Title: Avoiding hunger or attaining fullness? Implicit goals of satiety guide portion selection and food intake patterns

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Abstract

Although implicit theories have been studied in the context of personal traits, there has been limited investigation of their role in physiological domains such as appetite. Subjective feelings and affective states can function as goals and desired end states that individuals regulate their behaviors to attain. Likewise, different conceptualizations people maintain for the subjective experience of satiety (i.e., terminating hunger or attaining fullness) may also predict individual variations in eating behavior. We examined whether portion selection and food intake were guided by such implicit goals pertaining to the nature of satiety. Across 3 studies, we observed that individuals report distinct subjective requirements (degrees of fullness) to attain different states of satiety (*stop hunger*, *feel comfortably full*, *feel completely full*), suggesting that these states reflect independent goals or outcomes. Importantly, personal requirements to *feel completely full* (compared to *stop hunger* or *feel comfortably full*) were observed to be the strongest predictor of portion sizes selected in Study 1 ($B = 1.17$, $p < .001$) and Study 2 ($B = 4.26$, $p = .004$), and the quantity of energy consumed from a meal in Study 2 ($B = 3.07$, $p = .01$). Yet, experimentally activating a situational goal to *stop hunger* (vs. *feel full*) produced the selection of smaller portion sizes, $F(1, 41) = 5.64$, $p = .02$, and personal requirements to *stop hunger* to become the dominant predictor of portion selection patterns in Study 3 ($B = .43$, $p = .005$). These findings reveal that eating behavior of modern consumers may be guided by a predominant goal to attain the subjective experience of complete fullness, although this implicit goal may be malleable to situational demands.

Introduction

Among the many goals that we seek to fulfill, avoiding hunger and achieving satiety are among the most fundamental and pervasive. Every day, we must repeatedly decide how much we should eat and at what point we have consumed a satisfactory quantity of food to feel comfortably full at the end of a meal (i.e. satiation) and remove feelings of hunger during the inter-meal period (satiety). These related concepts have previously been shown to be correlated, as foods that deliver fullness, often tend to sustain that feeling between meals (Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Yet despite the basic recurring drive to achieve these goals, there has been strikingly limited research on how people conceptualize and pursue satiety, especially given powerful influences of non-homeostatic and psychological factors on the regulation of appetite and feeding (Brunstrom & Cheon, 2018; Cheon & Hong, 2017; Sim, Lim, Leow, & Cheon, 2018). It is likely that people differ in their satiety goal at the outset of meals between those that eat to feel full versus those that eat to remove hunger. Differences in these goals is also likely to influence the prospective portion selected and amount consumed during a meal, and in the context of the global obesity epidemic (Ng *et al*., 2014), understanding how people seek to achieve satiety may offer novel insights into potential drivers for increased energy intake. Here, we identify individual variations in how people conceptualize satiation and satiety (hereafter referred to as 'satiety goals').

Implicit theories reflect fundamental beliefs or assumptions that people have about properties of themselves or the world around them, which guide appraisals and cognitions in relevant domains (Dweck, 2000). While implicit theories have been applied heavily to the study of cognitions and expectations around individual traits, such as intelligence and personality (Dweck, 2000; Molden & Dweck, 2006), there has been limited research on implicit theories around physiological processes such as appetite and food intake. Prior research has revealed that implicit theories about the causes of obesity are associated with increased body mass (McFerran & Mukhopadhyay, 2013) and food intake (Dar-Nimrod, Cheung, Ruby, & Heine, 2014), as well as implicit expectations about 'healthy' food as being less filling (Suher, Raghunathan, & Hoyer, 2016). Yet despite these assumptions about causes of obesity or properties of foods, it remains unknown whether people maintain different implicit assumptions about satiety itself and how such assumptions may shape dietary decisions.

If people do maintain implicit assumptions regarding the nature of satiety, one possible way they may manifest is in how these subjective states are conceptualized as goals. Subjective states, such as affect or emotion, can act as desired end-states that guide how people navigate the environment and regulate their behaviors to achieve these desired outcomes (e.g., high versus low arousal affective states) (Tsai, 2007; Tsai, Knutson, & Fung, 2006). Similarly, people may also vary in their lay assumptions of how satiety should subjectively be experienced, which may have a profound impact in shaping judgments, decisions, and behaviors towards food. Prior research has suggested that satiety, or the state of feeling sufficiently fed, may be experienced as distinct states or on a continuum. The Boundary Model of Eating Regulation (Herman & Polivy, 1984) proposes a zone for optimal satiation, such that the experience of fullness within this zone produces an indifference in the drive to eat, whereas fullness below (above) this zone stimulates corrective behavior that motivates (suppresses) further food intake. Furthermore, individual differences may exist in the set points or demarcations between the boundaries of satiation, based on factors such as restrained, disinhibited, or binge eating patterns (Herman & Polivy, 1984). This model suggests that: 1) satiety is not a homogenous state and is represented by qualitatively different degrees or levels, and 2) individuals may vary in their degree of subjective experience of fullness required to feel sated. An individual's satiety goals are likely to be influenced by a range of factors from meal context and meal factors such as palatability (Yeomans, 2000), to differences in the broader implicit drive for 'satisfaction' (Andersen & Hyldig, 2015). The current studies draws comparison between participants satiety goals as they relate to the removal of hunger, the desire to be comfortably full and the drive to feel completely full at the end of the meal.

We propose that there may be three predominant ways that people may experience and conceptualize satiety, which reflect independent implicit goals[1] people may be seeking to fulfill when eating. The first goal is to remove or stop the experience of hunger. Both physiological and hedonic hunger may be driven by a subjectively experienced (often aversive) state of wanting or desiring food, which is terminated with sufficient food intake (Finlayson, King, & Blundell, 2008). The second goal may be to attain a state of satisfaction or *comfortable fullness*. The simple absence of hunger (without a feeling of fullness) may be independent of the presence of a

[1] We use the term 'implicit' to describe these goals based on the premise that individuals may not explicitly be articulating these goals or consciously aware of how these goals may be influencing their eating behavior. We are not referring to the *measurement* of these goals as being 'implicit.'

satisfactory feeling of fullness. A third, yet independent goal, may be to achieve a state of *complete fullness*, in which one has eaten to nearly full capacity or distention of the stomach (i.e., feeling "stuffed"). These three goals or targets for satiety are not meant to be exhaustive, as there are circumstances in which individuals may be motivated to maintain slight amounts of hunger after terminating a meal, yet these other goals may not be broadly representative of most people or typical eating occasions.

If satiety is indeed treated as an implicit goal state with discrete conceptualizations that vary across individuals and situations, then they may function as critical guides that shape eating habits and behavior. These satiety goals are referred to as being implicit, given that individuals may not be consciously aware or able to articulate these goals, or the influence they have on their food-related judgments and behavior. One outcome that may be highly regulated by implicit satiety goals is portion selection since an individual with the goal to feel *completely full* will likely require greater food intake than an individual seeking to feel *comfortably full* or *stop hunger* (and *comfortably full* requiring more intake than *stopping hunger*). In this regard, one's dominant implicit satiety goal may be a powerful determinant of how much food one considers to be an ideal portion. People generally consume most of the portions that they self-serve (Fay et al., 2011; Hinton et al., 2013), therefore the influence of a person's implicit satiety goals on portion selection may be a decisive factor in determining how much energy people ultimately consume.

Study 1

We conducted an initial exploratory study (Study 1) to identify whether different satiety goals (*stop hunger*, *feel comfortably full* or *feel completely full*) relied on distinct subjective requirements for fulfilment, and which of these requirements would be most predictive of self-selected portion sizes. Through this approach, we sought to determine which of these satiety goals may be the most dominant determinant of the quantity of food people selected to consume on a computer-based portion selection task.

Methods

Participants

Given that Study 1 was exploratory in nature and we did not have *a priori* hypotheses about the magnitude influence that each of the three satiety goals would exert on portion selection patterns, we sought to recruit a large sample of participants. Three hundred and thirty-two students (198 female; Age = 21.06 ± 2.01; BMI = 21.02 ± 3.11 kg/m^2) were recruited from a Singaporean university. Twenty-eight participants did not complete the required measures and were excluded from the analysis. The final sample included data from 304 participants (178 female; M_{age} = 21.08 ± 2.06; BMI, 21.06 ± 3.19 kg/m^2). Participants were each compensated $10 (Singaporean Dollars) for completing the study. University Institutional Review Board (IRB) approval was granted and written consent was obtained from all participants.

Procedure and Materials

The present study was part of a larger project in which participants completed a variety of measures assessing portion selection patterns, dietary habits, personal attitudes towards hunger/fullness and cognitions/preferences pertaining to food. After written consent was obtained, participants were asked to complete three main tasks: baseline appetite ratings, a computerized portion selection program, and demographics questionnaires.

Baseline Appetite Ratings. At the start of the session, participants completed four questions assessing their current appetite. Current hunger, fullness (reverse-scored), and desire to eat were assessed using visual analogue scales (VAS) with values ranging from 0 to 100, but anchored with the labels “not at all” and “extremely.” A similar VAS anchored with the labels “none at all” and “a large amount” asked participants the amount of food they could currently eat. The hunger, fullness, and desire to eat questions were averaged to produce a composite index of baseline appetite (α = .86).

Portion Selection Task. Next, participants completed a portion selection task similar to those used in prior research (Forde, Almiron-Roig, & Brunstrom, 2015; Lim, Sim, Forde, & Cheon, 2018; Sim, Lim, Forde, & Cheon, 2018; Wilkinson et al., 2012) that featured a diverse range of 53 foods typically available in Singapore (Singaporean, Asian, and Western meals and snacks). For each food, participants were asked to select a portion size that they would serve themselves during lunchtime when there is no other food available (Figure 1). Examples of food items include fried rice, ramen, pepperoni pizza, and Pringles potato chips. Each food consisted of a series of 50 images that depicted increasing portion sizes of the food in 20 kcal increments

(ranging from 20 to 1000 kcal). Participants were instructed to decrease or increase the portion size of the food by pressing the left and right arrow-keys on the keyboard. Each press of an arrow key changed the amount of food displayed by a standardized 20 kcal increment/decrement. Thus, although the foods presented on the portion selection task varied in energy density, available portion sizes for the foods were standardized to 20 kcal units. Participants were asked to explore the full range of portions for each food before selecting the appropriate portion. Food items were presented to participants in a randomized order. For each of the foods, participants were asked to select an ideal portion size with the question, "please select the amount of food that you like to eat for lunch today". The portion sizes selected across all 53 foods (in kcal) were averaged for each participant to create an overall index of ideal portion size.

Personal Requirements for Fulfilling Satiety Goals. A series of questions were used to assess participants' subjective requirements for experiencing different states of satiety. We distinguished the different satiety goals (*stopping hunger*, *feeling comfortably full* or *feeling completely full*) by examining whether these outcomes relied on different subjective or interoceptive feelings of 'fullness.' Participants were shown pictures of a schematic outline of a person with an exposed stomach that was filled to different levels of fullness, which were modified from a prior study that used similar images to assess hunger in children (Fisher & Birch, 2002). The images were presented as anchors over a series of 100-point VAS scales, such that the leftmost anchor depicted a stomach that was completely empty, the central anchor depicted a stomach that was half full, and the rightmost anchor depicted a stomach that was completely full. Participants completed 3 questions using the VAS scale, which asked how full the participants' stomach would need to be to stop hunger, to feel comfortably full, and to feel completely full. Participants also completed additional questions on their preferences to eat to *stop hunger* versus *feel completely full*, and on whether an image of a half full stomach reflected hunger versus fullness on 100-point VAS scales.

Results and Discussion

A repeated measures analysis of variance (ANOVA) was conducted comparing average ratings of fullness required to achieve each of the 3 states of satiety. The analysis had 80% power to detect an effect size of f = .08. The 3 states of satiety were rated differently, $F(2, 606) = 338.88$, $p < .001$, $\eta_p^2 = .53$, such that *stop feeling hungry* was rated to require the least fullness to

achieve (M = 53.71, SD = 20.61), followed by *feel comfortably full* (M = 65.89, SD = 13.43), and with *feel completely full* requiring the most fullness to achieve (M = 82.25, SD = 13.20). Pairwise comparisons confirmed that each of these 3 requirements significantly differed from each other, suggesting that these states of satiety may indeed correspond to distinct goals given different subjective requirements for fulfilling them [comfortably full vs. stop hunger: $t(303) = 10.99$, $p < .001$; completely full vs. stop hunger: $t(303) = 21.49$, $p < .001$; completely full vs. comfortably full: $t(303) = 20.44$, $p < .001$].

As an exploratory test to determine which of the 3 satiety goals (*stop feeling hungry*, *feel comfortably full*, *feel completely full*) implicitly guides portion selection patterns, we conducted a multiple regression analysis in which average ideal portion size selected across foods on the portion selection task was regressed on participants' ratings of their personal requirement to fulfill each of the 3 satiety goals, controlling for baseline appetite. Baseline appetite was entered into the model to control for individual differences in hunger during the session (given that appetite was not standardized). The analysis had 80% power to detect an effect size of $f^2 = .04$. The analysis revealed that the predictors explained a significant proportion of the variance, $R^2 = .13$, $F(4, 299) = 11.56$, $p < .001$, with minimal indications of multicollinearity between predictors (variance inflation factor did not exceed 1.533). Baseline appetite ($B = 1.17$, $p < .001$) predicted portion selection, with hungrier participants selecting larger portion sizes. Importantly, among the 3 satiety requirements, the requirement to *feel completely full* ($B = 1.52$, $p = .006$) emerged as the only significant predictor of overall portion sizes (*stop feeling hungry*: $B = .19$, $p = .59$; *feel comfortably full*: $B = .71$, $p = .24$) (see Table 1 for full regression results). As participants reported greater levels of fullness required to feel *completely full*, but not the other satiety goals, they also selected larger average portion sizes across the diverse foods presented in the portion selection task.

Study 1 provides an initial demonstration that satiety may be conceptualized as distinct goals or end states, each with different subjective requirements or means (levels of 'fullness') for attainment. Importantly, our findings suggest that people may implicitly be guided by the goal to feel *completely full* when considering and selecting portion sizes.

Study 2

Given the exploratory nature of Study 1, we sought to replicate the influence of these satiety goals on not only portion selection patterns, but actual food intake, in Study 2, which included an ad-libitum, self-served meal. Based on Study 1's findings, we hypothesized that requirements to *feel completely full* (compared to *stopping hunger* or *feeling comfortably full*) will be the best predictor of computerized portion selection patterns, actual self-served portion sizes, and actual amount of calories consumed ab-libitum from a meal.

Methods

Participants

Given that Study 2 relied on the same sample of participants who conducted Study 1, our final sample size was determined by the number of participants from Study 1 that we were able to successfully re-recruit to return to complete Study 2. Study 2 was conducted over the course of two days, and a final sample of sixty-one participants (29 Female; Age = 22.15 ± 8.86 years; BMI = 21.29 ± 3.07 kg/m^2) from Study 1 who had previously completed the satiety goals measures were successfully re-recruited. Study 2 took place between 1-2 months following Study 1. Participants were each compensated $5 (Singapore Dollars) and an ad-libitum lunch for completing the study.

Procedure and Materials

After providing informed consent, participants were asked to complete an online survey that included the same questions of baseline appetite from Study 1, a computerized portion selection task, and additional surveys pertaining to food preferences, eating habits, personal attitudes towards hunger/fullness, psychosocial dispositions (pertaining to subjective social status, gratitude, stress and well-being), and demographics[2]. Participants were invited to self-serve and consume an ad-libitum meal at the end of the session.

[2] The results for Study 2 came from a larger study that sought to examine the relationship between individual differences in various psychosocial processes and eating behavior (i.e., portion selection patterns and ad-libitum food intake). Observations on the relationships between some of these other variables and eating behaviors from this study have appeared in previous publications (Lim et al., 2018; Sim, Lim, Forde, et al., 2018).

Portion Selection Task. Participants completed a shortened version of the portion selection task, consisting of 14 food items from Study 1. Other than the smaller number of food items, the format of the task was identical to Study 1.

Ad-Libitum Food Intake. Participants were directed to an adjacent room where they were provided ad-libitum access to a test meal of Yang Chow fried rice (rice, wok-fried together with egg, cut-up chicken, vegetables, shrimp), a commonly consumed local dish. Participants self-served a desired portion from a buffet tray onto a dinner plate that was identical to the plates the foods were presented on in the portion selection task. Following this, as participants were distracted with the task of collecting a standardized 250ml cup of water to accompany their meal, the amount of fried rice served was surreptitiously weighed by an experimenter (adjusting for plate weight) behind a counter with the ostensible impression that the experimenter was adding dining utensils and napkins on the participants' serving tray. After finishing the meal, participants completed the same appetite rating measures from the start of the session. The amount of food left over on their plate at the end of the session was also weighed (adjusting for plate weight) to determine amount of ad-libitum consumption. The caloric density of the fried rice (approximately 165 kcal/100g) was determined via a commercially available near-infrared calorie-analysis device (*Calorie Answer*, Joy World Pacific, Aomori, Japan) (Lau, Goh, Quek, Lim, & Henry, 2016).

Results and Discussion

We conducted a series of multiple regression analyses similar to Study 1, in which the outcomes of interest (computerized portion selection size, actual portions sizes for fried rice self-served, and actual amount of fried rice consumed) were regressed on participants' ratings of their personal requirement to fulfill each of the 3 satiety goals (which had been measured 1-2 months earlier during Study 1) and baseline appetite ratings ($\alpha = .76$). The analysis had 80% power to detect an effect size of $f^2 = .21$. Replicating Study 1, the model was supported for computerized portion selection, $R^2 = .17$, $F(4, 56) = 2.85$, $p = .03$, such that the personal requirement to *feel completely full* ($B = 4.26$, $p = .004$) was the only significant predictor of average computerized portion size among the 3 satiety goals (*stop feeling hungry*: $B = -.84$, $p = .27$; *feel comfortably full*: $B = -1.04$, $p = .46$). Similarly, the model was also supported for actual self-served portion size for fried rice, $R^2 = .20$, $F(4, 56) = 3.53$, $p = .01$, such that personal requirement to *feel*

completely full (B = 3.63, p = .001) was again the only significant predictor of actual self-selected portion size among the 3 satiety goals (*stop feeling hungry*: B = -.21, p = .71; *feel comfortably full*: B = -1.02, p = .33). Importantly, the model for actual ad-libitum food intake was also supported, R^2 = .19, $F(4, 56)$ = 3.17, p = .02. The requirement to *feel completely full* (B = 3.07, p = .01) was the only significant predictor of actual amount of fried rice consumed among the 3 satiety goals (*stop feeling hungry*: B = -.61, p = .33; *feel comfortably full*: B = -1.95, p = .10) (see Table 2 for full regression results). Notably, minimal multicollinearity was observed across predictors in the multiple regression models (variance inflation factor for predictors did not exceed 1.378).

Study 2 provides further support for the finding that overall, individuals' predominant conceptualization of satiety may be a state of *complete fullness* – an implicit goal that associated with not only self-served portion sizes (simulated and actual), but also the quantity of food actually consumed. Rather than seeking to avoid or terminate hunger or achieve mere satisfaction (*comfortably full*), people may implicitly seek to feel fullness at near-maximum capacity when making decisions about how much to eat. Notably, Study 2 also reveals the chronic and stable effect that implicit satiety goals exert on eating behavior, such that requirements to achieve a dominant state of satiety measured at one time-point (during Study 1) were predictive of portion selection and eating behavior that occurred in a separate context over a month later (during Study 2).

However, there are some limitations with Studies 1 and 2 that preclude confidence in some of these interpretations and explanations of our findings. First, Studies 1 and 2 relied on a correlational approach, making it unclear whether activating a specific satiety goal (e.g., *stop hunger*) may cause that goal to become the dominant satiety goal that guides subsequent eating behaviors. Second, there may be some alternative mechanisms involved that are producing the heightened tendency for requirements for *complete fullness* to uniquely predict portion selection and food intake patterns. One alternative explanation could be that people may not be particularly effective in judging the portion sizes required to actually attain fullness and may over-serve themselves – a pattern of behavior that may be most consistent with and predicted by personal requirements to feel *completely full*. To address these limitations we conducted a follow-up study that involved a direct experimental manipulation of participants' satiety goals to

examine: 1) their potential causal effect on portion selection patterns, and 2) whether a satiety goal to *stop hunger* could also be promoted as the best predictor of portion sizes.

Study 3

We conducted Study 3 to address the limitations of the correlational design used in Studies 1 and 2, as well as address two additional objectives. First, we sought to examine the malleability of implicit satiety goals. Although Studies 1 and 2 suggest that people's default dispositional satiety goal may be to feel *completely full*, there are likely situational factors that activate different satiety goals. For instance, in some eating situations, *feeling completely full* may not be a reasonable or practical outcome, such as when consuming large amounts may be socially inappropriate. This may be the case in circumstances when one is eating while managing a simultaneous goal of making a positive impression on others who are present (e.g., during a date or business lunch), or when one is having a light snack while seeking to maintain appetite for a highly rewarding upcoming meal. Prior research on implicit theories have suggested their situational malleability and corresponding downstream consequences of their shifts on behavior (Dweck, 2000). For instance, experimental exposure to information that portrayed one's ability to exert self-control (i.e., willpower) as a limited resource was predictive of poorer performance on a task requiring self-control after a demanding task (Job, Dweck, & Walton, 2010). We predicted that implicit satiety goals will exhibit similar malleability in response to situational demands, such that when presented with a goal to *stop hunger* (vs. *feel full*), personal requirements for terminating hunger (vs. requirements for attaining states of fullness) would accordingly shift to become the strongest predictor of portion selection patterns. Our second objective was to identify whether activated satiety goals may actually produce changes in the quantity of food selected for consumption. One implication of satiety being calibrated to a state of complete fullness may be excessive energy intake to fulfill these goals. Changing implicit assumptions of satiety to correspond to the termination of hunger rather than achieving fullness may be a potentially promising method to encourage smaller portion sizes. We predicted that participants would select smaller portion sizes when pursuing an active goal to *stop hunger* (vs. *feel full*).

Methods

Participants

We estimated a sample size of approximately 102 participants as required to detect a difference in selected portion sizes based on exposure to satiety goals to *stop hunger* versus *feel full* (between-subjects design) (based on power of .80, α of .05, and *d* of .50). Although a total sample of 126 participants were originally recruited for a between-subjects design with random assignment to exposure to one of the two satiety goals (*stop hunger* or *feel full*), we decided to continue the study using a repeated-measures design by re-recruiting participants to return later to complete a separate experimental session in which they would be exposed to the other satiety goal. This decision was motivated by concerns that the effect of the satiety goal manipulation on average size of portions selected may be obfuscated by wide individual differences in portion selection patterns. A final sample of 45 university students (30 female; Age = 21.45 ± 2.74; BMI = 21.05 ± 3.32 kg/m2) completed both sessions of the study for the repeated measures design. Analyses and results on the full sample of 126 participants (based on a between-subjects design) are available in the supplemental online material (SOM) for this manuscript[3]. Participants were each compensated $7 (Singapore Dollars) for completing the IRB approved study.

Procedure and Materials

The study consisted of two identical sessions (within-subjects design), which consisted of two separate conditions (*feel full* vs. *stop hunger*), that were completed in a counterbalanced order across participants. The two sessions were separated by a long washout period of an academic semester and a summer (approximately 8 months) to minimize likelihood that their prior responses and exposure to the first session would influence their responses in the second session. At the start of each session, participants completed the baseline appetite ratings (α = .88) used in Studies 1 and 2, followed by the ratings of personal requirements to fulfill the three satiety goals used in Study 1, and a modified version of the portion selection task. The study also

[3] Although the 45 participants reported reflect the participants who completed both sessions of the study, there were an additional 81 participants who only attended the first session of the study but did not return to complete the second session. Thus repeated measures or within-subjects analyses could not be completed on these 81 participants. Results involving a between-subjects comparison of responses to experimentally manipulated satiety goals (*stop hunger* or *feel full*) for the full sample of 126 participants who completed the first session of the study are provided in Supplemental Materials. The results of this between-subject analysis of the first session is overall similar to the results observed in the within-subjects analysis reported in Study 3.

involved the completion of unrelated measures where participants rated various judgments and characteristics of food images.

Portion Selection task. Prior to starting the task, participants were provided different satiety goals to pursue when selecting their portions. In the *feel full* condition, participants were instructed to select a portion that they would "need to consume to feel full". Conversely, in the *stop hunger* condition, participants were instructed to select a portion that they would "need to consume to not feel hungry". Following the presentation of the satiety goal, participants completed a simplified version of the portion selection task which included a subset of 5 food items used in Study 2. This task used a visual analogue scale (VAS) response format in which each food item was presented with a 100 point VAS with an image of the lowest portion (20 kcal) and the largest portion (1000 kcal) anchored at each end. Participants were asked to move the slider along the VAS to indicate the appropriate portion that they would need to eat based on the corresponding satiety goal. This simplified portion selection task was confirmed to be predictive of responses on the full portion selection task used in Studies 1 and 2. Based on a pilot study (n = 44), there was a strong correlation between portion sizes selected for the identical foods on the full and simplified versions of the portion selection tasks, r = .77, p < .001.

Results and Discussion

Replicating the results of Study 1, the 3 satiety goals were rated with different levels of fullness required for their attainment, $F(1.48, 65.24) = 66.68$, $p < .001$, $\eta_p^2 = .60$, such that *stop feeling hungry* was rated to require the least fullness to achieve (M = 48.00, SD = 20.32), followed by *feel comfortably full* (M = 65.98, SD = 13.99), and with *feeling completely full* requiring the most fullness to achieve (M = 82.11, SD = 15.32). Pairwise comparisons confirmed that each of these 3 requirements significantly differed from each other [comfortably full vs. stop hunger: $t(44) = 6.14$, $p < .001$; completely full vs. stop hunger: $t(44) = 9.77$, $p < .001$; completely full vs. comfortably full: $t(44) = 8.73$, $p < .001$]. The analysis had 80% power to detect an effect size of f = .22.

To determine whether the activated satiety goal had a differential effect on portion selection patterns, we conducted a 2 (Goal: stop hunger or feel full) x 2 (Order: stop hunger as first or second session) mixed ANOVA on average selected portion size with Goal as a within-subjects factor and Order as a between-subjects factor while controlling for baseline appetite

ratings across the two separate sessions. The analysis had 80% power to detect an effect size of f = .19. The results revealed only a significant main effect of satiety goal, $F(1, 41) = 5.64$, $p = .02$, $\eta_p^2 = .12$, such that participants selected larger portion sizes when seeking to *feel full* ($M = 63.47$, $SD = 19.04$) compared to *stopping hunger* ($M = 57.70$, $SD = 19.52$) (Figure 2).

As in Studies 1 and 2, we conducted multiple regression analyses to examine whether requirements to fulfill the experimentally activated satiety goal would serve as the dominant predictor of portion selection patterns. For each session (*stop hunger* or *feel full*), average portion size selected was regressed on ratings of personal requirements to fulfill each of the 3 satiety goals and baseline appetite. The analysis had 80% power to detect an effect size of $f^2 = .30$. When the satiety goal was to *feel full*, the model explained a significant proportion of the variance in selected portion size, $R^2 = .42$, $F(4, 40) = 7.11$, $p < .001$, such that personal requirement to feel both *completely full* ($B = .30$, $p = .048$) and *comfortably full* ($B = .48$, $p = .01$) emerged as independently significant predictors of portion selection patterns, but not *stop feeling hungry* ($B = .02$, $p = .92$). The model was also supported when the satiety goal was to *stop feeling hungry*, $R^2 = .28$, $F(4, 40) = 3.87$, $p = .009$, such that personal requirements to *stop hunger* ($B = .43$, $p = .005$) was the only significant predictor of selected portion size (*feel comfortably full*: $B = .27$, $p = .23$; *feel completely full*: $B = .13$, $p = .50$) (see Table 3 for full regression results). As in Studies 1 and 2, there was limited multicollinearity observed across predictors in the regression models (variance inflation factors did not exceed 1.552 in the *stop hunger* session and 1.544 in the *feel full* session).

Study 3 provides experimental support for implicit satiety goals as having a causal influence on portion selection patterns. Although portion selection and food intake patterns may primarily be guided by an implicit goal to *feel completely full* (Studies 1 and 2), Study 3 revealed that such dispositional satiety goals are malleable to situational demands, such that subjective requirements for fulfilling the activated satiety goal (i.e., *stop hunger*) may act as the primary determinant of subsequent portion selection patterns. Additionally, Study 3 demonstrates that satiety goals also influence the size of portions selected, such that smaller (and potentially less excessive) portions may be selected when satiety is conceptualized as the termination of hunger rather than the experience of fullness.

General Discussion

Across 3 studies, we demonstrated that individuals maintain implicit theories or goals about satiety that guide their energy selection and intake. Specifically, one's assumptions about the subjective experience of satiety and how 'full' one should feel may guide how much food people intend to eat (portion selection in Studies 1, 2, and 3) and actually consume (Study 2). Notably, our findings suggest that individuals may predominantly be driven by a satiety goal to *feel completely full*, such that the implicit requirement to attain complete fullness was the strongest predictor of the actual quantity of energy selected and consumed (compared to *stopping hunger* or *feeling comfortably full*).

Several consumer trends in modern societies may contribute to the predominance of the goal of *complete fullness* in determining energy intake patterns. The growing trend for consumption of larger portion sizes (Nielsen & Popkin, 2003) combined with the tendency to consume more energy as portion size increases (i.e., the portion size effect) (Rolls, Morris, & Roe, 2002; Zlatevska, Dubelaar, & Holden, 2014) may be key factors that have 'normalized' subjective feelings associated with complete fullness. Consequently, consumers may have come to rely on such feelings as internal signals of sufficient food intake. Despite this, our findings from Study 3 suggest that these satiety goals and their relative influences on eating behavior are malleable and sensitive to situational demands. Thus, even if consumers may generally rely on feelings of *complete fullness* as a guide for how much energy to ingest, they may be dynamically shifting between satiety goals across diverse contexts such as snacking versus meals, eating alone versus with others, or depending on perceived characteristics of the food they are consuming (e.g., sensory properties, expected satiation delivered). Mapping how different types of real-world situations may influence the satiety goals consumers pursue may be a productive and important program of future research.

Another contributing factor may be how satiety is described and implicitly conceptualized through everyday language. Linguistic constraints and affordances can shape perceptions about not only external stimuli and events (Gordon, 2004), but also subjective internal experiences. For instance, cultural variations have been observed in the tendency to describe emotional experiences through somatic experiences, which may also contribute to cultural diversity in how emotions are manifested in behavior (Tsai, Simeonova, & Watanabe, 2004). Likewise, in English-speaking cultures, such as in the present studies, satiety tends to be asymmetrically described in terms of fullness rather than the absence of hunger (i.e., "I'm

stuffed," or "I'm so full"). Yet, other languages and cultures may describe satiety with more emphasis on meanings reflecting satisfaction or the absence of hunger (Pollan, 2013). Whether eating behavior in such cultures are primarily guided by a different set of satiety goals compared to English-speaking cultures would be a promising avenue for future investigations.

One limitation of the present study is that the sample size for some of the analyses (especially in Studies 2 and 3) were only sufficient for detecting relatively large effect sizes. Part of this limitation was due to logistical constraints that limited the total number of participants we could recruit, such as availability of facilities, research staff support, and budget for serving the ad-libitum buffet meal in Study 2. Although further replications and extensions of our initial findings will be required using larger sample sizes, we observed consistent support for the hypotheses across three studies (with Study 1 relying on a large sample). Consequently, these studies suggest that the relationships we are examining may indeed be robust and have relatively larger effect sizes. Another limitation of the present study is that we only observed the regulation or pursuit of implicit satiety goals through portion selection behaviors and quantity of food consumed. If satiety goals do indeed serve as guides or regulators of ingestive behavior, then their influence should manifest in other dietary decisions and patterns. For instance, expected satiety delivered by a food may be weighted differently during food choice based on the predominant satiety goal maintained by consumers. How implicit satiety goals guide these other types of decisions and behaviors beyond portion control would be a promising direction for future investigation. Finally, the current sample consisted of young adults who were on average lean and were studied in a controlled laboratory-context. It remains unknown whether satiety goals would exert similar influences on eating behavior in everyday eating episodes and routines which may be susceptible to a variety of environmental inputs and constraints. The generalizability of the current findings to those who are overweight/obese, as well as dietary behaviors in free-living contexts outside of a laboratory would also be important for further study.

Overall, these findings provide novel insights on how people conceptualize and pursue satiety and how this relates to energy selection and intake. The high prevalence of obesity may partially be attributed to the tendency of consumers to prioritize a goal of achieving complete fullness, which may lead to excessive portions. Given the dynamic and malleable nature of

implicit satiety goals observed in the present studies, these fundamental assumptions may be a promising target for future interventions to promote healthier dietary practices.

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Table 1. Summary of multiple regression results for Study 1.

Model *without* appetite covariate: R^2 = .07, R^2_{Adj} = .06, F(3, 300) = 7.36, p < .001	
Stop Hunger	B = .27, β = .05 p = .45
Comfortably Full	B = 1.02, β = .11, p = .10
Completely Full	B = 1.56, β = .17, p = .007
Model *with* appetite covariate: R^2 = .13, R^2_{Adj} = .12, R^2change = .07, F(4, 299) = 11.56, p < .001	
Stop Hunger	B = .19, β = .03, p = .57
Comfortably Full	B = .71, β = .08, p = .24
Completely Full	B = 1.52, β = .17, p = .006
Appetite Composite	B = 1.17, β = .26, p < .001

Table 2. Summary of multiple regression results for Study 2.

Study 2: Portion Selection Task	
Model *without* appetite covariate: R^2 = .14, R^2_{Adj} = .10, F(3, 57) = 3.15, p = .03	
Stop Hunger	B = -1.09, β = -.20, p = .14
Comfortably Full	B = -.54, β = -.05, p = .70
Completely Full	B = 3.90, β = .37, p = .007
Model *with* appetite covariate: R^2 = .17, R^2_{Adj} = .11, R^2change = .03, F(4, 56) = 2.85, p = .03	
Stop Hunger	B = -.84, β = -.15, p = .27
Comfortably Full	B = -1.04, β = -.11, p = .46
Completely Full	B = 4.26, β = .41, p = .004
Appetite Composite	B = 1.96, β = .17, p = .19
Study 2: Self-Served Portion Size	
Model *without* appetite covariate: R^2 = .39, R^2_{Adj} = .11, F(3, 57) = 3.45, p = .02	
Stop Hunger	B = -.46, β = -.11, p = .40
Comfortably Full	B = -.52, β = -.07, p = .62
Completely Full	B = 3.26, β = .41, p = .003
Model *with* appetite covariate: R^2 = .45, R^2_{Adj} = .14, R^2change = .05, F(4, 56) = 3.53, p = .01	
Stop Hunger	B = -.21, β = -.05, p = .71
Comfortably Full	B = -1.02, β = -.14, p = .33
Completely Full	B = 3.63, β = .46, p = .001
Appetite Composite	B = 1.96, β = .23, p = .07
Study 2: Ad-Libitum Food Intake	
Model *without* appetite covariate: R^2 = .34, R^2_{Adj} = .07, F(3, 57) = 2.54, p = .07	
Stop Hunger	B = -.94, β = -.21, p = .13
Comfortably Full	B = -1.28, β = -.16, p = .27
Completely Full	B = 2.59, β = .30, p = .03
Model *with* appetite covariate: R^2 = .43, R^2_{Adj} = .13, R^2change = .07, F(4, 56) = 3.17, p = .02	
Stop Hunger	B = -.61, β = -.13, p = .33
Comfortably Full	B = -1.95, β = -.24, p = .10
Completely Full	B = 3.07, β = .35, p = .01
Appetite Composite	B = 2.58, β = .28, p = .04

Table 3. Summary of multiple regression results for Study 3.

Study 3: *Stop Hunger* Session	
Model without appetite covariate: R^2 = .51, R^2_{Adj} = .20, F(3, 41) = 4.68, p = .007	
Stop Hunger	B = .40, β = .38, p = .008
Comfortably Full	B = .25, β = .19, p = .27
Completely Full	B = .16, β = .14, p = .41
Model with appetite covariate: R^2 = .53, R^2_{Adj} = .21, R^2change = .02, F(4, 40) = 3.87, p = .009	
Stop Hunger	B = .43, β = .41, p = .005
Comfortably Full	B = .27, β = .20, p = .23
Completely Full	B = .13, β = .12, p = .50
Appetite Composite	B = .11, β = .16, p = .25
Study 3: *Feel Full* Session	
Model without appetite covariate: R^2 = .57, R^2_{Adj} = .28, F(3, 41) = 6.68, p = .001	
Stop Hunger	B = -.08, β = -.07, p = .60
Comfortably Full	B = .46, β = .38, p = .02
Completely Full	B = .30, β = .29, p = .07
Model with appetite covariate: R^2 = .65, R^2_{Adj} = .36, R^2change = .09, F(4, 40) = 7.11, p < .001	
Stop Hunger	B = .02, β = .01, p = .92
Comfortably Full	B = .48, β = .41, p = .01
Completely Full	B = .30, β = .30, p = .048
Appetite Composite	B = -.27, β = -.31, p = .02

Figure 1. Example of a food item (penne pasta with tomato sauce) presented in the Portion Selection Task. All food items were presented in a series of 50 images that depicted incremental changes in portion sizes of the food in 20 kcal increments (ranging from 20 to 1000 kcal).

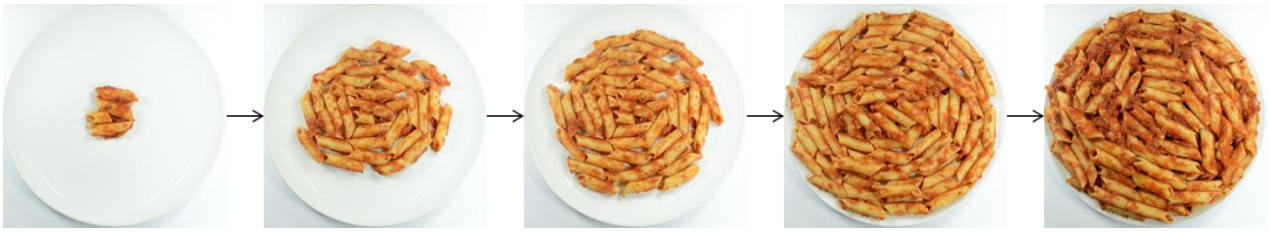

Figure 2. Effect of situationally activated satiety goals (*stop hunger* or *feel full*) on selected portion sizes. Only a main effect of satiety goal was observed such that participants generally selected larger portion sizes (on a visual analogue scale from 0 to 100) when selecting portions with the goal to *feel full* compared to *stop hunger*, $F(1, 41) = 5.64$, $p = .02$, $\eta_p^2 = .12$.