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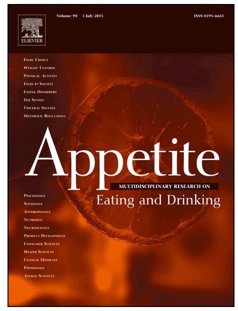

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The bogus taste test: Validity as a measure of laboratory food intake

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Abstract

Because overconsumption of food contributes to ill health, understanding what affects how much people eat is of importance. The 'bogus' taste test is a measure widely used in eating behaviour research to identify factors that may have a causal effect on food intake. However, there has been no examination of the validity of the bogus taste test as a measure of food intake. We conducted a participant level analysis of 31 published laboratory studies that used the taste test to measure food intake. We assessed whether the taste test was sensitive to experimental manipulations hypothesized to increase or decrease food intake. We examined construct validity by testing whether participant sex, hunger and liking of taste test food were associated with the amount of food consumed in the taste test. In addition, we also examined whether BMI (body mass index), trait measures of dietary restraint and over-eating in response to palatable food cues were associated with food consumption. Results indicated that the taste test was sensitive to experimental manipulations hypothesized to increase or decrease food intake. Factors that were reliably associated with increased consumption during the taste test were being male, have a higher baseline hunger, liking of the taste test food and a greater tendency to overeat in response to palatable food cues, whereas trait dietary restraint and BMI were not. These results indicate that the bogus taste test is likely to be a valid measure of food intake and can be used to identify factors that have a causal effect on food intake.

Key Words: Taste test; food intake; laboratory; appetite; eating behaviour;

The bogus taste test: Validity as a measure of laboratory food intake

Because of the damaging effects that poor diet and overconsumption of food have on health (Kopelman, 2007; Prentice, 2001), there is a need to understand the factors effecting how much people eat. Moreover, isolating the causal effect that biological, environmental and psychological factors have on food intake enables more nuanced theories of human eating behaviour. A variety of methods exist to measure eating behaviour. A large amount of epidemiological research has measured food and energy intake by using self-report methods, including food frequency questionnaires and dietary recalls. Although widely used and relatively inexpensive, the precision of such measures have long been questioned because of concerns over respondents' ability and motivation to provide highly accurate reports of their eating behaviour (Heitmann & Lissner, 1995; Macdiarmid & Blundell, 1998; Schoeller, 1990; Schoeller et al., 2013).

Laboratory measurement of food intake is another approach used to assess human eating behaviour. Unlike self-report measures, the controlled environment of the laboratory allows for objective examination of food intake. One laboratory approach is to examine food intake from test meals. In such studies participants are served a single or multi-item meal at breakfast, lunch and/or dinner, are told to eat until they are comfortably full, and the total amount of ad-libitum energy consumed is calculated (Blundell et al., 2010). The measurement of energy intake from test meals is common in research that examines the underlying physiology of human eating. For example, by assessing food intake at test meals across the day (or even for several days), it is feasible to examine whether pharmaceutical or nutritional interventions increase or decrease energy intake and/or affect food preference (Gibbons, Finlayson, Dalton, Caudwell, & Blundell, 2014; Hill, Rogers, & Blundell, 1995; Welch et al., 2011). This type of test meal design has been reported to be valid and reliable

(Blundell, et al., 2010; Gregersen et al., 2008; Martin et al., 2005). However, it has practical limitations. Test meal methods can be expensive and time consuming for researchers and require specialist research facilities. Furthermore, methods used at present rarely attempt to disguise that the test meal is being used to measure participant food consumption, e.g. (Andrade, Kresge, Teixeira, Baptista, & Melanson, 2012; Yip, Wiessing, Budgett, & Poppitt, 2013). This could be problematic because transparency of the purpose of the test meal may affect the amount of food that participants eat due to self-presentation concerns (Robinson, Hardman, Halford, & Jones, 2015; Robinson, Kersbergen, Brunstrom, & Field, 2014) and this effect may be differential dependent on participant individual differences within or across samples (Robinson, Proctor, Oldham, & Masic, 2016). This line of reasoning is consistent with classic social psychology research on demand characteristics and 'observer' effects, whereby behaviour can be biased by awareness of the purpose of a study (Nichols & Maner, 2008; Orne, 1962). Indeed, for some time there has been concern that commonly used laboratory methods to study eating behaviour are too artificial, and therefore lack ecological validity (de Castro, 2000; Meiselman, 1992).

A different laboratory measure of food intake is the bogus taste test. The bogus taste test typically involves providing participants with one or more food items and unobtrusively measuring the amount of food consumed. In an attempt to disguise that food intake is being measured, participants are led to believe that the purpose of the task is to assess their taste perception of the food(s). Participants are provided with the food, a series of taste ratings to complete (e.g. how sweet is the food?) in a set time period (e.g. 10 minutes) and are normally informed that once they have completed the ratings they are free to eat as they please. The taste test therefore is relatively inexpensive and convenient to use, as well as acting as a 'disguised' and objective measurement of food intake that can be easily implemented in laboratory settings. The taste test has been employed to examine whether a range of environmental and psychological factors influence food intake, including but not exclusive to; social norms (Robinson, Sharps, Price, & Dallas, 2014), advertisement (Harris, Bargh, & Brownell, 2009), portion size (Spanos, Kenda, & Vartanian, 2015), alcohol intoxication (Christiansen, Rose, Randall-Smith, & Hardman, 2016), stress (Sproesser, Schupp, & Renner, 2013), memory for recent eating (Higgs, 2002), attentional bias (Werthmann et al., 2011), mindfulness (Hooper, Sandoz, Ashton, Clarke, & McHugh, 2012), impulsivity (Guerrieri, Nederkoorn, & Jansen, 2008) and inhibitory control (Houben, 2011). Although the taste test has been employed by researchers for some time, e.g. (Conger, Conger, Costanzo, Wright, & Matter, 1980), unlike other measures of eating behaviour there has been no formal assessment of the validity of the taste test as a measure of food intake. For a recent examination of the bogus taste test in alcohol research see (Jones et al., 2016).

Variables Associated with Food Intake

Here we examine the validity of the bogus taste test as a measure of food intake by making use of participant level data from 31 published studies that adopted the taste test. If the taste test is a valid measure of food intake then factors that have been shown to reliably predict how much food a person consumes using other paradigms would be expected to predict food intake in the taste test. For example, although not all studies show a statistically significant relationship between hunger and food intake, there is now consistent evidence that self-reported hunger measured prior to eating modestly predicts how much a person will subsequently eat during a meal (de Castro & Elmore, 1988; Horner, Byrne, & King, 2014; Sadoul, Schuring, Mela, & Peters, 2014). Likewise, studies have consistently shown that individuals prefer to eat less of foods they dislike and more of a food if they like its taste (Brunstrom & Shakeshaft, 2009; de Graaf et al., 2005; Drewnowski & Hann, 1999). There are also marked sex differences in food intake, whereby men have a higher energy need and tend to consume more food than women (Rolls, Fedoroff, & Guthrie, 1991). Thus, in the present analyses we predicted that hunger, food liking and being male (as opposed to female) would positively predict taste test food intake and that evidence for these associations would imply support for construct validity of the taste test.

We also examined whether trait dietary restraint and the tendency to over-eat in response to palatable food cues predict taste test food intake. Trait dietary restraint can be defined as the tendency to consciously attempt to restrict food intake in order to prevent weight gain. Based on this definition, we predicted that higher dietary restraint should be predictive of lower taste test food intake. However, we made this prediction tentatively because whether attempts to restrict food intake reliably translate to reduced food intake is questionable, with some research suggesting that dietary restraint can often 'backfire'. Rather than being predictive of lower energy consumption, restraint has in some studies been associated with over-eating (Herman & Mack, 1975; Johnson, Pratt, & Wardle, 2012; Stroebe, van Koningsbruggen, Papies, & Aarts, 2013; Wardle, Steptoe, Oliver, & Lipsey, 2000). In addition, there is observational data which suggest that dietary restraint does not predict restriction of objectively measured food intake in the real world (Stice, Sysko, Roberto, & Allison, 2010).

The tendency to over-eat in response to palatable food cues is a factor that may also predict taste test food intake. In the present research we made use of self-reported data on trait disinhibited eating and trait external eating to characterize 'over-eating in response to palatable food cues'. In particular, trait disinhibition has been implicated in greater food intake and weight gain in multiple studies (Bryant, King & Blundell, 2008; French, Epstein, Jeffery, Blundell, & Wardle, 2012). However, there has been some debate over the accuracy and validity of self-reported trait measures of behaviour (Evers et al., 2011; Bongers & Jansen, 2016; Evers, de Ridder, & Adriaanse, 2009). Based on this we tentatively predicted that self-reported tendencies to over-eat in response to palatable food cues would be positively associated with taste test food intake.

We also know that participants with a higher body mass index (BMI) should on average have a greater energy need and therefore eat more than individuals with a lower BMI. In line with this, in multiple laboratory and epidemiology studies individuals of heavier body weight have demonstrated a greater total energy intake (Forslund, Torgerson, Sjostrom, & Lindroos, 2005; Sadoul, et al., 2014; Trichopoulou, Gnardellis, Lagiou, Benetou, & Trichopoulos, 2000). De Castro et al. (2012) found evidence that a heavier BMI was associated with self-reported energy intake and this relationship was most pronounced when participants were eating outside of the home. Yet, there are studies which report no significant association between BMI and energy intake. For example, Bell and Rolls (2001) found no difference in laboratory measured energy intake between females with normal weight and obesity. Similarly, in addition, although Berg et al. (2009) found that obesity was related to larger self-reported meal size for main meals among a large sample of Swedish adults, there was no significant relationship between BMI and daily energy intake in this study. There are also complex relationships between dietary restraint, over-eating in response to food cues and BMI. Individuals of heavier BMI are more likely to be restrained eaters, but ironically, also more likely to score higher on measures of over-eating (French, et al., 2012). In addition, laboratory taste tests typically involve the consumption of ‘unhealthy’ energy dense food. Because individuals of heavier body weight may be more likely to present their eating behaviour in a socially desirable way (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995), or eat minimally when they are aware that their food intake is assessed because of self-presentation concerns (Robinson, et al., 2016), heavier BMI may not predict greater food intake. Thus, in the context of a taste test it is not clear whether a heavier BMI would predict greater, limited or equivocal food intake. Because of these considerations we tentatively predicted that a higher BMI would be associated with greater taste test food intake.

Sensitivity to Experimental Manipulation

A further test of the validity of the taste test is whether the amount of food a participant eats in a taste test is sensitive to experimental manipulations hypothesized to increase or decrease food intake. Although previous research suggests that the taste test is sensitive to experimental manipulation (Conger, et al., 1980; Roth, Herman, Polivy, & Pliner, 2001), there are instances in which taste test methods have been used, and manipulations expected to increase or decrease food intake, did not do so (Blodorn, Major, Hunger, & Miller, 2016; Cavanagh, Vartanian, Herman, & Polivy, 2013). It is difficult to conclude why ‘null’ findings occur in individual studies; it may be that theoretical predictions are inaccurate, studies lack adequate statistical power and/or the methods used (e.g. the taste test) are not sufficiently sensitive. In the present analyses we were able to formally examine, with more than adequate statistical power, whether manipulations that had been hypothesized to increase or decrease taste test food intake did do so. We predicted that the taste test would be sensitive to manipulations hypothesized to increase or decrease food intake and evidence of this would provide further support for the validity of the taste test.

Testing Validity of the Taste Test

We reasoned that the taste test being sensitive to experimental manipulation and associated with participant level variables that are reliably associated with food intake in other paradigms (participant sex, baseline hunger and liking of the food used in a taste test) would provide strong confirmatory evidence for the validity of the taste test.

Methods

Because our approach required analysis of participant level data, we made use of available data sets from published studies of three research groups based in the UK and Australia that have routinely employed the bogus taste test in laboratory settings over the last 15 years. These studies were performed by, or under the supervision of, at least one of the present article's authors. See https://osf.io/ggkqp/ for preregistration of our methods and a-priori analysis strategy.

Inclusion: In total, 34 independent studies from 27 publications were identified initially. We limited our analysis to 31 studies (from 26 publications) that used between-subjects designs. As the taste test is typically used in between-subjects studies and there would be insufficient data to make comparisons between study types (i.e. comparing within, mixed and between-subjects), we did not include 3 studies that used within or mixed subjects designs. Studies included in the analysis are denoted in the reference list with an asterisk.

Study procedure: In all studies participants were led to believe that the aim of the taste test was to examine taste perception of the foods in the taste test, rather than to assess food intake. Participants were provided with the taste test food, a questionnaire about taste perceptions (e.g. how crunchy is the food?), before being asked to complete the ratings and were told that they were free to eat as much or as little of the foods as desired after completing the ratings. Participants were left alone to do this task, typically for 10 minutes. Hunger was self-reported shortly before the taste test in all studies. Liking of the foods used in the taste test was self-reported by participants during or immediately after the taste test. Self-reported participant level characteristics (sex, trait dietary restraint, trait over-eating in response to palatable food cues) tended to be measured after the taste test. Weight and height tended to be measured after the taste test to calculate BMI, although in a small proportion of studies, weight and height were self-reported. See Supplemental Table 1 for a list of the individual studies included and the variables included in the analyses for each study.

Sex: Participants in the 31 studies were predominantly female (2613/2692: 97%), so our main analyses were planned only on women (N=2613). However, we conducted an additional separate analysis to examine sex differences in food intake from studies (N=4) in which both men and women participated.

Participant level variables: To assess variables of interest that would have sufficient data for analysis, we first identified variables that were measured and available in the majority of data sets (i.e. > 50% data sets were required to include a measurement of a variable of interest in order to ensure adequate statistical power for analyses). This resulted in us extracting participant level data for baseline hunger (N=2464), taste test food liking (N=1871), trait dietary restraint (N=1640), trait over-eating in response to palatable food cues (N=1546) and BMI (N=2275). A total of N = 1071 participants had data for taste test food intake and all of the above participant level variables. We Z-scored baseline hunger, liking, restraint and over-eating in response to palatable food cues for each individual study because of variability in the way these constructs were measured across studies. BMI was measured consistently in each study (weight/height squared), so we did not Z score BMI.

Experimental conditions: Based on the introduction section of each published article, two authors independently coded the experimental conditions in each study as either hypothesised to increase, decrease or have no overall effect on food intake (no effect on food intake 'control' condition). Blinded initial agreement between the two coders was high (90%

agreement). In the remaining cases there was some ambiguity in papers about the specific hypotheses for an experimental condition, but the two coders agreed after discussion.

Operationalising taste test food intake: Because the amount of time given, number of taste test ratings required, type of food, number of food items, quantities of food and measurement of intake (e.g. grams, calories) used varied (and was sometimes not reported in detail) across taste tests in each study, to standardize our dependent variable of interest we Z scored food intake in each individual study. In 25/31 studies food intake was coded as total amount of food consumed. In two studies (Kemps et al., 2016a, 2016b), 50% of participants received grapes as the taste test food and 50% received chocolate. We did not include the data from participants receiving grapes, as taste tests typically involve an energy dense food and there were insufficient studies using only grapes to be able to formally compare them to other studies in the analysis. In four studies (Kakoschke, Kemps, & Tiggemann, 2014; Kemps, Tiggemann, & Elford, 2015; Kemps, Tiggemann, Orr, & Grear, 2014; Schumacher, Kemps, & Tiggemann, 2016) there were multiple taste test foods and the authors had experimental hypotheses specific to the intake of one of the foods in the taste test (e.g. chocolate muffin, but not blueberry muffin intake). In these studies, we used food intake data for only the food type that was central to the authors' experimental hypotheses.

Planned primary unadjusted analyses: We first planned to examine our hypotheses using all available data in a set of unadjusted analyses, in which statistical significance was set at $p <$ .05. To assess whether the taste test is sensitive to experimental manipulation, we planned a one way ANOVA, with experimental condition as the between-subjects factor. If a main effect was observed, we planned follow up pairwise comparisons between the three experimental conditions (increase, decrease and control). To assess whether participant level variables were associated with food intake we planned Pearson's r correlations. To examine sex differences on taste test food intake, we planned an independent samples-test on data from the four studies in which men and women participated.

Planned primary adjusted analyses: Next, we planned to assess the extent to which experimental conditions and participant level variables independently predicted food intake using stepwise regression. The first step included experimental design (i.e. dummy coded experimental conditions). The second step included participant level variables (hunger, restraint, over-eating in response to palatable food cues, BMI). Because taste test food liking in the studies was measured during the taste test, or immediately after, we reasoned that its association with food intake may be inflated due to reverse causality. According to self-perception theory (Bem, 1972), people base their beliefs in part on their prior behaviour (e.g., 'I ate a lot of cookies, so I must really like the taste of cookies'), so it is plausible that a participant who ate a lot of food in the taste test would assigned a higher liking rating to it. Because of this, we planned to enter liking separately in a final step of the regression model.

Planned secondary analyses: We planned to test whether results were similar in the UK vs Australian studies. If any participant level variables were predictive of food intake, we planned to assess whether these associations were observed consistently across UK vs Australian studies by computing interactions between country of origin and the participant level variables and entering them into the above regression model at a further step. We also planned to examine whether the associations between taste test food intake and trait measures of restraint and over-eating in response to palatable food cues differed dependent on the trait questionnaire used; restraint and disinhibition subscales of the TFEQ (Stunkard & Messick, 1985) vs. the restraint and external eating subscales of the DEBQ (Van Strien, Frijters, Bergers, & Defares, 1986), by computing interactions between trait measure type and scale score, and entering them into the regression model at a further step.

Statistical power: Sample sizes provided us with adequate statistical power to detect statistically small effects ($f^2 = 0.02$, > 80% power, $p < .05$) in our planned primary and secondary analyses.

Results

In our unadjusted analyses we made use of data from 2613 female participants, with a mean age of 20.7 years (SD = 4.6) and a mean BMI (kg/metres^2) of 22.8 (SD = 4.4).

Experimental manipulations of food intake

There was a significant effect of experimental condition on food intake ($F(2, 2610) = 26.10$, $p < .001$, partial eta sq = 0.02). Pairwise comparisons indicated that participants in conditions that were hypothesized to increase food intake ate significantly more ($p = .016$, $d = 0.11$) than did the participants in 'control' conditions that were not hypothesized to have an effect on food consumption, and participants in conditions that were hypothesized to decrease food intake ate significantly less ($p < .001$, $d = 0.27$) than did participants in 'control' conditions that were not hypothesized to affect food consumption. The difference in food intake between participants in the conditions hypothesized to increase vs. decrease food intake was also statistically significant ($p < .001$, $d = 0.38$). See Table 1.

Table 1. Effect of experimental conditions on taste test food intake

Condition	**N**	***Z* scored food intake**
Decrease intake	689	-.22 (0.89)
Control	1180	.04 (0.99)
Increase intake	744	.15 (1.06)

Z scored food intake values are means (standard deviations in brackets)

Unadjusted associations between participant level variables and food intake

Baseline hunger, liking of taste test food and trait over-eating in response to palatable food cues were all significantly positively correlated with taste test food intake. Trait dietary restraint was significantly negatively correlated with taste test food intake, whereas BMI was not significantly correlated with taste test food intake. See Table 2.

Table 2. Unadjusted associations between taste test food intake and participant level variables

	Baseline hunger	**Body mass index**	**Liking of test food**	**Trait dietary restraint**	**Trait over-eating**
Food intake	r = .19 p < .001 N = 2464	r = .03 p = .18 N = 2275	r = .27 p < .001 N = 1871	r = -.05 p = .04 N = 1640	r = .13 p < .001 N = 1546
Baseline hunger		r = -.04 p = .09 N = 2126	r = .20 p < .001 N = 1871	r = -.05 p = .06 N = 1640	r = .10 p < .001 N = 1546
Body mass index			r = .02 p = .53 N = 1735	r = .10 p < .001 N = 1528	r = .08 p = .002 N = 1463
Liking of test food				r = -.07 p = .016 N = 1248	r = .22 p < .001 N = 1155
Trait dietary restraint					r = .10 p < .001 N = 1543

Sex and food intake

An independent samples t-test indicated that male participants (N = 79, M *Z* scored intake = .23, SD = 1.10) consumed significantly more food (t (258) = 2.50, p = .013, *d* = 0.34) than did female participants (N = 181, M *Z* scored intake = -.10, SD = 0.93).

Predictors of taste test food intake using stepwise regression

The final model was statistically significant ($F = 37.05$, $p < .001$, Adjusted $R^2 = .12$) and included the following predictor variables; experimental manipulations hypothesized to decrease food intake, baseline hunger, over-eating in response to palatable food cues and taste test food liking. See Table 3. Manipulations hypothesized to increase food intake, BMI and restraint were not significant predictors in any steps of the model. Over-eating in response to palatable food cues was a significant predictor in all steps, but became non-significant in the final step in which taste test food liking was included. Experimental manipulations hypothesized to increase food intake approached significance as a predictor variable in a number of the steps of the model, but was not included in the final model.

Table 3. Stepwise linear regression model results

Predictor variables	**Model (step one) Adjust R^2 = .**02	**Model (step two) Adjust R^2 =** .07	**Final model Adjust R^2 =** .12
Exp. condition decrease intake	B = -.14, p < .001[a]	B = -.14, p < .001[a]	B = -.14, p < .001[a]
Exp. condition increase intake	B = .05, p = .15[b]	B = .06, p = .06[b]	B = .04, p = .15
Baseline hunger	-	B = .21, p < .001[a]	B = .16, p < .001[a]
Trait over-eating	-	B = .09, p = .002[a]	B = .05, p = .12[a]
Trait dietary restraint	-	B = -.02, p = .57[b]	B = -.01, p = .80[b]
Body mass index	-	B = .02, p = .58[b]	B = .01, p = .62[b]
Taste test food liking	-	-	B = .23, p < .001[a]

B refers to standardized Beta values. [a] indicates predictor variable was included in model step. [b] indicates predictor variable was not included in model step.

Generalizability of findings

Of the 31 included studies, 18 were conducted in the UK and 13 in Australia. Study country of origin did not interact significantly with participant liking of the taste test food or trait over-eating in response to palatable food cues to predict food intake. However, there was a small but significant interaction between study country and baseline hunger (B = .09, p = .04, R^2 change = .004). To examine the direction of the interaction we conducted our planned main regression models separately in studies conducted in the UK and Australia. In line with our main findings, baseline hunger was a modest significant positive predictor of food intake in both countries, although the strength of association between hunger and food intake was stronger in UK studies (N participants = 439, B = .25, p < .001) than Australian studies (N participants = 631, B = .11, p = .006). We also found a significant interaction between trait over-eating in response to palatable food cues and measure type (i.e., TFEQ disinhibition versus DEBQ external eating) (B = .07, p = .04, R^2 change = .003). To follow up this interaction we conducted our planned main regression models separately using data from studies that measured trait over-eating in response to palatable food cues using the TFEQ vs. the DEBQ. Over-eating in response to palatable food cues was a significant predictor of food intake in studies that used the TFEQ disinhibition scale (N = 324, B = .15, p = .005), but was not a significant predictor of food intake in studies that used the DEBQ external eating scale (N = 746, B = .002, p = .95). By contrast, there was no significant interaction between trait dietary restraint score and restraint measure type (i.e, TFEQ versus DEBQ).

Post-hoc analyses

As we found no correlation between BMI and taste test food intake we examined whether consistent results were observed when categorizing participants according to World Health Organization BMI categories; underweight (BMI < 18.5, N = 163), normal weight (BMI 18.5-24.9, N = 1642), overweight (BMI 25-29.9, N = 330) and obese (BMI ≥30, N = 140). In line with the correlational analyses, there was no significant effect of BMI category on food intake tested using a one way ANOVA (F (3, 2271) = 1.27, p = .28, partial eta sq = 0.002).

Discussion

The aim of the present study was to examine the validity of the bogus taste test as a laboratory measure of food intake. We made use of data from over 2500 participants across 31 published laboratory studies from three research groups in the UK and Australia that have used the taste test paradigm. To assess validity we examined whether the taste test was sensitive to manipulations hypothesized to decrease or increase food intake and the extent to which participant level characteristics reliably associated with food intake in other paradigms predicted taste test food intake. By finding that the taste test was sensitive to experimental manipulation and all variables identified as being reliably associated with food intake in other paradigms (hunger, sex, liking of food) were associated with taste test food intake, we provide evidence for the validity of the taste test. When examining other participant level characteristics that tend not to be reliably associated with food intake in other paradigms, we found less consistent results; neither BMI or trait dietary restraint were reliably associated with taste test food intake, although trait tendencies to over-eat in response to palatable food cues were predictive of taste test food intake.

Is the taste test sensitive to experimental manipulation?

We found that experimental manipulations hypothesized to increase taste test food intake were associated with increased consumption, and manipulations hypothesized to decrease food intake were associated with reduced taste test food intake. In both instances, the overall effects of the experimental manipulations on taste test food intake were statistically small. Moreover, although a statistically significant predictor of food intake in unadjusted analyses, the effect of manipulations hypothesized to increase food intake on taste test intake was not statistically significant in an adjusted analysis with a smaller sample size. These relatively small effects are perhaps not too surprising because these manipulations were only *hypothesized* to increase food intake. For example, in Robinson et al., (2014a) a condition was hypothesized to increase food intake because it would make participants feel less self-aware, but the manipulation did not successfully alter self-awareness. Unsurprisingly taste test food intake was also unaffected in this study. The present analyses alongside a range of other studies (Conger, et al., 1980; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2010; Van Strien et al., 2013) indicate that the taste test is a sensitive enough measure to be able to examine the causal effect of a manipulated variable on food intake.

Hunger and taste test food liking

In the present analyses we found that hungry participants tended to eat more during the taste test than did less hungry participants, and that the extent to which participants liked the food used in the taste test positively predicted food intake. We observed these results in our unadjusted analyses and in an analysis which included other participant level predictors of taste test food intake. We found this pattern of results irrespective of the country (UK vs. Australia) that studies were conducted in, although there was a tendency for baseline hunger to be more strongly associated with taste test food intake in studies conducted in the UK. This result was not predicted and could reflect differences between UK and Australian study methodologies. Overall, these findings are in line with other research which has shown that hunger (Sadoul, et al., 2014) and food liking (de Graaf, et al., 2005) are predictors of food intake, and thus confirm the construct validity of the taste test.

Sex

In a small sub-analysis we also examined whether there are sex differences in taste test food intake. Based on the notion that men have a higher energy need than women (Rolls, et al., 1991), we hypothesized that men would consume significantly more than women in the taste test. In line with this hypothesis, men consumed significantly more than women and this was a small to medium sized effect. This result is in support of the taste test having good construct validity.

Trait eating behaviour measures

We found evidence that self-reported over-eating in response to palatable food cues predicted food intake in the taste test, whereby participants with a greater tendency to overeat in response to palatable foods consumed significantly more in the taste test than participants with lower scores. However, this association was dependent on the measure used, whereby responses on the TFEQ disinhibition subscale (Stunkard & Messick, 1985), but not DEBQ external eating subscale (Van Strien, et al., 1986) were reliable predictors of taste test food intake. The present finding may reflect that the items on the DEBQ external eating subscale tend to ask participants about the influence that external cues have on stimulating over-eating, whereas the TFEQ disinhibition subscale is a more general measure of 'overeating' or loss of control over eating (e.g. scale item: 'Sometimes when I start eating, I just can't seem to stop'). This may results in it being more predictive of taste test food intake because taste test procedures promote initial consumption of food in order to complete taste ratings. We found little evidence that trait dietary restraint predicted taste test food intake. In an unadjusted analysis, there was a very small ($r = -.05$, $p = .04$) negative association between restraint and food intake that was close to the threshold for statistical significance. However, in the adjusted analysis this association was no longer statistically significant ($p = .80$) and was close to zero. Restraint was also correlated with other participant level characteristics that did significantly predict taste test intake which indicates that the small unadjusted association between restraint and taste test food intake may have been caused by confounding. Although we made a tentative hypothesis that dietary restraint would be associated with lower taste test food intake, other studies outside of the laboratory have suggested that there is a lack of reliable relationship between dietary restraint and energy intake (Johnson, Pratt, & Wardle, 2012; Stice, et al., 2010). However, in the context of a laboratory taste test the association between dietary restraint and food intake may be determined by the extent to which a test food is perceived as being ‘forbidden’ by a participant. This is a hypothesis we were not able to test in the present study. Moreover, in line with restraint theory (Herman & Mack, 1975), dietary restraint may interact with certain types of experimental manipulation to predict taste test food intake , rather than having a direct association with intake as was tested in the present study. Thus, more sophisticated tests of when dietary restraint does/does not predict food intake may uncover an association between dietary restraint and taste test food intake.

BMI

We found no evidence of a significant relationship between BMI and taste test food intake, irrespective of whether this relationship was examined with BMI as a continuous variable or when BMI was grouped according to weight status (e.g. normal weight, overweight, obese). We had predicted that there would be a positive association because a higher BMI should be associated with a larger energy intake requirement. Both Acosta et al. (2015) and Meyer-Gerspach et al. (2014) report data which indicates that participants with severe obesity have a higher energy intake in the laboratory than participants with normal weight. In the present study we had relatively few participants with obesity and most were of class I obesity (30-34.9 kg/m^2). Thus, we may have found a relationship between BMI and taste test food intake if we had a wider BMI range in the present study. In the context of a taste test it is also plausible that individuals of heavier body weight do not eat more than their slimmer counterparts because overconsumption of the foods commonly used in taste tests (high calorie snack food) may invoke self-presentation concerns. Moreover, there is some debate whether individuals of heavier BMI eat larger meal sizes in the real world and it has instead been argued that eating frequency may be more reliably associated with BMI (Mattes, 2014). Thus, the lack of association between BMI and taste test food intake in the present study may reflect this.

Limitations and Methodological Considerations

The present project involved participant level data and because of this it was not feasible to review and analyze data from all published studies that have adopted the taste test. Thus, it is important to note that our conclusions are based on findings from three research groups. However, we did make use of a relatively large number of studies that had been conducted in two countries and this increases confidence in the generalizability of our findings. A limitation of the present study was that a lack of data from male participants resulted in our main analysis being limited to young women. Although a smaller sub-analysis showed that the taste test is sensitive to sex differences in food intake, we do not know whether our results regarding the sensitivity of the taste test to experimental manipulations and participant level predictors of taste test food intake apply to men. We are not aware of any convincing rationale why for example, taste test food intake in men would not be predicted by baseline hunger, but further work assessing the validity of the taste test in male samples would be informative.

Based on our findings we recommend that the use of the taste test in laboratory eating behaviour research to identify that affect food intake is valid. However, there are caveats to this recommendation. Given that baseline hunger and taste test food liking predicted food intake in our analyses, ensuring that these variables are standardized and/or measured in taste test studies is recommended. All of the included studies in the present analyses adopted cover stories to attempt to ensure that participants were not aware of the aims of the study or experimental hypotheses. It has been shown in a number of studies that when participants believe their food intake is being measured this tends to affect the amount of food they eat (Robinson et al, 2015). Thus, we would argue that studies which adopt the taste test should a) attempt to ensure that participants are unaware of study hypotheses and b) attempt to conceal that food intake is being measured. The present studies also all used between-subjects designs, as opposed to participants attending several laboratory sessions, being exposed to different manipulations and completing multiple taste tests. Thus, our conclusions are limited to between-subjects designs. It is feasible that with repeated use of the taste test (e.g. a crossover design) the purpose of the taste test may become more apparent to a participant. A final point is that the predictor variables in our analyses combined explained only 12.5% of taste test food intake. Thus, identifying and understanding other factors that explain how much participants consume during a taste test would now be of interest.

Conclusions

The results of our analyses indicate that the bogus taste test is likely to be a valid measure of food intake and can be used to identify whether experimental manipulations have a causal effect on food intake.

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