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Nutritious or Delicious? A Survey Demonstrating The Impact of Hunger And Health Behaviors on Food Preferences.

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Abstract

Unhealthy eating habits involving the consumption of highly-palatable energy-dense foods are a major contributor to weight gain its associated health conditions. Consumption of these "unhealthy" items continues to be common despite ongoing efforts for promoting healthy-eating behavior. However, relatively little is known about the factors that lead to the consumption of unhealthy foods. Prior research has shown that states of hunger influence the desire to eat without changing the perception or enjoyment of food items. The present study utilized an online-survey which asked participants to rate foods according to the items' palatability, the likelihood of being consumed, and healthiness. Demographic and bodily state information was also collected. The results of this study demonstrate that, in college students, a state of hunger biases the selection ("wanting") of foods toward highly-palatable ("tasty") food items. However, this finding was not observed in data gathered from a sample of older adults affiliated with a health and fitness organization. Collectively, this may suggest that age, education, or increased health-awareness can influence the preference for high-palatable foods that occurs when individuals are hungry.

Keywords: Hunger, Palatability, Likelihood, Wanting, Healthiness, Food-viewing, Energy-Dense.

Introduction

Weight-gain caused by excess caloric intake and sedentary lifestyles is thought to be a major contributing factor the development of serious health conditions like obesity, heart disease, type-II diabetes, stroke, and certain types of cancer [1,2]. Obesity, in particular, is a strong concern for both individuals and society given its association with diminished quality of life [3], increased health-care costs [4, 5] and higher incidences of psychiatric conditions [6]. The rates of obesity have risen in recent decades, likely due to a combination of increased access to cheap, energy-dense foods [2, 7, 8], poor eating habits [9, 10], lack of exercise [2], and problems in eating-related self-regulation [11].

The widespread consumption of energy-dense foods is thought to be one of the major factors contributing to weight-gain and the development of obesity [2, 7, 12; 13]. These foods, which commonly include fast-food, snack foods, sweetened-drinks, and desserts, are high in their calorie-per-gram content (MJ/kg), usually due to a lack of water and high concentrations of carbohydrates, starches, and fats [7]. This concentration of nutrients can lead to excess intake of calories, especially since these foods often displace low-density ("healthy") foods in the diet [2] and are consumed at similar volumes as less-dense foods [7]. These foods are also often affordable and readily available [2, 7], more rewarding [14], more tasty/palatable [15, 16], and more likely to be craved [17], than "healthy" low-density foods. Recently, efforts have been made at promoting healthy eating through nutritional labeling of food products, particularly for "snack foods," but evidence suggests that consumers may not properly utilize nutritional information or fully understand its relevance to their own daily energy needs [18, 19]. It is therefore important to consider what factors other than perceived healthiness of foods may influence the preference for highly-palatable energy-dense food items.

An obvious but critical influence on our food preferences is a state of hunger. While there is a widespread notion that hunger increases our enjoyment of food, this claim has mixed empirical support and is complicated by the

difficulty in dissociating our enjoyment of eating from the taste of the food itself [9, 21]. However, there is a significant body of evidence which suggests that hunger alters our desire to eat and that this change does not necessarily coincide with a change in our appraisal or enjoyment of food [9, 20-26). This distinction between the enjoyment of food items ("liking") and the desire or motivation to eat them ("wanting") has been consistently observed in studies of both normal and compulsive eating behavior (See [20] and [27, 28] for respective reviews). It is also supported by neurobiological evidence that suggests these two processes may be mediated by distinct neurochemical pathways [29]. This distinction is also thought to explain "irrational" eating behavior, whereby individuals crave or consume foods despite the negative consequences that result from eating those items [27, 28, 30]. Interestingly, their evidence that that states of hunger caused by food-deprivation increase the attractiveness of and motivation to eat highly palatable foods, without changing our perceived enjoyment of them [11, 31-33]. These findings may explain, in part, why highly-palatable energy-dense foods are consumed at high rates throughout society despite ongoing efforts to promote healthy eating.

Evaluation food selection and preferences can take many forms, though one common approach is the "food-viewing" paradigm. In this type of study, participants use a computer, tablet, or cell-phone to view images of food and rate them according to any number of qualities [26]. Two common qualities assessed in this task are the "tastiness" of food items (termed here as "palatability") and the participant's desire to eat them (termed here as "likelihood"), qualities that parallel the "liking" and "wanting" of food described above [26]. Due to its reliability and efficiency, the "food-viewing" paradigm has become a popular tool for assessing the properties of food stimuli, and the influences of environmental stimuli and bodily processes on food selection [26, 34-36]. To aid in this research, the Blechert research group has created a food-image database consisting of 896 food images characterized in terms of macro-nutrient content and image characteristics. This databased has allowed for the standardized study of food preferences across different regions and cultures [26, 36].

The aim of the present study is to utilize a subset of the images from the food-pics database to assess the influence on hunger on the evaluation of foods. This study utilizes the ratings of "palatability" and "likelihood" described in Blechert et al., [26] while also adding a new rating of "healthiness." We predict that a state of hunger may influence food selection by biasing participants toward wanting to eat highly-palatable foods rather than foods they rate high in healthiness. Also, this study collected data from two distinct samples: college students from Widener University and affiliates of a health and fitness center, Paradigm Fitness, LLC. The goal of this separate sampling is to determine if the effects of hunger are influenced by the lifestyle factors associated with a more health-conscious population.

Materials and Methods

Participants

Data were collected from 116 participants drawn from two populations — undergraduate introductory psychology students from Widener University (n=90), and affiliates of a health and fitness center, Paradigm Fitness, LLC (n=26). Participant demographic information is displayed in Table 1.

Survey Distribution:

Assessment of health behaviors and food preferences was conducted via an online survey distributed via Google Forms. For the Widener student population, the study was advertised and the survey-link made available via a posted sign-up sheet on the Widener University campus. For the Paradigm Fitness participants, the survey was distributed via the use of the association's email list. The use of the online distribution ensured that all participant responses remained de-identified. Participants received no compensation for participation in this study, and all procedures were approved by the Widener University Institutional Review Board.

Survey Items:

The online survey was divided into three sections. The first section provided participants with information on the study, obtained their informed consent, and then surveyed their health behaviors and eating habits through a combination of open-ended and scale-rated questions, a number of which were adapted from Blechert et al., [26], Bernsmeier et al, [44], and the American Medical Association's *Eating Pattern Questionnaire* [45]. A full listing of survey items, rating scales, and food images can be found in the supplementary materials section.

The second section asked participants to view and rate 42 images of food items. Food images were selected from the "Food Pics" database (Blechert et al., 2014) on the basis that they represent a variety of macronutrient content while also being recognizable to North American participants. Each image was displayed individually and was followed by three separate questions that assessed the qualities of *Palatability*, *Likelihood of Eating,* and *Healthiness*. The questions were "How palatable (tasty) do you find this food item?", "If this food item was in front of you right now, how likely are you to eat it?", and "How healthy do you think this food item is?" Answers to each question could be provided by the use of a 10-point scale, with 10 being high in that quality [e.g., "very palatable," "very likely", or "very healthy"] and 0 being low in that quality [e.g., "not at all palatable," "not at all likely," or "not at all healthy"], with no neutral point.

The third section of the survey evaluated participant demographic information, including age, gender, race/ethnicity, education, and region of a primary residence. Following this section, the participant was debriefed as to the purpose of the study and thanked for their participation.

Data Analysis:

The first analyses utilized this study examined whether participant hunger status and sex influenced their rating of food items. For each rating type (Palatability, Likelihood, Healthiness), mean subject scores were obtained by averaging their responses across the 42 image presentations. These scores were then used as the dependent variable(s) in three separate Factorial Analysis of Variance tests, which examined each rating type (Palatability, Likelihood, Healthiness) as the dependent variable and utilized participant hunger status (Hungry/Not Hungry) and sex (Male/Female) as fixed factors. To further examine the effect of hunger and sex on image ratings, participant data was split based upon either hunger status (hungry/not hungry) or sex (male/female), and then correlations were conducted between each rating type (Palatability, Likelihood, Healthiness). The resulting correlations were then compared across conditions through the use of Fisher's r to z transformations and subsequent z-tests, as provided by Lenhard & Lenhard [37]. Similar correlation analyses were conducted examining the relationship between each rating type and the macronutrient content (total fat, carbohydrates, protein, and kCalories) of the food items utilized in the study.

The second analyses conducted in this study examined the effect of hunger and sample group on the rating of food items. The factor of sex was omitted from these analyses since its inclusion would have resulted in small sample sizes and poor statistical power. This second set of analyses, therefore, mirrored the above descriptions, with the factor of sample group replacing sex in all analyses. Comparison of lifestyle and demographic factors between Paradigm Fitness and Widener University participants involved the use of independent samples t-test or Chi-Square tests for independence, based on the data obtained from the question.

Results and Discussion

Analysis 1: How do hunger status and participant sex affect image ratings?

Individual Factorial Analysis of Variance tests revealed the following for each rating type: For palatability, there was a significant main effect of hunger ($F(1, 112)=4.719$; $p=0.032$), but no main effect of sex ($F(1, 112)=2.447$;

p=0.121), nor a hunger by sex interaction effect (F(1, 112)=0.601; p=0.440). For likelihood ratings, there was a significant main effect of hunger (F(1, 112)=19.151; p=0.000), a significant main effect of sex (F(1,112)=6.561; p=0.012), but no hunger by sex interaction effect (F(1,112) = 0.415; p=0.521). For healthiness, there was no main effect of hunger (F(1,112)=0.18; p=0.893), but there was a significant main effect of sex (F(1,112)=5.387; p=0.022). There was not a significant hunger by sex interaction effect (F(1,112)=2.490; p=0.117). Given the lack of interaction between these variables, further analyses were conducted separately for each factor (hunger and sex). See Figure 1 for a depiction of these findings.

Correlations by Hunger Status

Splitting participants by hunger status revealed interesting differences in the relationships between rating types. For not-hungry participants, there were significant correlations between likelihood and palatability, likelihood and healthiness, and healthiness and palatability ratings. Similarly, hungry participants showed significant correlations between likelihood and palatability, likelihood and healthiness, and healthiness and palatability ratings. Comparison of these relationships across conditions revealed a significant difference in the correlations for likelihood and palatability ratings between hungry and not hungry participants (Z=-2.703; p=0.003). However, hunger status did not produce any significant difference in the correlations between likelihood and healthiness ratings (z=-0.095; p=0.462), nor healthiness and palpability ratings (z=-0.763; p=0.223). See Figure 2 for a depiction of these findings, including the exact r, r^2, and p-values.

To further examine the influence of hunger on food preferences, image ratings were correlated with macronutrient content for hungry and not-hungry participants. These analyses revealed that not-hungry participants show a significant positive relationship between carbohydrate count and palatability, while hungry participants show only a trending relationship between these factors. Additionally, not-hungry participants show a significant negative correlation between likelihood ratings and fat content, while hungry participants only show a trend. Healthiness ratings did not significantly correlate with macronutrient content in either condition nor did caloric content with any rating type. See Table 2 for a summary of these correlations.

Correlations by Sex

When participants were split by sex (male/female), correlation analyses revealed few differences in the relationship between rating types. Female participants showed significant correlations between likelihood and palatability, likelihood and healthiness, and healthiness and palatability ratings. Similarly, male participants showed significant correlations between likelihood and palatability, likelihood and healthiness, and healthiness and palatability ratings. Z-tests comparing these relationships across conditions revealed no sex-based differences in the correlations for likelihood and palatability (z=-0.914; p=0.18), likelihood and healthiness (z=-0.83; p=0.203), nor healthiness and palpability (z=-0.941; p=0.173). Exact correlations and p-values for these findings can be found in the supplementary materials.

To further examine the influence of sex on food preferences, participant data was split according to sex, and individual correlations were conducted between food macronutrient content and the three rating types. Female participants showed a significant negative correlation between likelihood ratings and fat content. Also, they showed trending relationships between palatability ratings and fat content, healthiness and fat content, and healthiness and total calories. For male participants, there were no significant relationships between palatability ratings and macronutrient content, nor likelihood ratings and macronutrient content. Male participant healthiness ratings did show a trending negative correlation with fat content. See Table 2 for a summary of these correlations.

Analysis 2: How do hunger status and sample group affect image ratings?

Age and regular participation in health-related activities are interesting factors to consider in evaluating how individuals rate foods in terms of palatability, the likelihood of being eaten, and healthiness. As described in our methodology, participants in this study were drawn from two participant pools: Widener University

undergraduate students and affiliates of a health and fitness center, Paradigm Fitness LLC. Therefore, the second set of analyses were conducted to determine the influence of participant pool (Widener University/Paradigm Fitness) and hunger status (Hungry/Not Hungry) on image ratings.

Individual Factorial Analysis of Variance tests revealed the following for each rating type: For palatability, there was no main effect of hunger ($F(1, 112) = 1.825$; $p=0.179$), no main effect of subject pool ($F(1,112) = 0.122$, $p=0.728$), nor a hunger by subject pool interaction effect ($F(1,112) = 0.152$, $p=0.697$). For likelihood ratings, there was a significant main effect of hunger ($F(1,112)=7.916$; $p=0.006$, a significant main effect of subject pool ($F(1,112)=6.956$; $p=0.010$), but no hunger by subject pool interaction effect ($F(1,112)=0.001$; $p=0.970$). For healthiness, there was no main effect of hunger ($F(1,112)=0.316$; $p=0.575$), a significant main effect of subject pool ($F(1, 112)=10.397$; $p=0.002$), but no hunger by subject pool interaction effect ($F(1,112)=0.0.38$; $p=0.845$. See Figure 3 for a depiction of these findings.

Correlations for Sample Group

Given the differences were seen in image ratings based on the subject pool, participant data were split based upon this factor and further analyzed using correlations between each rating type (Palatability, Likelihood, and Healthiness). Participants from Widener University showed significant correlations between likelihood and palatability, likelihood and healthiness, and palatability and healthiness ratings. Participants from Paradigm Fitness showed a significant correlation between likelihood and palatability ratings, but no significant relationships between likelihood and healthiness nor palatability and healthiness ratings. Z-tests comparing likelihood and palatability correlation coefficients between Widener University and Paradigm Fitness participants yielded a significant difference ($z=2.914$; $p=0.002$), suggesting that Widener Participants have a stronger relationship between these two factors. The same analyses were not performed for the likelihood and healthiness nor the healthiness and palatability correlations given the lack of significant correlations among the Paradigm Fitness participants. See Figure 4 for a depiction of these findings, including the exact r, r^2, and p-values.

To further examine the effect of sample group on food preferences, participants data was split according to that factor, and individual correlations were conducted between food macronutrient content and the ratings of palatability, likelihood, and healthiness. Participants drawn from Widener University show significant correlations between palatability and carbohydrate content, and likelihood and fat content. These participants also showed a trending relationship between carbohydrate content and likelihood ratings. Healthiness ratings did not significantly correlate with any macronutrient factor. Participants from the Paradigm Fitness pool show no relationships between palatability ratings and macronutrient content of foods. However, these individuals do show a trending negative correlation between likelihood and carbohydrate content, healthiness ratings and carbohydrate content, and healthiness and total calories. See Table 2 for a summary of these correlations.

Analysis of Survey Questions & Demographic Factors:

Given the observed effect of the sample group, it is interesting to consider whether Paradigm Fitness participants report differences in their eating habits compared to Widener University subjects. Chi-square tests for independence were used to compare the frequency of answers provided for each of the survey items. For the questions related to how participants choose their foods, Paradigm Fitness participants more often agree/strongly agree with statements that foods are chosen based upon healthiness ($\chi^2(4)=16.210$, $p=0.003$) and desire to feel full ($\chi^2(4)= 11.169$; $p=0.025$). Widener University participants more often agree/strongly agree that foods are chosen based on Craving ($\chi^2(4)=14.707$; $p=0.005$). See Table 3 for a summary of participant responses to these questions. A table summarizing responses to questions that did not yield significant differences between sample groups is available in the supplementary materials.

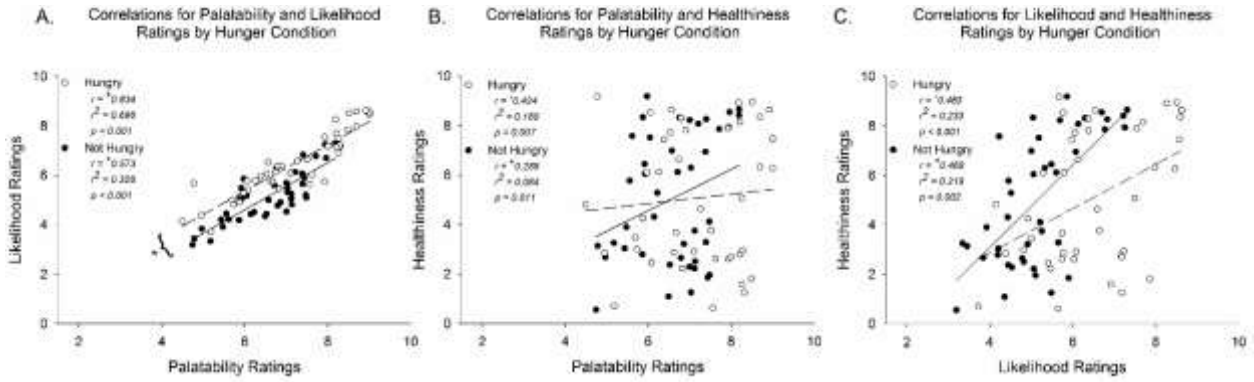
Chi-Square tests for independence also report that Paradigm Fitness participant are more likely to answer yes to whether they exercise ($\chi^2(1)= 4.6$; $p=0.032$), try to maintain a healthy diet ($\chi^2(1)=12.580$, $p>0.001$), and if they are currently trying to lose weight ($\chi^2=6.56$; $p=0.01$) (Table 4). Lastly, an independent samples t-test revealed

that participants from Paradigm Fitness LLC were significantly older than Widener University subjects (t(109)=-16.89; p<0.001). The mean age of Paradigm Fitness participants was 46.54 (SD=15.453), while Widener University participants had a mean age of 18.7 (SD=1.036).

Figure 1:

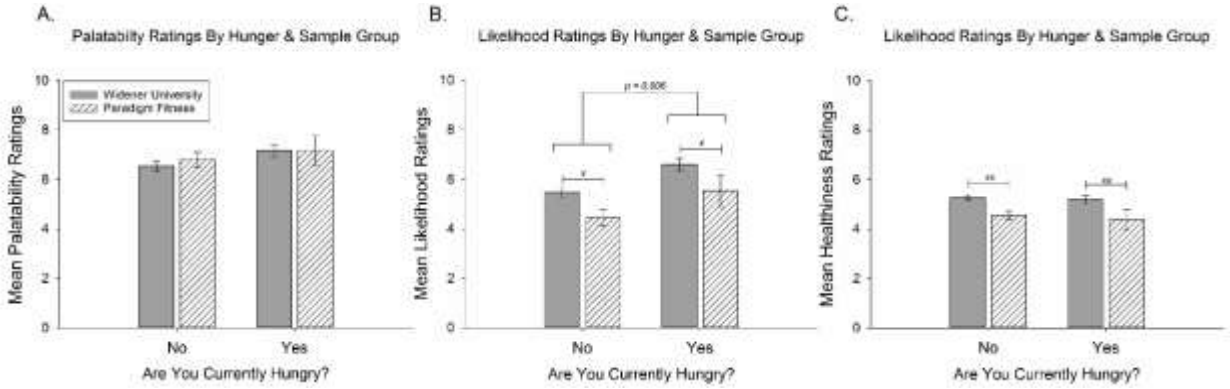
Mean image ratings displayed by sex and hunger condition. Error bars represent ± 1 SEM. A.) Palatability ratings displayed by sex and hunger condition. Hungry participants rate foods as more palatable than not-hungry participants. B.) Likelihood ratings displayed by sex and hunger condition. * indicates the significant main effect of sex (*p=0.012*). Males rate foods as more likely to be eaten than females. Hungry participants rate foods as more likely to be eaten than not-hungry participants. C.) Healthiness ratings displayed by sex and hunger condition. ** indicates the significant main effect of sex (*p=0.022*). Males rate foods are healthier than females.

Figure 2:



Correlations for the relationships between rating types split by hunger condition. Correlation coefficients (r), the goodness of fit (r^2), and significance values (p) are displayed under the identifying markers for each condition. A.) Palatability and Likelihood ratings show a positive relationship that is stronger in hungry subjects. * Indicates a significant difference in the correlation coefficients (p= 0.003). B.) There is a moderate positive relationship between palatability and healthiness ratings. Hunger does not affect this relationship. C.) There is a moderate relationship between Likelihood and Healthiness ratings. Hunger does not affect this relationship.

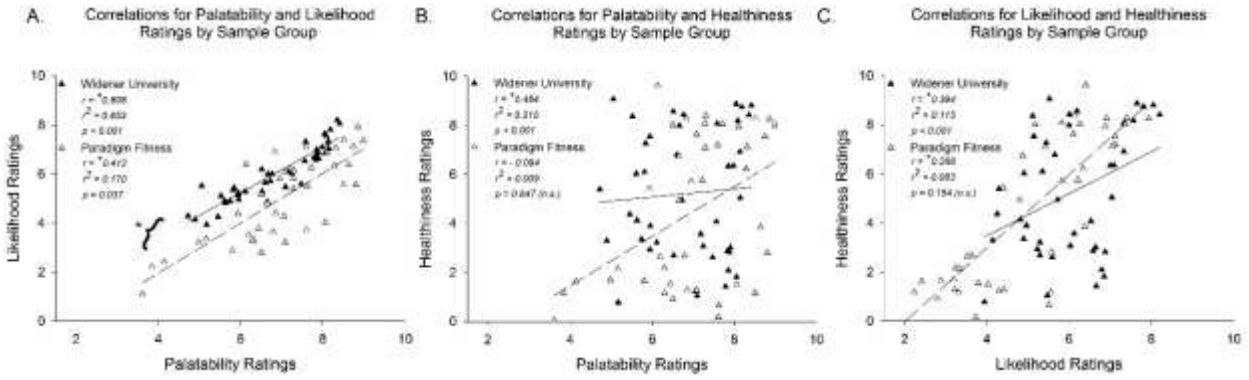
Figure 3:



Mean image ratings displayed by hunger and sample group. Error bars represent ± 1 SEM

A.) Palatability ratings displayed by hunger and sample group. When participants are split by a sample group, palatability is not affected by hunger nor sample condition. B.) Likelihood ratings displayed by hunger and sample group. *x* indicates the significant main effect of sample group (p = 0.01). Paradigm fitness participants show overall lower ratings in the likelihood of eating food items. Hungry participants rate foods as more likely to be eaten than not-hungry participants. C.) Healthiness ratings displayed by hunger and sample group. *xx* indicates the main effect of the sample group (p = 0.002). Paradigm Fitness participants rate foods as less healthy than Widener University participants.

Figure 4:



Correlations for the relationships between rating types split by sample group. Correlation coefficients (r), the goodness of fit (r^2), and significance values (p) are displayed under the identifying markers for each group. A.) Palatability and Likelihood ratings show positive, moderate to strong relationships in both sample groups. Participants from the Widener University sample show a significantly stronger relationship between these two rating types. * Indicates a significant difference in the correlation coefficients (p= 0.002). B.) Palatability and Healthiness ratings show a moderate positive relationship in Widener University participants. There is no significant relationship between these ratings in Paradigm Fitness Participants. C.) Likelihood and Healthiness ratings show a moderate positive relationship in Widener University participants. There is no significant relationship between these ratings in Paradigm Fitness Participants.

Summary of Findings:

The first notable finding in this study is that hungry participants rated foods as more likely to be eaten compared to their not-hungry peers in both of our analyses (Figures 1B & 3B). This effect resembles a number of results obtained from similar studies of eating behavior and food preferences. For example, Rogers & Hardman [9]

found a correlation between ratings of current hunger level and rated desire to eat foods. Finlayson et al., [20] found that hungry individuals show a preference for wanting high-fat/high-sugar foods compared to participants who just ate. Blechert et al., [26] found that ratings of individuals' current hunger status are moderately correlated with a desire to eat those foods ("likelihood"). Findings by both Epstein et al., [22] and Brunstrom & Mitchell [24] revealed that eating a small meal altered individuals' desire to eat those food items.

Similarly, Havermans et al., [25] found that participants who have recently consumed a snack item (chocolate milk) are less willing to work for these items. Studies by Drobes et al., [21] and Hawk Jr. et al., [23] found that food-deprived participants show changes in startle responding during the presentation of food-images, suggesting an altered motivation toward those items. Our data, therefore, add to this growing body of evidence, which suggests that states of hunger change the motivational processes related to food consumption.

However, our data also revealed a conflicting result whereby palatability ratings were influenced by states of hunger in our first analysis (Figure 1A) but not in the second (Figure 3A). This unexpected result may reflect a broader discrepancy of findings observed throughout the field. While there is evidence that the perceived enjoyment of eating is unaffected by states of food deprivation or hunger [20, 22, 24], there is also evidence which may suggest that hunger influences on the perceived palatability or "liking" of food. For example, Blechert et al., [26] found that numeric ratings of participant hunger status correlated weakly with the palatability of those food items. Similarly, Cameron et al., [31] found that the hedonic "liking" of food items was significantly higher in participants undergoing 8 weeks of caloric restriction. Numerous studies involving food-deprived participants eating a snack have also consistently shown a decrease in the reported "liking" or "enjoyment" of those food items [9, 25, 38], though that may relate more to a change in sensory perception rather than the bodily state [39]. Lastly, Drobes et al., [21] and Hawk Jr. et al., [23] observed changes in startle responding during the presentation of food cues. This may suggest that hunger alters the "liking" of foods, given that changes in startle responding relate to the perceived "pleasantness" of the images present at the time of startle-probe delivery [40]. Given the lack of consistent replication in our analyses and the body of conflicting literature, we are hesitant to interpret this finding without further replication.

In this study, we observed an interesting effect whereby hungry participants show a significantly stronger relationship between palatability and likelihood ratings compared to their not-hungry peers (Figure 2A). In contrast, there was no noticeable change in the relationships between palatability and healthiness ratings (Figure 2B), and healthiness and likelihood ratings (Figure 2C). This finding is in agreement with several studies which show a similar change in the preference for highly-palatable foods during states of hunger or food-deprivation [11, 31-33]. This finding is also interesting given the substantial evidence that states of hunger alter our attentional processing toward food stimuli (see [33] for a review). It is, therefore, possible that states of hunger bias our food selection toward highly-palatable foods, and that this could potentially outweighing factors involved in food selection, such as desire health outcomes.

The Effects of Sex

In our analyses, we also found that sex was a mediating factor for both likelihood and healthiness ratings, with both being significantly higher in males. This finding is in agreement with Blechert et al., [26] who also found that male participants rated foods as more likely to be eaten. Further analysis revealed that the relationships between the three rating types were not influenced by sex, with both males and females showing moderate positive relationships between palatability, likelihood, and healthiness ratings. These results suggest that male participants tend to rate food items are healthier and more likely to be eaten than females, but that this factor is not influenced by a state of hunger.

The Effect of Sample Group

One unique aspect of this study was the usage of two distinct samples groups: a sample of undergraduate students from Widener University and affiliates of a health and fitness center, Paradigm Fitness LLC. The purpose of this distinction was to determine whether factors related to regular participation in health-related activities

influence the rating of food items. Interestingly, the factor of the sample group produced significant effects on both likelihood (Figure 3B) and healthiness ratings (Figure 3C), with both types being lower in the Paradigm Fitness group. Palatability did not differ between the sample groups (Figure 3A).

Furthermore, correlations between the rating types revealed several interesting between-group differences in the relationships between these ratings. Widener University students showed positive relationships between each rating type, with the strongest between likelihood and palatability. However, Paradigm Fitness participants showed a significantly weaker relationship between likelihood and palatability ratings, and they also did not show any significant relationship between likelihood and healthiness nor healthiness and palpability ratings. See Figure 4 (A, B, & C) for a depiction of these results.

Given these results, we thought it important to examine further whether demographic factors, lifestyle or health behaviors differ between these two groups. Paradigm fitness participants were older, with a mean age of 46.54 compared to the Widener mean of 18.7. Paradigm Fitness subjects state that they more often choose foods based on healthiness and a desire to feel full, while Widener University participants more often choose foods based on craving. Paradigm fitness participants also more often answer yes to whether they exercise, maintain a healthy diet, and are attempting to lose weight

In summary, Participants from Paradigm Fitness show more conservative estimates of food-healthiness, lower likelihood of eating foods, and a weaker relationship between palatability and likelihood ratings. These individuals are older and tend to choose foods based on a desire to feel full rather than cravings. It is also important to note that the sample group differences do not replicate if participants are instead sorted into conditions based on their exercise habits alone (data not shown). This suggests other the presence of other mediating factors in the Paradigm Fitness that sample group, such as age, health-education, fitness goals, and eating habits. These findings align with other literature, which suggests that each of those factors contribute to food preferences and health behavior. For example, adolescents (ages 10-19) show higher rates of unhealthy eating behaviors, eating fewer vegetables, frequent snacking, and show preferences for salty, sweetened, high-carbohydrate, and processed foods (see [13] for a review). Evidence from Nascimento-Ferreira et al., [41] suggests that young adults may be interested in maintaining good health, but do not adequately understand the factors that lead to healthy food choices.

Similarly, Salama & Esmail, [42] found that students have little knowledge of the macro- and micro-nutritional content and value of the foods they were eating. Swanson et al., [43] found that Appalachian youth base their food choices on factors such as taste, cost, and convenience, rather than healthiness. Taken together, these findings suggest the presence of one or more mediating factors between the two sample groups besides the tendency to engage in exercise. Further investigation into these factors could lead to novel approaches in promoting healthy eating behavior.

Conclusions

Understanding how hunger and lifestyle choices influence our eating behavior could help us better promote positive health outcomes in the general population. This study utilized an adaptation of the food-viewing task developed by the Blechert research group (Blechert et al., [26, 36] to assess how hunger influences food preferences. The results presented here provide two key insights into the process of food selection. The first is that, when hungry, our food selection may be biased toward tasty or enjoyable foods, rather than those that we consider being healthy. This lends further support to the idea that “grocery shopping when hungry” and similar circumstances are risky ventures for those trying to maintain a healthy diet, as our bodily state may influence our behavior in a way that conflicts with our health-goals. Secondly, and perhaps more importantly, this increased desire to eat tasty foods caused by a state of hunger may be influenced by factors such as age, education, and routine health practices. This result is promising, as it suggests there may be a multitude of factors which could be used to further promote positive health in the general population.

Table 1: Participant age, sex, and hunger status listed by sample group.

	Sample Group		
Factor	***Widener University***	***Paradigm Fitness***	**Total**
Age	18.7 (SD = 1.036)	46.54 (SD = 15.453)	24.72 (SD = 13.539)
Sex			
Males	46 (71.9%)	18 (28.1%)	64 (55.2%)
Females	44 (84.6%)	8 (15.4%)	52 (44.8%)
Total	90	26	116
Are You Currently Hungry?			
Yes	34 (37.8%)	5 (19.2%)	39 (33.6%)
No	56 (62.2%)	21 (80.8%)	77 (66.4%)
Total	90	26	116

Table 2: Correlations between ratings and macronutrient content of food items sorted by hunger status, sample group, and participant sex. * indicates statically significant correlation ($p<0.05$). ᵀ indicates trending correlation ($p<0.10$).

Hungry Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = -0.061	r = -0.198	r = +0.299 ᵀ	r = +0.002
Likelihood	r = -0.109	r = -0.276 ᵀ	r = +0.228	r = -0.090
Healhitness	r = -0.094	r = -0.231	r = -0.176	r = -0.227

Not Hungry Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = -0.156	r = -0.238	r = +0.291 ᵀ	r = -0.046
Likelihood	r = -0.265 ᵀ	r = -0.360 *	r = +0.035	r = -0.255
Healhitness	r = -0.107	r = 0.250	r = -0.233	r = -0.267 ᵀ

Widener University Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = 0.125	r = -0.226	r = +0.372 *	r = -0.006
Likelihood	r = -0.228	r = -0.332 *	r = +0.286 ᵀ	r = -0.135
Healhitness	r = -0.107	r = -0.237	r = -0.182	r = -0.240

Paradigm Fitness Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = +0.019	r = -0.119	r = -0.051	r = -0.054
Likelihood	r = -0.012	r = -0.211	r = -0.263 ᵀ	r = -0.217
Healhitness	r = -0.077	r = -0.254	r = -0.277 ᵀ	r = -0.272 ᵀ

Male Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = +0.162	r = -0.003	r = +0.230	r = +0.158
Likelihood	r = +0.135	r = -0.142	r = -0.145	r = -0.090
Healhitness	r = +0.029	r = -0.160	r = -0.258 ᵀ	r = -0.187

Female Participants

	Macronutrient:			
Rating:	*Protein*	*Fats*	*Carbohydates*	*kCal*
Palatability	r = -0.169	r = -0.264 ᵀ	r = +0.140	r = -0.118
Likelihood	r = -0.229	r = -0.348 *	r = +0.010	r = -0.244
Healhitness	r = - 0.131	r = -0.273 ᵀ	r = -0.225	r = -0.279 ᵀ

Table 3: Answers to questions on food selection sorted by sample group. Items displayed here showed statically significant chi-square values ($p<0.05$). All other questions and responses are available in the supplementary materials.

When deciding what to eat, I choose foods based on…					
			Healthiness		
Sample:	**Strong Agree**	**Agree**	**Neither**	**Disagree**	**Strongly Disagree**
Widener	13 (14.4%)	36 (40.0%)	23 (25.6%)	12 (13.3%)	6 (6.7%)
Paradigm	9 (34.6%)	16 (61.5%)	1 (3.8%)	0 (0.0%)	0 (0.0%)
			To Satisfy Craving		
Sample:	**Strong Agree**	**Agree**	**Neither**	**Disagree**	**Strongly Disagree**
Widener	25 (28.1%)	41 (46.1%)	15 (16.9%)	3 (3.4%)	5 (5.6%)
Paradigm	1 (3.8%)	10 (38.5%)	10 (38.5%)	4 (15.4%)	1 (3.8%)
			Desire to Feel Full		
Sample:	**Strong Agree**	**Agree**	**Neither**	**Disagree**	**Strongly Disagree**
Widener	19 (21.1%)	35 (38.9%)	20 (22.2%)	13 (14.4%)	3 (3.3%)
Paradigm	0 (0.0%)	7 (26.9%)	11 (42.3%)	7 (26.9%)	1 (3.8%)

Table 4: Answers to questions related to participant exercise and health habits sorted by sample group. * indicates statically significant chi-square value ($p<0.05$).

Do you exercise?		
Sample:	**Yes**	**No**
Widener	76 (84.4%)	14 (15.6%)
Paradigm	26 (100.0%)	0 (0.0%)

Try to maintain a healthy diet?		
Sample:	**Yes**	**No**
Widener	57 (64.8%)	31 (35.2%)
Paradigm	26 (100.0%)	0 (0.0%)

Are you trying to lose weight?		
Sample:	**Yes**	**No**
Widener	33 (37.1%)	56 (62.9%)
Paradigm	17 (65.4%)	9 (34.6%)

Data Availability (excluding Review articles)

All data used in this study can be obtained by contacting the principal investigator, Luke Ayers, at lwayers@widener.edu.

Conflicts of Interest

Luke Ayers is an affiliate of Paradigm Fitness LLC and asked to use their mailing list for this study. There was no monetary compensation nor any other personal benefit involved in the conducting of this research.

Vasilis Ikonomou has no conflicts to disclose.

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