Valence and arousal-based affective evaluations of foods

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ABSTRACT

We investigated the nutrient-specific and individual-specific validity of dual-process models of valenced and arousal-based affective evaluations of foods across the disordered eating spectrum. 283 undergraduate women provided implicit and explicit valence and arousal-based evaluations of 120 food photos with known nutritional information on structurally similar indirect and direct affect misattribution procedures (AMP; Payne et al., 2005, 2008), and completed questionnaires assessing body mass index (BMI), hunger, restriction, and binge eating. Nomothetically, added fat and added sugar enhance evaluations of foods. Idiographically, hunger and binge eating enhance activation, whereas BMI and restriction enhance pleasantness. Added fat is salient for women who are heavier, hungrier, or who restrict; added sugar is influential for less hungry women. Restriction relates only to valence, whereas binge eating relates only to arousal. Findings are similar across implicit and explicit affective evaluations, albeit stronger for explicit, providing modest support for dual-process models of affective evaluation of foods.

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How we feel about a food shapes what, when, and how much we eat (e.g., Berridge, Ho, Richard, & DiFeliceantonio, 2010). We are more likely to eat the chocolate cake in the break room if we think the cake is very pleasant and desirable. In addition, dual process models suggest that automatic processes predict spontaneous behaviors, while controlled processes predict deliberative behaviors,[2] although these processes interact (Fazio & Olson, 2014; Perugini, 2005; Strack & Deutsch, 2004). Automatic evaluations of foods may contribute to disinhibited consumption, especially of fatty, sugary foods. Controlled evaluations are linked to deliberate, planful behaviors (e.g., Fazio & Olson, 2014), such as eating restriction. Understanding how automatic and controlled affective evaluations interact to shape eating behavior may inform intervention choice.

Classic dual-process models would predict theoretically that automatic evaluations of foods may play a greater role than controlled evaluations in the disinhibited consumption of foods high in fat and sugar, particularly when there are insufficient resources to inhibit the initial positive or activating evaluation (e.g., Hofmann, Rauch, & Gawronski,

2007). For example, when our cognitive resources are harnessed by an engrossing movie, we may be surprised to find that we have emptied the popcorn bucket, despite our intention to eat only a few handfuls. In contrast, theoretically, traditional dual-process models would posit that more effortful controlled evaluations may contribute to successful restriction of food intake to a greater degree than automatic evaluations. For instance, when our self-control resources have been bolstered by a good night's sleep, we may choose to forego a tasty pastry at the meeting, despite our initial desire for a baked good. It is important to understand for whom and under what circumstances automatic and controlled affective evaluations shape eating behavior.

However, three theoretical and methodological issues limit prior works' interpretability. First, researchers interested in automatic and controlled processes often juxtapose indirect evaluation measures (e.g., implicit association tests, IATs) with direct evaluation measures (e.g., self-reports). Often, null correlations between IATs and self-reported food attitudes are interpreted as dissociations between indirect and direct food affective evaluations. Such measures differ in procedural dimensions (e.g., response scaling and speed); such discrepancies, known as *poor structural fit* (Payne, Burkley, & Stokes, 2008), may inflate differences between implicit and explicit assessments. Without accounting for structural fit, implicit-explicit dissociations could reflect differences in the constructs of interest or the methods used to assess them.

The second issue involves affective dimensions. Most food evaluation studies examine only the pleasant-unpleasant *valence* dimension, though most affect models converge on both a valence and an activating-unactivating *arousal* dimension (e.g., Lang, 1995). Arousal is implicated in appetite for or motivation to approach reinforcing stimuli

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[2] Automatic processes possess *efficiency, unawareness, unintentionality,* and/or *lack of control,* whereas controlled processes may require cognitive resources, operate consciously and/or intentionally, and/or be under volitional control (Bargh, 1994; Moors & De Houwer, 2006). We use *implicit* and *explicit* as synonyms for *automatic* and *controlled,* respectively (e.g., De Houwer, 2006; De Houwer & Moors, 2007).

(e.g., Berridge, Robinson, & Aldridge, 2009; Berridge et al., 2010), such as palatable food, and may be relevant to disinhibited eating. For example, a dieter may *want* a cookie but may not *like* it because consuming high-fat, high-sugar foods is inconsistent with her weight-loss goal; she has evaluated the cookie to be activating but not pleasant. Much prior food-related affective evaluation work has overlooked arousal, though arousal theoretically plays a critical role in eating-related behavior (e.g., Craeynest, Crombez, Koster, Haerens, & De Bourdeaudhuij, 2008; Czyzewska & Graham, 2008).

Third, prior work typically examines restrictive or disinhibited eating, and utilizes coarse distinctions among food stimuli (e.g., healthy/unhealthy). Investigating the full disordered eating spectrum provides a more nuanced test of eating-related dual-process models. Coarse stimulus distinctions confound nutritional characteristics (e.g., fat and sugar content), which may independently influence affective evaluations (e.g., Woodward & Treat, 2015).

1. Overview of the present study

We examined the nomothetic (i.e., food-specific) and idiographic (i.e., person-specific) relevance of automatic and controlled processes to valenced and arousal-based food-related affective evaluations. We investigated both arousal-based and valenced evaluations, and simultaneously included both restrictive and disinhibited-eating measures to assess the role of food-related affective evaluations across the disordered-eating spectrum. We examined a dual-process model of food evaluations using measures that control method variance.

1.1. Nomothetic, food-specific predictors

We employed many food images with known nutritional properties to examine the effects of added sugar, added fat, and their interaction on food evaluations. We expected that foods high in added fat, added sugar, or both would be evaluated positively—especially for explicit affective evaluations (e.g., Berridge et al., 2010; Finlayson, King, & Blundell, 2007)—and evaluated as activating (e.g., Craeynest et al., 2008).

1.2. Idiographic predictors

We included BMI, hunger, binge eating concerns, and restrictive eating as individual-differences predictors of food affective evaluations. Table 1 depicts the associations between individual-differences factors and affective dimensions expected theoretically within a dual-process model framework. Generally, dual process models predict that more spontaneous eating behaviors will be better predicted by implicit affective evaluations, whereas more deliberative eating behaviors will be better predicted by explicit affective evaluations (Fazio & Olson, 2014; Perugini, 2005; Strack & Deutsch, 2004). We expected that arousal- and valence-based affective evaluations would differentially predict binge eating and restriction, respectively, and would both be associated with hunger.

Table 1
Current theoretical framework of affective evaluations of foods drawn from dual-process models: expected associations between affective evaluations of foods and eating- and weight-related criterion variables.

		Affective dimensions	
		Valence	Arousal
Dual-process model	Explicit	Hunger*	Hunger**
		Restriction***	Binge Eating*
	Implicit	Hunger*	Hunger**
		Restriction*	Binge Eating***

Note: * indicates the expected strength of the effect. Note: BMI is not listed in any of the cells as the equivocal literature precludes our making specific predictions.

1.2.1. Binge eating

Binge eating characterizes both bulimia nervosa and binge eating disorder (American Psychiatric Association, 2013), and falls at the more impulsive, disinhibited end of the disordered eating spectrum. We expected binge eating to predict positively both valenced and arousal-based affective evaluations of foods, consistent with our prior work (Woodward & Treat, 2015). Theoretically, the impulsive and thus more automatic nature of disinhibited eating should be more strongly related to implicit evaluations of foods, though in our prior work, disinhibited eating in response to external cues correlated more strongly with explicit evaluations of foods. We used a different measure of binge eating in the current work, and thus tentatively hypothesized that implicit food-related evaluations would be more strongly associated with binge eating than explicit evaluations of foods. We expected implicit evaluations, with their presumed greater reliance on automatic processes, would reflect the impulsive, out-of-control nature of binge eating. We anticipated that binge eating would be associated with more activating affective evaluations of foods, since arousal is implicated in motivation to approach palatable food.

1.2.2. Eating restriction

Restricting individuals (i.e., those with anorexia nervosa and successful dieters) evaluate foods more negatively than healthy control subjects (e.g., Roefs et al., 2011). We expected that successful eating restriction would predict more negative evaluations of foods. Successful eating restriction is deliberate and overcontrolled by nature. Explicit food-related affective evaluations are presumed to rely on primarily controlled processes. We further hypothesized that deliberate, overcontrolled eating restriction would be more strongly associated with explicit than implicit evaluations of foods, as the former are presumed to rely on primarily controlled processes. We tentatively expected that restriction would predict valenced, but not arousal-based, affective evaluations of foods (e.g., Keating, Tilbrook, Rossell, Enticott, & Fitzgerald, 2012).

2. Method

2.1. Participants

384 undergraduate women participated for class credit. Participants were excluded if they scored <75% correct on conceptual check (n = 27; see Procedure) or if they endorsed food allergies (n = 30), familiarity with Chinese characters (which are used as neutral stimuli [see Measures]; n = 3), low motivation (n = 13; see Self-reported measures) or poor understanding (n = 14; see Self-reported measures). Technical errors rendered 15 participants' AMP data incomplete. The final sample (n = 283) averaged 19.08 (SD = 1.40) years old, and 89.9% identified as White.

2.2. Stimuli

Food stimuli consisted of 120 food images (see Fig. 1) available via internet or photographed by study personnel. Nutritional labels, brand websites, and www.nutritiondata.com provided nutrition facts. Food stimuli varied along dichotomous dimensions of added sugar and added fat (high or low).

2.3. Measures

2.3.1. AMP tasks

The affect misattribution procedure (AMP) provides one means of improving poor structural fit. Participants view rapidly presented images (i.e., photo, neutral Chinese character). In the direct AMP, participants rate the photo's pleasantness and ignore the character; in the indirect AMP, participants ignore the photo and rate the character's pleasantness (see Fig. 2). The AMP's indirect (Payne, Cheng, Govorun,
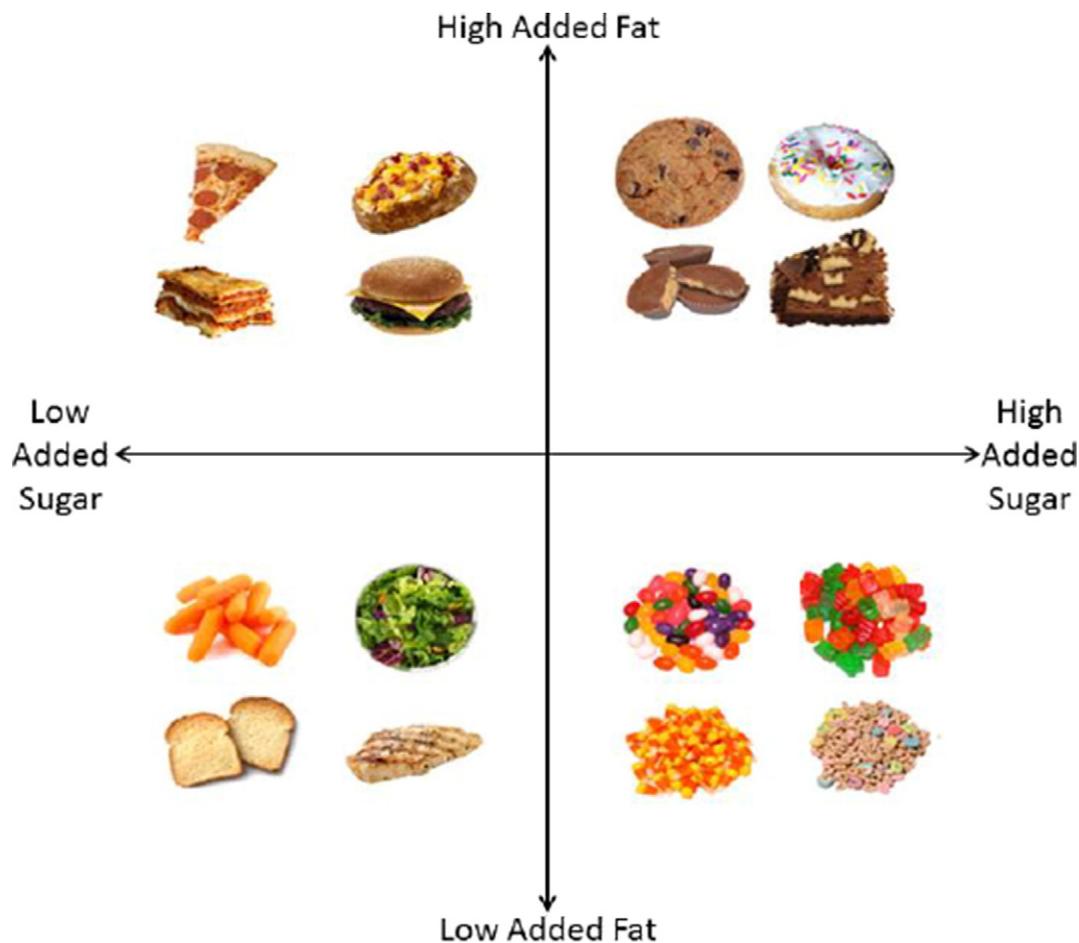
Fig. 1. Sample stimuli across dimensions of Added Fat and Added Sugar.

& Stewart, 2005) and direct (Payne et al., 2008) assessments of affective evaluations differ only in the intentionality of participants' responses (Payne et al., 2013). The indirect AMP relies on a misattribution mechanism (Blaison, Imhoff, Hühnel, Hess, & Banse, 2012; Gawronski & Ye, 2013; Payne & Lundberg, 2014); participants erroneously attribute their food photo evaluations to the Chinese characters, thus indirectly evaluating the foods. The AMP's psychometrics are comparable to those of the IAT; the indirect AMP has demonstrated meta-analytic predictive validity ($r = 0.35$ with behavior and 0.30 with direct measures; Cameron, Brown-Iannuzzi, & Payne, 2012), incremental validity over self-report, and good reliability (mean internal consistency = 0.88; Payne et al., 2005). The indirect and direct AMP tasks demonstrate theoretically expected divergence (e.g., Payne et al., 2013). These versions of the AMP allow simultaneous examination of both implicit and explicit affective evaluations with improved structural fit, which permits more accurate inferences to be drawn.

Two studies have used the indirect AMP to examine valenced food affective evaluations (Spring & Bulik, 2014; Woodward & Treat, 2015); one utilized both indirect and direct AMP tasks to assess evaluations of foods high or low in added fat and added sugar (Woodward & Treat, 2015). Normatively, both added fat and added sugar predicted more positive evaluations. Both hunger and environmentally driven, disinhibited eating correlated positively with explicit fat-based valence evaluations. Few significant individual-differences correlates were found for implicit evaluations (Woodward & Treat, 2015), perhaps reflecting a dissociation between automatic and controlled processes. Neither of the AMP-based investigations examined arousal.

For each AMP task, participants viewed 120 AMP trials presenting pairs of randomly selected, rapidly presented images (Payne et al., 2005; see Fig. 2). For direct tasks, the participant explicitly evaluated the food image by dichotomously judging the food photo. For indirect tasks, the participant implicitly evaluated the food photo by dichotomously judging the Chinese character. For the valence AMPs, participants rated the specified image as "pleasant" or "unpleasant". For the arousal-based AMPs, participants rated the specified image as "activating" or "unactivating".[3] Good to excellent reliability was demonstrated. Average split-half correlations for direct valence and arousal-based AMPs were 0.91 and 0.89, respectively; average split-half correlations for indirect valence and arousal-based AMPs were 0.93 and 0.96, respectively. The implicit-explicit correlations for valenced and arousal-based AMPs were $r = 0.41$ and $r = 0.47$, respectively. The valence-arousal correlations for direct and indirect AMPs were $r = 0.54$ and $r = 0.13$, respectively.

2.3.2. Self-reported measures

BMI was computed from self-reported height and weight. The Binge Eating Scale (BES; Gormally, Black, Daston, & Rardin, 1982) assessed aspects of binge eating ($\alpha = 0.88$). The Three Factor Eating Questionnaire – Cognitive Restraint Subscale (TFEQ; Stunkard & Messick, 1985) measured the deliberate control of food intake ($\alpha = 0.83$). A visual analogue scale (VAS; Flint, Raben, Blundell, & Astrup, 2000) assessed state hunger. The items "How hard did you try to follow the instructions of the

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[3] For the arousal-based AMPs, participants received the following orientation to the arousal dimension derived from Bradley and Lang (1999): "At the activated end of the scale, the specified image would make you feel things like excited, agitated, frenzied, jittery, wide-awake, et cetera. At the unactivated end of the scale, the specified image would make you feel things like dull, calm, sleepy, sluggish, bored, et cetera. These activation ratings are ONLY about whether the specified image makes you feel activated or not, COMPLETELY SEPARATE FROM how positive or negative the specified image makes you feel."
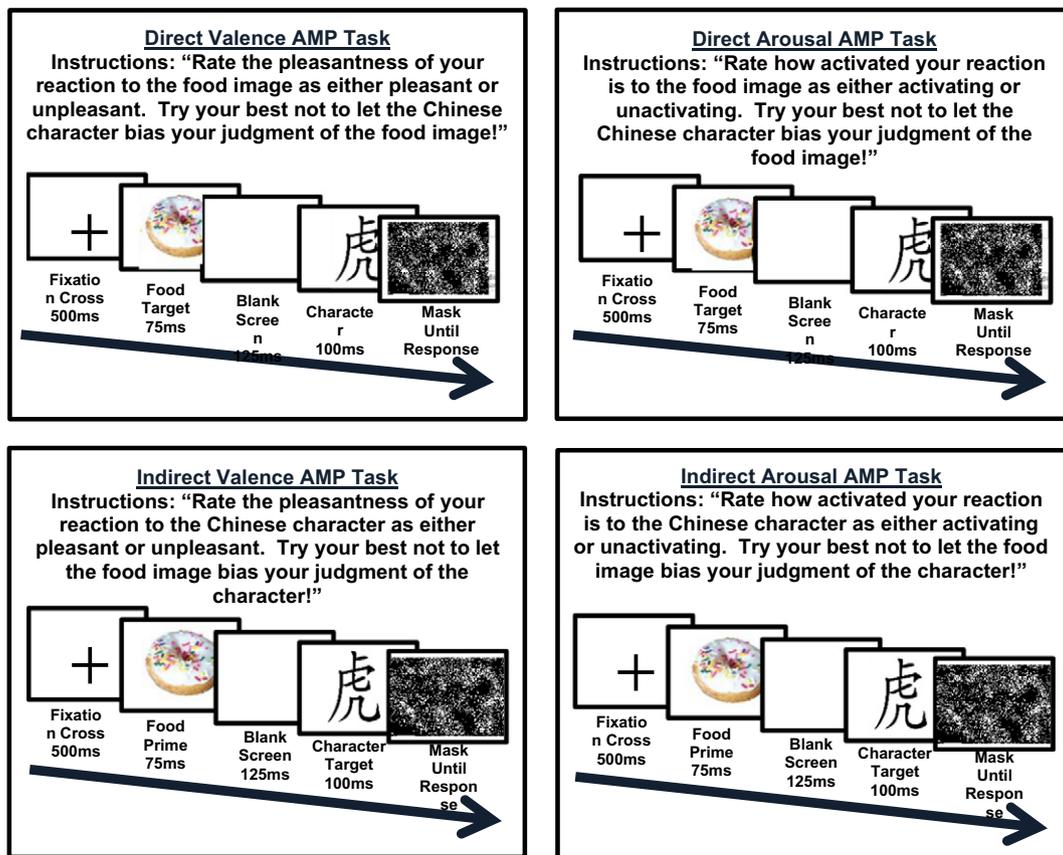
Fig. 2. Sample trials for direct (top row) and indirect (bottom row) versions of the valence (left column) and arousal-based (right column) AMP tasks.

computer tasks?" and "How well did you understand the instructions of the computer tasks?" assessed motivation and understanding (participants were excluded if they answered did not understand/try or somewhat understood/tried, respectively).

2.4. Procedure

Participants completed the hunger VAS, two counterbalanced pairs of AMP tasks (indirect and direct valence AMP, indirect and direct arousal AMP; 4 AMPs total), conceptual check, and questionnaires. On conceptual check, participants categorized 20 verbal exemplars—10 for each affective dimension—from the task instructions as pleasant or unpleasant for valence, and as activating or unactivating for arousal.

2.5. Analytic approach

Two logistic mixed effects models, one for valenced and one for arousal-based judgments, were fit to the data using the glmer function in the lme4 package (Bates, 2005; version 3.1.0) within R software. We estimated p and df values using lmerTest (Kuznetsova, Brockhoff, & Christensen, 2013). Added Sugar, Added Fat, and Measurement Type (i.e., direct or indirect) were effect coded; +1 corresponded to high sugar, high fat, and direct measurement. Model-comparison procedures indicated that the maximal random effects structure supported by these data included random intercepts across subjects and food photos, as well as random slopes for Measurement Type, Added Fat and Added Sugar across subjects. Fixed effects included main effects for BMI, Hunger, Binge Eating, Restriction, Measurement Type (direct or indirect), Added Fat (high or low), and Added Sugar (high or low); Measurement Type, Added Fat, Added Sugar, and their interactions were permitted to interact with the individual-differences factors, which were not

permitted to interact with one another. Multicollinearity was within acceptable limits.

3. Results

3.1. Sample characteristics

Average self-reported BMI was 23.65 ($SD = 4.61$), with 70.8% normal weight and 23.85% overweight or obese. The average Hunger rating (out of 100) was 32.76 ($SD = 24.75$) and average endorsement of Restriction (TFEQ-R) was 9.61 ($SD = 5.42$), which fell within the middle range of cognitive restraint (Timko, 2007). 27.5% of the sample met or exceeded the cutoff score of 17 for greater than mild Binge Eating (Greeno, Marcus, & Wing, 1995; average BES score = 12.46, $SD = 7.69$).

3.2. Valenced affective evaluations of foods

3.2.1. Nomothetic findings

We will integrate and discuss the empirical and theoretical implications of both the nomothetic and idiographic findings in the discussion. All significant findings are presented in Table 2. We examined how Added Fat, Added Sugar, and their bivariate interaction influenced women's implicit and explicit pleasantness judgments of foods (see Fig. 3, panels 1 and 2). The average probability of a pleasant response was 0.57. Foods higher in Added Fat or Sugar were more likely to be rated pleasant, on average, than those lower in one or both dimensions (Added Fat: $z = 3.049$, $p = 0.002$; Added Sugar: $z = 3.004$, $p = 0.003$; Fat by Sugar: $z = 1.993$, $p = 0.046$). Measurement Type moderated the relationships between pleasantness ratings and the nutritional characteristics (Measurement Type by Fat: $z = 16.650$, $p < 0.001$; Measurement Type by Sugar: $z = 6.850$, $p < 0.001$; Measurement Type by Fat by Sugar: $z = 6.031$, $p < 0.001$). On the direct AMP, a two-way

Table 2
Summary of significant mixed effects results.

	Valenced		Arousal-based	
	z	p	z	P
Nomothetic effects				
Nutrients				
Added Fat	3.049	0.002	3.046	0.002
Added Sugar	3.004	0.003	3.284	0.001
Added Fat * Added Sugar	1.993	0.046		
Measurement Type				
Measurement Type			3.355	<0.001
Measurement Type * Added Fat	16.650	<0.001	13.629	<0.001
Measurement Type * Added Sugar	6.850	<0.001	10.645	<0.001
Measurement Type * Added Fat * Added Sugar	6.031	<0.001	2.444	0.015
Idiographic main effects and nomothetic by idiographic interactions				
BMI				
BMI	2.616	0.009		
BMI * Measurement Type			2.245	0.025
BMI * Measurement Type * Added Fat	2.986	0.003	2.343	0.019
Hunger				
Hunger			3.668	<0.001
Hunger * Measurement Type	2.664	0.008		
Hunger * Measurement Type * Added Sugar	−2.569	0.010	−2.814	0.005
Hunger * Added Fat	3.027	0.002		
Restriction				
Restriction * Measurement Type * Added Fat	−2.086	0.037		
Binge Eating				
BES			2.716	0.006
BES * Measurement Type			−2.159	0.031

interaction between Added Fat and Added Sugar emerged ($z = 2.177$, $p = 0.030$), as did main effects of both Added Fat ($z = 4.231$, $p < 0.001$) and Added Sugar ($z = 2.801$, $p = 0.005$). On the indirect AMP, only a positive main effect of Added Sugar ($z = 2.686$, $p = 0.007$) emerged; foods high in Added Sugar were more likely to be judged to be pleasant implicitly than foods low in Added Sugar.

3.2.2. Idiographic findings

We tested the main effect of the individual-differences factors, including BMI, Hunger, Restriction, and Binge Eating, on valenced affective evaluations, as well as their moderation of normative effects (see Table 2). All significant individual-differences effects are reported below.

3.2.2.1. BMI. BMI increased the likelihood of a pleasantness rating ($z = 2.616$, $p = 0.009$), regardless of measurement strategy. BMI moderated the bivariate interaction between Added Fat and Measurement Type ($z = 2.986$, $p = 0.003$), such that the bivariate BMI by Added Fat interaction was only significantly related to explicit ($z = 2.149$, $p = 0.032$), and not implicit, pleasantness ratings. Added Fat enhanced the likelihood of an explicit pleasant rating to a greater degree for heavier women ($z = 4.023$, $p < 0.001$) relative to lighter women ($z = 2.894$, $p = 0.004$).

3.2.2.2. Hunger. No main effect of Hunger emerged on the likelihood of a pleasant response. Measurement Type interacted with Hunger ($z = 2.664$, $p = 0.008$), such that Hunger positively predicted only explicit pleasantness ratings ($z = 3.060$, $p = 0.002$). Hunger moderated the nomothetic bivariate interaction between Added Sugar and Measurement Type ($z = -2.569$, $p = 0.010$), such that the Measurement Type by Sugar interaction was only significant for women whose hunger fell at or below the median ($z = 8.081$, $p < 0.001$). Among women whose hunger was low, the main effect of Added Sugar on the likelihood of an explicit pleasant rating ($z = 3.825$, $p < 0.001$) was stronger than for an implicit pleasant rating ($z = 2.987$, $p = 0.003$). The nomothetic main effect of Added Fat on valenced affective evaluations was also moderated by Hunger ($z = 3.027$, $p = 0.002$), such that Added Fat only influenced the likelihood of a pleasant response for women whose hunger fell above the median ($z = 3.772$, $p < 0.001$).

3.2.2.3. Restriction. Restriction moderated the normative interaction between Measurement Type and Added Fat ($z = -2.086$, $p = 0.037$). However, follow-up tests indicated that Added Fat influenced explicit pleasantness ratings to a similar degree for those who reported more
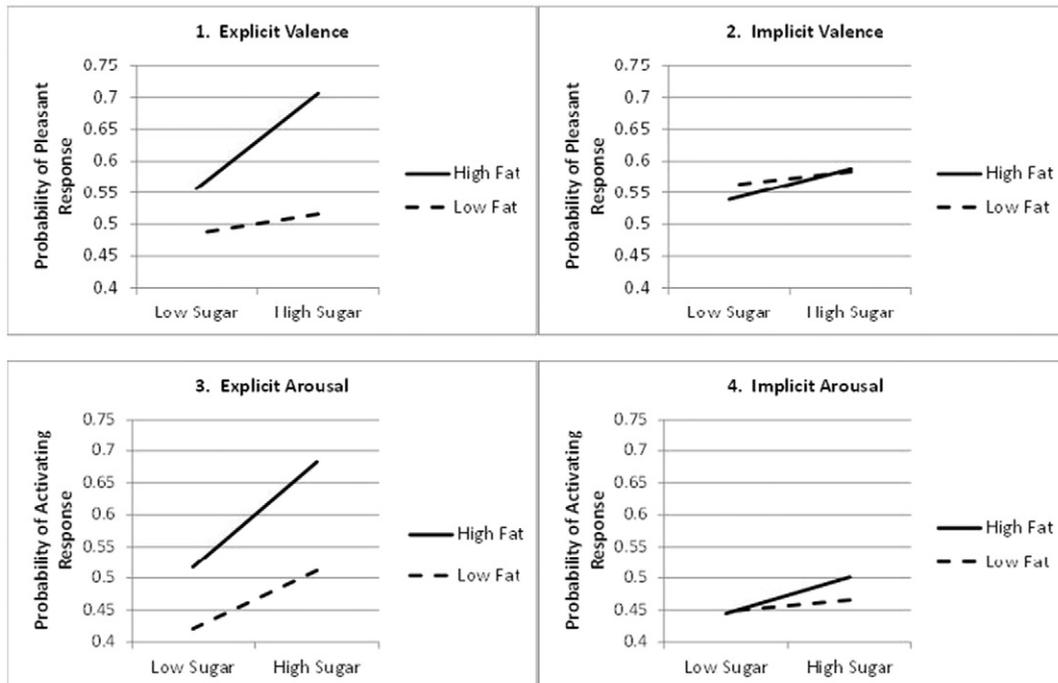

Fig. 3. Nomothetic effects of added fat, added sugar, and their interaction on valenced (panels 1 & 2) and arousal-based (panels 3 & 4) affective evaluations.

restriction (z = 4.014, p < 0.001) and those who reported less restriction (z = 3.960, p < 0.001). Added Fat did not influence implicit pleas­antness ratings for those who reported more versus less restriction (z = −0.371, p > 0.05; z = −1.0341, p > 0.05, respectively); Added Fat influenced the perceived pleasantness of directly evaluated foods, but not indirectly evaluated foods.

3.2.2.4. Binge eating. No significant effects emerged.

3.3. Arousal-based affective evaluations of foods

3.3.1. Nomothetic findings

A main effect of Measurement Type arose, such that explicit arousal-based affective evaluations were more likely to be activating than implicit affective evaluations (z = 3.355, p < 0.001; see Fig. 3, panels 3 and 4). We examined how Added Fat, Added Sugar, and their bivariate interaction influenced women's implicit and explicit activation ratings. The average probability of an activating response was 0.49. Nomothetically, women were more likely to judge foods that are higher in Fat or Sugar to be activating, on average, than those low in these dimensions (Added Fat: z = 3.046, p = 0.002; Added Sugar: z = 3.284, p = 0.001). Measurement Type moderated the relationships between activation ratings and the nutritional characteristics (Measurement Type by Fat: z = 13.629, p < 0.001; Measurement Type by Sugar: z = 10.645, p < 0.001; Measurement Type by Fat by Sugar: z = 2.444, p = 0.015). Main effects emerged for both Added Fat (z = 4.194, p < 0.001) and Added Sugar (z = 3.899, p < 0.001), such that foods high in Added Sugar and foods high in Added Fat were more likely to be judged explicitly to be activating than foods low in either dimension.

3.3.2. Idiographic findings

We tested the main effect of the individual-differences factor on arousal-based affective evaluations, and whether individual-differences factors moderated the nomothetic findings for arousal-based affective evaluations.

3.3.2.1. BMI. No main effect of BMI on arousal-based affective evaluations emerged. BMI interacted with Measurement Type (z = 2.245, p = 0.025) to predict activating ratings, such that the likelihood of an explicit activation rating significantly exceeded that of an implicit activation rating for those above the median in BMI (z = 3.210, p = 0.001) and not for those at or below the median (z = 1.208, p = 0.227). BMI moderated the two-way Fat by Measurement Type interaction (z = 2.343, p = 0.019); Added Fat enhanced the likelihood of an explicit activating rating to a slightly greater degree for heavier women (z = 2.837, p = 0.005) than lighter women (z = 2.423, p = 0.015).

3.3.2.2. Hunger. Hunger positively predicted arousal-based affective evaluations (z = 3.668, p < 0.001). Hunger moderated the bivariate interaction between Measurement Type and Added Sugar (z = −2.814, p = 0.005); the bivariate Added Sugar by Hunger interaction significantly attenuated the likelihood of an explicit activation rating (z = −2.008, p = 0.045) but was not associated with implicit activation ratings. Added Sugar enhanced the likelihood of an explicit activating rating for those who were less hungry (z = 4.702, p < 0.001) relative to those who were more hungry (z = 2.438, p = 0.015).

3.3.2.3. Restriction. No significant effects emerged.

3.3.2.4. Binge eating. Binge Eating positively predicted activation ratings (z = 2.716, p = 0.006). A bivariate interaction between Measurement Type and Binge Eating emerged (z = −2.159, p = 0.031). Binge Eating enhanced the likelihood of only an implicit activating rating (z = 3.009, p = 0.002), and not an explicit (z = 1.263, p = 0.206) arousal-based

affective evaluation. Relatively more automatic evaluations of foods as activating were associated with greater endorsement of binge eating.

4. Discussion

The present study investigated both arousal-based and valenced affective evaluations of food, and examined both restrictive and disinhibited eating correlates, as well as hunger and BMI, to better assess the role of affective evaluations of foods across the disordered eating spectrum. We also examined the applicability of a dual-process model to food-related affective evaluations using structurally identical indirect and direct assessments, and explored both nomothetic (i.e., food-specific) and idiographic (i.e., person-specific) correlates of affective evaluations of foods. We will discuss the nomothetic effects, idiographic main effects, and moderation of nomothetic effects by idiographic factors. We will then comment on the importance of examining both fundamental affective evaluation dimensions: valence and arousal. Finally, we will consider the validity of dual-process models in affective evaluations of food by comparing patterns of findings across indirect and direct affect misattribution procedures.

4.1. Food- and person-specific correlates of affective evaluations

4.1.1. Nomothetic findings

Both added sugar and added fat positively predicted both valence and activation ratings (see top half of Table 2), particularly for explicit affective evaluations. This extends prior work documenting nutrient-specific effects on valenced affective evaluations (Woodward & Treat, 2015) and on ratings of craving and liking of foods (Gearhardt, Rizk, & Treat, 2014). Moreover, the arousal-based findings extend prior work establishing positive links between fat content and explicit craving ratings (Gearhardt et al., 2014) by demonstrating the importance of both added fat and added sugar to explicit evaluations of arousal. This work underscores the utility of relying on fine-grained stimulus sets. Future work should examine other potential nutritional correlates of food-related affective evaluations.

4.1.2. Idiographic findings

Here, we discuss both idiographic main effects and moderation of nomothetic effects by individual differences (see lower half of Table 1).

4.1.2.1. BMI. BMI was positively associated with both valence and (only explicit) arousal-based affective evaluations. BMI also moderated the interaction between added fat and measurement type. Consistent with the explicit preferences for high-fat foods among overweight individuals (e.g., Drewnowski, 1985), heavier women were more likely to find foods—especially foods high in added fat, but not added sugar—to be both pleasant and arousing than their lighter peers. However, this result contradicts the limited literature finding no BMI-related differences in youths' arousal associations with foods (Craeynest et al., 2008). The absence of implicit BMI findings here adds to the mixed literature on the relations between BMI and implicit valenced affective evaluations (e.g., Roefs et al., 2011). The absence of implicit findings suggests that BMI may be related more strongly to controlled food-related affective evaluations.

4.1.2.2. Hunger. Hungry women were more activated by food, but hunger did not affect women's perceptions of food pleasantness (e.g., Woodward & Treat, 2015), and hunger also moderated the normative effects of added fat, added sugar, and measurement type. When less hungry, women rated high added-sugar foods as both pleasant and arousing; when hungry, women rated high added-fat foods as pleasant, but not arousing. Hunger's positive association with fat-based valenced evaluations may reflect the role of dietary fat in acute satiety signaling after consumption (e.g., Cecil, Francis, & Read, 1999; Maljaars et al., 2008). Food-seeking is driven not only by physiological processes,

such as hunger, but also by emotional, hedonic processes (Berridge et al., 2009). Thus, when people are not hungry, they may be most activated by sweet, hedonically pleasant foods.

4.1.2.3. Restriction. Successful eating restriction was associated positively with explicit fat-based affective evaluations, although restriction typically is negatively associated with food evaluations—especially unhealthy foods (e.g., Roefs et al., 2011; Spring & Bulik, 2014). In contrast to our findings, patients with anorexia nervosa explicitly liked low-fat foods more than high-fat foods to a greater degree than healthy controls (Stoner, Fedoroff, Andersen, & Rolls, 1996). Pending replication, this finding suggests that controlled affective evaluations may predominate in restriction, at least among undergraduate women. Future work should extend these investigations to clinical samples. As expected, restriction correlated with valenced—but not arousal-based—food-related affective evaluations (e.g., Keating et al., 2012); pleasantness, but not activation, is implicated in successful eating restriction.

4.1.2.4. Binge eating. Women who binge eat rated foods as activating, but only implicitly, and impulsive eating behavior was unrelated to valenced evaluations. This finding joins that of Gearhardt et al. (2014) who found that addictive-like (disinhibited) eating was associated with greater explicit food craving, especially for foods high in added fat or sugar. Indeed, activation ratings likely reflect incentive salience or action dispositions to approach and consume emotionally salient stimuli, such as food (e.g., Berridge et al., 2009; Lang, 1995), and are akin to wanting or craving, whereas valence ratings may be more akin to liking (e.g., Berridge et al., 2010; Finlayson et al., 2007, but see Havermans, 2011). Thus, automatic arousal-based affective evaluations are implicated in binge eating to the exclusion of both controlled and valenced evaluations, which suggests performance-based interventions that influence unconscious, unintentional processing of might enhance overeating treatments. Implicit interventions reduce women's cravings for and consumption of snack foods (e.g., Houben & Jansen, 2011; Kemps, Tiggemann, Orr, & Grear, 2014). These investigations must be extended to samples with significant binge-eating symptoms.

4.1.3. Affective dimensions: arousal and valence

As Table 2 illustrates, some patterns of findings converged across both valence and arousal. Normatively, added fat and added sugar enhanced both valenced and arousal-based affective evaluations. Idiographically, hunger and BMI correlated positively with both affective dimensions. A theoretically expected idiographic dissociation occurred between valenced and arousal-based affective evaluations: restriction was associated only with valenced evaluations, whereas binge eating was associated only with arousal-based evaluations. Thus, the arousal dimension of affective evaluations seems to matter. This pattern of findings demonstrates what may be overlooked when researchers focus on a single affective dimension, or a single eating- and weight-related correlate. Future work should continue to consider both affective dimensions, which may illuminate other hedonic processes, such as liking, wanting, and learned reward associations (e.g., Berridge et al., 2009; Berridge et al., 2010). Additionally, this first step toward considering both dimensions of affective evaluation assumed that valence and arousal operate independently, which may not always be the case (Kuppens, Tuerlinckx, Russell, & Barrett, 2012). Future work should probe the circumstances under which arousal and valence are related in affective evaluations, as the associations among liking and wanting, as well as arousal and valence, are likely more complex than was permitted in this initial test (e.g., Havermans, 2011).

4.1.4. Does a dual-process model fit?

Unlike most previous work, we employed structurally matched indirect and direct assessments that differed only in the intentionality of participants' responses. We see modest evidence supportive of a dual-process model of affective evaluations when method variance is controlled. For valence, associations with explicit affective evaluations were consistently stronger than those with implicit affective evaluations, though directionality was comparable. For arousal, individual-differences factors predicted explicit affective evaluations, except that binge eating enhanced the likelihood of implicit arousing judgments. Controlled processes may underlie arousal-based affective evaluations, excepting the binge eating-implicit link.

Though a similar pattern of implicit and explicit valence findings emerges, the frequent evidence of moderation by measurement type provides some support for a dual-process model for valence. Evidence in support of a dual-process model is more compelling for arousal-based affective evaluations, given that implicit and explicit associations diverged in all but one instance. The similar patterns of findings between implicit and explicit affective evaluations seen here is somewhat unusual in the existing literature. For example, in their comprehensive review, Roefs and colleagues reported implicit-explicit correlations that are typically small to moderate in magnitude (Roefs et al., 2011). We found implicit-explicit correlations of $r = 0.41$ and $r = 0.47$ for proportions pleasant and activating, respectively. The degree of convergence in our implicit and explicit findings may reflect our more conservative approach to estimating the validity of dual-process models. Effects were consistently stronger for explicit than implicit affective evaluations, yet the significant effects associated with implicit affective evaluations of foods were consistent with theoretical predictions and support the validity of the indirect AMP for both valence and arousal-based affective evaluations. Future research should continue to use structurally matched indirect and direct assessments, which may inform our interpretations of the implicit-explicit dissociations widely reported in the food-related affective evaluation literature (e.g., Roefs et al., 2011).

5. Conclusion

Often, our implicit and explicit reactions to foods differ appreciably: we may automatically reach for a freshly baked cookie before deliberately turning away if we are watching our weight. Prior literature makes it difficult to determine the strength of this implicit-explicit dissociation, because differences in indirect and direct measures may have inflated differences in implicit and explicit affective evaluations in prior work. The present study enhances methodological rigor by structurally matching indirect and direct measures to better account for method variance, incorporating both primary dimensions of affect, and varying systematically nutritional characteristics of foods, all while accounting for multiple eating-related individual differences. Our findings suggest that accounting for these factors can help the picture become somewhat more refined. Moreover, the current work suggests a useful and more methodologically sophisticated path forward for examining affective evaluations of food (Woodward, Cameron, & Treat, 2016).

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