Appetite 74 (2014) 1–5

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Research report

Do hunger and exposure to food affect scores on a measure of hedonic hunger? An experimental study

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ARTICLE INFO

Article history:
Received 1 August 2013
Received in revised form 4 October 2013
Accepted 11 November 2013
Available online 21 November 2013

Keywords:
Eating behavior
Hedonic hunger
External Eating
Disinhibition
Self-report

ABSTRACT

Research suggests that visceral bodily states, such as hunger, can affect participants' responses on self-report measures of eating behavior. The present study evaluated the influence of hunger and exposure to palatable food on self-reported hedonic appetite, measured using the Power of Food Scale (PFS). A secondary aim was to evaluate the effects of these manipulations on self-reported external eating and disinhibition. Participants ($N = 67$) ate a standardized meal followed by a 4-h fast. Participants were randomized to one of four groups (Fasted/Food Absence, Fasted/Food Exposure, Fed/Food Absence, or Fed/Food Exposure). In Phase I of the experiment (Hunger Manipulation), participants randomized to the "Fed" group drank a protein shake, while those in the "Fasted" group did not receive a shake. In Phase II (Palatable Food Exposure), participants in the "Food Exposure" group were visually exposed to palatable food items, while "Food Absence" participants were not. All participants completed the PFS, Dutch Eating Behavior Questionnaire External Eating subscale, and the Disinhibition subscale from the Eating Inventory during Phase II. Results showed no significant main or interactive effects of Hunger condition or Food Exposure condition on PFS, External Eating, or Disinhibition scores (all p's < .33). All effect sizes were small (partial etas squared $\leqslant$.015). Manipulation checks confirmed that the intended hunger and exposure interventions were successful. Results suggest that relatively short fasting periods (e.g., 4 h) analogous to typical breaks between meals are not associated with changes in scores on the PFS, External Eating, or Disinhibition scales. Hedonic hunger, at least as measured by the PFS, may represent a relatively stable construct that is not substantially affected by daily variations in hunger. In addition, individual differences in exposure to food in the immediate environment are unlikely to confound research using these measures.

Introduction

Self-report measures are commonly used in research on eating behaviors. However, research suggests that some such measures may be influenced by an individual's hunger status at the time of questionnaire completion (e.g., Evers et al., 2011). This finding comes from a line of research suggesting that visceral bodily states that motivate the individual to satisfy physiological needs (for instance, hunger or drug cravings) can affect the individual's self-report, particularly when the visceral state relates to the construct being measured (e.g., Nordgren, van Harreveld, & van der Pligt, 2009). The experience of a visceral impulse has been referred to as a "hot state" (Nordgren et al., 2009). People may more accurately appraise the effects and behavioral correlates of a particular hot state when they are in that state (Nordgren et al., 2009). For instance, a participant who is not hungry might overestimate his or her ability to resist unhealthy foods, while a participant who is hungry while filling out a self-report measure may report more accurately because the hunger state facilitates recall of past hunger states.

A recent experimental study found that self-reports of external eating, or the tendency to eat in response to external cues such as the sight or smell of food, are affected by current hunger status (Evers et al., 2011). After an overnight fast, college students who were hungry at the time they completed questionnaire measures scored significantly higher on the External Eating Scale of the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien, Frijters, Bergers, & Defares, 1986) compared to participants who were randomly assigned to eat breakfast prior to completing the questionnaire. This finding suggests that measures of similar constructs

Abbreviations: DEBQ, Dutch Eating Behavior Questionnaire; EI, Eating Inventory; PFS, Power of Food Scale.

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http://dx.doi.org/10.1016/j.appet.2013.11.010

should also be investigated to assess the possibility of systematic differences associated with visceral states; such research would allow investigators to account for potential confounding effects of visceral states in their research designs.

Hedonic hunger, the drive to eat for pleasure in the absence of a physiological energy deficit, is a construct that has received increased attention in research on eating behaviors (e.g., Lowe & Butryn, 2007). A frequently used measure of hedonic hunger is the Power of Food Scale (PFS; Lowe et al., 2009), a self-report questionnaire that assesses sensitivity to the availability of palatable food and includes items assessing frequency of thoughts about food in the absence of physical hunger, degree of pleasure associated with eating, and urges to eat when exposed to palatable food. While the PFS and the DEBQ External Eating Scale tend to be significantly correlated (e.g., $r = .66$; Lowe et al., 2009), the PFS differs from the DEBQ External Eating Scale in that the PFS does not assess actual food consumption; rather, the PFS measures hedonically driven motivation to eat. The importance of the construct of hedonic hunger in understanding eating behavior is suggested by a number of studies that have demonstrated associations between PFS scores and overeating (e.g., Appelhans et al., 2011; Lowe et al., 2009) as well as the experience of loss of control over eating (i.e., binge eating; Davis et al., 2009; Witt & Lowe, in press).

Given the apparent effects of concurrent physiological state on individuals' self-report ratings of similar constructs, we sought to determine whether self-reported hedonic hunger, as measured by the PFS, is similarly affected by hunger status. In addition, because theories of hedonic hunger suggest that hedonic hunger may be externally stimulated by exposure to abundant palatable food (Lowe & Butryn, 2007), we speculated that exposure to palatable food might also produce a "hot state" that might be relevant to scores on self-report measures of hedonic hunger. More specifically, because the PFS asks individuals to report on their appetitive responsiveness to the availability of palatable food, the presence of food in the immediate environment may cue participants to report more accurately on their responsiveness to the availability of food, just as hunger is theorized to facilitate recall of past hunger states. This may be especially the case for participants who are highly prone to cravings and thoughts about food when exposed to food stimuli: it is possible that such individuals might underestimate their appetitive responsiveness to the presence of food when they complete a measure such as the PFS in the absence of food in their environment. Accordingly, we sought to extend previous research by investigating the effects of exposure to palatable food, in addition to hunger, on PFS scores. These questions were investigated by manipulating participants' hunger levels and the presence of palatable food in the immediate environment prior to administering the PFS. For convergent validity purposes, the External Eating Scale from the DEBQ and the Disinhibition subscale from the Eating Inventory (EI; Stunkard & Messick, 1985) were also administered in order to assess the effects of the experimental manipulations on self-reports of constructs related to hedonic hunger.

The present study employed a shorter fasting period (4 h) prior to the experiment than was used in the prior study on the DEBQ (Evers et al., 2011) to determine whether a fasting period that better represents daily intervals between meals and snacks is likely to affect PFS scores. This shorter fasting period was used to improve generalizability: it was considered important to determine whether effects previously found for the DEBQ after a longer (overnight) fast are likely to represent confounds in studies using similar measures as part of assessment batteries that may take place at a variety of times of day. While prior research suggests that studies administering such measures after very lengthy or overnight fasting periods may obtain different results relative to what would be obtained during a participant's more typical day, it is unclear whether scores on the PFS and similar measures are likely to fluctuate throughout the day based on hunger status, or if these measures tap more stable, trait-like constructs. If scores were found to be significantly influenced by a four-hour fast, this would suggest a need for studies using these measures to rigorously control the timing of eating in relation to measure administration.

Based on prior research on the effects of hot states on self-report measures, it was hypothesized that self-reported hedonic appetite, as measured by the PFS, would be higher among hungry participants than among satiated participants. In addition, it was hypothesized that PFS scores would be higher for participants exposed to palatable food at the time of questionnaire completion compared to participants who complete the PFS without concurrent exposure to food. A similar pattern was expected for scores on External Eating and Disinhibition. We also sought to assess any interactive effects of hunger and exposure to food on these self-report measures, although no specific hypotheses were made.

Methods

Participants

Participants ($N = 71$) were undergraduate students age 18–25 enrolled at a Philadelphia area university. Recruitment was conducted through a university-based electronic system, and interested students were screened for eligibility by telephone. Potential participants were deemed ineligible upon meeting any of the following exclusion criteria: (1) current or previously diagnosed eating disorder, (2) inability or refusal to eat any of the foods in the experiment. Eligible participants were instructed to eat a standardized meal (1 bagel, 1 pat of butter, 8 oz of apple juice) 4 h before the scheduled visit and to otherwise refrain from eating or drinking beverages other than water during that period, and an email reminder with these instructions was sent 24 h prior to the scheduled visit.

Experimental procedure

All procedures were approved by the Institutional Review Board at Drexel University. Informed consent was obtained upon arrival at the laboratory. Adherence to the standardized breakfast and four hour fast was assessed via open-ended questioning about the timing and content of the participant's breakfast as well as other food or beverage consumption, and two participants who had deviated from the instructions were not permitted to proceed with the experiment. Participants were randomized to one of four groups: (1) Fasted/Food Absence ($N = 19$), (2) Fasted/Food Exposure ($N = 15$), (3) Fed/Food Absence ($N = 15$), or (4) Fed/Food Exposure ($N = 18$). The Fasted vs. Fed groupings correspond to the hunger manipulation detailed in Phase I, and the Food Absence vs. Food Exposure groupings correspond to the Palatable Food Exposure manipulation detailed in Phase II. All participants completed experimental Phases I and II.

As an additional check for adherence to the standardized breakfast, participants received a short debriefing questionnaire about their experience participating in the study following completion of the experiment, which included questions about adherence to the standardized breakfast as well as an explicit statement that compensation would not be affected by the answers. The aim of this procedure was to increase the likelihood that participants would report any non-adherence by removing concerns about compensation and minimizing potential embarrassment about verbally reporting non-adherence directly to the experimenter. Data from two participants who had completed the study but later reported non-adherence to the breakfast were not used in the analyses (the cell sizes reported above do not include these participants).

Phase I: Hunger Manipulation

All participants completed an initial assessment of hunger at the start of Phase I followed by a brief questionnaire about demographic characteristics. Participants in the two Fed conditions were also presented with a standardized meal replacement (8 oz Ensure shake) after completing the first hunger assessment and prior to completing the questionnaire. They consumed the shake within 5 min, rated their liking of the shake on the Food Liking Scale (see below), and completed a second hunger assessment 15 min after shake consumption. Participants in the two Fasted conditions did not receive the shake.

Phase II: Palatable Food Exposure

All participants completed the PFS, the EI Disinhibition subscale, and the DEBQ External Eating Scale during Phase II. For participants assigned to the two Food Exposure conditions, the study room included a covered tray with several snack foods (chocolate candy, mixed nuts, Chex Mix, cheese, crackers, slices of baguette, and a chocolate chip cookie), which was placed in participants' line of sight but was out of reach. A variety of foods were used to maximize the chances that participants would be exposed to a food that they found appealing. At the beginning of Phase II, the experimenter uncovered the tray of food. Nothing was said about whether the participant would be able to eat the foods presented. After a 5-min waiting period, participants completed the self-report measures with the food tray in sight. They then rated their liking (based on previous experience, not in vivo tasting) of the most appealing food item on the tray on a 9-point Likert scale; this manipulation check allowed the researchers to verify that each participant was exposed to at least one appealing food item. For participants in the Food Absence conditions, the laboratory room did not contain a tray of food. Finally, all participants were measured for height and weight.

Measures

Participant characteristics

Demographic characteristics (age, gender, marital status, and race/ethnicity) were assessed using a brief self-report questionnaire. Weight was measured using a digital scale and height was measured using a stadiometer.

Food Liking Scale

The Food Liking Scale used in the present study was based on a measure used in prior research (Zimmerli, Devlin, Kissileff, & Walsh, 2010), and included one item evaluating participants' liking of a given food item on a 9-point scale from "dislike extremely" to "like extremely."

Hunger assessment

Hunger was assessed using Friedman and colleagues' measure (Friedman, Ulrich, & Mattes, 1999), which includes 4 items evaluating participants' hunger level, desire to eat, fullness, and the amount they currently feel able to eat on a 9-point scale. The fullness item was reverse scored and the mean of the four items was calculated for analytic purposes.

Power of Food Scale (PFS)

The PFS (Lowe et al., 2009) is a 15-item measure designed to assess individual differences in appetitive motivation towards highly palatable food, as described above. Sample items include, "I find myself thinking about food even when I'm not physically hungry" and "when I eat a delicious food, I focus a lot on how good it tastes." Items are rated on a five-point scale ranging from "don't agree at all" to "strongly agree." The PFS has been shown to have adequate internal consistency, test–retest reliability, and convergent validity (Cappelleri et al., 2009; Lowe et al., 2009), and showed high internal consistency in the present sample (Cronbach's alpha = .89).

Dutch Eating Behavior Questionnaire (DEBQ)

The DEBQ External Eating Scale (Van Strien et al., 1986) includes 10 items assessing eating stimulated by exposure to food or food-related cues (e.g., "do you eat more than usual when you see others eating?"). Items are rated on a five-point scale ranging from "never" to "very often." The External Eating Scale showed high internal consistency in the study sample (Cronbach's alpha = .81).

Eating Inventory (EI)

The Disinhibition subscale of the EI (Stunkard & Messick, 1985) measures participants' tendency toward disinhibited overeating (e.g., "sometimes when I start eating, I just can't seem to stop"). Response options are 1 (True) or 0 (False) for most items, with the exception of three items that are initially rated on a 4-point scale (from "never"/"not like me" to "always"/"describes me perfectly") but are scored dichotomously as 1 or 0. The Disinhibition subscale showed acceptable internal consistency in the present sample (Cronbach's alpha = .76).

Results

Descriptive statistics and Pearson correlations among the variables are shown in Table 1. Participants' mean age was 19.5 years (SD = 1.2), and mean BMI was 22.7 (SD = 4.0). The sample was primarily female (71.6%). The majority of participants (61.2%) identified as white/Caucasian, 17.9% identified as Asian/Pacific Islander, 6.0% as Latino/Hispanic, 4.5% as African American, 1.5% as Native American, 4.5% as multiracial, and 4.5% as "other" race or ethnicity (see Table 2).

Manipulation checks revealed that participants in the Fed condition reported significantly less hunger (M = 3.7, SD = 1.4) following consumption of the meal replacement compared with participants in the Fasted condition (who did not consume the meal replacement; M = 4.6, SD = 1.5, t[65] = 2.55, p = .01, d = .62). There were no significant group differences in hunger at the time of arrival at the laboratory (M = 4.8, SD = 1.4 for the Fed condition and M = 4.5, SD = 1.5 for the Fasted condition, t[65] = 0.81, p = .42, d = .20). Participants' mean rating of liking for the most appealing food on the tray in the Food Exposure condition was 7.9 out of 9 (SD = .88; range 6–9). Tests of normality and homogeneity of variance indicated that the assumptions of the analyses were met.

Table 1
Descriptive statistics and intercorrelations in the full sample.

	Min	Max	Mean	SD	1	2	3	4	5
1. PFS	1.1	4.5	2.7	0.8	–	–	–	–	–
2. External Eating	15.0	40.0	30.9	5.3	.70**	–	–	–	–
3. Disinhibition	0.0	14.0	5.7	3.2	.50**	.51**	–	–	–
4. BMI	16.9	39.5	22.7	4.0	.06	−.11	.28*	–	–
5. Hunger Scale	0.3	7.8	4.2	1.5	.23	.23	.09	.25*	–

Note: Pearson correlations appear in the numbered columns on the right-hand side. BMI = body mass index; PFS = Power of Food Scale. Data are shown from the econd hunger assessment (after the hunger manipulation).
* $p < .05$.
** $p < .01$.

Table 2
Descriptive statistics by condition.

	Fasted/Food Absence (*N* = 19) M (*SD*)	Fasted/Food Exposure (*N* = 15) M (*SD*)	Fed/Food Absence (*N* = 15) M (*SD*)	Fed/Food Exposure (*N* = 18) M (*SD*)
PFS	2.5 (0.9)	2.8 (0.8)	2.7 (0.7)	2.7 (0.7)
External Eating	30.4 (5.7)	31.3 (5.7)	31.1 (5.3)	30.8 (5.0)
Disinhibition	4.8 (3.1)	6.3 (3.3)	5.9 (2.9)	5.8 (3.7)
Hunger Scale	4.5 (1.5)	4.9 (1.6)	3.6 (1.3)	3.8 (1.5)

Note: PFS = Power of Food Scale. Data for the Hunger Scale are shown from the second hunger assessment (after the hunger manipulation).

Table 3
Main effects and interaction effects of hunger and food exposure by outcome variable.

	F	*p*	η_p^2
PFS			
Hunger	.060	.808	.001
Food exposure	.583	.448	.009
Hunger * food exposure	.625	.432	.010
DEBQ External Eating			
Hunger	.010	.921	.000
Food exposure	.062	.804	.001
Hunger * food exposure	.225	.637	.004
EI Disinhibition			
Hunger	.195	.660	.003
Food exposure	.732	.395	.011
Hunger * food exposure	.961	.331	.015

Note: DEBQ = Dutch Eating Behavior Questionnaire; EI = Eating Inventory; PFS = Power of Food Scale.

The effects of the experimental manipulations were examined using a series of univariate ANOVAs (see Table 3). There were no significant main effects of Hunger condition or Food Exposure condition on any of the outcome variables (PFS, DEBQ External Eating, or EI Disinhibition). There were also no significant interaction effects between Hunger and Food Exposure on any of the outcome measures. The effect sizes for all outcome measures were small (partial eta squared ranging from .001 to .015).

Exploratory analyses were conducted to examine the bivariate associations between hunger scores and scores on the outcome measures, within and across groups. The correlations between hunger and each of the outcome measures were low and non-significant within each experimental condition and in the full sample (see Table 1). Additional exploratory analyses were conducted to examine potential effects of participant characteristics (e.g., sex or BMI) on the results. An independent samples t test indicated that males ($N = 19$) and females ($N = 48$) did not differ on PFS scores ($t[65] = 0.23$, $p = .82$), DEBQ External Eating, ($t[65] = 0.60$, $p = .55$) or EI Disinhibition ($t[65] = 1.38$, $p = .17$). Bivariate correlation analyses indicated no significant correlations between BMI and PFS scores or DEBQ External Eating scores. However, there was a weak but significant positive correlation between BMI and EI Disinhibition (see Table 1). A series of univariate ANCOVAs was conducted to determine whether including BMI as a covariate affected the analyses of the effects of the experimental manipulations on any of the outcome measures. Results for all outcome measures were unchanged when controlling for BMI.

Discussion

The primary aim of this study was to examine whether hunger or exposure to palatable food affect self-reported hedonic hunger, as measured by the PFS. Secondary aims were to determine whether the effects of hunger on DEBQ External Eating scores documented in previous research appear when a shorter fasting period is used, and to explore any effects of hunger and exposure to food on EI Disinhibition scores. A relatively short (4-h) fasting period was used following a standardized breakfast to approximate the amount of time between meals and snacks in participants' daily lives and to allow for generalizability of results to studies that do not use very lengthy or overnight fasts.

Results indicated no effects of hunger status or exposure to palatable food on any of the above measures. Manipulation checks indicated significant group differences in hunger across the Fasted and Fed conditions. In addition, examination of participants' liking for the foods on the tray suggested that all participants were exposed to at least one food that they rated as highly palatable. These results suggest that although the experimental manipulations of hunger and food exposure were effective, these manipulations did not affect the self-report questionnaires administered in this study. In addition, exploratory analyses indicated low and nonsignificant correlations between current hunger rating and scores on the PFS and other measures, suggesting that current hunger state is not a strong influence on scores on these measures. While it is possible that more extreme degrees of hunger might produce greater effects, the measures used in this study appear likely to be relatively stable in the presence of more moderate fluctuations in hunger.

The present results further suggest that hedonic hunger, at least as measured by the PFS, is a relatively stable construct that is not prone to fluctuation based on daily variations in hunger or the presence of food. These findings suggest that individual differences in hunger and exposure to food in the immediate environment are unlikely to represent significant confounds in research using the PFS and EI Disinhibition subscale. Furthermore, these results suggest that it is not necessary to burden research participants by giving specific instructions for eating prior to administration of these measures.

Despite the significant differences on the DEBQ External Eating Scale produced by an overnight fast in prior research (Evers et al., 2011), the present findings suggest that shorter fasting periods more analogous to typical breaks between meals or snacks are not associated with changes in External Eating scores. While the present study and the Evers et al. study used different measures of hunger and therefore the hunger scores cannot be directly compared to those in the present study, comparison of effect sizes for the hunger manipulation suggests that the lengthier fast in the prior study produced a stronger hunger effect: the hunger manipulation in the present study was associated with a moderate effect size, while the manipulation in Evers and colleagues' study was associated with a large effect size. Differential strength of the hunger manipulation, which is to be expected based on the design of the current study, is therefore a plausible explanation for the divergent results for External Eating across the two studies. Both the current study and the Evers et al. study utilized samples of college students who were, on average, in the normal weight range, suggesting that the divergent results are unlikely to be attributable to sample differences. It should be noted that the present sample, while predominantly female, included both male and female participants. Although males and females did not differ on the questionnaire measures in analyses using the full sample, the present study was under-powered to examine gender differences in the effects of the experimental manipulations; thus, direct comparisons to prior data sets based on gender are not possible.

Strengths of this study include investigation of two different "hot states" in a single sample, random assignment to experimental conditions, and the use of a fasting period representative of typical intervals between meals or snacks. In addition, we sought to isolate the effects of mere visual exposure to foods without strong odors in order to avoid confounding the effects of the presence of food with the smell of particular foods. Limitations include the use of a relatively homogenous college sample and the inability to entirely verify adherence to the standardized breakfast, although measures were taken to verify adherence to the extent possible. The sample size, while similar to the sample size in a previous, related study (Evers et al., 2011), was somewhat small; however, an advantage of the 2×2 design is the ability to examine main effects across pooled cells, and the very small effect sizes (see Table 3) suggest that the null results are unlikely to be attributable to low power.

The present findings suggest several directions for future research. Although the use of the four-hour fasting period in the present study has advantages for generalizability, it is unclear whether a longer fasting period, as was used in the study by Evers and colleagues, would produce group differences in PFS or EI Disinhibition scores. Furthermore, while the purpose of the food exposure manipulation in the present study was to examine whether mere visual exposure to food is sufficient to affect scores on the PFS and similar measures, the stability of these measures should also be tested under other conditions. For example, it is possible that smelling palatable foods might produce cravings sufficiently strong to affect PFS scores. Because exposure to food outside of the laboratory may or may not include olfactory cues, it is important to separately investigate the effects of both visual and olfactory cues on PFS scores. Future research should also investigate whether scores on these measures are affected by the manipulation of expectations regarding future food consumption. It is possible that if participants were informed that they would soon be able to eat the foods presented, the anticipation of imminent consumption of highly palatable food might produce an intensified "hot state" relative to mere presentation of the food without any indication of whether later consumption would occur. As above, because exposure to food outside the laboratory may or may not involve anticipation of imminent food consumption, the stability of the PFS and related measures should be tested under both conditions. These questions should be investigated in future research among more heterogeneous samples.

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