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# Satiety Relaxes Thinness Criteria When Judging Others' Body Shapes

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## Abstract

While people might endorse tolerance, social/environmental biases can remain operative and drive action in an unconscious manner. Herein, we investigated whether the criteria for judging others' body shapes as "fat" or "thin" change with the degree of satiety. Nine females participated in the present study. The participants judged nine women's figures as fat or skinny on a computer monitor in two conditions (Fasting and Satiety). Each figure ranged in body mass index (BMI) from 18.3 to 45.4 (*i.e.*, 18.3, 19.3, 20.9, 23.1, 26.2, 29.9, 34.3, 38.6, and 45.4). Parameter estimates showed that a one-unit change in condition (Fasting vs. Satiety) resulted in a 20.0% greater probability of switching from "fat" to "thin" (SE = 0.056, z = 3.631, $p < 0.0001$). Notably, figures judged as "fat" in the fasting condition were judged as "thin" in the satiety condition. Thus, we concluded that satiety relaxes criteria for judging the thinness of others' body shapes.

## Keywords

Satiety, Body Image, Perception, Judgment

## 1. Introduction

The criteria by which we judge people and events can be modified by social/environmental factors and thus are often fraught with bias. This can include our preconceptions of other people. For example, judgments about how a baseball player has struck the ball can be influenced by the count [1] and temporal order judgments can be influenced by previous repeated exposures [2] [3] [4].

Recently, French lawmakers have been considering a ban on thin fashion models (*i.e.*, a body mass index of under 18). Our criteria for judging others' body shapes have become a recognizable social problem. At present, the criteria that we use to judge women's body shapes appear to be strict with regard to what is considered "thin". Coupled with these strict criteria is a widespread cultural desire to be thin, which has been linked to an increasing prevalence of child and adolescent anorexia nervosa [5], binge eating, and dangerous fad dieting [6]. In this culture where "thin is in," people tend to suffer, at one point or another, from issues relating to weight, body shape, and self-image [7].

Anorexics tend to have an extremely warped body image; despite being extraordinarily thin, most see themselves as obese [8]. This suggests the possibility of a relationship between body shape criteria and appetite. When people ingest food, their parasympathetic nervous system activates their digestive system. The parasympathetic nervous system also reduces feelings of aggression [9]. We therefore hypothesized that, if the criteria for others' body shape rely on the judge being in a fasting state, then the probability of an individual judging a person as "fat" or "thin" would shift such that they would be more likely to consider a body as "thin" when they previously judged it as fat—namely, they would relax their criteria for what constitutes "thin" and "fat".

## 2. Material and Methods

### 2.1. Participants

To test our hypothesis, we used a computer-based psychophysics task to examine changes in individuals' judgments of body shape. Nine female volunteers (age 18 - 22, height: 165.0 ± 3.5 cm, body mass: 59.9 ± 5.0 kg, BMI: 22.0 ± 2.0 $kg/m^2$) were participants in this study, and all were naive to the purpose of the experiment. All participants were right-handed, had norm al or corrected-tonormal vision, were neurologically healthy. In the present study, we used all images of women, so we limited participant to women. A target sample size of participants was specified in advance based on previous studies in this area and our expectation that, if the main experimental effect was present, it should be observed in almost all participants, then we conducted the calculation of the optimal number of subjects using G*Power (effect size = 0.25, alpha error probability = 0.05, Power (1-beta error probability) = 0.95, number of measurements = 9) [10]. Written informed consent was obtained from each subject after they were informed about the nature of this non-invasive study and procedure. The subjects were instructed not to engage in any intense exercises on the day before and on the day of the test. They were also asked to refrain from consuming food or beverages containing caffeine for 3 hours before testing. This 3-hour break between food intake and test was specified in advance based on previous studies in this area [11]. All experiments on the subjects were conducted in strict compliance with the Declaration of Helsinki, and all procedures were carried out only when their correct understanding of this experiment was confirmed, which was approved by the Ethics Committee of Niigata University of Health and Welfare (No. 17619-150909).

### 2.2. Apparatus and Stimuli

The stimuli were presented on a 17-in CRT monitor (LCD172VXL; NEC, Japan) with a resolution of 1024 × 768 pixels and a refresh rate of 100 Hz. The presentation of stimuli and data collection was controlled using a computer (M8-D; NEC, Japan). The visual stimuli were generated by Psychopy [12] [13]. These stimuli comprised a fixation point, command cursors for rating, and images of the nine female figures that were randomly presented to participants. Each figure ranged in body mass index (BMI) from 18.3 to 45.4 (*i.e.*, 18.3, 19.3, 20.9, 23.1, 26.2, 29.9, 34.3, 38.6, and 45.4) [14].

Stimuli were presented at a viewing distance of 40 cm. The fixation point comprised two concentric rings, one small and one large, with radii of 0.24˚ and 0.47˚ of the visual angle, respectively. The luminance of each ring was 91.0 cd/m$^2$. The command cursors were white boxes surrounding each rating value (0.95˚ × 1.89˚; 91.0 cd/m$^2$) and the selected box was filled in white. Each stimulus was displayed on a gray background (43.5 cd/m$^2$) in the center of the computer screen.

## 2.3. Procedure

The experiment was conducted in a darkened room. We created two conditions: (a) the Fasting condition and (b) the Satiety condition. In both conditions, the participants had abstained from eating, ingesting caffeinated or alcoholic beverages, and exercise for 3 h. Then, the participants drank 285 ml of water while either eating (in the Satiety condition) a 400 kcal block of solid food (80 g; 8% protein, 50% fat, and 42% carbohydrates; Calorie Mate, Otsuka Pharmaceutical Co. Ltd., Japan) or not eating anything (in the Fasting condition). All participants performed a total of 297 trials of the judgment task in each condition.

Participants initiated each trial by pressing the spacebar on the computer keyboard. The fixation point was presented throughout the experiment whenever there was no image onscreen. For each trial, after a delay of a random duration between 800 to 1200 ms, a body image stimulus was presented and remained on the screen until a response was made (−3000 ms). The participant's task was to judge the body image as either fat or thin by pressing the assigned keys as quickly as possible while maintaining accuracy. All participants performed a total of 297 trials (33 repetitions of 9 images) of the judgment task in each condition. The trial order was randomized for each participant.

## 2.4. Statistical Analysis

The response data were sorted according to figure BMI to calculate the probabilities of judging a figure as fat. We fitted the judgment probabilities to a cumulative density function on a Gaussian distribution. Participants were included for analysis only if the data met the following basic criteria: the response data of the judgment probabilities obtained from the participant did not fit to a cumulative density function on a Gaussian distribution. In all participants, the response data fitted to a cumulative density function on a Gaussian distribution. If the judgment of body shape was biased by the condition (Satiety/Fasting), the PSE of categorization would shift in the direction of the corresponding category. PSEs were calculated for each participant in each condition using the following algorithm. Specifically, individual PSE estimates were obtained by transforming the proportions of short responses for the nine comparison intervals to z-coordinates and then fitting a straight line though the transformed points, as described in a previous study [14] [15]. Because the observations were repeated measures (5346 data; 2 conditions × 297 stimuli × 9 subjects), we conducted a generalized linear mixed model analysis with multinomial distribution and a binomial logit link function for the probability of fat judgment across 9 stimuli to avoid the occurrence of type-I error caused by the small sample size and uncontrolled conditions (fixed effect: condition; mixed effect: subjects and stimulus). The tests of the model effects revealed the predicted effect of condition. We used R 3.2.4 and lmer. Test package to perform a linear mixed effects analysis of the relationship between conditions and the judgments for women's body shape. As fixed effects, we entered conditions into the model. As random effects, we had intercepts for subjects and stimulus (figures of women's body shape), as well as by-subject and by-stimulus random slopes for the effect of conditions. *p*-values were obtained by likelihood ratio tests of the full model with the effect in question against the model without the effect in question.

## 3. Results

We conducted a generalized linear mixed model analysis. **Figure 1** shows the average of response to 9 stimulis, and **Figure 2** shows the response in each participants. Parameter estimates showed that, when holding all other variables constant (*i.e.*, conditions, subjects, stimulus), a one-unit change in condition (Fasting vs. Satiety) resulted in a 20.0% greater probability of switching from "fat" to "thin" (SE = 0.056, z = 3.631, $p < 0.0001$, lower CI = 0.308, Upper CI = 0.092) (**Figure 1** and **Figure 2**). Next, we calculated the PSE to visualize the degree of the delay in the response in the Satiety condition compared with that in the Fasting condition. **Figure 3** shows the PSEs in both conditions. The mean

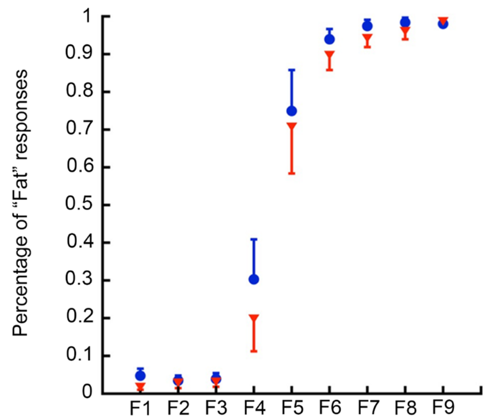


**Figure 1.** The percentage of "fat" to each body shape stimuli in Fasting (red) and Satiety (blue) conditions. Each plot shows the average and standard error.

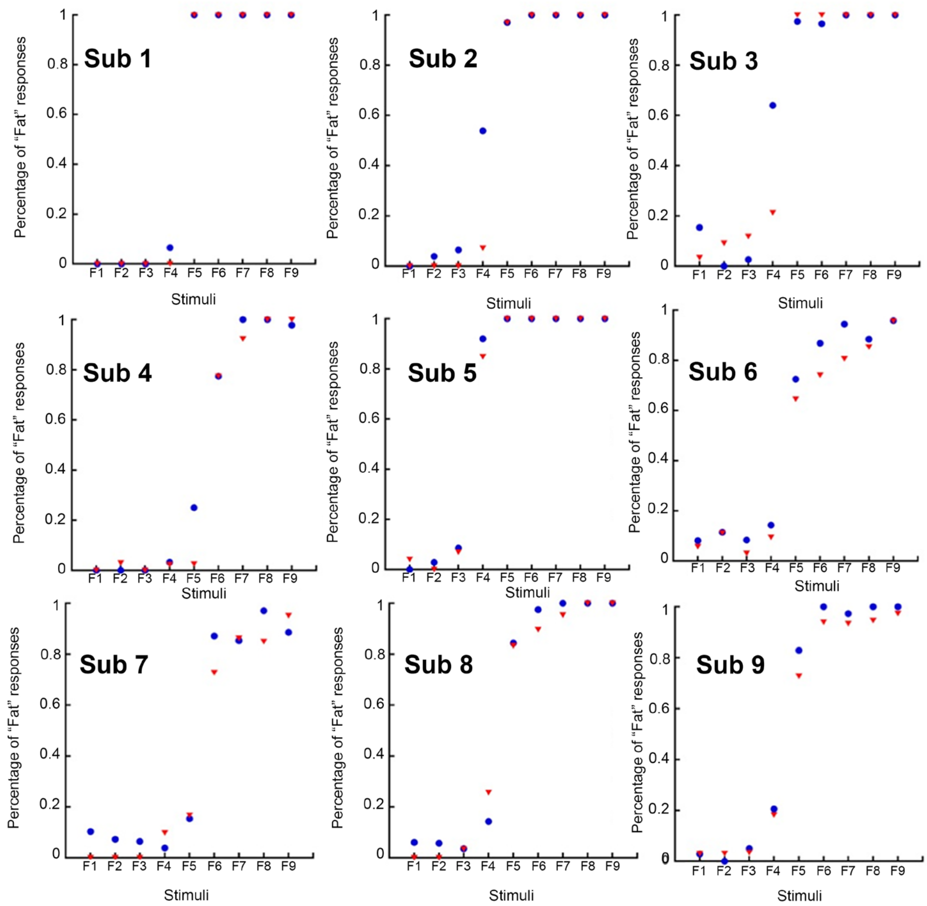


**Figure 2.** The response to each body shape stimuli on each participant. The percentage of "fat" responses in Fasting (red) and Satiety (blue) conditions in each participant.

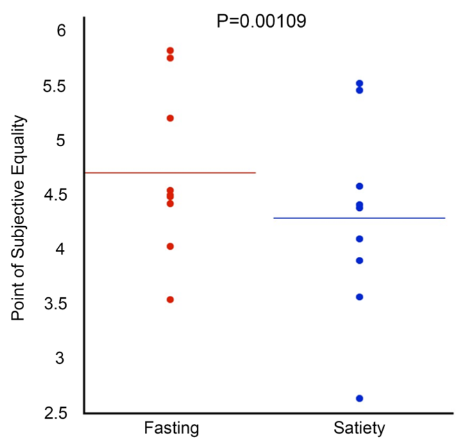


**Figure 3.** The point of subjective equality (PSE) in Fasting (red) and Satiety (blue) conditions in each participant.

PSE in the Satiety condition was 4.71 ± 0.25, while that in the Fasting condition was 4.29 ± 0.30. A linear mixed model fit test revealed a significant difference between the two conditions (F = 24.712, $p = 0.0011$), with a one-unit change in condition resulting in a 0.418 greater PSE (SE = 0.084, t = 4.97, $p = 0.0011$, Lower CI = 0.224, Upper CI = 0.612).

## 4. Discussion

Regulation of food intake comprises both homeostatic and hedonic components controlled by hunger and satiety signals in both peripheral and central pathways. Previous studies revealed that food intake increases the parasympathetic nerve activities [11] [16]. In addition, parasympathetic nervous activity reduces aggression in adults [17].

In relation to a human hunger-satiety shift after food intake, changes of the autonomic nervous system can occur before those in nutritional hormone levels, as demonstrated by instant changes in the states of alertness [18] [19] [20]. It is known that sour and salty stimuli are mediated by transient receptor potential vanilloid-1 (TRPV-1) receptors [21]. Research showed that facial skin blood flow increased with only 1 ml taste solutions of sweet, sour, salty, umami, and bitter [22]. Thus, parasympathetic nervous activity increased after small doses of food intake. In the present study, we used 80 g/400 kcal solid food. Even in 80 g solid food, it may be enough to activate parasympathetic nervous activity. Harthoorn and Dransfield [11] showed that 590 kcal food was enough to change sympathetic-parasympathetic balance, and van Orshoven *et al.* [23] reported that 300 kcal food after 3 hours intervals from the last food consuming changed the sympathetic-parasympathetic balance. As such, 400 kcal food after 3 hours intervals from the last food consuming would be enough to change sympathetic-parasympathetic balance. From these results, it was thought that there was no effect of refraining from consuming food or beverages containing caffeine for only 3 hours before testing on the results in the present study. In addition, in the present study, we used all images of women, so we limited participant to women. To the best of our knowledge, there was no report of the response difference for the judgment of others' body shape between women and men. In the future, it may be necessary to examine the effect of gender on the judgments of others' body shape.

In the present study, we found the effect of satiety on judgments of others' body shape. Specifically, satiety relaxes criteria for judgments of thinness. This suggests that increases in parasympathetic nerve activity can ease criteria for judgments of others. Notably, in this study, all participants were young women (aged 18 - 22), and young women have a relatively stable body image [24]. The criteria for the body shape of others are not liable to change. From these results, we concluded that, for humans, food intake increases the activity of parasympathetic nervous system to sustain life, then, that satiety relaxes criteria for judging the thinness of others' body shapes.

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