International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 5, Issue 1, 2026
DOI: https://doi.org/10.38124/ijsrmt.v5i1.1141

From Behaviour to Brain: A Statistical and Neurobehavioural Study of Eating Disorders

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Publication Date: 2026/01/16

Abstract

This study investigates the relationship between brain functions and eating disorders by examining how neurobehavioral factors influence perceptions related to eating disorders. A 57-item questionnaire was designed, integrating items from the Dutch Eating Behavior Questionnaire, the Eating Disorder Examination Questionnaire, and self-designed questions. The survey was structured into six domains: cognitive control, emotional triggers, body image perception, sensory processing, reward processing, and demographic variables. Data collected from the university students were analyzed using Chi-square tests to determine significant associations of certain behaviors and perceptions of eating disorders. Following individual variable analysis, variables were combined into broad neurobehavioral categories and analyzed at the group level. Significant findings at the group level, following aggregation, were mapped into corresponding brain regions, thus creating a neurobiological framework that explains eating disorders. This study puts much emphasis on the neurobehavioral factors in determining perceptions about eating disorders and is therefore very valuable for the development of targeted interventions and future studies in this field.

Keywords: *Eating Disorder Neurobiology, Neurobehavioral Mapping, Brain-Behavior Associations, Cognitive-Emotional Triggers, Neurobiological Intervention.*

I. INTRODUCTION

Eating disorders represent an important public health concern because of their increased prevalence rate due to biological, psychological, and sociocultural factors. Commonly, EDs are represented by pathological eating behavior and disturbances in body image; such conditions can frequently result in very serious physical and psychic complications, impairing quality of life and increasing morbidity and mortality rates. In spite of extensive research in the field of EDs, underlying mechanisms are still not well determined, especially in resource-poor countries, where diagnosis and treatment are further affected by cultural influences.

Neuroscientific developments give important insights into the interplay between brain functioning and the behaviors linked with ED. Earlier studies identified disturbed neural mechanisms in cognitive control, reward processing, taste perception, and body image regulation. Most of these reports are based on clinical groups from high-income countries, with considerable knowledge gaps regarding ED in diverse populations and those with no clinical manifestations.

This study fills these gaps by investigating various eating disorders in relation to multiple demographics, cognitive, and affective factors within a sample population of university students from Bangladesh. The dataset included 56 independent variables categorized into six composite domains of interest: Cognitive Control, Affective Value Representation, Salience/Taste Processing, Body Image Perception, Reward Processing/Habit Formation, and Demographics. This study will apply Chi-square statistics in order to identify significant neurobiological and behavioral correlates associated with EDs.

Hasan, R., Hosen, M. M., Sanzit, S. H., Talukder, M. A., & Mim, H. S. (2026). From Behaviour to Brain: A Statistical and Neurobehavioural Study of Eating Disorders. *International Journal of Scientific Research and Modern Technology*, *5*(1), 28–44. https://doi.org/10.38124/ijsrmt.v5i1.1141

The present study furthers the literature by investigating a population that has received scant attention in this field and provides a finely tuned understanding of EDs, blending neurobiological knowledge with cultural and demographic elements. Such findings may have potential for guiding targeted interventions and enlightening health policy strategies at a population level.

II. LITERATURE REVIEW

Eating disorders are a multifaceted interaction of environmental, biological, and psychological factors and a severe public health issue with devastating medical and psychiatric effects (Feng et al., 2023). Eating disorders are a spectrum of disorders that consist of Anorexia Nervosa, Bulimia Nervosa, and Binge Eating Disorder, which are characterized by distinctive but overlapping pathological eating habits, weight, and emotional dysregulation (Musai & Şabani, 2024). Literature further underscores the two-way strong relationship between eating disorders and metabolic dysregulation, depicting how malnutrition and disordered eating are to blame for the formation of long-term diseases like cardiovascular disease, diabetes, and gastrointestinal disease (Franjić et al 2022; Yu & Muehleman, 2023). Psychological impairment like depression, anxiety, or obsessive-compulsive traits is an essential etiology of disordered eating, which in turn goes on to drive the pathology cycle (Baweja, 2024). Integrative theoretical models suggest that sociocultural stressors, neurobiological risk, and maladaptive cognitive styles are all implicated in the development and maintenance of these disorders (Zanella & Lee, 2022). Targeted psychosocial interventions and early treatment have been demonstrated to decrease symptoms and improve recovery pathways, with implications for the need for ordered, evidence-based therapeutic interventions (Chang et al., 2021; Davey et al., 2023). Further, developments in the area of neuroscience have delineated explicit alterations in reward processing and executive function in eating disorder patients, revealing more about their neurocognitive foundation (Feng et al., 2023). Owing to their multi-factorial aetiology, their management should be multi-disciplinary in nature to be effective, with the inclusion of medical, nutritional, and psychological interventions so as to offer an holistic approach to prevention and treatment (Cole, 2024).

Dutch Eating Behavior Questionnaire (DEBQ) and Eating Disorder Examination-Questionnaire (EDE-Q) are also the most popular self-report questionnaires used to assess disordered eating behaviors among various populations. DEBQ, originally used to measure emotional, external, and restrained eating styles, has been extensively cross-culturally validated. It has been found to differentiate eating disorders from obesity-related eating patterns through the modifications that are found to continue to be valid for various groups like adolescents (Małachowska et al., 2021; Kim et al., 2023). Emotional and external eating styles assessed using the DEBQ were strongly correlated with obesity and further establishing why it remains very crucial to dysfunctional eating patterns (Benbaibeche et al., 2023). In addition, DEBQ has enabled the exploration of differences in eating due to gender and age, e.g., evidence regarding self-regulation deficiency and its impact on eating disorders (Biberdzic et al., 2021; Kiro et al., 2021). The EDE-Q still remains a gold standard for the measurement of eating disorder psychopathology with necessary clinical cut-offs for symptomatology (Velkoff et al., 2023). Its psychometric validity has been demonstrated in a series of studies, cross-validating the factor structures and the population-dependent cut-off points on men and gender-diverse groups (Rica et al., 2022; Nagata et al., 2023). Cross-cultural validation such as Turkish adaptation of EDE-Q-13 also render it suitable in many settings (Esin & Ayyıldız, 2022). In addition, the questionnaire has been utilized to detect disordered eating in special populations, including elite athletes, which underscores its use as a diagnostic tool even in nonclinical samples (Lichtenstein et al., 2022). In general, these instruments are a requirement both in clinical and research contexts, enabling sophisticated understanding of eating disorders and their behavioral manifestation.

The Chi-square test is a simple statistical method of categorical data analysis of disease research data, particularly clinical and epidemiological studies, since it can identify significant relationships between variables (Chandrasekaran et al. 2023; Valarmathi et al., 2024). Chi-square test also finds application in establishing statistical dependence between medical data sets and is a fundamental part of risk factor and disease presence analysis (McDonnell Sill, 2021; Kishore & Jaswal, 2023). For instance, Odetunmibi et al. (2021) utilized the Chi-square test in Hepatitis B prevalence computation and Rosdiana et al. (2022) utilized it alongside machine learning algorithms like KNN in heart disease computation. It was also demonstrated by Çalışkan (2023) in the diagnosis of malaria employing deep learning through the application of the same in a feature selection mechanism. It currently focuses on development for privacy-preserving Chi-square testing of small sample medical trials (Sei & Ohsuga, 2021) and epidemiologic simulation programs, conversion of the risk ratio to Chi-square statistics for advanced disease modeling (Chao et al., 2024). Furthermore, effect sizes of Chi-square have enhanced explainability in categorical data analysis (Ben-Shachar et al., 2023). Continued merging of the Chi-square test with epidemiological modeling and artificial intelligence continues to affirm its position as a useful tool in modern healthcare analytics.

The neurobiological pathways of eating disorders (ED) are complex and multi-dimensional and consist of numerous brain regions that take part in processing emotion, body perception, reward, and cognitive regulation. The genetic factors and neurobiological mechanisms have risen to become fundamental to the

pathophysiology of ED. Bulik et al. (2022) also described the genetics and neurobiology of ED and hypothesized that abnormal brain circuitry, specifically the striatum and the hypothalamus, are to blame for the pathophysiology of the disorders. Neuroinflammation and dysregulation of gastrointestinal microbiota also contribute to ED, and Butler et al. (2021) described how the intricate interplays between the components can have an impact on eating behavior. The brain's reward system also plays an important role in ED, as identified by Frank et al. (2021), who linked reward response to body mass index and brain circuitry, i.e., in the ventral striatal-hypothalamic network. Cognitive control deficits are also a primary feature of ED, and Wonderlich et al. (2021) and Iceta et al. (2021) determined that cognitive flexibility and decision-making were compromised in food addiction and binge eating disorder. These deficits also result in deficits in control over eating behavior, thereby perpetuating ED symptoms. Representation of affective value, equally significant in processing representations of affective body image and food, is also necessary. Studies by Henning et al. (2022) and Wong et al. (2021) ascertain the way in which self-perception and emotional regulation share a very close correlation with ED symptom severity. Sensory processing, and salience and taste processing itself, have been involved in ED, too, with studies from Cobbaert et al. (2024) and Nimbley et al. (2022) demonstrating the manner in which sensory hypersensitivities map onto pathological eating. Finally, body image processing and reward-learning systems are present in ED, as well. Press et al. (2022) and Krohmer et al. (2022) also described that neural body image processing correlates are also impaired in ED patients who have binge eating disorder. Besides, habituation and reward processing in ED form the foundation for perpetuation of maladaptive eating behavior, and investigations in Bodell and Racine's (2023) and Forester et al.'s (2022) studies elaborate on the pathways through which dysregulation of the reward system contributes to the perpetuation of maladaptive eating behavior.

III. KNOWLEDGE GAP

Although there is extensive knowledge about eating disorders from the existing literature, much about their neurobehavioural and neurobiological mechanisms is still unknown. Franjić 2022 and other works have reiterated that eating disorders are complex illnesses that involve biological, psychological, and social factors. The interlink between specific behaviours with their corresponding brain functions has been minimally explored. Although previous studies have focused on triggers and effects over the long term, less is known about how those triggers correlate with activity in the brain to impact eating behaviour.

Most diagnostic tools currently in use, including the EDE-Q and the DEBQ, consider only behavioural and psychological patterns, and they do so reliably. These tools, though, do not link behaviours to specific neurobiological mechanisms. This leaves a gap in integrating the findings of a questionnaire-based approach with those arising from neuroscience. Whereas the EDE-Q and DEBQ have been validated on diverse populations, the capacity to map these behavioural data onto brain regions has remained unexplored in research, leaving considerable disconnections between neurobehavioural patterns and their biological origins.

The Chi-square test has been used in the study of diseases for finding out the relationship among categorical variables. Though it was widely applied in studies concerning diseases like COVID-19, Hepatitis B, and heart disease, this area is sparse as far as eating disorders are concerned, along with linking behavioural data with neural mechanisms. Most the works existing in literature focus on symptom classification or factors of risk without exploring neurobehavioural domains affecting these disorders.

Neuroscientific studies have elaborated on the disturbed neural circuits and other disturbed brain functions associated with eating disorders. In this regard, for instance, cognitive controls, reward processing, and body image perception have been associated with impairments in specific parts of the brain. These findings come mostly from neuroimaging studies but are usually presented without any integration concerning the behavioural data obtained with assessment questionnaires such as the EDE-Q or DEBQ. This makes it difficult to develop holistic interventions since the gap in understanding how measurable behaviours align with brain-based evidence is left wide open.

Despite the literature to date indicating the complexity of eating disorders, there is a lack of integration of behavioural, statistical, and neuroscientific data. The aim of this paper is to bridge that gap by integrating questionnaire-based behavioural data, statistical analysis through the Chi-square test, and neuroscientific insight for an overall understanding of eating disorders. The current study correlates behaviours with specific brain functions in the hope that this will address the gap that has existed between measurable behavioural patterns and their underlying neural mechanisms; such a link could make the treatments more focused and efficient.

A. Research Question and Hypothesis Development

This research attempts to discover the following:

- What are the factors determining the perception of eating disorders among university students in Bangladesh?
- How are these factors associated with specific areas of the brain?

To find out, this paper reports on a survey among university students in Bangladesh. The questionnaire

was completed in a standardized form to learn about the mindset of the respondents and to overcome any literacy obstacles.

B. Hypothesis Development

The study is grounded on the Neurobehavioral Model of Eating Disorders that includes cognitive, emotional, sensory, and reward components. The study considers elements emphasized in past literature, such as cognitive control, emotional signals, sensory processing, perception of body image, and reward processing. The study also introduces three new elements that have seldom been emphasized in past research: cognitive control, affective value representation, and salience/taste processing. The elements are anticipated to have a significant influence on the perception of eating disorders.

The variables included in this study and the hypotheses related to them are listed below and illustrated in Figure 1:

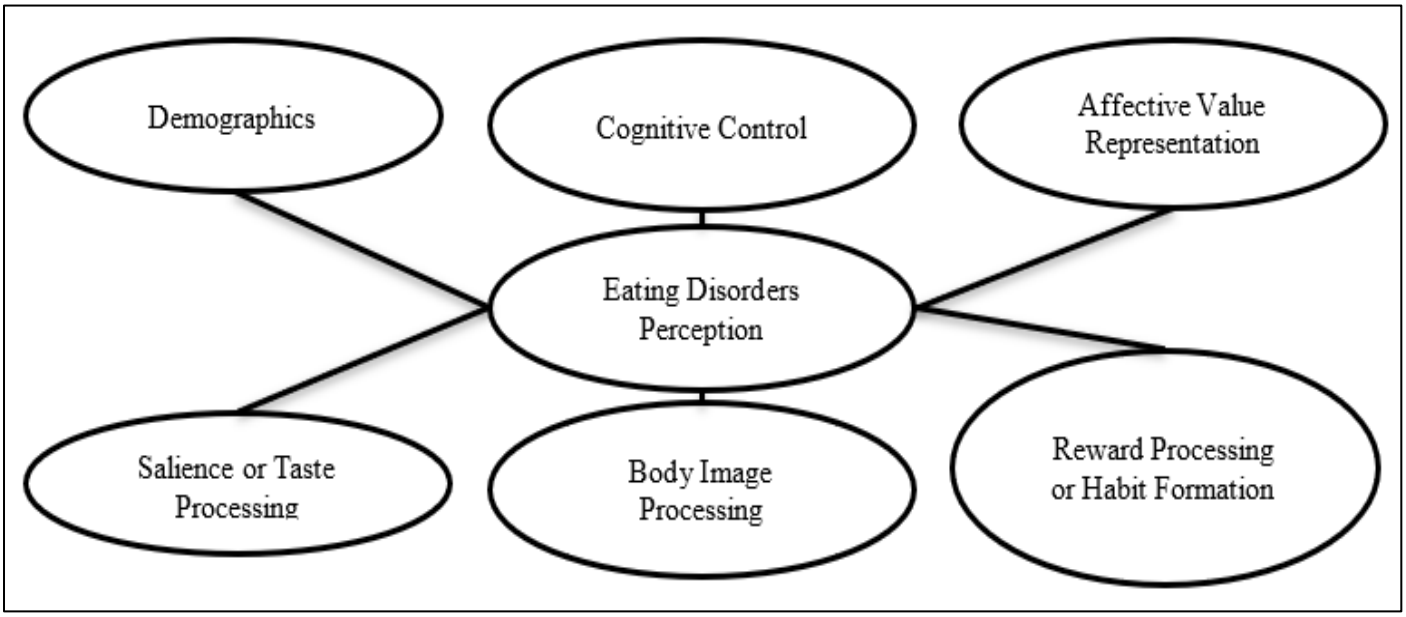

Fig 1 Neurobehavioral Framework Based on the Hypotheses

➢ *Demographic Variables*

Demographic variables, including age, gender, and marital status, play a crucial role in shaping perceptions of eating disorders. Bassett and Ewart (2023) highlight discrepancies in media portrayals, which may contribute to misunderstandings about who is affected. Similarly, D'Adamo et al. (2023) emphasize how demographic factors influence the prevalence and characteristics of eating disorders. This forms the basis for the following hypotheses related to them are listed below and illustrated in Figure 2:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

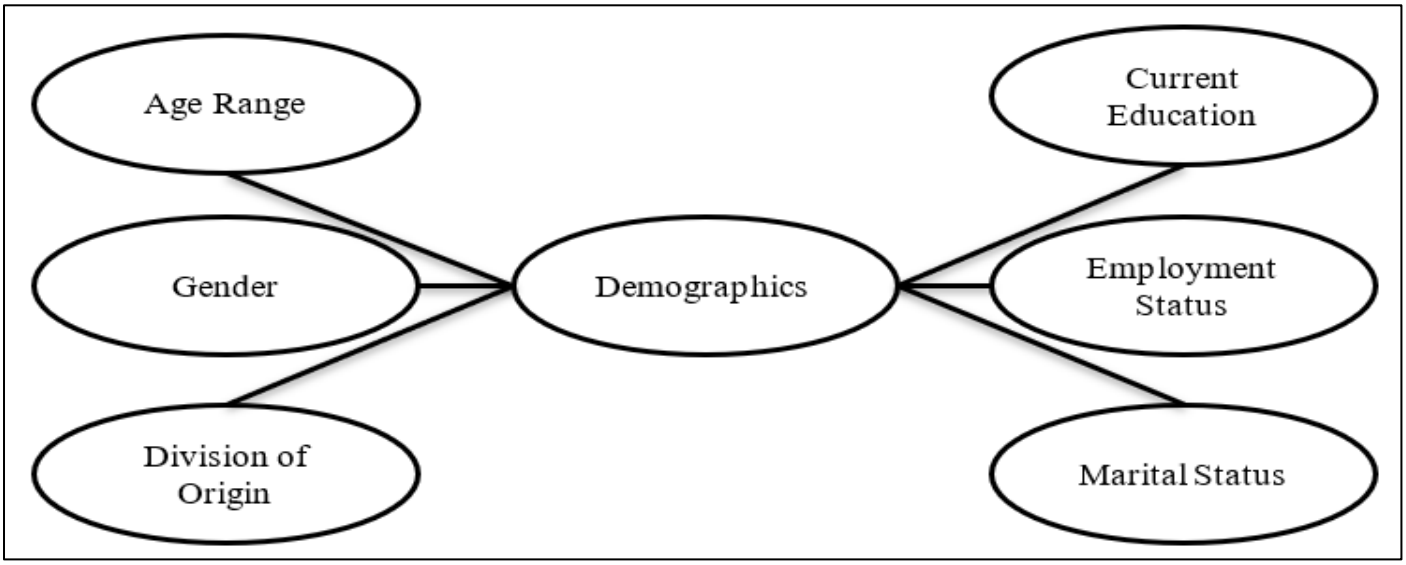

Fig 2 Demographic Indicators Based on the Hypotheses

➢ *Cognitive Control*

Cognitive control is the ability to regulate thought, behavior, and emotion in regard to eating behaviors. Wonderlich et al. (2021) and Iceta et al. (2021) propose through their studies that individuals with eating disorders struggle with impaired cognitive control, which maintains eating disorder actions such as restriction or bingeing. This is the basis for the following hypothesis related to them are listed below and illustrated in Figure 3:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

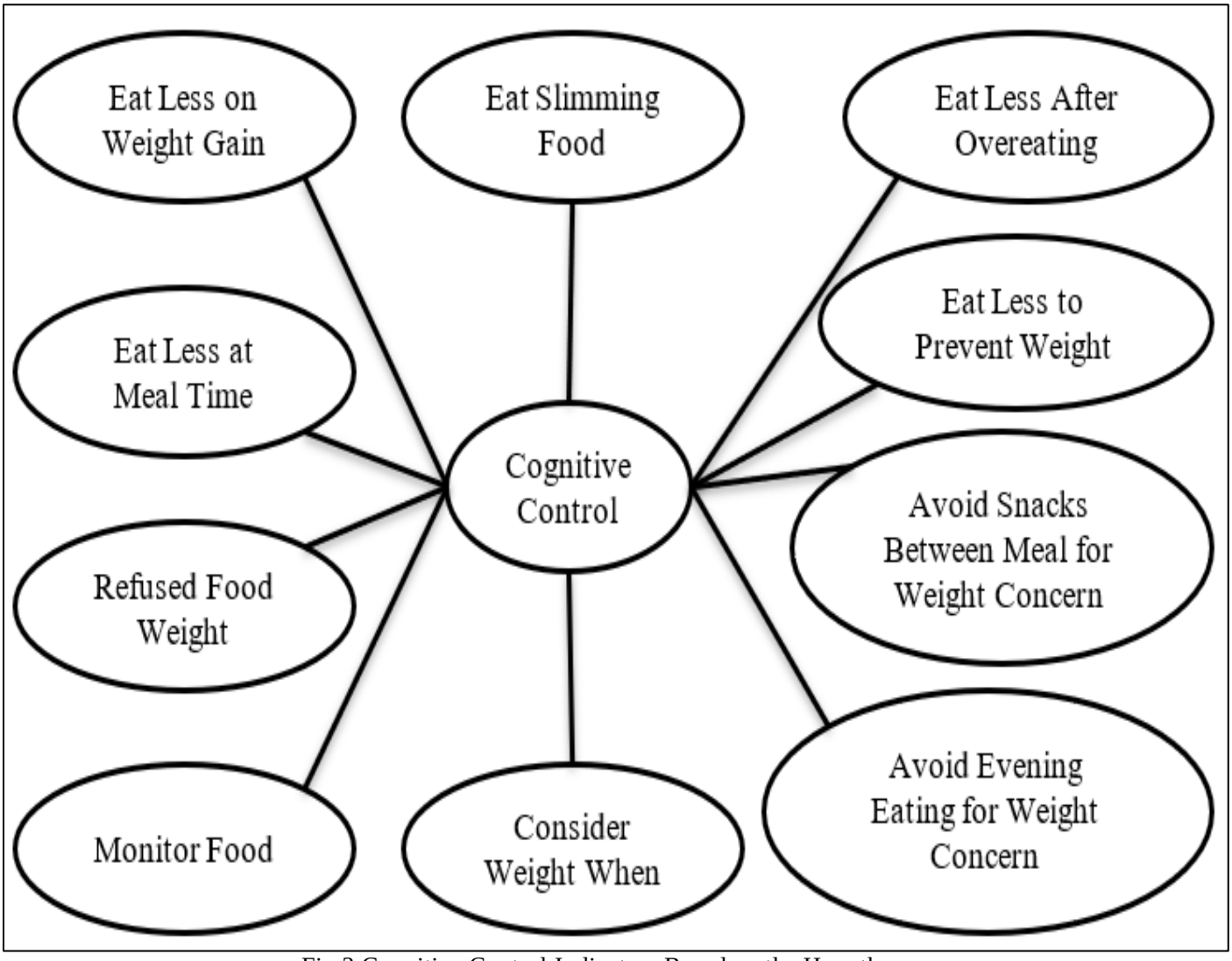

Fig 3 Cognitive Control Indicators Based on the Hypotheses

➢ *Affective Value Representation*

Affective value representation refers to the emotional significance attributed to food and eating behavior. Henning et al. (2022) and Wong et al. (2021) studies point out that stress-, anxiety-, or boredom-driven emotional eating is a prevalent characteristic of eating disorders. This forms the foundation for the following hypothesis related to them are listed below and illustrated in Figure 4:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

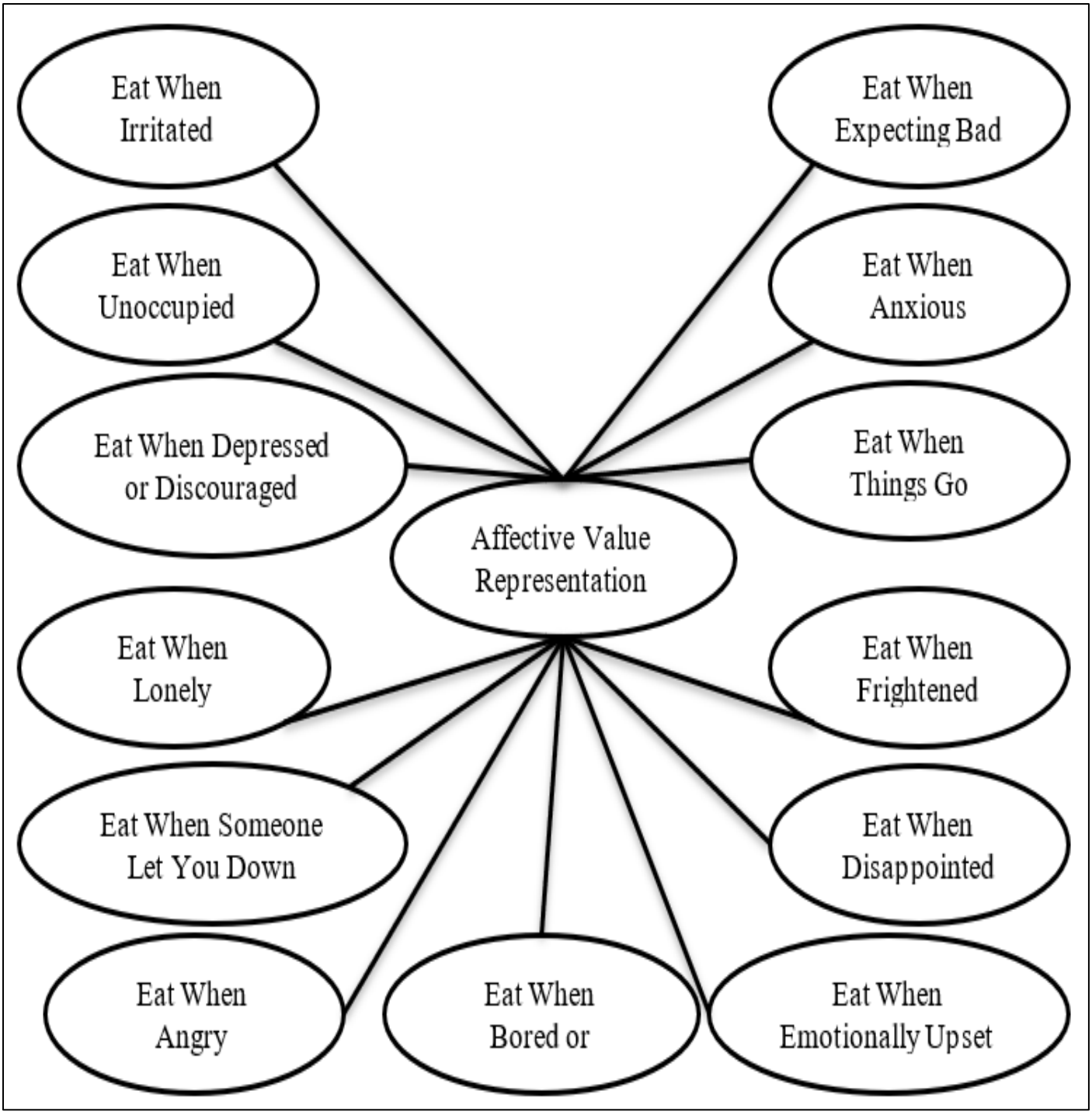

Fig 4 Affective Value Representation Indicators Based on the Hypotheses

➢ *Salience/Taste Processing*

Salience/taste processing refers to perceptual and sensory aspects of the act of food consumption, i.e., taste, olfactory perception, and visual appeal of food. Facts presented by Cobbaert et al. (2024) and Nimbley et al. (2022) confirm that individuals who suffer from eating disorders are even more sensitive towards this sensory stimulation, and these have a pivotal role in modulating their diet. This provides the basis of the following hypothesis related to them are listed below and illustrated in Figure 5:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

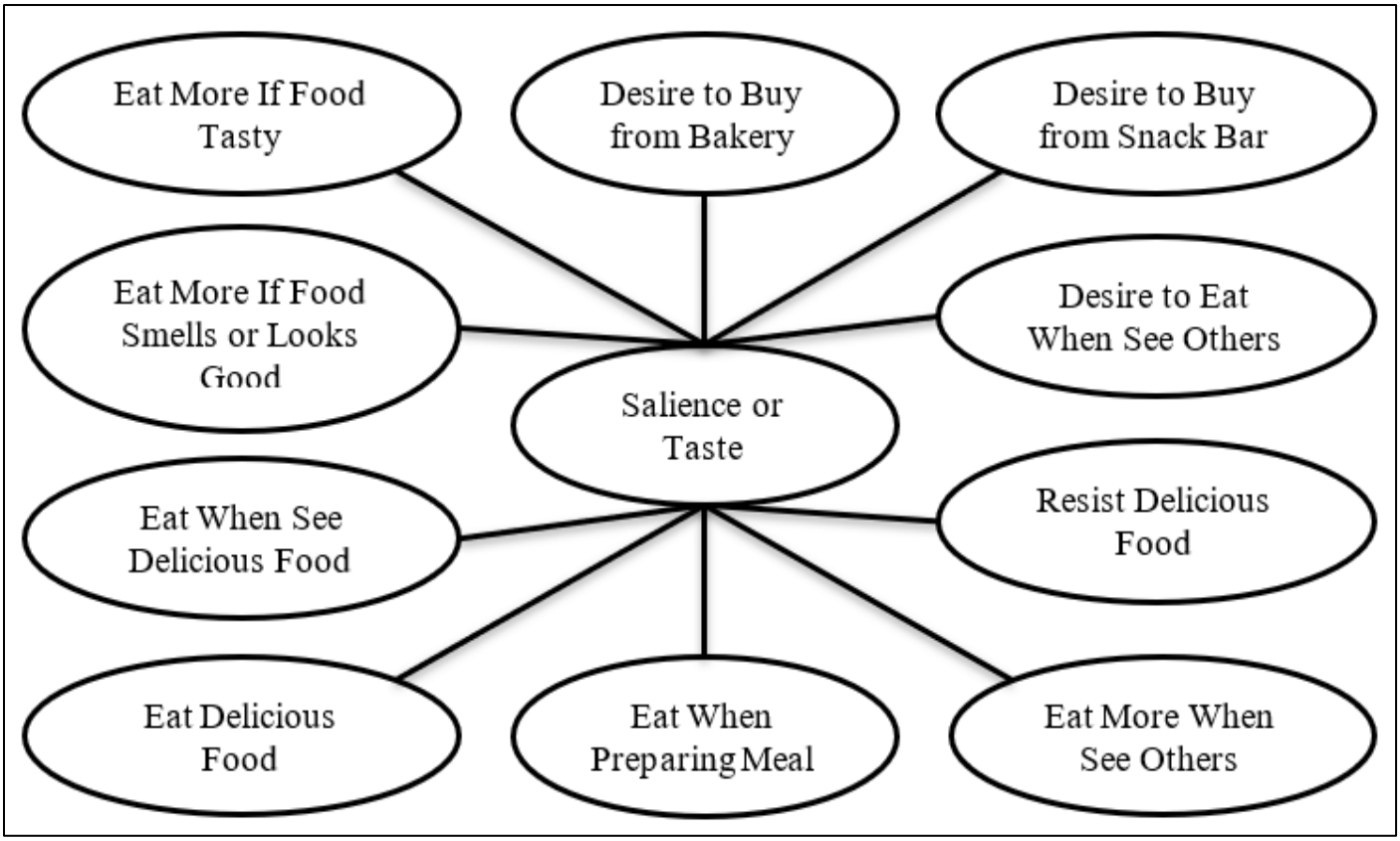

Fig 5 Salience or Taste Processing Indicators Based on the Hypotheses

➢ *Body Image Perception*

Body image perception refers to the manner in which people perceive and conceptualize their bodies. Press et al. (2022) and Krohmer et al. (2022) theorize that negative body image is a key feature of eating disorders and usually goes hand in hand with such behaviors as extreme dieting or excessive exercising. This is the basis for the following hypothesis related to them are listed below and illustrated in Figure 6:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

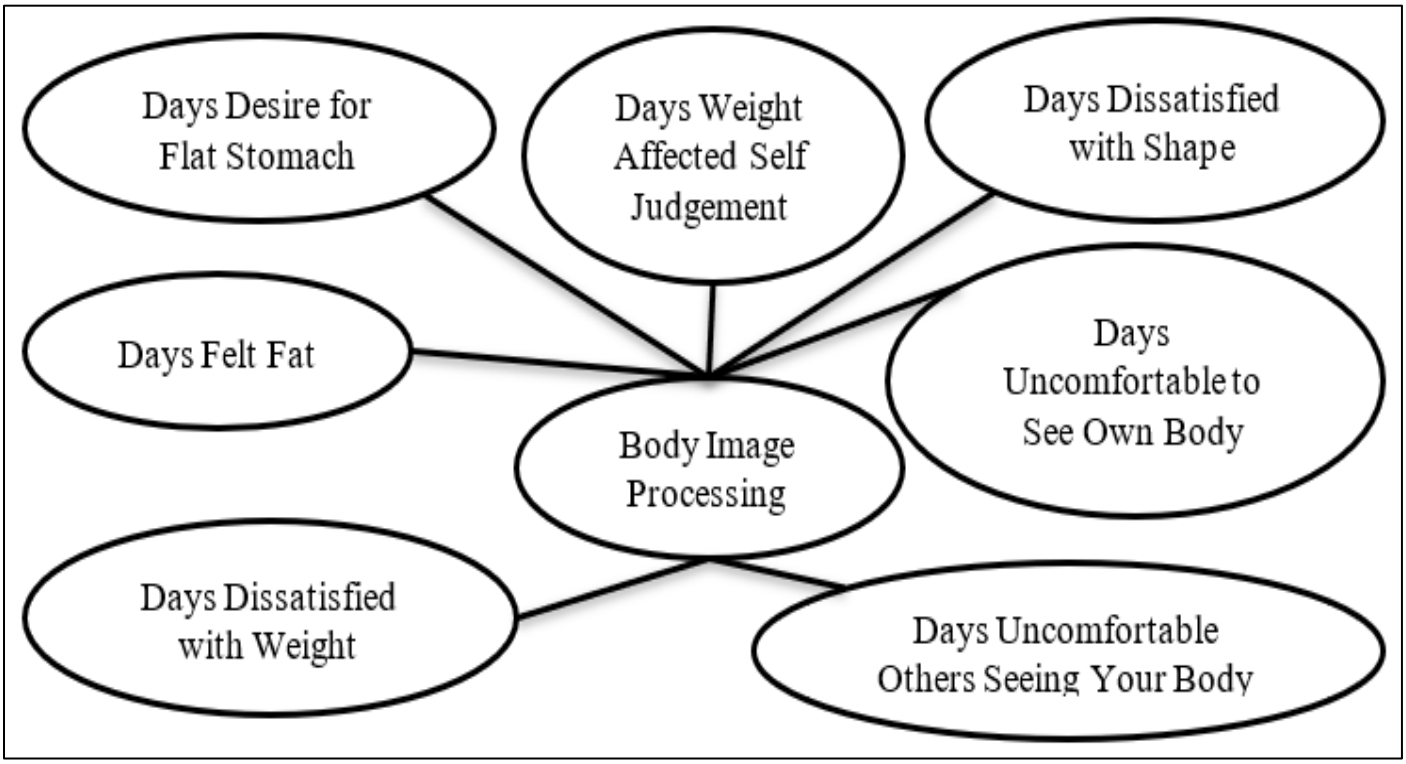

Fig 6 Body Image Processing Indicators Based on the Hypotheses

➢ *Reward Processing/Habit Formation*

Reward processing and habit acquisition encompass the brain's response to rewarding stimuli and the formation of habits. According to Bodell and Racine (2023) and Forester et al. (2022), individuals with eating disorders may form habituated eating habits based on emotional reward or compulsion. This is the basis of the following hypothesis related to them are listed below and illustrated in Figure 7:

- H_0: There is no relationship between demographics and Eating Disorders Perception.
- H_1: There is a relationship between the demographics and Eating Disorders Perception.

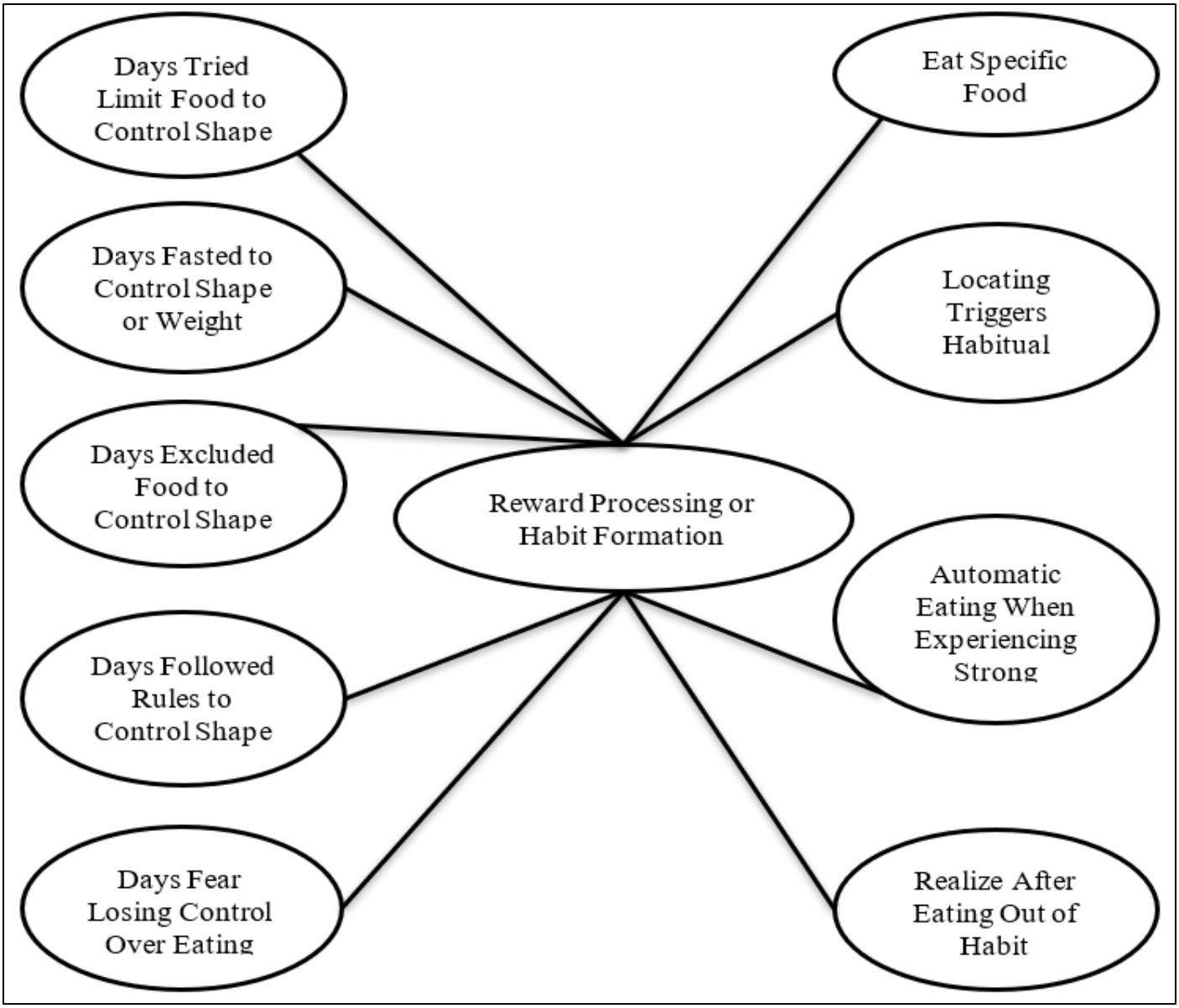

Fig 7 Reward Processing or Habit Formation Indicators Based on the Hypotheses

IV. RESEARCH METHODOLOGY

This is a descriptive study that was conducted with the aim of applying a quantitative methodology. The survey was carried out among students at the university in Bangladesh to test the relationship between neurobehavioral, psychological, and demographic factors and the eating disorders. The research focused on six hypothesized areas: Cognitive Control, Affective Value Representation, Salience or Taste Processing, Body Image Perception, Reward Processing or Habit Formation, and Demographics. The dependent measure was self-report by participants on having an eating disorder.

➢ *Selection of Survey Participants*

The questionnaire was conducted among the students of Daffodil International University in Bangladesh. The respondents were selected based on some criteria for the sake of having a representative sample. The inclusion criteria were that the respondents should be 18 years and above, currently studying undergraduate and postgraduate courses, and willingly volunteered to participate in the study. A total of 550 respondents were selected to have a variation in terms of age, gender, and levels of study. This sample size was chosen in order to gain statistical significance and generalizability of the findings, a solid foundation for the study.

➢ *Developing and Pre-Testing the Questionnaire*

The survey was designed to measure consumption behavior and brain functioning dimensions. The survey contained 57 items, including items of the Dutch Eating Behavior Questionnaire (DEBQ), Eating Disorder Examination Questionnaire (EDE-Q), and self-made questions for the present study. The questionnaire was organized into six sections: Demographics, Cognitive Control, Affective Value Representation, Salience or Taste Processing, Body Image Perception, and Reward Processing or Habit Formation, and concluded with the self-perception of eating disorders question. All questions except demographic and self-reported eating disorder questions utilized the 4-point Likert scale practice in the measurement of response. The questionnaire was pre-tested with university students, and academics in order to determine its clarity, relevance, and comprehensiveness. The remarks made during the pre-testing stage were used in refining and finalizing the survey to ensure no ambiguous language was used and all the variables needed were covered. The exercise enabled the survey to be thorough and adequate for the study's purpose.

➢ *The Pilot Study*

A pilot survey for August 2024 was then conducted in an attempt to pilot the survey tool in terms of question order, wording, and layout. 28 university members participated and were provided with the questionnaire in both English and Bangla. Pilot study helped identify any confusion or problem in the interpretation of questions so as to make sure the questionnaire was actually measuring what was intended and whether important variables had been excluded. Pilot study results indicated differences in wordings being too general and respondents not knowing the Likert-scale system.

➢ *Final Survey Instruments and the Scale of Measurement*

The final poll was done using the English language with Bangladeshi translation and consisted of seven sections, including Demographics, Cognitive Control, Affective Value Representation, Salience or Taste Processing, Body Image Perception, Reward Processing or Habit Formation, and Perceived Eating Disorders. Demographics section recorded details regarding age bracket, gender, current level of education, job, marital condition, and partition of residence. Perception of Eating Disorders section included only one question that asked if the participants thought that they had an eating disorder (Yes/No). Most of the questions made use of a 4-point Likert scale with options from "Strongly Disagree" to "Strongly Agree," and demographic queries were placed towards the end of the survey so that participants keep their focus directed towards the overall goal of the study during early phases. The last survey tool was created to be easy, concise, and understandable, so as to achieve accurate and dependable data collection.

➢ *The Survey Process*

The survey was conducted entirely online using Google Forms to ensure ease of access and participation. The survey link was distributed via email and social media platforms, targeting university students at Daffodil International University in Bangladesh. Participants were provided with a clear explanation of the study's purpose and assured of the confidentiality of their responses. Over a period of four months (August–November 2024), a total of 550 valid responses were collected. The online format allowed participants to complete the survey at their convenience, ensuring a higher response rate and minimizing logistical challenges. For participants who faced difficulties understanding the questions, follow-up support was provided through email or messaging platforms to clarify any ambiguities. The large sample size and online administration ensured robust data collection, making the results statistically significant and representative of the target population.

V. RESEARCH RESULT AND DISCUSSION

The answers to the survey were treated using Python under the Google Colab environment with assistance from data manipulation and statistical analysis libraries Pandas, NumPy, and SciPy. The data were summarized using frequency and percentages for an overview. The analysis proved the presence of strong relationships among neurobehavioral variables and opinions regarding eating disorders through the implementation of Chi-square tests.

A. Demographic Data

The demographic figures Table 1 revealed a heterogenic group of participants. As far as the age distribution of the participants, 50.55% of them were 18-24 years, 46.00% 25-34 years, and 3.45% 35 years and older. The gender distribution was 53.82% male and 46.18% female. The respondents were from different divisions of Bangladesh, and the highest proportion was from Dhaka (14.91%), followed by Sylhet (14.00%), Rangpur (13.45%), Barishal (12.00%), Rajshahi (12.18%), Khulna (11.27%), Chattogram (11.45%), and Mymensingh (10.73%). Educationally, 19.64% were in their 3rd year of a Bachelor's degree, 17.64% were in their 1st year of a Master's degree, and 17.09% were in their 1st year of a Bachelor's degree. With regard to work, 44.00% of the participants were student, 19.45% full-time employed, 17.82% part-time employed, and 18.73% self-employed. With regard to marital status, 37.82% were single, 31.45% married, and 32.73% in relationship. Such demographic findings enable a clearer understanding of the profile of participants and place the research findings into context.

Table 1 Demographic Data

Demographic Characteristics	Items	Frequency	Percentage
Age_Range	18-24	278	50.55
	25-34	253	46.00
	35 or above	19	3.45
Gender	Male	296	53.82
	Female	254	46.18
Division_ofOrigin	Dhaka	82	14.91
	Chattogram	63	11.45
	Rajshahi	67	12.18
	Khulna	62	11.27
	Barishal	66	12.00
	Sylhet	77	14.00
	Rangpur	74	13.45
	Mymensingh	59	10.73
Current_EducationLevel	Bachelor's degree 1st year	94	17.09
	Bachelor's degree 2nd year	96	17.45
	Bachelor's degree 3rd year	108	19.64
	Bachelor's degree 4th year	74	13.45
	Master's degree 1st year	97	17.64
	Master's degree 2nd year	81	14.73
Employment_Status	Student	242	44.00
	Employed full-time	107	19.45
	Employed part-time	98	17.82
	Self-employed	103	18.73
Marital_Status	Single	208	37.82
	Married	173	31.45
	In a relationship	169	32.73

B. Hypothesis Testing

The hypothesis testing was carried out by using Chi-square tests in determining the relationship between independent variables and eating disorder perception. The null hypothesis (H_0) was that there was no significant relationship between the independent variables and eating disorder perception, while the alternative hypothesis (H_1) was that there was a significant relationship.

➢ *Demographic Indicators*

Chi-square analysis of the six demographic variables yielded Table 2 that most of them were not significantly associated with the perception of eating disorders, since their p-values were mostly greater than 0.05. In particular, the variables Age_Range (Chi^2 = 0.77, p = 0.38, df = 1), Gender (Chi^2 = 0.04, p = 0.84, df = 1), Division_ofOrigin (Chi^2 = 4.15, p = 0.76, df = 7), Current_EducationLevel (Chi^2 = 4.16, p = 0.53, df = 5), and Employment_Status (Chi^2 = 1.87, p = 0.60, df = 3) did not show significant associations with eating disorder perceptions. However, only one variable, Marital_Status, reached statistical significance: Chi^2 = 6.03, p = 0.049, df = 2, and thus perhaps contributes to perceptions about eating disorders. Despite this individual significance, the overall Demographic Domain Score, aggregating all six indicators, did not reach a significant association: Chi^2 = 23.09, p = 0.19, df = 18. Such results have set a direction suggesting demographic variables, excluding marital status, to potentially be a factor affecting their perceptions of the issue of eating disorders within the population in context.

Table 2 Demographic Indicator

	Chi-Square	DoF	P-value
Age_Range	0.77	1	0.38
Gender	0.04	1	0.84
Division_ofOrigin	4.15	7	0.76
Current_EducationLevel	4.16	5	0.53
Employment_Status	1.87	3	0.60
Marital_Status	6.03	2	0.049
Demographic_Score	23.09	18	0.19

➢ *Cognitive Control Indicators*

Eating disorder perception had a statistically significant relationship with all ten cognitive control indicators shown in Table 3. EatLess_OnWeightGain Chi^2 = 15.287, p = 0.0016, df = 3; EatLess_AtMealtime Chi^2 = 9.792, p = 0.0204, df = 3; RefuseFood_WeightConcern Chi^2 = 8.833, p = 0.0316, df = 3; Monitor_Food Chi^2 = 15.081, p = 0.0017, df =

3; Eat Slimming Foods Chi² = 9.517, p = 0.0232, df = 3; and Eat Less_After Overeating Chi² = 11.726, p = 0.0084, df = 3 all had significant associations. In this respect, EatLess_ToPreventWeightGain (Chi² = 19.174, p = 0.0003, df = 3), AvoidSnacks_BetweenMealsForWeightConcern (Chi² = 12.435, p = 0.0060, df = 3), AvoidEveningEating_ForWeightConcern (Chi² = 8.746, p = 0.0329, df = 3), and ConsiderWeight_WhenEating (Chi² = 18.179, p = 0.0004, df = 3) pointed out a strong relation of the eating attitude of restriction with a perception about the eating disorder. The combined Cognitive Control Score (Chi² = 102.16, p = 5.16e-13, df = 20) even further underlined the role of cognitive control as a domain in perceiving eating disorder.

Table 3 Cognitive Control Indicators

	Chi-Square	**DoF**	**P-value**
EatLess_OnWeightGain	15.287	3	0.0016
EatLess_AtMealtime	9.792	3	0.0204
RefuseFood_WeightConcern	8.833	3	0.0316
Monitor_Food	15.081	3	0.0017
Eat_SlimmingFoods	9.517	3	0.0232
EatLess_AfterOvereating	11.726	3	0.0084
EatLess_ToPreventWeightGain	19.174	3	0.0003
AvoidSnacks_BetweenMealsForWeightConcern	12.435	3	0.0060
AvoidEveningEating_ForWeightConcern	8.746	3	0.0329
ConsiderWeight_WhenEating	18.179	3	0.0004
CognitiveControl_Score	102.16	20	5.16e-13

➢ *Affective Value Representation Indicators*

The results presented also indicated significant relations in all thirteen indicators of the affective value representation domain demonstrated in Table 4. Among the key variables, Eat_When Irritated (Chi² = 8.536, p = 0.0361, df = 3), Eat_When Unoccupied (Chi² = 10.116, p = 0.0176, df = 3), Eat_When Depressed Or Discouraged (Chi² = 8.589, p = 0.0353, df = 3) and Eat_When Lonely (Chi² = 17.657, p = 0.0005, df = 3) have thus shown significant relations. On the contrary, Eat_WhenSomeoneLetYouDown (Chi² = 12.223, p = 0.0067, df = 3), Eat_WhenAngry (Chi² = 18.460, p = 0.0004, df = 3), Eat_WhenExpectingBad (Chi² = 10.035, p = 0.0183, df = 3), and Eat_WhenAnxious (Chi² = 15.503, p = 0.0014, df = 3), it would be observed that all are significantly associated with the perception of eating disorder. Apart from the above, other factors that are greatly influenced by the affective state include Eat_When Things Go Wrong (Chi² = 9.549, p = 0.0228, df = 3), Eat_When Frightened (Chi² = 12.261, p = 0.0065, df = 3), Eat_When Disappointed (Chi² = 10.472, p = 0.0150, df = 3), Eat_When Emotionally Upset (Chi² = 10.305, p = 0.0161, df = 3), and Eat_When Bored Or Restless (Chi² = 9.357, p = 0.0249, df = 3). The combined Affective Value Representation Score (Chi² = 85.884, p = 6.84e-09, df = 24) reflected the strong position of affective triggers in setting perceptions of eating disorders.

Table 4 Affective Value Representation Indicators

	Chi-Square	**DoF**	**P-value**
Eat_WhenIrritated	8.536	3	0.0361
Eat_WhenUnoccupied	10.116	3	0.0176
Eat_WhenDepressedOrDiscouraged	8.589	3	0.0353
Eat_WhenLonely	17.657	3	0.0005
Eat_WhenSomeoneLetYouDown	12.223	3	0.0067
Eat_WhenAngry	18.460	3	0.0004
Eat_WhenExpectingBad	10.035	3	0.0183
Eat_WhenAnxious	15.503	3	0.0014
Eat_WhenThingsGoWrong	9.549	3	0.0228
Eat_WhenFrightened	12.261	3	0.0065
Eat_WhenDisappointed	10.472	3	0.0150
Eat_WhenEmotionallyUpset	10.305	3	0.0161
Eat_WhenBoredOrRestless	9.357	3	0.0249
AffectiveValueRepresentation _Score	85.884	24	6.84e-09

➢ *Salience or Taste Processing Indicators*

The associations between salience/taste processing indicators and eating disorder perceptions were significant in all ten indicators shown in Table 5. Variables included EatMore_IfFoodTasty, which had a Chi² = 9.100, p = 0.0280, df = 3; EatMore_IfFoodSmellsOrLooksGood, with Chi² = 19.275, p = 0.0002, df = 3; Eat_WhenSeeDeliciousFood, with a value of Chi² = 10.900, p = 0.0123, df = 3; and Eat_DeliciousFoodImmediately, with a Chi² = 9.380, p = 0.0246, df = 3. Similarly, there exist significant

relations within DesireToBuy_FromBakery (Chi^2 = 9.886, p = 0.0196, df = 3), DesireToBuy_FromSnackBarOrCafe (Chi^2 = 9.139, p = 0.0275, df = 3), DesireToEat_WhenSeeOthersEating (Chi^2 = 8.858, p = 0.0312, df = 3), and Resist_DeliciousFood (Chi^2 = 8.980, p = 0.0296, df = 3) with the eating disorder perception. Furthermore, the sensory cue role was underlined by EatMore_WhenSeeOthersEating (Chi^2 = 13.530, p = 0.0036, df = 3) and Eat_WhenPreparingMeal (Chi^2 = 19.512, p = 0.0002, df = 3). Confirmation of the importance of this domain in setting eating disorder perceptions came from the aggregated Salience/Taste Processing Score: Chi^2 = 61.818, p = 1.99e-06, df = 19.

Table 5 Salience or Taste Processing Indicators

	Chi-Square	**DoF**	**P-value**
EatMore_IfFoodTasty	9.100	3	0.0280
EatMore_IfFoodSmellsOrLooksGood	19.275	3	0.0002
Eat_WhenSeeDeliciousFood	10.900	3	0.0123
Eat_DeliciousFoodImmediately	9.380	3	0.0246
DesireToBuy_FromBakery	9.886	3	0.0196
DesireToBuy _FromSnackBarOrCafe	9.139	3	0.0275
DesireToEat_WhenSeeOthersEating	8.858	3	0.0312
Resist_DeliciousFood	8.980	3	0.0296
EatMore_WhenSeeOthersEating	13.530	3	0.0036
Eat_WhenPreparingMeal	19.512	3	0.0002
SalienceOrTasteProcessing _Score	61.818	19	1.99e-06

➢ *Body Image Perception Indicators*

The test showed Table 6 significant associations in all eight indicators of body image perception. Among them, Days_DesireForFlatStomach (Chi^2 = 18.265, p = 0.0004, df = 3), Days_FeltFat (Chi^2 = 50.322, p = 6.82e-11, df = 3), Days_WeightAffectedSelfJudgment (Chi^2 = 41.083, p = 6.28e-09, df = 3), and Days_ShapeAffectedSelfJudgment (Chi^2 = 24.006, p = 0.00002, df = 3) had highly significant associations. Analogous significant findings were returned for Days_DissatisfiedWithWeight (Chi^2 = 22.923, p = 0.00004, df = 3), Days_DissatisfiedWithShape (Chi^2 = 38.667, p = 2.04e-08, df = 3), Days_UncomfortableToSeeOwnBody (Chi^2 = 21.721, p = 0.00007, df = 3), and Days_UncomfortableOthersSeeingYourShape (Chi^2 = 47.459, p = 2.78e-10, df = 3). These underlined the important role of discontent with body shape and weight in shaping conceptions relative to eating disorders. The overall Body Image Perception Score showed strong evidence of the domain in question given the data, Chi^2 = 143.33, p = 1.46e-21, df = 18.

Table 6 Body Image Perception Indicators

	Chi-Square	**DoF**	**P-value**
Days_DesireForFlatStomach	18.265	3	0.0004
Days_FeltFat	50.322	3	6.82e-11
Days_WeightAffectedSelfJudgment	41.083	3	6.28e-09
Days_ShapeAffectedSelfJudgment	24.006	3	0.00002
Days_DissatisfiedWithWeight	22.923	3	0.00004
Days_DissatisfiedWithShape	38.667	3	2.04e-08
Days_UncomfortableToSeeOwnBody	21.721	3	0.00007
Days_UncomfortableOthersSeeingYourShape	47.459	3	2.78e-10
BodyImagePerception _Score	143.33	18	1.46e-21

➢ *Reward Processing or Habit Formation Indicators*

In this domain, all nine indicators have shown Table 7 significant associations. For example, Days Tried Limit Food to Control Shape or Weight (Chi^2 = 13.743, p = 0.0033, df = 3), Days Fasted to Control Shape or Weight (Chi^2 = 19.544, p = 0.0002, df = 3), Days Excluded Food to Control Shape or Weight (Chi^2 = 14.909, p = 0.0019, df = 3), and Days Followed Rules to Control Shape or Weight (Chi^2 = 9.911, p = 0.0193, df = 3) exhibited strong associations. Moreover, Days Fear Losing Control Over Eating (Chi^2 = 12.725, p = 0.0053, df = 3), Eat Specific Foods Habitually (Chi^2 = 20.085, p = 0.0002, df = 3), and Location Triggers Habitual Eating (Chi^2 = 9.688, p = 0.0214, df = 3) had significant associations with eating disorder perception. Likewise, Automatic Eating When Experiencing Strong Emotion (Chi^2 = 8.854, p = 0.0313, df = 3) and Realize After Eating Out of Habit (Chi^2 = 11.134, p = 0.0110, df = 3) were more significantly associated with eating disorder perceptions. Combined reward processing/habit formation score, at group level: Chi^2 = 47.199, p = 0.0002, df = 18-the very important role rewarded and habitual behaviors are playing in building perceptions on the disorders of eating was very well brought out.

Table 7 Reward Processing or Habit Formation Indicators

	Chi-Square	DoF	P-value
Days Tried Limit Food to Control Shape or Weight	13.743	3	0.0033
Days Fasted to Control Shape or Weight	19.544	3	0.0002
Days Excluded Food to Control Shape or Weight	14.909	3	0.0019
Days Followed Rules to Control Shape or Weight	9.911	3	0.0193
Days Fear Losing Control Over Eating	12.725	3	0.0053
Eat Specific Foods Habitually	20.085	3	0.0002
Location Triggers Habitual Eating	9.688	3	0.0214
Automatic Eating When Experiencing Strong Emotion	8.854	3	0.0313
Realize After Eating Out of Habitually	11.134	3	0.0110
Reward Processing or Habit Formation Score	47.199	18	0.0002

➢ *Mapping Accepted Hypothesis to Brain Regions*

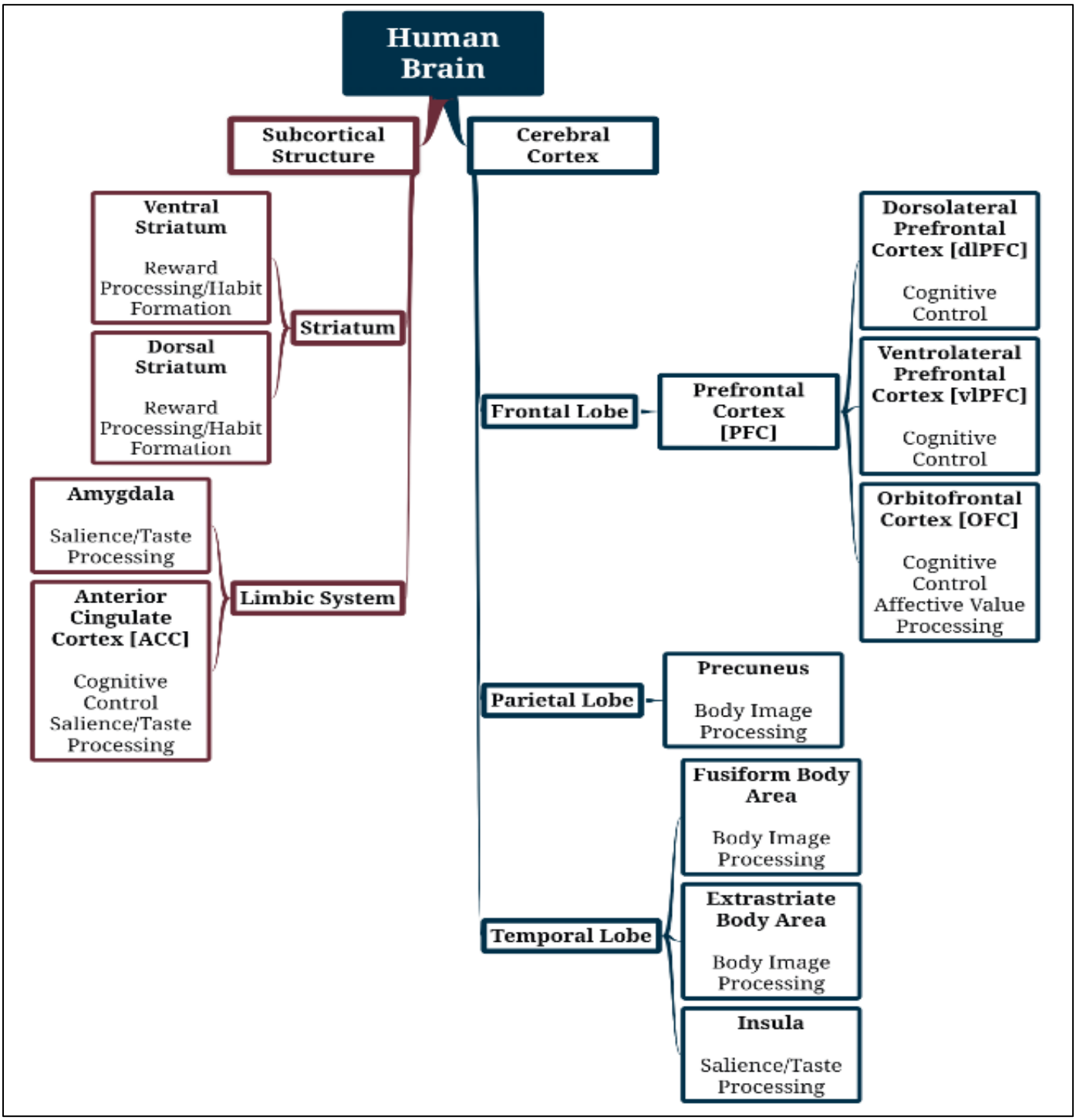

Fig 8 Mapped Accepted Hypothesis to Brain Regions

This study underscores the strong connection between eating disorders and distinct brain functions. Specifically, we found Figure 8 that cognitive control, affective value representation, salience/taste processing, body image processing, and reward processing/habit formation are crucial to the manifestation of eating disorders. These functions are regulated by specific brain regions, highlighting the neurobiological basis of these disorders. Previous research has demonstrated that genetic and neurobiological factors are integral to eating disorders, with certain brain circuits involved in reward response and cognitive control (Bulik et al., 2022). Furthermore, neuroinflammation, the gut microbiome, and immune system disruptions have been implicated in the pathophysiology of these disorders, affecting brain function (Butler et al., 2021). Studies also indicate that the brain's reward system, particularly the ventral striatum and hypothalamic circuitry, plays a significant role in eating disorders, especially in regulating body mass index (Frank et al., 2021). Additionally, glutamatergic dysfunction has been identified as a potential neurobiological factor that sets the stage for these disorders, particularly in individuals with post-traumatic stress disorder (Murray & Holton, 2021). These findings provide a deeper understanding of the biological mechanisms underlying eating disorders.

Cognitive control is primarily regulated by the prefrontal cortex, encompassing regions such as the Dorsolateral Prefrontal Cortex (dlPFC), Ventrolateral Prefrontal Cortex (vlPFC), Orbitofrontal Cortex (OFC), and Anterior Cingulate Cortex (Wonderlich et al., 2021). These areas are essential for managing thoughts, actions, and decision-making processes. However, individuals with eating disorders often experience disruptions in the functioning of these regions, making it challenging to resist unhealthy food choices or focus on healthier options (Iceta et al., 2021). This neural impairment in cognitive control may contribute to the maladaptive eating behaviors commonly observed in these disorders.

Affective value representation is primarily controlled by the orbitofrontal cortex (OFC), which assigns emotional significance to stimuli, such as food. This brain region plays a key role in evaluating whether eating a particular food brings comfort or satisfaction (Henning et al., 2022). In individuals with eating disorders, this process can become disrupted, leading to heightened emotional reactions to food, such as excessive guilt after eating or an exaggerated perception of the importance of certain foods (Wong et al., 2021). Such disruptions contribute to the emotional disturbances often seen in eating disorder behaviors.

Salience and taste processing involve brain regions such as the Insula, Amygdala, and Anterior Cingulate Cortex (ACC), which help individuals recognize the taste, smell, and emotional significance of food (Cobbaert et al., 2024). The Insula processes taste sensations, while the Amygdala contributes to the emotional response to food, determining whether it is perceived as enjoyable or unpleasant (Nimbley et al., 2022). Disruptions in these regions can lead to heightened sensitivity or a disconnection from the sensory experience of eating, potentially contributing to the development of abnormal eating behaviors commonly seen in individuals with eating disorders.

Body image processing involves brain regions such as the Precuneus, Fusiform Body Area, and Extrastriate Body Area, which play a crucial role in forming perceptions of body size, shape, and appearance (Press et al., 2022). These regions help individuals form an accurate mental image of their bodies. However, in individuals with eating disorders, these areas often show dysfunction, leading to distorted body perceptions or negative self-image (Krohmer et al., 2022). This dysfunction can contribute to harmful behaviors such as food restriction or excessive exercise, which are common in those struggling with eating disorders.

The Ventral Striatum plays a critical role in reward processing, while the Dorsal Striatum is involved in habit formation, both contributing to the brain’s reward system (Bodell & Racine, 2023). These regions enable individuals to experience pleasure from rewarding activities and form habits based on those experiences. For instance, consuming one's favorite food typically activates the Ventral Striatum, leading to feelings of enjoyment (Forester et al., 2022). However, in individuals with eating disorders, these systems may become dysregulated, resulting in the development of maladaptive habits, such as compulsive overeating or food avoidance, which can become deeply ingrained in the brain.

Taken together, these findings demonstrate that eating disorders are not solely a psychological disorder but have strong neurobiological underpinnings. Each of the five functions mentioned above is involved in eating behaviour through its own specific manner, while disturbances in them are responsible for the problems in individuals with eating disorders. Relating the respective functions to particular brain areas, the present study contributed to a better understanding of the biological background of eating disorders. This knowledge can be used to direct future research, aiming at the development of targeted treatments that focus on these brain areas for more effective ways of supporting individuals struggling with eating disorders.

VI. CONCLUSION

This study explored the neurobehavioral mechanisms underlying eating disorders by examining individual behaviors and aggregating them into broader neurobehavioral domains. Statistical analyses identified significant associations between eating disorder perceptions and five key domains: cognitive control, affective value representation, salience/taste processing, body image perception, and reward

processing/habit formation, which were mapped to their presumed brain regions to provide a neurobiological framework for understanding these disorders. By highlighting the interconnected nature of behavior, brain function, and eating disorders, this research underscores the importance of integrating behavioral and neurobiological perspectives to deepen understanding and advance the field. The findings contribute to the growing body of literature on the biological underpinnings of eating disorders and may inform the development of more targeted prevention strategies and therapeutic interventions, paving the way for more effective treatments.

FUTURE WORK

Building on the insights from this study, several avenues for future research are proposed. First, expanding the study to include participants from diverse demographic groups and cultural backgrounds would enhance the generalizability of the findings. Second, incorporating neuroimaging techniques, such as functional magnetic resonance imaging (fMRI) or electroencephalography (EEG), could provide direct evidence of brain activity associated with eating disorder-related behaviors. Third, using the identified neurobehavioral domains and their corresponding brain regions, future research could focus on designing and testing targeted interventions or therapies for individuals with eating disorders. Finally, exploring broader behavioral and environmental factors, such as familial, societal, or genetic influences, could offer a more holistic understanding of eating disorders. These future directions would not only deepen the understanding of eating disorders but also pave the way for more effective prevention and treatment strategies.

- *Ethics Statement*

This study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants. All participants were informed about the study's purpose, and procedures. It was also made clear that the survey was conducted anonymously to ensure respondent confidentiality.

- *Data Availability*

Dataset of Neurobehavioral Influences on Eating Disorder Perceptions Among Bangladeshi University Students (Original Data) (Mendeley Data).

- *Credit Author Statement*

Rakib Hasan: Formal Analysis, Investigation, Conceptualization, Methodology Writing – original draft; Md. Mamun Hosen: Data curation, Visualization, Writing – review & editing, Visualization; Sanimul Hossain Sanzit: Visualization, Validation, Software, Writing – review & editing; Mahmuda Akter Talukder: Investigation, Data curation, Visualization, Writing – review & editing; Halimatus Sadia Mim: Investigation, Data curation, Writing – review & editing.

ACKNOWLEDGEMENT

This research was not supported by any specific grant from public, commercial, or non-profit funding agencies.

- *Declaration of Competing Interests*

The authors declare that there is no known financial interest or personal relationships that could have influenced work presented in this paper.

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