was not significant in this model (standardized indirect effect = .02, SE = .03, 95% CI [-0.03, 0.08]).

4. Discussion

The present study examined associations between thin-ideal internalization, eating pathology, and implicit and explicit motivational reactions to food stimuli. We found that rating low-calorie foods as more pleasant was associated with greater thin-ideal internalization and eating pathology, and that the association between self-report valence ratings of low-calorie foods and eating pathology was partially attributable to thin-ideal internalization. In contrast, rating high-calorie foods as less pleasant was only related to eating pathology and not to thin-ideal internalization. These findings are consistent with the vast body of literature highlighting the importance of thin-ideal internalization for EDs (e.g., Keel & Forney, 2013) and suggest that

altered reactions to food may be another facet of eating pathology that is associated with this construct.

Previous studies have reported enhanced approach toward low-calorie food in individuals with AN (Cowdrey et al., 2013; Neimeijer et al., 2015; 2019). These results are consistent with the present finding that positive ratings of low-calorie food (which may elicit an approach response) were associated with both thin-ideal internalization and global eating pathology. Furthermore, the association between pleasure ratings to low-calorie food and eating symptomatology was partially explained by thin-ideal internalization. These results suggest that low-calorie foods may be rated positively due to their association with weight loss and potential attainment of an idealized thin body. This interpretation is consistent with that of Cowdrey and colleagues (2013) who suggested that increased motivation to consume low-calorie food in individuals with AN may be a result of cognitive processes (e.g., overvaluation of eating, shape, and weight; Cowdrey et al., 2013). In further support of this idea, arousal and craving ratings of low-calorie food were not significantly associated with thin-ideal internalization. These null findings suggest that investment in the thin ideal does not increase the desire to eat (i.e., craving) nor the excitement or interest (i.e., arousal) sparked by low-calorie foods, but rather that the pleasure associated with these foods for individuals with eating pathology may relate to a perceived association between this type of food and weight loss/dieting.

Thin-ideal internalization was not related to implicit or explicit/evaluative reactions to high-calorie food. Thin-ideal internalization can be thought of as an indicator of approach motivation towards thin bodies (see Dondzilo et al., 2019 for a discussion) and thus may not be implicated in avoidant/defensive reactions of bodies and/or food. A next logical step for future studies may be to examine constructs representing an avoidance/defensive motivation

orientation, such as fear of fat (e.g., Chow et al., 2019) or fear of an overweight self (e.g., Dalley & Buunk, 2009; 2011) and their potential roles in the high-calorie food reactions- eating pathology association. These indicators of avoidance/defensive motivation have already been associated with ED symptoms, including dietary restraint (Chow et al., 2019; Dalley & Buunk, 2009; 2011; MacLeod et al., 2020), which suggests they may also play a role in the relationship between reactions to food and eating pathology.

There was no association between physiological (i.e., startle blink reflex and PAR) responses to high- or low-calorie food with either thin-ideal internalization or global eating pathology. These null findings may suggest that the relationship between thin-ideal internalization and reactions to food is reflected at the explicit, cognitive level, as reflected by self-report measures, as opposed to the implicit, motivational level, as reflected by physiological measures. The fact that these two types of measures tap different aspects of emotion/motivation likely explains why they are often unrelated to one another, as was the case in the current study, and why studies often report divergent results for physiological and self-report assessments (e.g., Drobes et al. 2001, Mauler et al., 2006; Racine et al., 2018). Thin-ideal internalization may reflect a self-regulatory factor that influences eating behavior by contextualizing motivational and homeostatic systems within an individual's values and goals (Treasure et al., 2012); thus, it is not surprising, that thin-ideal internalization is more strongly related to cognitive evaluations, rather than emotional experience of food. Though results for the physiological measures were null, they help us to situate the relationship between thin-ideal internalization and reactions to food at the conscious level. These null findings suggest that existing cognitive interventions (e.g., dissonance-based strategies; Stice et al., 2019) may be effective in addressing the relationship between altered responding to food and eating pathology as it relates to thin-ideal

internalization, given that these relations were only observed at the explicit, cognitive rather than the implicit, unconscious level.

It is important to note that, in the same sample as reported here, *lower* valence, arousal, and craving ratings of low-calorie food, as well as attenuated PAR to high-calorie food, were associated with the presence/frequency of restrictive eating episodes (Racine et al., 2021). This suggests that the results described here pertaining to positive valence ratings of low-calorie food are not accounted for by a relationship between thin-ideal internalization and restrictive eating. The association between positive valence ratings of low-calorie food with thin-ideal internalization and global eating pathology in the same sample may reflect the distinction between cognitive restraint (i.e., intentions to limit caloric intake) and dietary restriction (i.e., actual reduction of caloric intake). Indeed, Racine (2018) previously found a similar pattern of results, where cognitive restraint was correlated with more positive valence (and craving) ratings of low-calorie food, while dietary restriction was related to less positive valence and craving ratings of both high- and low-calorie food, in female undergraduates. Taken together, the association between thin-ideal internalization and eating pathology with greater pleasure towards low-calorie food likely reflects the *desire* to lose weight in order to attain thinness insofar as low-calorie food is viewed as consistent with eating and weight goals.

The present study is strengthened by the use of both implicit and explicit measures to examine reactions to not only high-calorie, but also low-calorie food. In the extant research literature, contrasting patterns of responding to food stimuli have been noted between implicit and explicit measures (e.g., Drobes et al., 2001; Mauler et al., 2006), suggesting that different types of measures may capture distinct reactions to food stimuli. It is therefore important to use a multi-method approach to gain a more complete understanding of the range of affective and

evaluative responses to food stimuli. Furthermore, past (e.g., Cowdrey et al., 2013) and present findings suggest the importance of taking caloric content into account when investigating reactions to food, as different patterns of responding have been observed for high- as compared to low-calorie food in individuals with eating pathology.

A limitation of the present study is the recruitment of a heterogeneous sample of women with a variety of forms of eating pathology (e.g., binge eating and/or restrictive eating; subthreshold vs. clinical eating pathology), which may have masked effects that might characterize one group but not others. Further, though the present study was adequately powered to detect significant medium correlations between physiological reactions to food and thin-ideal internalization, it was underpowered to detect smaller effects. That said, the observed associations were extremely small, which suggests that insufficient power does not fully explain the null results obtained in the present study. Additionally, due to the cross-sectional nature of the data, it is impossible to make temporal or causal inferences regarding relationships between these constructs. For example, it would be interesting for future studies to measure the causal effects of exposure to high- and low-calorie food images on state thin-ideal internalization. Also, though the foods included in the OLAF were selected to represent only extremely high- and low-calorie foods, the lack of normative data relating to perception of caloric density of the food depicted in the images is a limitation of this image set (Blechert et al., 2019). Finally, the present study was limited in that it measured thin-ideal internalization, an indicator of the importance of approaching thinness, and did not include a measure of avoidance motivation (e.g., fear of fat, fear of an overweight self, etc.). Future studies would benefit from investigating the relative roles of thin-ideal internalization and fears relating to body shape and weight in the relationship between reactions to food stimuli and eating pathology.

In conclusion, thin-ideal internalization was identified as a factor that partially contributes to the relationship between positive valence ratings of low-calorie food and ED symptoms. Lack of significant findings for the association between thin-ideal internalization and physiological reactions to food stimuli suggest that this construct may be implicated at the conscious rather than automatic or basic motivational level, though this may change with increasing ED severity. The results of the present study highlight the need to broaden our examination of the relationship between eating pathology and reactions to food to include higher-order factors such as thin-ideal internalization. As motivational responses to food influence eating (Boswell & Kober, 2016), understanding and targeting the factors that may contribute to this relationship may have a significant impact on modifying disordered eating behaviours. Dissonance-based strategies have been found to be effective in ED prevention (Stice et al., 2019) and may be applicable to attenuating the impact of investment in the thin-ideal on the relationship between reactions to food and eating pathology. Although replication is needed, the present findings suggest that, in addition to their utility in prevention programs, interventions targeting thin-ideal internalization may also be helpful in clinical contexts when faced with maladaptive reactions to food.

Author Contributions

Samantha Wilson: Conceptualization, Formal analysis, Writing – Original Draft. **Stephen D. Benning:** Methodology, Writing – Review and Editing. **Sarah E. Racine:** Conceptualization, Methodology, Writing – Review and Editing, Supervision.

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Data Availability

Data are available from the corresponding author (S. E. R.) upon request.

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Table 1

Correlations, means, and standard deviations for thin-ideal internalization, eating pathology, as well as self-reported and physiological responses to food

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. SATAQ	-													
2. EDE-Q	.59***	-												
3. IDAS-II[c]	.20	.45***	-											
4. BMI[d]	-.26**	.05	.08	-										
High-calorie														
5. SBR[a]	-.04	.07	-.05	.17	-									
6. PAR[a]	.07	-.06	.01	.01	-.05	-								
7. Valence[b]	.002	.23*	.19	.13	.01	.07	-							
8. Arousal[b]	-.19	-.04	-.02	.14	.04	.10	.62***	-						
9. Craving[b]	.06	.23*	.10	-.03	.08	.07	.67***	.67***	-					
Low-calorie														
10. SBR[a]	-.04	-.003	-.09	-.05	.58***	.03	-.01	.001	.12	-				
11. PAR[a]	-.08	-.01	.03	-.02	-.08	.50***	.12	.15	.15	.17	-			
12. Valence[b]	-.26*	-.21*	.04	.12	-.08	.01	.29**	.40***	.28**	.08	.12	-		
13. Arousal[b]	-.20	-.14	.02	.17	-.04	.02	.19	.76***	.33**	-.05	.01	.57***	-	
14. Craving[b]	-.08	.02	.06	.09	.07	.03	.24*	.48***	.60***	.10	.10	.72***	.61***	-
Mean	3.65	2.70	46.64	25.27	-.12	.39	3.50	4.56	3.56	-.11	.22	3.56	5.32	3.95
SD	1.11	1.37	13.55	5.39	.44	1.34	1.32	1.73	1.76	.52	1.44	1.07	1.57	1.62
N	87	87	86	87	82	81	88	88	88	82	81	88	88	88

Note. SATAQ = Sociocultural Attitudes Towards Appearance Scale, version 4, 'Internalization: Thin/Low Body Fat' subscale; EDE-Q = Eating Disorder Examination-Questionnaire, Global Score; IDAS-II = Inventory of Depression and Anxiety Symptoms-II, 'general depression' subscale; BMI = body mass index; SBR = startle blink reflex; PAR = postauricular reflex.

[a] relative to neutral images; [b]measured by Self-Assessment Manikin (SAM) scales; [c]suicide items omitted from subscale score; [d]natural log transformation applied

* $p < .05$; ** $p < .01$; *** $p < .001$