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論文題目	Investigating the Relationship Between Visual Food Stimuli and Appetite Behavior Using fNIRS Indicators
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論文の内容の要旨

This study aimed to explore the relationship between visual food stimuli and appetite-related behaviors within the framework of the Stimulus-Organism-Response (SOR) model, employing functional near-infrared spectroscopy (fNIRS) to examine metabolic responses. We developed and validated a biological food preference task that simultaneously assesses physiological responses to various visual food stimuli and subjective evaluations of these foods, aiming to understand how these physiological responses relate to food preference behaviors. Specifically, we provided an in-depth analysis of how visual food stimuli influence cerebral hemodynamics, subjective evaluations, and implicit preferences. The experiment focused on the prefrontal cortex and parotid regions, examining neural responses to static and dynamic visual stimuli of ice cream in different melting states and colors. We analyzed neural activity in the left and right prefrontal cortices and parotid regions, as well as the relationship to response times (as measures of implicit preferences) in evaluating "liking" and "wanting." This approach enabled us to investigate the effects of visual stimuli on physiological responses and subjective evaluations through complex mechanisms involving the brain's reward system and appetite behaviors.

Our findings revealed that subjective evaluations varied significantly with the melting state and color of the ice cream stimuli. Notably, fresh, intact ice cream (State 1) received high ratings for both "liking" and "wanting," whereas melted ice cream (State 4) received significantly lower ratings. These results suggest that freshness and visual appeal are critical factors in stimulating appetite, emphasizing the importance of visual integrity in food presentation.

Physiological responses indicated that visual stimuli, both static and dynamic, significantly influenced hemodynamic responses in the parotid and prefrontal regions, with specific regional activations corresponding to "liking" and "wanting" evaluations. Static images elicited increased blood flow in the left prefrontal cortex and left parotid region during "liking" evaluations, suggesting that hedonic and reward processing is predominantly mediated by the left hemisphere. Conversely, dynamic video stimuli induced activation in the right prefrontal cortex and right parotid region, indicating that motivational processes related to "wanting" are more prominent in the right hemisphere. The contrast between static

and dynamic stimuli revealed differential brain responses, with videos necessitating complex sensory integration and cognitive processing, leading to distinct hemodynamic patterns. These findings elucidate mechanisms by which visual stimuli affect physiological responses and behavior through both conscious and unconscious processes.

We observed significant correlations between subjective evaluations and physiological indicators. Specifically, differential correlations were identified between changes in parotid blood flow and "liking" and "wanting" evaluations across hemispheres. Furthermore, a negative correlation between reaction times and selection frequency was found, indicating that shorter reaction times were associated with more frequent selections. This suggests that intuitive preferences influence decision-making speed.

Additionally, we observed a trend in the relationship between subjective evaluations (explicit evaluations) and reaction times (implicit preferences), wherein shorter reaction times (indicating stronger implicit preferences) generally corresponded to higher subjective evaluations. This finding highlights a connection between explicit "liking" and "wanting" evaluations and unconscious response speeds. A significant correlation was also found between reaction times and physiological indicators, with shorter reaction times associated with changes in parotid and prefrontal cortex activity. These results suggest that implicit preferences may influence appetite behaviors via physiological responses.

In conclusion, visual food stimuli influence appetite behaviors through physiological responses, subjective evaluations (explicit measures), and reaction times (implicit preferences). Utilizing fNIRS to measure brain activity, our study demonstrated that visual food stimuli (S) elicit specific physiological responses (O) that closely correlate with subjective evaluations (R), thereby providing critical empirical evidence supporting the theoretical framework of the S-O-R model. These findings offer valuable insights into how visual food cues impact physiological responses and behavioral intentions. Specifically, we confirmed that visual ice cream stimuli triggered parotid blood flow changes associated with subjective evaluations of "liking" and "wanting."

Keywords: Visual food stimuli, Appetite-related behavior, Metabolic responses, fNIRS indicators, Stimulus-Organism-Response (SOR) model, Biological food preference task

論文審査の結果の要旨

Lai Kecheng 氏は食欲について研究し、食品の写真や映像が人の食欲にどのように影響するのかを調べた。氏の独創性は、どのようなときに食べたくなるかだけでなく、どのようなときに「食べたくなくなるか」という否定傾向を併せて調べたことである。つまり、食欲を表すために Liking と Wanting という二つの尺度を導入し、「好きだけど今は食べたくない」「あまり好きではないが今は食べたい」といった反応を捉えられるようにした。これらは主観評価であるが、加えて Lai Kecheng 氏は脳血流と唾液分泌を調べる装置を用いて、生理的反応を調べた。食欲について、いつ「食べたくなくなるか」をこれら多様なデータを集めて明らかにしようとした点に独創性がみられる。データ分析を通して生理的反応が主観評価とどのように相関するかを示した。実用的観点からは食品開発に有用であり、味覚評価の確からしさを高めるものと期待できる。自覚がなく主観評価できないが生理的に反応が検出できるケースがあきらかにできればなおよかったが、そのような研究に至る道筋を切り開いた点で学術的に評価できる。人の反応は近年、神経活動を中心に研究されているが、本研究は新陳代謝という観点から脳と唾液分泌腺の活動を統合的に捉えており、食欲を身体的欲求という側面から明らかにしている。身体知を科学的に解明しており、知識科学の発展に寄与している。以上より、本研究を知識科学の学位に相応しいものと判断する。