Association between energy intake and viewing television, distractibility, and memory for advertisements[1–5]

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ABSTRACT

Background: The effect of television viewing (TVV) with and without advertisements (ads) on energy intake is unclear.

Objective: The objectives were to test *1*) the effect of TVV, with and without ads, on energy intake compared with a control and reading condition and *2*) the association of distractibility and memory for ads with energy intake and body weight.

Design: Forty-eight (26 female) adults (age: 19–54 y) with a body mass index (in kg/m^2) of 20–35 completed this laboratory-based study. All participants completed 4 buffet-style meals in random order in the following conditions: *1*) control, *2*) while reading, *3*) while watching TV with food and nonfood ads (TV-ads), and *4*) while watching TV with no ads (TV-no ads). Energy intake was quantified by weighing foods. Distractibility and memory for ads in the TV-ads condition were quantified with a norm-referenced test and recognition task, respectively.

Results: Repeated-measures analysis of variance indicated that energy and macronutrient intake did not differ significantly among the 4 conditions ($P > 0.65$). Controlling for sex, memory for ads was associated with body weight ($r = 0.36$, $P < 0.05$) and energy intake but only when viewing TV ($r = 0.39$, $P < 0.05$ during the TV-no ads condition, and $r = 0.29$, $P = 0.06$ during the TV-ads condition). Controlling for sex, distractibility was associated with body weight ($r = 0.36$, $P < 0.05$) but not energy intake. Distractibility, however, accounted for 13% of the variance in men's energy intake ($P = 0.11$).

Conclusions: TVV did not affect energy intake, but individual characteristics (memory for ads) were associated with body weight and energy intake in certain conditions. These characteristics should be considered in food intake and intervention studies. *Am J Clin Nutr* 2009;89:37–44.

INTRODUCTION

Longitudinal studies indicate that television viewing (TVV) is associated with increased body mass in adults (1) and adolescents (2), which suggests that TVV affects energy intake, energy expenditure (activity levels), or both. Most laboratory-based studies indicate that TVV increases energy intake during test meals (3–6), although participant characteristics, study sample size, and effect sizes vary considerably [TVV has been reported to increase energy intake 11.5–71% (*see* References 3 and 5, respectively)]. At least one study, however, found that TVV decreased the energy intake of children (7).

TVV might increase energy intake through a number of mechanisms, including the effect of advertisements (ads) on behavior, mood alteration, or by fostering passive overconsumption and dishabituation to food cues. Exposure to food ads increased the energy intake of children and adolescents (8, 9), and induction of positive and negative emotional arousal with films increased women's energy intake with increasing levels of dietary restraint (10, 11). TVV might also increase food intake by decreasing awareness of the amount of food that is being ingested (12) or by disrupting habituation to food cues (13). Temple et al (13) found that TVV disrupted habituation to food cues only if TVV required attention allocation. Consequently, people who score high on measures of distractibility and whose attention is easily captured by external stimuli should experience larger increases in energy intake during TVV. In addition, the presence of other distracting stimuli, such as reading, could also increase energy intake among individuals with high levels of distractibility. Importantly, passive distracting stimuli such as TVV contribute to energy intake more so than distracting tasks that require visual-motor resources, such as playing video games (14).

This is one of the first studies with adult participants to directly examine the following: *1*) the effect of TVV, with and without ads, on energy intake; *2*) whether distractibility is associated with energy intake or body weight; and *3*) the influence of memory for ads on energy intake or body weight. It was hypothesized that energy intake would be greater when viewing *1*) TV with and without ads compared with a control and reading condition and *2*) TV with ads compared with viewing TV without ads. It was also hypothesized that distractibility would be associated with energy intake and body weight and, on the basis of previous studies conducted with children (9, 15), that memory for ads would be associated with energy intake.

[1] From the Pennington Biomedical Research Center, Baton Rouge, LA (CKM, SMC, NM, FLG, and SDA).

[2] Preliminary data from this study were presented at the Obesity Society 2007 Annual Meeting.

[3] The content is solely the responsibility of the authors and does not necessarily represent the official view of the National Institutes of Health.

[4] Partially supported by the National Institutes of Health [National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) grant 1 K23 DK068052-01A2] and Clinical Nutrition Research Unit Center grant 1P30 DK072476, entitled "Nutritional Programming: Environmental and Molecular Interactions," sponsored by the NIDDK.

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Received April 21, 2008. Accepted for publication September 18, 2008.

First published online December 3, 2008; doi: 10.3945/ajcn.2008.26310.

SUBJECTS AND METHODS

Ethics

The study was conducted at the Pennington Biomedical Research Center (PBRC), Baton Rouge, LA. All applicable institutional and government regulations concerning the ethical use of human volunteers were followed. All participants provided written informed consent, and the research was approved by the institutional review board of the PBRC.

Participants

Fifty-one healthy males and females, ages 18–54 y with a body mass index (BMI, in kg/m^2) of 20–35 were enrolled in the study. Exclusion criteria were as follows: *1*) use of medications that affect eating behavior or body weight (eg, antipsychotic medication); *2*) diagnosis of a chronic disease such as diabetes, cardiovascular disease, or cancer; *3*) tobacco use; *4*) refusal to eat the foods provided during the study; and, for females, *5*) irregular menstrual cycles or pregnancy. Three participants failed to complete the study because of scheduling difficulties. Participants received monetary compensation ($125) for participation.

Study design and random assignment

Using a within-subjects or repeated-measures design, participants completed 4 conditions in random order. During all conditions, participants were provided with a meal consisting of 16 food items served simultaneously in individual dishes that included grilled and breaded chicken and other low- and high-fat food items. Water and fruit punch were also served with each meal. The types and amount of foods served during the test meals are shown in **Table 1**. The 4 conditions were as follows:

1) Control: participants were not allowed to read or watch TV while eating.
2) Reading: participants were asked to read provided material while eating.
3) TV-ads: participants viewed a TV program that was interspersed with an equal number of food and nonfood ads while eating.
4) TV-no ads: participants viewed a TV program without ads while eating.

Participants completed 2 d of testing; they consumed a standard 359-kcal breakfast followed by the first test meal at lunch (4 h after breakfast) and the second test meal at dinner (4.5 h after lunch). The food items and energy content of the breakfast, lunch, and dinner meals are listed in Table 1. On the second test day, the same standardized breakfast was consumed, followed by the third test meal at lunch and the fourth test meal at dinner. Test days were scheduled 7 ± 2 d apart. To reduce demand characteristics, participants were told that the purpose of the study was to test the consistency of taste rating over time. Energy intake was quantified by weighing each food item before serving it to participants and weighing what remained after participants finished eating. Each food was measured to 0.1 g, and the food was weighed out of sight of the participant.

Sample size determination (statistical power analysis)

The study relied on a within-subjects design; as such, each participant served as his or her own control and all participants completed all 4 conditions. The sample size was determined by an a priori power analysis that relied on the published literature to estimate the minimally acceptable effect size (10.75% increase in energy intake). Variance estimates for energy intake were calculated on the basis of previously collected laboratory data that were derived from similar test meals. The power analysis assumed a large SD for energy intake (465 kcal), 80% power, an effect size of 10.75%, $\alpha = 0.05$, and a one-sided hypothesis test. Given these assumptions, the results of the power analysis indicated that we could detect a 10.75% increase in energy intake with 48 participants. This power estimate was considered conservative on the basis of the large variance and inclusion of an effect size that is smaller than any effect size reported in the literature to date.

Materials

During the TV conditions, participants viewed 2 different episodes of the same program (*Net Café*; http://www.archive.org/details/Performi1999). This program describes the uses of the Internet for security technology and arts and entertainment, including the performing arts. The *Net Café* was broadcast in >100 countries. The production style and episode templates were consistent between the 2 episodes, with both focusing on interviews and demonstrations with 4 to 5 technology developers and community members. One episode contained ads and one did not. The ads consisted of 6 food ads (eg, a pizza commercial) and 6 nonfood ads (eg, an automobile commercial) that lasted 30 s each and were recorded in the weeks before the study (the ads are listed in **Table 2**). Therefore, ads that were in circulation at the time of the study were used. The 6 food and nonfood ads were selected randomly by recording network television for 3 h in the evening and selecting the first 6 food and nonfood ads.

The reading material consisted of prose in topic and content similar to the TV programs. Specifically, the *Internet Travel Planner* (http://www.amazon.com/Internet-Travel-Planner-Trips-Online/dp/0762705795) by Michael Shapiro was used as reading material. With the use of the methods of McLaughlin (16), the material obtained a Flesch-Kincaid grade level of 7.3.

Participants were informed that they would be asked several questions about the material that they viewed or read during the TV and reading conditions. This procedure ensured that participants watched the TV programs and read the narrative, ie, attended to and dedicated cognitive resources to these stimuli while eating.

Test of memory for ads

After completing the TV-ads condition, participants' memory for the ads from the TV program was quantified using methods similar to those of Halford (15). The memory task consisted of a list that contained descriptions of ads that were and were not in the TV program. As outlined in Table 2, 50% of the ads on the list were in the program and 50% were not. Participants were asked if they remembered each ad as being in the program.

TABLE 1
Serving size and energy and macronutrient content of foods served during the study[1]

	Serving size	Energy	Protein	Fat	Carbohydrate
	g	*kcal*	*g*	*g*	*g*
Breakfast					
Fruit and grain cereal bar	37	140	3.0	1.0	26.0
Skim milk	230.8	86	8.4	0.4	12.0
Raisins	43.3	129	0.0	1.3	34.0
Total	311.1	359	3.0	10.4	71.4
Buffet meals					
Low-fat (<20% fat) items					
Baked potato chips	40	157	2.9	2.1	32.9
Salsa	85	29	0.0	0.0	5.9
Baby carrots	110	46	1.3	0.0	11.8
Pretzel twists	50	197	3.6	1.8	41.1
Fat-free Ranch dressing	70	72	0.0	0.0	14.5
Grilled chicken bites	250	328	56.6	8.9	6.0
High fat and/or high sugar (>45% fat or >30% sugar) items					
Corn chips	70	400	5.0	25.0	40.0
Cheese dip	65	96	2.0	6.7	5.7
Butter popcorn	60	240	0.0	13.7	34.3
Salted mixed nuts	90	546	25.7	45.0	16.1
Candy-coated chocolate bites	145	713	6.3	30.6	103.3
Chocolate cake rolls with icing	85	377	2.8	16.7	53.0
Breaded chicken bites	270	759	42.5	36.4	66.7
Cheddar cheese	115	493	24.6	41.1	0.0
Swiss cheese	110	432	31.4	31.4	0.0
Raisins	85	276	2.1	0.0	65.9
Fruit punch	740	355	0.0	0.0	89.5
BBQ sauce	80	140	1.0	0.2	33.7
Sweet and sour sauce	80	98	0.4	1.9	19.8
Total	1995.0	4921	152.1	241	528.6

[1] Product names and manufacturers: Kellogg's Strawberry Nutri-Grain Bar (Kellogg's, Battle Creek, MI), Sun-Maid Raisins (Sun-Maid, Kingsburg, CA), Lays Baked Potato Chips (Frito-Lay, Dallas, TX), Tostitos Salsa (Frito-Lay), Rold Gold Pretzel Twists (Frito-Lay), Hidden Valley Fat Free Ranch Dressing (Clorox Company, Oakland, CA), Tyson Grilled Chicken Bites (Tyson Foods, Springdale, AR), Fritos Corn Chips (Frito-Lay), Fritos Cheese Dip (Frito-Lay), ACT II Butter Lovers Popcorn (ConAgra Foods, Omaha, NE), Planters Mixed Nuts (Kraft Foods Global, Glenview, IL), M&Ms (Mars, Hackettstown, NJ), Little Debbie Swiss Cake Rolls (McKee Foods, Collegedale, TN), Tyson Popcorn Chicken (Tyson Foods), Hawaiian Punch Fruit Juicy Red Punch (Dr. Pepper Snapple Group, Plano, TX), Heinz BBQ Sauce (HJ Heinz Co, Pittsburgh, PA), and Heinz Sweet and Sour Sauce (HJ Heinz Co).

Ad memory was quantified by calculating the proportion of ads that participants remembered. Participants' familiarity with the ads was also quantified using similar methods, but this variable is not described in further detail, because it was not of primary interest and did not correlate with the primary outcome variables, including energy intake. Ad memory data were fitted to a dichotomous Rasch model (17) to assess the reliability and construct validity of the ad recognition task and to test for differential item functioning between males and females. Instrument reliability was acceptable and differential item functioning was not detected, which indicated that item responses were not sex-biased. Average model fit was acceptable, although significant item-item interactions were identified at the level of individual respondents. In practice, such interactions equate with nonlinearities that threaten the validity of the person score. These effects were removed by using the model error components, generating adjusted person scores that were then incorporated into all subsequent analyses.

Self-report measures and measures of distractibility and reading level

The following assessments were completed during baseline:

Conner's Continuous Performance Test II (CPT-II): The CPT-II is a norm-referenced, computer-based test that measures an individual's ability to attend to and concentrate on prompts of visual stimuli. The CPT-II provides an objective measure of attention deficit/hyperactivity disorder (ADHD) symptoms, and it has established reliability and validity (18, 19). The confidence index was used as an objective measure of distractibility to quantify the extent to which a participant's responses reflect the performance of an ADHD population. Inattentiveness or the tendency to be easily distracted is a core feature of ADHD, and the majority of people (at least children and adolescents) diagnosed with ADHD exhibit this symptom (20).

Wide Range Achievement Test 4 (WRAT-4): Participants completed the WRAT-4, a norm-referenced measure of academic skills, to obtain an objective measure of reading level and to

TABLE 2
List of the food and nonfood ads shown in the TV-ads condition

Food ads	Nonfood ads
Ads shown in video[1]	
Fried chicken fast food chain	Digital television service
Delivery pizza	Guitar retailer
Iced tea	Insurance provider
Rice and vegetable meal	Cellular communication company
Snack crackers	Automobile manufacturer
Fruit and grain cereal bars	Home vacuum (cleaning)
Ads not shown in video, but presented on the recognition task[2]	
Rice cereal	Diamond jewelry
Cookies	Digital television service
Yogurt	Automobile manufacturer
Fast food chicken sandwiches	Home sweeper (cleaning)
Milk chocolate candy bar	Car insurance
Vitamin water	Hotel chain

[1] Products advertised and manufacturers: Church's Chicken (Atlanta, GA), DirecTV (El Segundo, CA), Papa Johns Pizza (Louisville, KY), Gibson guitars (Nashville, TN), Lipton Iced Tea (Unilever, London, United Kingdom), Aflac (Columbus, GA), Uncle Ben's Rice (Mars, Hackettstown, NJ), Cingular Cell Communications (AT&T Mobility LLC, Atlanta, GA), Keebler crackers (Kellogg's, Battle Creek, MI), Lexus automobiles (Toyota Motor Sales Inc, Torrance, CA), Nutri-Grain Bars (Kellogg's, Battle Creek, MI), and Eureka Optima (Bloomington, IL).

[2] Products advertised and manufacturers: Kellogg's Special K cereal (Kellogg's), Kay Jewelers Diamonds (Sterling Jewelers Inc, Akron, OH), Tollhouse cookies (Nestle, Vevey, Switzerland), Cox Communications (Cox Communications Inc, Atlanta, GA), Dannon yogurt (The Danone Group, White Plains, NY), Chevrolet Automobiles (Detroit, MI), Wendy's Sandwiches (Wendy's International Inc, Dublin, OH), Swiffer Sweeper (Procter & Gamble, Cincinnati, OH), Three Musketeers Candy Bar (Mars), Geico Car Insurance (Chevy Chase, MD), Propel Fitness Water (Gatorade, Chicago, IL), and Hyatt Hotels (Hyatt Hotels Corporation; Chicago, IL). The fruit and grain cereal bar item was inadvertently omitted from the list of ads for the ad recognition task.

determine whether the reading material used in the study was consistent with participants' reading level. Grade equivalents and standard scores were obtained with the WRAT-4.

Eating inventory: The eating inventory is a 51-item self-report inventory that assesses dietary restraint (the intent to restrict energy intake), disinhibition (the tendency to overeat), and perceived hunger. The eating inventory has been found to be reliable and valid (21). In this study the eating inventory was used to quantify dietary restraint, which is associated with body weight and energy intake (22, 23), and the relation between energy intake and emotional arousal induced by movie watching (10, 11).

Visual analog scales (VASs): Computerized VASs were completed before and after each test meal to measure subjective ratings of hunger, fullness, desire to eat, food craving, strength of cravings, and desire to eat something sweet, salty, and fatty. When completing the VAS, participants rated the intensity of these subjective states on a 100-unit line anchored from ''not at all'' to ''extremely.'' VASs have satisfactory reliability and validity (24).

Visual analog mood scales (VAMSs): Computerized VAMSs were used to measure mood (happy vs sad), alertness (alert vs drowsy), tranquility (troubled vs tranquil), anxiety (tense vs relaxed), energy levels (lethargic vs energetic), and calmness (calm vs excited) before and after each test meal to determine whether the TV programs or the reading material differentially affected mood. VAMSs rely on the same 100-unit line as the VAS ratings and have satisfactory reliability and validity (25).

Procedures

Before reporting to the clinic to eat breakfast on test days, participants were instructed to fast for 12 h, refrain from vigorous exercise for 24 h, and refrain from consuming alcohol for 48 h. On arrival they completed a questionnaire to assess if they had fasted or were experiencing a cold or allergies. Participants reporting cold or allergy symptoms that affected their ability to taste or smell food were rescheduled. Female participants completed all test meals during their luteal menstrual cycle phase.

At each test meal, participants were instructed to eat as much or as little as they wished. The length of time that participants remained in the room (32 min) was standardized across testing conditions. For the purpose of the study, an office at the PBRC was altered to accommodate the TV and to provide a comfortable environment in which to eat. Bookshelves and office equipment were removed or covered. Environmental stimuli in the room were identical across conditions (eg, the TV was always in the room, but it was only on during the 2 TV conditions). Participants completed VAS and VAMS ratings before and after each test meal. On completion of the TV-ads condition, participants completed the memory task. Participants answered questions about the reading material after the reading condition.

Data analytic plan

The primary outcome variables were energy intake (kcal) and intake of kilocalories from fat, carbohydrate, and protein. Repeated-measures analysis of variance (ANOVA) was performed to test if energy intake differed significantly by condition (control, reading, TV-ads, TV-no ads). Sex was a between-subject factor.

Correlation analyses were used to examine the association of distractibility with energy intake and body weight and included sex as a partial covariate. Correlation analyses were also used to assess the relation between memory for ads and energy intake and body weight. The distributions for ad memory were negatively skewed; therefore, nonparametric Spearman's rho correlation coefficients were reported for these variables. Memory for ads was measured during the TV-ads condition but was correlated with energy intake in all conditions to determine whether people with better memory for ads have greater energy intake in general or if the associations only occur when certain stimuli, namely TV, are present.

The α level for the aforementioned primary outcome variables was 0.05. The number of correlations was limited to only those of primary interest and was planned a priori; therefore, α was set at 0.05 for the correlation analyses.

Repeated-measures ANOVAs were used to test if change in subjective ratings of appetite and mood differed across conditions. Change scores (postmeal minus premeal) were calculated for the VAS and VAMS ratings. These change scores were subjected to repeated ANOVAs, which included condition (meal

type) as the repeated factor and sex as a between-subject factor. α was set at 0.01 for the VAS and VAMS analyses to help control α inflation.

To ensure data integrity, the presence of order effects was tested with repeated-measures ANOVA, with contrasts to test for energy intake differences among the first, second, third, and fourth meal presented during the study. These tests were conducted with the variable of primary interest, energy intake.

The ANOVAs reported herein relied on the Greenhouse-Geisser *P*-value. All analyses were conducted with SPSS software, version 15 (SPSS Inc, Chicago, IL), with the exception of the Rasch model analysis, which was conducted with the use of Winsteps, version 3.65.1 (Winsteps, Chicago, IL).

RESULTS

Participant characteristics

The demographic characteristics of the study sample are depicted in **Table 3**. The sample was 54% female and predominantly white. The mean dietary restraint score was 7.3, which indicated that the sample did not have high levels of dietary restraint (21). The mean BMI was 25.8 and ranged from 20 to 35. The Word Reading and Sentence Comprehension Grade Equivalent scores from the WRAT-4 (12.0 and 11.8, respectively) indicated that the participants' reading level was above the reading level of the material in the reading condition (Flesch-Kincaid grade level of 7.3). Men scored higher on distractibility than did women (Table 3), which is consistent with research that shows that disorders involving distractibility (eg, ADHD) are more prevalent in males than in females (26).

Effect of TVV on energy intake

The repeated-measures ANOVA indicated that energy intake did not vary by condition [$F(2.8, 130.5) = 0.30$, $P = 0.81$] and the condition-by-sex interaction was nonsignificant [$F(2.8, 130.5) = 0.48$, $P = 0.69$; **Figure 1**]. The effect sizes for these comparisons were small (partial $\eta^2 \leq 0.01$). Similar analyses indicated that macronutrient intake (kilocalories from fat, carbohydrate, and protein) did not differ significantly by condition ($P > 0.65$) or condition-by-sex ($P > 0.29$; **Figure 2**, A, B, and C). The analyses were also conducted using grams of food consumed as the dependent variable, and the results were virtually identical.

Association of memory for ads and distractibility with energy intake and body weight

The results of the correlation analyses are summarized in **Table 4**. The first row of results demonstrates that, with sex entered as a partial covariate, distractibility was significantly associated with body weight but not energy intake. Examination of the correlation coefficients for each sex indicated associations of moderate magnitude between distractibility and energy intake for men ($r =$ 0.20–0.36, $P > 0.10$, across testing conditions) but not women ($r = -0.15$ to 0.07, $P > 0.47$). Conversely, distractibility was significantly associated with body weight for women ($r = 0.46$, $P <$ 0.05) but not men ($r = 0.23$, $P = 0.29$). Memory for ads was significantly associated with body weight and with energy intake in the TV-no ads condition ($P < 0.05$), and this relation was marginally significant in the TV-ads condition ($P = 0.06$; Table 4).

VASs and VAMSs

Mean VAS and VAMS change scores (postmeal minus premeal) that represent subjective levels of appetite and mood are shown in **Table 5**. Change scores for VAS and VAMS ratings did not differ significantly ($\alpha = 0.01$) by condition, as indicated in Table 5. The models also included effects for sex and sex-by-condition interactions, and these effects were not significant for VASs ($P > 0.01$) and VAMSs ($P > 0.03$).

TABLE 3
Characteristics of the study sample[1]

	Total sample ($n = 48$)		Male ($n = 22$)		Female ($n = 26$)		
	Mean	SEM	Mean	SEM	Mean	SEM	*P* value
Age (y)	31.9	1.5	31.4	2.1	32.4	2.2	0.73
Height (cm)	170.4	1.3	178.1	1.3	163.9	1.23	<0.001[2]
Body weight (kg)	75.1	2.1	83.4	2.9	68.1	2.2	<0.001[2]
BMI (kg/m^2)	25.8	0.6	26.3	0.8	25.4	0.8	0.43
Eating inventory							
Dietary restraint	7.3	0.7	6.6	1.0	7.8	1.0	0.41
Disinhibition	4.4	0.5	4.1	0.7	4.6	0.8	0.66
Perceived hunger	4.9	0.5	5.4	0.8	4.5	0.6	0.37
CPT-II							
Confidence index	46.2	2.4	53.5	2.5	39.8	3.5	0.003[2]
WRAT-4							
Sentence comprehension standard score	102.7	2.7	107.6	2.8	98.7	4.2	0.10
Reading composite standard score	107.5	3.8	112.6	5.8	103.4	4.9	0.23
Word reading grade equivalent	12.0	0.2	12.7	0.1	11.5	0.4	0.01
Sentence comprehension grade equivalent	11.8	0.3	12.5	0.2	11.2	0.5	0.03

[1] CPT-II, Conner's Continuous Performance Test II; WRAT-4, Wide Range Achievement Test 4. The column on the far right contains the *P* values from the one-factor ANOVA that compared men and women on baseline values. α was set at 0.01 for the secondary analyses to help control α inflation.

[2] These *P* values are significant.

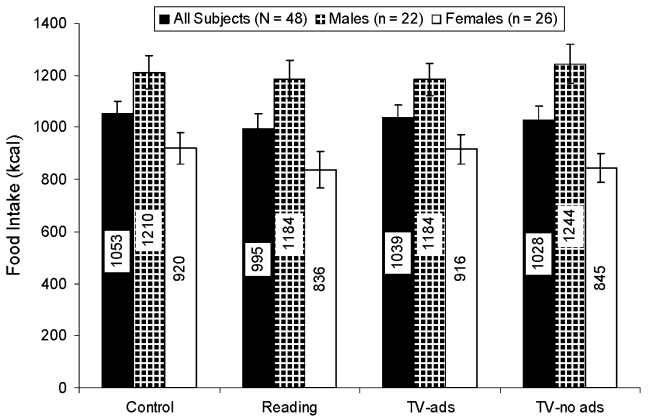

FIGURE 1. Mean (error bars represent SEM) energy intake (kcal) across conditions for the entire study sample and by sex. Repeated-measures ANOVA indicated that energy intake did not differ by condition [$F(2.8, 130.5) = 0.30$, $P = 0.81$], and the condition-by-sex interaction was nonsignificant [$F(2.8, 130.5) = 0.48$, $P = 0.69$].

Order effects

The test of order effects indicated that energy intake was significantly lower during the fourth (final) meal compared with the other meals ($P < 0.01$). The primary analyses were repeated with the fourth meal excluded, and the results did not change. Therefore, we reported results from the analyses that included all data.

DISCUSSION

In contrast to previous studies, TVV was not found to influence energy intake. The failure of TVV to increase energy intake in this tightly controlled study is surprising because most (3–6), but not all (7), published studies found TVV to increase energy intake. The effect sizes reported in the literature vary widely, however. Viewing TV has been found to increase energy intake by 11.5% (3) to 71% (5), and most study samples consisted of college-age females who scored high on dietary restraint. In such study samples, TVV might increase energy intake by disrupting dietary restraint, whereas this effect would not be observed in more representative samples of unrestrained adults. It is also possible that TVV affects energy intake through alteration of mood, which is consistent with earlier studies (10, 11). In our study we controlled the effects of mood alteration on energy intake by selecting test stimuli (TV programs and reading material) that were mood neutral, and the VAMS data indicate that mood did not change differently among the testing conditions. Therefore, if mood alteration is necessary for TVV to affect energy intake, our study would not find an effect, because change in mood did not differ among testing conditions.

A novel finding of the present study was that memory for ads was associated with energy intake, but this association was significant only when distracting stimuli (ie, TV) were present. Specifically, the correlation between memory for ads and energy intake was significant in the TV-no ads condition and marginally significant in the TV-ads condition. Memory for ads was also significantly associated with body weight, suggesting that people with better memory for ads eat more food or are more sedentary, which would promote a positive energy balance and weight gain. After controlling for sex, distractibility was significantly associated with body weight, but the correlation between distractibility and energy intake failed to reach statistical significance. Nevertheless, distractibility accounted for up to 13% of the variance in the energy intake of men during the TV-ads condition, and the significance of this correlation coefficient ($r = 0.36$, $P = 0.11$) was negatively affected by the sample size for males ($n = 22$).

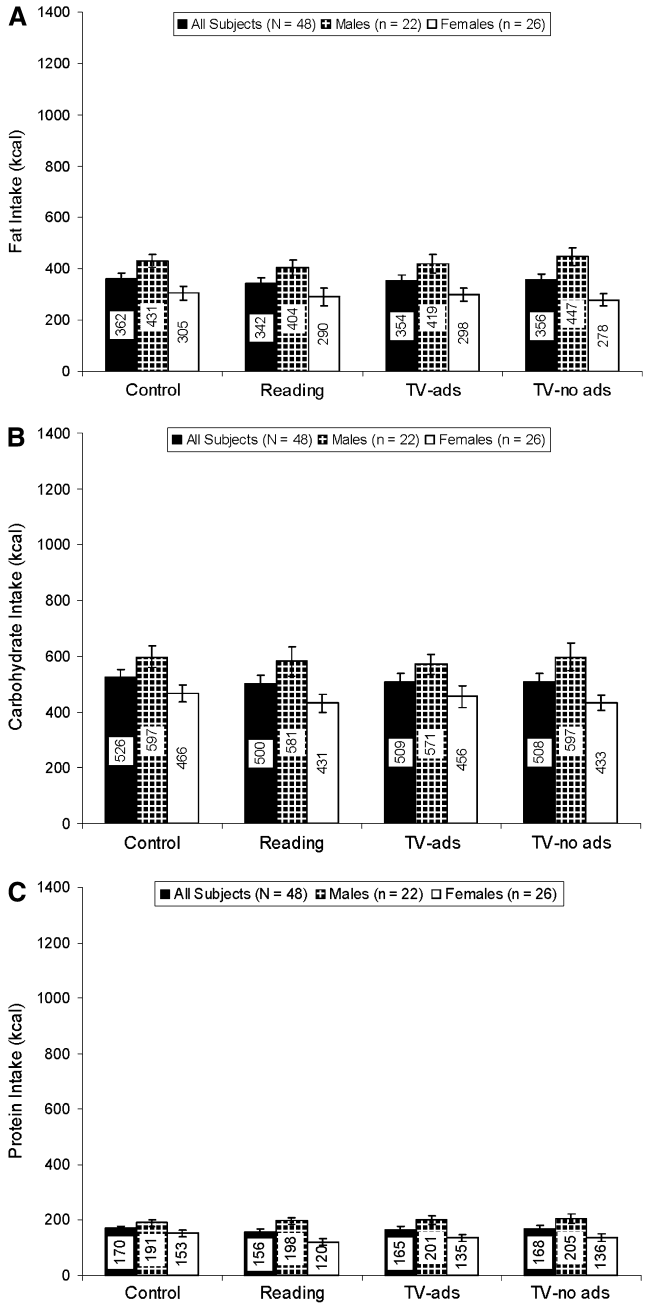

FIGURE 2. Mean (error bars represent SEM) intake (kcal) of fat (A), carbohydrate (B), and protein (C) for the entire study sample and by sex. Repeated-measures ANOVA indicated that fat intake (kcal) did not differ significantly by condition [$F(2.8, 129.3) = 0.24$, $P = 0.85$] or condition-by-sex [$F(2.8, 129.3) = 0.47$, $P = 0.69$] (A). Repeated-measures ANOVA also indicated that carbohydrate intake (kcal) did not differ significantly by condition [$F(2.8, 128.5) = 0.22$, $P = 0.87$] or condition-by-sex [$F(2.8, 128.5) = 0.21$, $P = 0.87$] (B). Last, protein intake (kcal) did not differ significantly by condition [$F(2.8, 130.4) = 0.52$, $P = 0.66$] or condition-by-sex [$F(2.8, 130.4) = 1.25$, $P = 0.30$] (C).

TABLE 4
Correlation coefficients for the association of distractibility and memory for ads with energy intake (kcal) and body weight (kg)[1]

	Energy intake				
	Control	Reading	TV-no ads	TV-ads	Body weight
Distractibility	−0.01	0.14	0.08	0.17	0.36[2]
Memory for ads	0.13	−0.04	0.39[2]	0.29[3]	0.36[2]

[1] Partial correlation coefficients are reported for the association between distractibility and energy intake, and distractibility and body weight (sex was entered as a partial covariate). Spearman's rho correlation coefficients are reported for the association between memory for ads and energy intake, and memory for ads and body weight.
[2] $P < 0.05$.
[3] $P = 0.06$.

The findings from this study suggest that individual characteristics are associated with energy intake and body weight, and these characteristics might interact with environmental stimuli (eg, TVV). Memory for ads was associated with energy intake only while viewing TV, and these data suggest that ads affect the energy intake of adults, which extends results reported for children and adolescents (8, 9). The role of conditioning requires further examination, because memory for ads was associated with energy intake in the TV-no ads condition, which suggests that the presence of TV, even if no ads are shown, contributes to the energy intake of people who have better memory for ads. It is possible that these individuals are more susceptible to conditioning and are more sensitive to TV as a cue for food intake. Importantly, the results from this study demonstrate that people can be identified who are more sensitive to the effect of environmental stimuli on energy intake and who would benefit from targeted interventions.

The measure of distractibility in this study, the confidence index of the CPT-II, reflects the degree to which participants' responses match those of people diagnosed with ADHD. ADHD is associated with overweight and obesity (27, 28) and is more common in males (26). Distractibility accounted for 13% of the variance in the energy intake of men during the TV-ads condition. Consequently, distractibility in males is likely associated with energy intake, and the presence of distracting stimuli might increase the strength of this association. This would help explain the association between ADHD and obesity. This study did not a priori recruit participants who scored high or low on distractibility, and additional research is warranted to determine whether TVV (or other tasks that require attention-cognitive resources) distracts susceptible individuals and results in passive overconsumption (12) or the disruption of habituation to food cues (13). Mood alteration during TVV might also interact with distractibility to modify energy intake, and this is worthy of future investigation.

Strengths and limitations

Our study has a number of strengths. First, the study included a control condition, a reading condition that served as a distracting task other than TVV, and TVV conditions that did and did not include ads. Second, the study sample's level of dietary restraint was low and did not correlate with energy intake (data not shown). Third, the study relied on a sample of adult men and women whose BMI ranged from healthy (20) to obese (35), and the mean BMI (25.8) was similar to the national mean for the US population (29). Finally, the confounding effects of mood alteration on energy intake were controlled.

The study also has limitations. First, it was conducted at a research center that offered exceptional experimental control, but the clinical environment is likely dissimilar to participants' natural eating environments. Nevertheless, significant efforts were

TABLE 5
Visual analog scale (VAS) and visual analog mood scale (VAMS) difference scores by condition[1]

	Control	Reading	TV-no ads	TV-ads	Condition main effect P value
VAS					
Hunger	−48.3 ± 3.9	−52.6 ± 3.7	−55.9 ± 3.5	−45.3 ± 4.2	0.09
Fullness	48.3 ± 4.0	55.4 ± 3.5	54.8 ± 3.6	47.2 ± 4.2	0.17
Desire to eat	−48.7 ± 4.2	−52.0 ± 4.2	−48.5 ± 4.4	−46.8 ± 3.9	0.67
Food craving	−25.1 ± 4.0	−28.5 ± 4.2	−24.1 ± 3.4	−23.4 ± 3.5	0.56
Desire to eat something sweet	−25.2 ± 3.3	−30.5 ± 4.1	−27.0 ± 3.7	−24.0 ± 3.8	0.36
Desire to eat something salty	−43.7 ± 3.9	−41.1 ± 4.4	−38.8 ± 4.0	−35.7 ± 3.7	0.35
Desire to eat something fatty	−26.2 ± 3.1	−27.7 ± 3.7	−24.6 ± 3.5	−25.1 ± 3.4	0.84
Strength of cravings	−15.5 ± 3.1	−19.3 ± 3.6	−20.5 ± 3.2	−15.7 ± 3.1	0.38
VAMS					
Alertness (alert–drowsy)	9.1 ± 5.0	2.7 ± 4.7	3.9 ± 4.1	2.5 ± 4.0	0.52
Tranquility (troubled–tranquil)	−6.3 ± 3.4	−8.0 ± 3.8	−8.6 ± 3.6	−2.7 ± 4.3	0.58
Anxiety (tense–relaxed)	−9.7 ± 4.1	−6.9 ± 2.1	−6.2 ± 4.4	2.9 ± 3.0	0.11
Mood (happy–sad)	8.6 ± 2.4	2.9 ± 2.3	4.5 ± 2.2	3.8 ± 2.2	0.20
Energy level (lethargic–energetic)	5.2 ± 2.6	7.2 ± 2.0	0.45 ± 3.2	4.0 ± 1.9	0.29
Calmness (calm–excited)	−2.0 ± 1.9	−2.7 ± 1.5	1.1 ± 1.8	−4.0 ± 1.8	0.19

[1] Values are means ± SEMs. Repeated-measures ANOVAs were used to test if change in subjective ratings of appetite (VAS) and mood (VAMS) differed across conditions. Change scores (postmeal minus premeal) were calculated for the VAS and VAMS ratings, and these change scores were subjected to repeated ANOVAs, which included condition (meal type) as the repeated factor and sex as a between subjects factor. α was set at 0.01 for these secondary analyses to help control for α inflation.

made to make the eating environment pleasant and as comfortable as possible. Second, an order effect was detected; energy intake during the last food intake test was lower than the other food intake tests. The primary analyses were repeated with data from the last test excluded, and the results were identical, as expected, because of the random sequence of testing conditions.

Conclusions

In contrast to previous studies, TVV did not influence energy intake. Two novel findings from this study are as follows: *1*) memory for ads was associated with energy intake and body weight and *2*) distractibility was associated with body weight, and 13% of the variance in men's energy intake was accounted for by distractibility. The results suggest that individual characteristics are associated with energy intake and body weight, and these characteristics should be considered in food intake and intervention studies. The results also suggest that individual characteristics may play a significant role in the effect that environmental stimuli (eg, TVV) have on energy intake, and further research is warranted to determine whether these characteristics help explain energy intake mechanisms.

The authors' responsibilities were as follows—CKM, SMC, NM, and SDA: responsible for study design, execution, statistical analysis, data interpretation, and writing of the manuscript; and FLG: responsible for medical monitoring and writing of the manuscript. None of the authors had a conflict of interest.

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