The Influence of Visual Cues on Menu Choices: Behavioral and Physiological Insights into High-and Low-Energy Density Foods

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Introduction

"Obesity affects 40.3% of Americans, creating severe health problems including chronic health diseases such as diabetes and cardiovascular conditions" (Centers for Disease Control and Prevention). One contributing factor is the predisposition to choose high-energy density (high calorie) foods over low-energy density (low calorie) options. The reasons for choosing more energy dense foods over alternatives are influenced by a variety of reasons, including visual cues. Visual cues in advertising triggers psychological and physiological responses that motivate eating.

Existing research demonstrates how powerful visual food cues are on behaviors when selecting energy-dense foods. The Food and Drug Administration (FDA) has implemented food labeling policies to encourage healthier eating choices, yet results are mixed and limited by contexts. This indicates the importance of better understanding human behavior and the decision-making. Although much is known about the behavioral effects of food-related stimuli, there is a need to know more about the physiological response that accompanies these behaviors. Psychophysiological can provide a moment-to-moment assessment of attention and motivational responses. Using these tools may illuminate how participants react when choosing high and low-calorie food options in a lab under controlled experimental conditions. This research aims to uncover patterns behind food choices and the importance behind engaging visual stimuli.

Methods

Participants: Participants N= 115 were young (*M*=21.23, *SD*=4.8), mostly female (71.4%), mostly white (51.7%) followed by Hispanic (17.6%), and African American (10.9%).
New participants will include young adult college students from Florida State University, recruited through the School of Communications SONA system.

Measures: The study used menus created to vary energy density and visual cues of the food choices.

Metrics:

- Heart Rate (ECG): Participant's attention level
- Skin Conductance (EDA): changes in sweat production as indications of emotional arousal
- Facial Electromyography (EMG): tracks emotions experienced whether negative, positive, or ambivalent
- Eye Tracking Device: infrared device used to track eye movements
- Dutch Eating Behavior Questionnaire (DEBQ): determines general knowledge about food habits with 33 questions on food items with 5-choice answers ranging from "never" to "very often" in 3 different subscales: Restrained Eating, Emotional Eating and External Eating
- The General Nutrition Knowledge Questionnaire (GNKQ): determines general knowledge about nutrition and health that is related to food

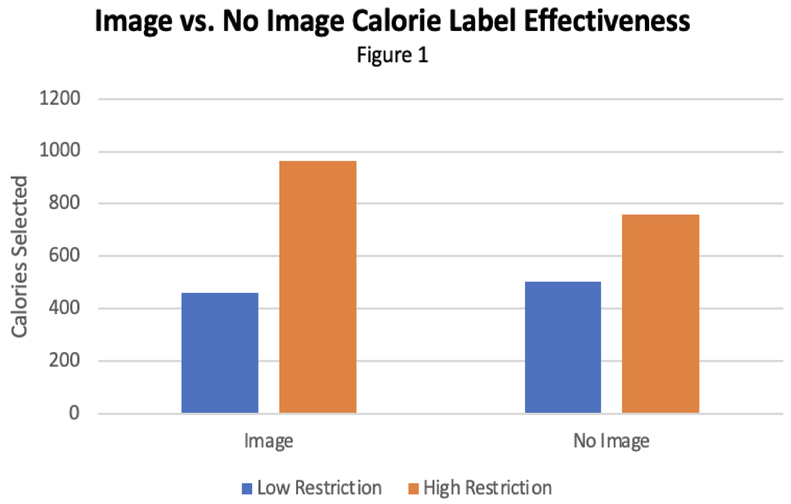
Food Visual Array Presentation through Qualtrics: Participants were presented food array images varying in calorie density. These images were taken from the website menus of three of the leading convenience food restaurants: Taco Bell, Chick Fil A, and Burger King.

Software Tools:

- BioPAC MP160 System: Collects data on participant's physiological response
- Observer XT Software: Qualitative observational data collection
- Tobii Pro Lab: Records gaze-tracking data
- Qualtrics: Facilitated surveys and recorded participant responses

Procedure

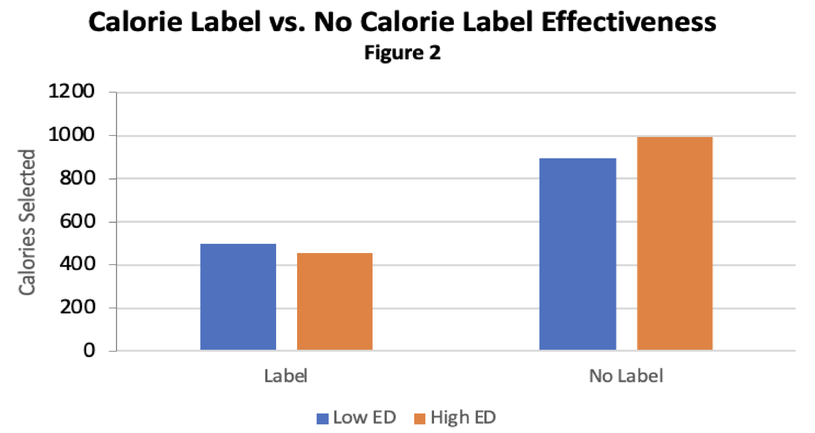
The preparation of equipment includes electrodes, leads, and computers, and software applications including BIOPAC, Observer XT, Tobii Pro Lab and Qualtrics.
Questionnaires and consent forms were prepared and given for participants to sign. Once the consent forms were signed, Heart Rate (ECG), Skin Conductance (EDA), and Facial Electromyography (EMG) were placed on the participants' forearms, palms and facial regions following standard procedures. A screen-based eye tracking system (Tobii Nano) was used to collect gaze track data through Tobii Pro Lab. Participants first viewed a set of 12 menus and selected the items they would eat in a typical meal. Then they answered the General Nutrition Knowledge Questionnaire and Dutch Eating Behavior Questionnaire (DEBQ). Throughout the tasks participants completed, physiological data and eye tracking were continuously recorded.
After completing the questions on food habits and knowledge, participants completed a demographics section, and then asked a series of questions about the food arrays they viewed earlier in the study. The questions were based on the previous food arrays they were presented and identifying if they have seen before and which they have not. Additionally, participants answered multiple choice questions about the different items in the arrays to determine what types of calorie information they retained. Finally, the participant was debriefed on the procedure, thanked, and dismissed.



Results

The data on calories selected were analyzed using a 2 (image vs. no image) × 2 (lower vs. higher energy density) repeated measures ANOVA.

A main effect of image was observed, $F(1,101) = 4.12$, $p = .045$, $\eta^2p = .04$. Participants selected more calories when images were present ($M = 706.00$, $SE = 28.91$) compared to when images were absent ($M = 639.58$, $SE = 28.91$). This effect was not influenced by eating restriction.
A main effect of energy density was also found, $F(1,101) = 110.10$, $p < .001$, $\eta^2p = .52$, indicating that participants selected more calories when foods were higher in energy density. This effect was moderated by eating restriction, $F(1,101) = 12.05$, $p < .001$, $\eta^2p = .11$, as individuals with higher levels of restriction were more susceptible to visual cues than those with lower levels of restriction. See Figure 1.



Calories selected were analyzed using a 2 (label vs. no label) × 2 (lower vs. higher energy density) repeated measures ANOVA.
A main effect of label was observed, $F(1,102) = 145.28$, $p < .001$, $\eta^2p = .59$, with participants selecting more calories when labels were absent ($M = 946.11$, $SE = 44.29$) compared to when labels were present ($M = 474.97$, $SE = 23.38$). This effect was not significantly moderated by eating restriction, $F(1,102) = 3.48$, $p = .065$, $\eta^2p = .03$, and no main effect of restriction was identified.
An interaction between calorie labels and energy density was found, $F(1,102) = 4.15$, $p = .04$, $\eta^2p = .04$. Participants selected more calories when foods were higher in energy density, though this effect was not influenced by eating restriction ($F < 1$). Additionally, no main effect of energy density was observed. See Figure 2.

Conclusion

The study resulted with a larger percentage of subjects choosing a larger amount of calories to consume when exposed to visual cues compared to when the visual cues were absent. These findings demonstrate the significant role of visual stimuli on decision-making, which suggests how visual cues can trigger motivation that may limit the use of previous nutritional knowledge when selecting foods. The controlled experimental setting in the laboratory allowed for analysis of this effect, but the artificial environment cannot stimulate a real-world scenario where multiple factors can influence one's decisions such as price, peer influence or social desirability.

Future Directions

Future research will be measuring physiology and eye tracking to understand the subconscious process involved in people's decisions. These findings have significant public health implications and highlight the need for people to be educated about their nutrition, and visual information regarding food advertising and labeling practices.

References

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