



## Food portion size area mediates energy effects on expected anxiety in anorexia nervosa



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### ABSTRACT

A study in which adolescent patients with anorexia nervosa ( $n = 24$ ) rated their expected food-anxiety in response to images of portions of food (potatoes, rice pizza, and M&Ms) showed that lower energy-dense foods elicited higher expected anxiety per kilocalorie than higher energy-dense foods. However, the area of the portion sizes could be an unmeasured variable driving the anxiety response. To test the hypothesis that area mediates the effects of energy content on expected anxiety, the same images of portions were measured in area ( $\text{cm}^2$ ), and standardized values of expected anxiety were regressed from standardized values of energy and area of portions. With regression of expected anxiety from portion size in area, M&Ms, which had the highest energy density of the four foods, elicited the highest expected anxiety slope ( $\beta = 1.75$ ), which was significantly different from the expected anxiety slopes of the other three foods ( $\beta$  range =  $0.67 - 0.96$ ). Area was confirmed as a mediator of energy effects from loss of significance of the slopes when area was added to the regression of expected anxiety from energy  $\times$  food. When expected anxiety was regressed from food, area, energy and area by energy interaction, area accounted for 5.7 times more variance than energy, and  $\beta$  for area (0.7) was significantly larger (by 0.52,  $SE = 0.15$ ,  $t = 3.4$ ,  $p = 0.0007$ ) than  $\beta$  for energy (0.19). Area could be a learned cue for the energy content of food portions, and thus, for weight gain potential, which triggers anxiety in patients with anorexia nervosa.

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### 1. Introduction

Severely reduced caloric intake is a hallmark of anorexia nervosa (Sysko, Walsh, Schebendach, & Wilson, 2005). Research has shown that food-related anxiety and obsessionality are important contributors to intake restricting behaviors (Wilson, Touyz, O'Connor, & Beumont, 2013; Gianini et al., 2015). Steinglass et al. (2010) demonstrated that pre-meal anxiety was significantly and negatively correlated with intake of both a multi-item and a single-item meal (macaroni and cheese); such that patients' intakes were significantly lower than those of healthy controls. Patients with anorexia nervosa (AN) also tend to be preoccupied with the calorie content and portion size of foods because of fear of weight gain (Halmi, 2007). Although a relationship between fear of food and food intake has been proposed (Steinglass et al., 2011), few studies

have systematically assessed the predictors of food-related anxiety in anorexia. Accurate cooperation and compliance with assessments and treatment is also a common problem with patients with AN (Crisp & Kalucy, 1974), because they fear loss of control over eating and of weight-gain (Vitousek, Watson, & Wilson, 1998).

To compare differences in the anxiety potentials of foods, Kissileff et al. (2016) used a novel paradigm to measure expected anxiety responses to food. To avoid causing distress to the participants, a computerized task with images of foods, rather than actual food portions, was used. Four pictured foods were tested: M&Ms<sup>®</sup> and pizza, to represent tasty high energy-dense foods, and plain rice and potatoes to represent bland low energy-dense foods. These foods are also common components of the American diet (Smiciklas-Wright, Mitchell, Mickel, Cook, & Goldman, 2002).

In that preliminary study, Kissileff et al. (2016) proposed that increases in the energy of a portion would produce measurable increases in expected anxiety, and that higher energy-dense foods would produce more expected anxiety than low-energy dense

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foods. Participants' anxiety responses were regressed from the calorie content of portions, and the expected anxiety-inducing potential of a food was derived from the slope of the response level as the portion size increased. Paradoxically, in patients with AN, steeper expected anxiety slopes (that is, more anxiety per log kilocalorie) were found for the foods with a lower energy density (rice and potatoes) than for the foods higher in energy density (pizza & M&Ms). This result was not explained by the participants' liking of the foods or by their familiarity ratings. The result of greater fear of low-energy dense foods contradicts evidence that patients with AN tend to avoid high energy-dense foods to prevent weight gain (Jiang, Soussignan, Rigaud, & Schaal, 2010). Visual examination of the food images suggested that the physical size of the portions and not their energy content was the common factor that predicted anxiety responses. For example, (Fig. 1), portions of pizza (320 kilocalories) and rice (160 kilocalories) that differed in energy content, occupied equivalent areas on the plate and both elicited identical anxiety responses on a VAS anxiety scale (see Kissileff et al., 2016). Several other pairings can be observed by comparison of food energies and areas in Table 1 and Fig. 1. To determine whether these observations were mere illusions or actual contributors to the response, in the current report, areas of the food images were measured and the original data were re-analyzed, so that contributions of both area and energy could be assessed

**Table 1**  
Areas (cm<sup>2</sup>) of Foods by energy content (kcal).

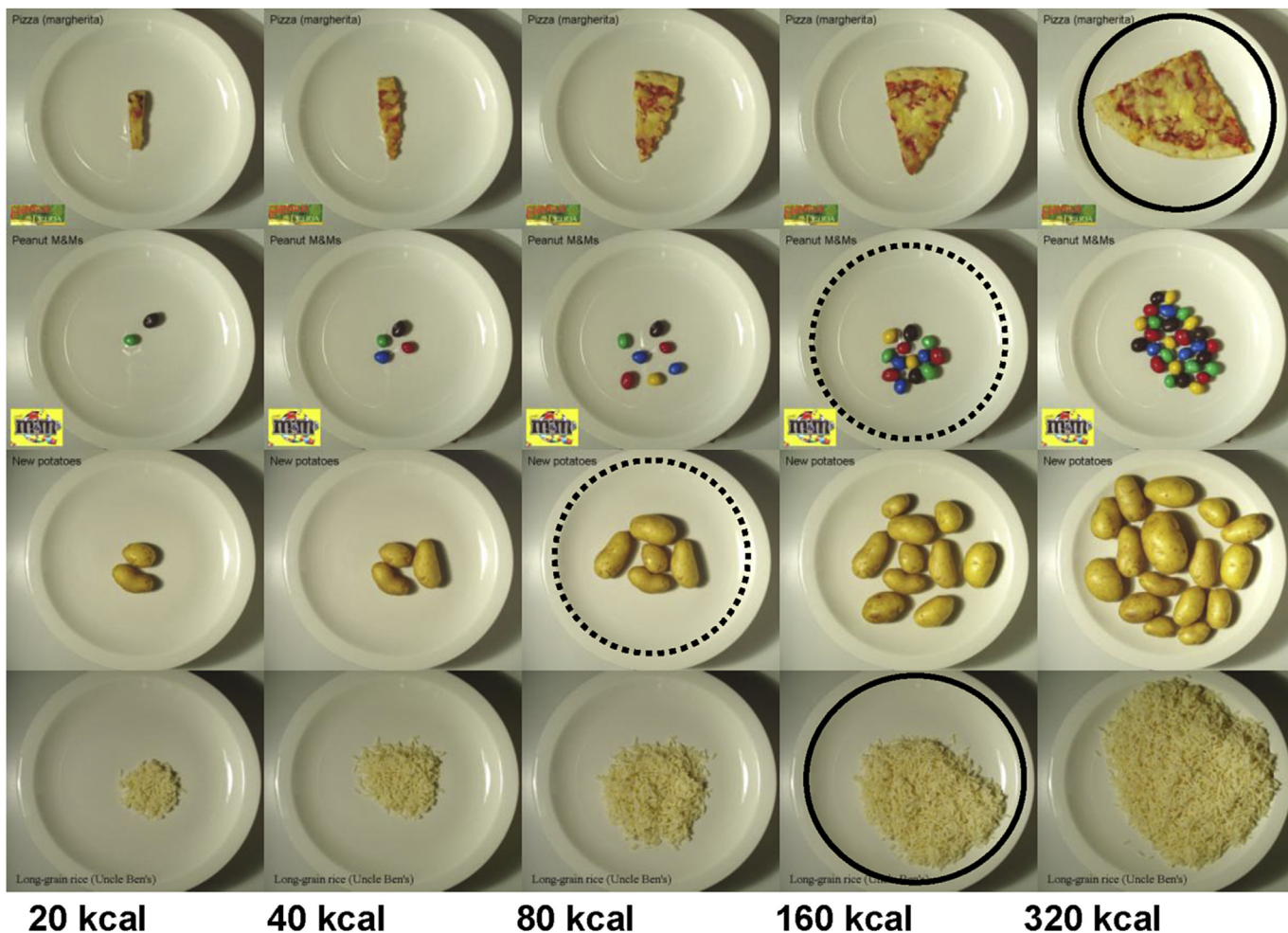
Food	20 kcal	40 kcal	80 kcal	160 kcal	320 kcal
Potatoes	11.72	23.45	46.9	93.8	187.6
Rice	15.99	31.97	63.95	127.9	255.79
Pizza	7.67	15.35	30.7	61.39	122.79
M&Ms	3.07	6.13	12.27	24.54	49.07

independently and in combination.

**2. Materials and methods**

*2.1. Study sample*

Data were reanalyzed from twenty-three females and one male, all of whom met the DSM-IV criteria for anorexia nervosa, as determined by a licensed psychiatrist, using the Structured Clinical Interview (First, Gibbon, Spitzer, & Williams, 1996). The DSM-IV was the most current version of the DSM in use at the time of data collection. Participants were recruited from the Weill Cornell Medical College treatment facility in White Plains, NY, between October 2008 and June 2010. The Yale-Brown-Cornell Eating Disorder Scale (Mazure, Halmi, Sunday, Romano, & Einhorn, 1994) was



**Fig. 1.** Images of portions shown to participants with their energy content shown below. Two pairs of almost equal sized images elicited equivalent anxiety responses are circled for comparison. The solid circles are for pizza (area = 63.9 cm<sup>2</sup>) and rice (61.3 cm<sup>2</sup>) which elicited a response of 50 mm out of 100 mm on a visual analogue scale for expected anxiety. The dotted circles show equal sized portions of M&M's and potatoes both of which elicited the same anxiety response (35 mm out of 100 mm).

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