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SHORT COMMUNICATION

The significance of cultural context in the classification of preferred mouth behavior: Exploring eating behavior using causal network analysis

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Abstract

Preferred mouth behavior studies have mostly focused on Western populations using the JBMB tool to determine how food is manipulated in the mouth. The objective of this study was to determine the relationship between preferred mouth behavior and eating behavior among the diverse group of 209 Malaysians participants. A series of Analysis of Variances and an unsupervised machine learning technique known as Latent Class Clustering were utilized to determine individual's oral behavior. The Adult Eating Behavior Questionnaire was later modeled using causal networks, specifically Partial Least Squares-Confirmatory Factor Analysis, to uncover relationship between appetitive qualities. The results from this study showed that cultural context and appropriateness play an essential role when classifying preferred mouth behavior using behavioral questionnaires and models. Furthermore, this study also determined the relationship between eating behavior and preferred mouth behavior, as well as unique differences in eating behavior observed among the mouth behavior groups.

KEYWORDS
eating behavior, food approach, food avoidance, oral behavior, food oral processing, model

1 | INTRODUCTION

According to Jeltema et al. (2014), oral action plays a significant role in determining texture preferences. The movement of food between their tongue and the roof of their mouths referred to as "mouth behavior," has an impact on how individuals perceive the textures of the food they eat. Textures that correspond to a desired mouth action and behavior are often more appreciated, influencing food choices.

The Graphic Mouth Behavior Instrument was developed by Jeltema et al. (2015) to classify participants as Crunchers, Chewers, Smooshers, or Suckers. Chewers prefer chewy foods and tend to chew them longer prior to swallowing. Crunchers prefer food that fracture on biting. Smooshers prefer soft foods, whereas Suckers like harder foods such as hard candies that can be sucked on for a long time. These variations in mouth behavior may affect food structure, leading to altered oral sensory experiences and mouthfeel sensations.

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In a previous study by de Wijk et al. (2003), it was discovered that participants who chewed a product in their preferred manner experienced optimal sensory experience. Engelen and de Wijk (2012) identified four distinct mouth behaviors: "simple," "flavoured," "manipulative," and "tongue," with distinct differences in the use of the tongue, palate, and teeth. These findings demonstrate a correlation among chewing activity, mouth behavior, and food preference. Further research by de Wijk et al. (2006), and de Wijk et al. (2008) demonstrated that oral trait interpretation changes during mastication were associated with complex oral movements. They suggested that individuals' oral movements may also influence emotional responses.

It is important to consider cultural context when examining perception of consumers from different backgrounds. The Graphic Mouth Behavior was originally developed for Western consumers, with familiar foods assigned for each of the categories (i.e., Chewers, Crunchers, Smooshers, and Suckers). This tool has been successful in classifying the preferred mouth behavior of Western European consumers. A study done by Cattaneo et al. (2020) utilized the same tool without any modifications for Danish and Chinese consumers. In their study, the same food was presented for both Danish and Chinese consumers living in Denmark for less than 2 years. This approach may have been challenging for the Chinese consumers who are not familiar with some of the food presented in the questionnaire. However, a study conducted by Cattaneo et al. (2020) utilized the same tool without modification to examine Danish and Chinese consumers. Interestingly, the same food was presented to both Danish and Chinese consumers living in Denmark for less than 2 years. However, this approach may have been challenging for Chinese consumers who are not accustomed to some of the foods presented in the questionnaire. This highlights the need to adapt research methods to appropriately reflect cultural context, as unfamiliar foods presented to participants from different cultural backgrounds could yield inaccurate results.

The Adult Eating Behavior Questionnaire (AEBQ) is an expanded version of a widely used and validated measure of individual variations in food approach and avoidance in adults. It was developed on the basis of the literature on eating behavior, with its significance further confirmed by qualitative research (Hunot et al., 2016). The AEBQ demonstrates strong internal consistency and robustness, with high test–retest reliability and consists of eight dimensions, with four categorized as "food approach" characteristics: hunger, food responsiveness, emotional overeating, and food enjoyment. The four remaining dimensions fall under "food avoidance" characteristics: satiety responsiveness, emotional under-eating, food fussiness, and slow eating.

This study is particularly significant as it will be the first to highlight the importance of cultural context in the classification of preferred mouth behavior groups, specifically for non-Western populations. By accounting for cultural differences, the study aims to gain a better understanding of the different patterns of eating behavior among the four mouth behavior groups. Additionally, the study will utilize causal network statistics to further explore the relationships among various factors influencing eating behavior. Results of this study have the potential to enhance our understanding of eating behaviors across different populations and provide valuable insights into the complex interactions between cultural factors and food preferences.

2 | MATERIALS AND METHODS

2.1 | Participant selection

Malaysian participants ($N = 209$) aged 18–65 were recruited through social media platforms and official email communication. Participants completed an online self-administered questionnaire remotely via the Google Forms platform (Google LLC, California, United States). All volunteers received the information package and provided informed consent. Participants were screened using self-reported screening tool for their oral health.

2.2 | Questionnaire

The online questionnaire consisted of 35 questions that were administered in both Malay (language of Malaysia) and English to promote inclusion and encourage participation. The translation from English to Malay followed the WHO back translation process (WHODAS 2.0 Translation Package). The questionnaire comprised three sections: a section for demographic information (e.g., age and gender) and two sections that focused on determining participants' preferred mouth and eating behaviors.

2.2.1 | Determination of mouth behavior

The Graphic Mouth Behavior Tool approach by Jeltema et al. (2015) was adapted to include the appropriate food and cultural context of Malaysian consumers. A newly developed pictorial matrix (Figure 1) was used in the questionnaire used in our present research to determine participants' mouth behavior. The food images classified for each mouth behavior group (Figure 1) were carefully chosen by the co-authors who are academics of Malaysian nationality with expertise in food oral processing and sensory science from University Putra Malaysia. The selected food items for each mouth behavior group are illustrated in Figure 1. The selection process considered the popular ethnic cuisines in Malaysia, reflecting the country's three major unique food cultures: Malay, Chinese, and Indian. For example (see Table S1 for more detailed explanation), the food items in Figure 1 include *Muruku*, *which* is an Indian traditional crunchy and crispy snack enjoyed by Malaysians. Another example is *Tau Fu Fa*, a Chinese dessert made of very soft tofu and served with a clear sweet syrup. Participants who enjoy consuming *Tau Fu Fa* might be categorized as "Smooshers" due to their preference for softness. On the other hand, participants belonging to the "Chewers" group may enjoy *Kek Batik*, a Malay delicacy with a texture similar to brownies. Incorporation of these diverse food items aims to capture the varied preferences and mouth behaviors among Malaysian participants from different cultural backgrounds.

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FIGURE 1 Pictorial matrix used to determine Malaysians preferred mouth behavior group.

This approach ensures that the food images align with the culinary preferences of Malaysia's multicultural society, enhancing the relevance of the study's findings. Participants in this study were first asked to select the matrix that resonated with them best.

Second, participants also indicated their overall food preference based on foods classified from the developed pictorial matrix per mouth behavior groups using a 9-point scale (Cattaneo et al., 2020). Based on their selection, participant scores were used to categorize their respective mouth behavior groups.

Finally, a set of 12 behavioral questions (adapted from Cattaneo et al., 2020; Jeltema et al., 2015) with appropriate food and cultural context for Malaysians were administered using yes/no statements. Each statement was linked to a specific preferred mouth behavior. For example, participants were asked questions like "Do you like to suck on Malaysian ice cream (*Ais krim Malaysia)* for a long time?" Three statements (Table S2) were provided for each preferred mouth behavior. To minimize bias, the presentation of the statements was randomized and counterbalanced for each participant. During this step, individuals received a score based on their behavior for each preferred mouth behavior statement. This three-step approach allows for a comprehensive understanding of participants' preferred mouth behaviors in relation to the selected food items within the Malaysian cultural context.

2.2.2 | Approach and avoidance in eating behavior

The AEBQ, as described by Hunot et al. (2016) and Subramaniam et al. (2017) (for a translated Malay version), was used in this study to investigate the eating behavior of the Malaysian population. The questionnaire comprised eight dimensions, with four dimensions categorizing approach behavior (i.e., hunger, food responsiveness, emotional overeating, and food enjoyment) and four dimensions categorizing avoidance behavior (i.e., satiety responsiveness, food fussiness, emotional under-eating, and slowness in eating). Each dimension contained approximately three to five questionnaire items. Participants rated the items using a 5-point agreement scale anchored from strongly disagree to strongly agree. The four dimensions were further averaged to generalize the overall approach–avoidance behavior of participants toward food. Assessment of subscale reliability was performed in this study by determining Cronbach's α, and it was found to be consistent (Cronbach's $\alpha = .831$). This indicates that the questionnaire items within each dimension yielded reliable and consistent results, enhancing the validity of the assessment of participants' approach and avoidance behaviors toward food.

2.3 | Statistical analysis

All univariate, multivariate, and network analyses were carried out using XLSTAT (version 2020.1.2, Lumivero LLC, Colorado, United States). Only significant relationships in the network analysis were reported. Unless stated otherwise, the significance level was set at 5% for all analyses.

2.3.1 | Preferred mouth behavior classification

A supervised machine learning clustering technique, namely, Latent Class Clustering (LCC) was employed to assist in classification of participants based on their pictorial matrix selection and behavioral questions. LCC was utilized for its ability to handle multiple data types, specifically categorical data from the pictorial matrix, and continuous data from the behavioral questions in this study. In addition, LCC provides probability-based classification, which captures the complex nature of preferred mouth behavior. In this study, LCC was configured to generate precisely four clusters, representing the four preferred mouth behaviors. The convergence criteria for LCC were set at a tol-

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erance of 0.01 for the expectation–maximization algorithm following a similar approach as Cattaneo et al. (2020).

2.3.2 | The comparison between mouth behavior groups on their influence on eating behavior

Analysis of Variance (ANOVA) was employed to compare the participants' attitudes toward eating behavior among the four preferred mouth behavior groups. If the ANOVA model reached statistical significance, then a Tukey's honestly significant difference (Tukey's HSD) post hoc test was performed to compare means between the preferred mouth behavior groups.

To note that in this study, all univariate analysis was determined to be sufficiently powered (ca. 70%–80%) based on post-priori power analysis.

2.3.3 | Network analysis of each preferred mouth behavior group

Partial Least Squares-Confirmatory Factor Analysis (PLS-CFA) was used to evaluate the relationship and visualize the network model. PLS-CFA is useful in managing multidimensional formative constructs in the approach–avoidance eating behavior survey used in this study. Furthermore, it is robust when handling situations with smaller sample sizes due to this nature.

In this study, an individual network was built for each preferred mouth behavior group in terms of their generalized approach and avoidance behavior, and the interaction among different dimensions. Additionally, model stability parameters, such as Cronbach's alpha and Dillon-Goldstein rho coefficient, were calculated to ensure the robustness and reliability of the network models.

3 | RESULTS

3.1 | Demographics

The demographics information of 209 Malaysian participants are summarized in Table 1.

3.2 | Classification of Malaysian preferred mouth behavior groups

The distribution of each mouth behavior group from this survey ($N = 209$) is shown in Figure 2. The majority of participants belong to the Chewers ($n = 72$), Crunchers ($n = 69$), and Smooshers ($n = 63$) groups, with only five participants in the Suckers group (Figure 2). Despite the small sample size of the Suckers group ($n = 5$), the authors conducted a series of analyses to further explore the relationship between Suckers and their eating behavior. Although the results should be interpreted with caution, they provide a starting point for future research in this area.

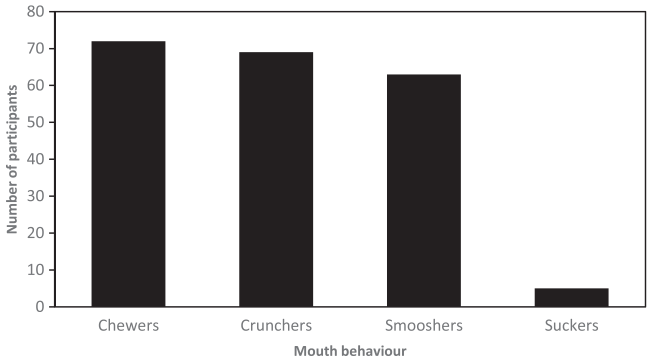

FIGURE 2 Preferred mouth behavior of 209 Malaysian participants in this study.

3.3 | Relationship between mouth behavior and eating behavior

Crunchers show the highest avoidance behavior ($\bar{x} = 3.19$), followed by Chewers ($\bar{x} = 3.06$) and Suckers ($\bar{x} = 2.91$). The avoidance behavior of Crunchers was significantly different from Smooshers ($\bar{x} = 2.90$) ($F_{(15,209)} = 2.941$; $p < .05$). Interestingly, no significant difference was observed for approach behavior within the mouth behavior group (Figure 3).

Although there was no significant difference at a generalized level of approach behavior, two dimensions from the approach behavior, namely, emotional overeating and hunger, reached significance at the 5% and 10% levels, respectively. Crunchers, Chewers, and Smooshers had significantly higher ratings of hunger than Suckers. Suckers had significantly higher ratings of emotional overeating compared to the other groups, followed by Crunchers and Chewers in the same category, with Smooshers having the significantly lowest rating.

In terms of avoidance behaviors, satiety responsiveness and fussiness reached significance at 5% level. Crunchers and Chewers had significantly higher ratings of satiety responsiveness compared to Smooshers and Suckers. Crunchers had a significantly higher rating in food fussiness, compared to Smooshers and Suckers.

3.4 | Approach–avoidance eating behavior model based on each preferred mouth behavior

PLS-CFA was performed to understand the role of specific mouth behavior groups on eating behavior (Figure 4). A bi-directional arrow between approach and avoidance behaviors indicates a correlational relationship between the two dimensions and weighing for each item was measured. Model quality of each PLS-CFA was assessed and deemed reliable and robust based on Cronbach's alpha (>.6) and Dillon-Goldstein rho coefficient (>.7) (Malavalli et al., 2021).

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TABLE 1 Demographics distribution of age, gender, ethnicity, and BMI classification of Malaysian participants in this study.

Variable	Categories	Counts	%
Age	18–25	129	61.72
	26–35	28	13.39
	36–45	18	8.61
	46–55	26	12.44
	56–65	8	3.82
Gender	Female	140	66.98
	Male	68	32.53
	Others	1	0.47
Ethnicity	Chinese	12	5.74
	Indians	6	2.87
	Malays	187	89.47
	Others	4	1.91
BMI classification	Normal	119	56.93
	Obese	25	11.96
	Overweight	35	16.74
	Underweight	30	14.35

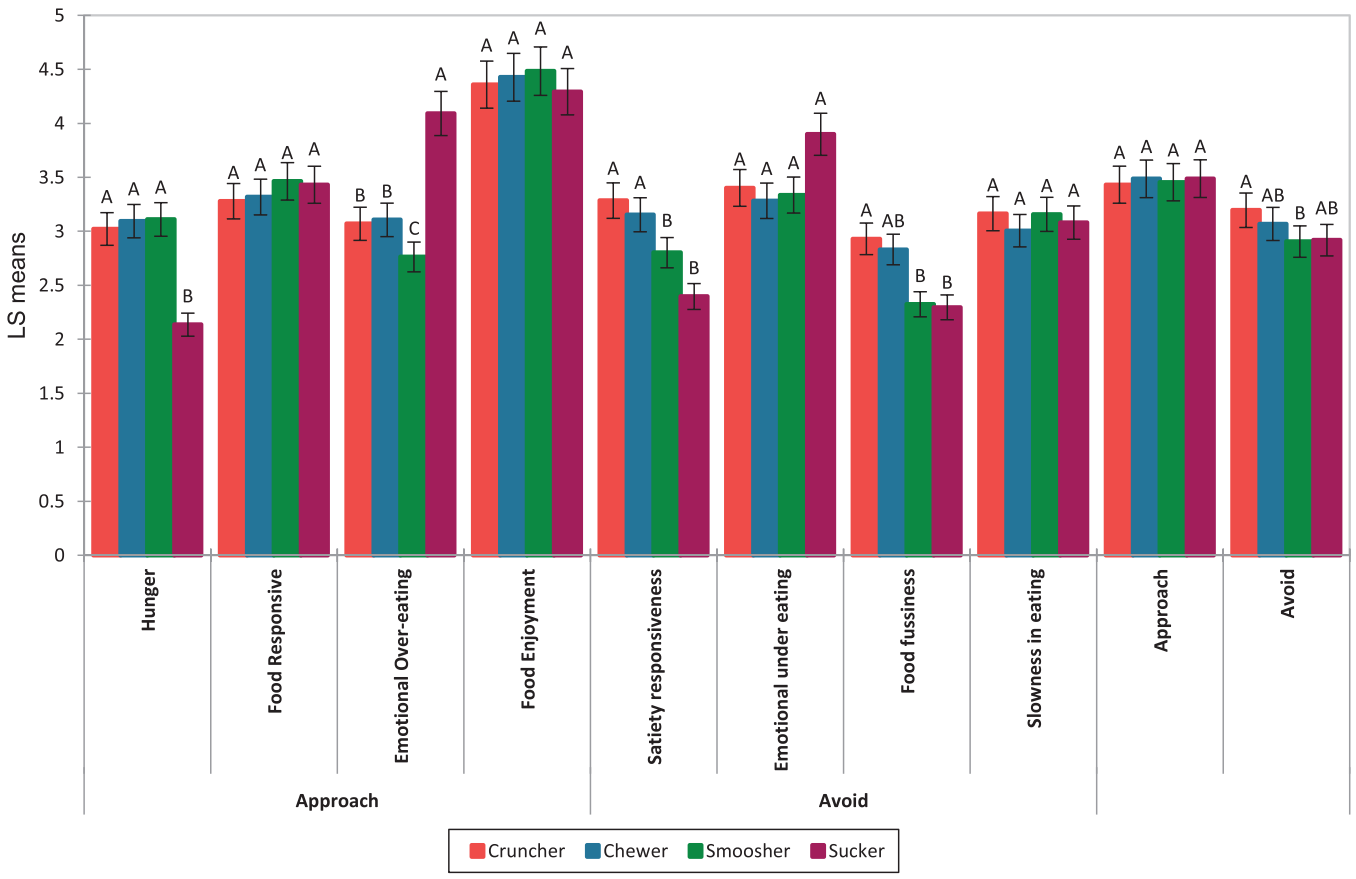

FIGURE 3 Relationships between mouth behavior and eating behavior, a,b, and c means with different letters shows significant difference between the mouth behavior group in terms of their eating approach and avoidance behavior using Tukey's HSD.

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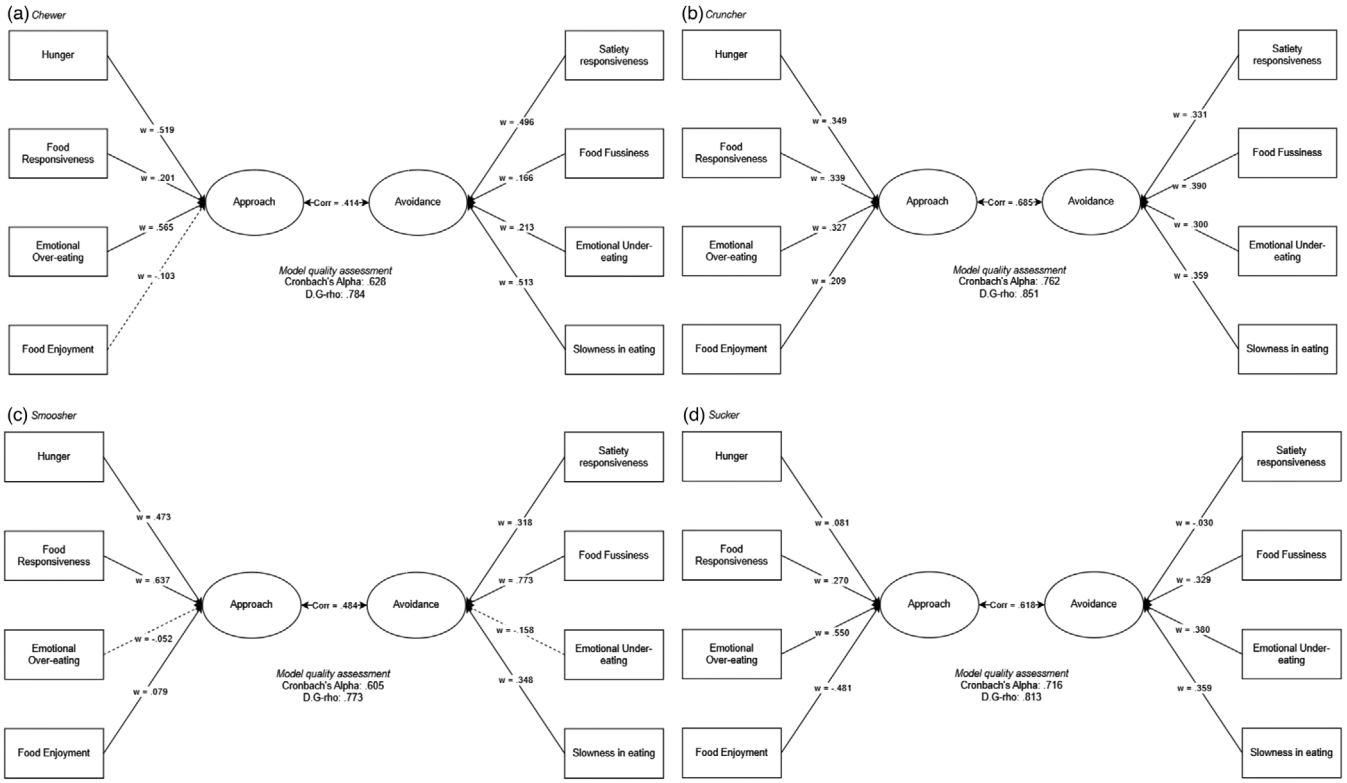

FIGURE 4 Partial Least Squares-Confirmatory Factor Analysis (PLS-CFA) of 4 mouth behavior groups: (a) Chewer, (b) Cruncher, (c) Smoosher, and (d) Sucker. Dimension weights of each group were measured for approach and avoidance behavior. A solid line indicates a positive weight, whereas a dotted line indicates a negative weight.

For Chewers, it was shown that emotional overeating ($w = .565$) and hunger ($w = .519$) were the most important factors for approach behavior, followed by food responsiveness ($w = .201$). Food enjoyment showed a negative relationship toward approach behavior ($w = -.103$). On the other hand, avoidance behavior in Chewers was mainly driven by slowness in eating ($w = .513$). Additionally, emotional under-eating ($w = .213$) and food fussiness ($w = .165$) also played a minor role in driving avoidance behavior.

For Crunchers, their approach behaviors showed a more balanced weighting across multiple factors. Food enjoyment ($w = .209$), hunger ($w = .349$), food responsiveness ($w = .339$), and emotional overeating ($w = .327$) were all significant in driving their approach behaviors. Similarly, avoidance behaviors for Crunchers also displayed evenly distributed dimensional weights. Food fussiness ($w = .390$) was the highest contributing factor. Slowness in eating ($w = .359$), satiety responsiveness ($w = .331$), and emotional under-eating ($w = .300$) also played significant roles in driving avoidance behaviors for Crunchers.

Approach behavior in Smooshers was found to be highly influenced by food responsiveness ($w = .637$), followed by hunger ($w = .473$), food enjoyment ($w = .079$), and emotional overeating ($w = -.052$). Avoidance behavior in Smooshers was characterized by fussy eaters with food fussiness ($w = .773$) having the highest dimensional weight. Slowness in eating ($w = .348$), satiety responsiveness ($w = .318$), and emotional under-eating ($w = .158$) were also found to play significant roles in driving avoidance behavior for Smooshers. Finally, emotional under-eating ($w = .158$) emerged as a minor contributor to avoidance behavior.

When it comes to approach eating behavior, suckers had the highest weighting for emotional overeating ($w = .550$), followed by food enjoyment ($w = .481$), food responsiveness ($w = .270$), and hunger ($w = .081$). Food responsiveness ($w = .270$) and hunger ($w = .081$) had relatively smaller contributions to the approach behavior of Suckers. In terms of avoidance eating behavior, emotional under-eating ($w = .380$) had the highest weighting, followed by slowness in eating ($w = .359$), food fussiness ($w = .329$), and satiety responsiveness ($w = .030$), which had the smallest contribution to avoidance behavior in Suckers.

3.5 | Detailed network of eating behavior based on preferred mouth behavior

In this study, PLS-CFA was conducted to examine the relationships between approach and avoidance behaviors within each mouth behavior category (Figure 5).

Among the food approach traits, hunger was positively correlated with food responsiveness and emotional overeating in all mouth behavior groups ($\rho > .6$), except for Chewers. Emotional overeating positively correlated with food enjoyment for Crunchers and Suckers, respectively ($\rho > .5$). Slowness in eating was positively correlated with satiety

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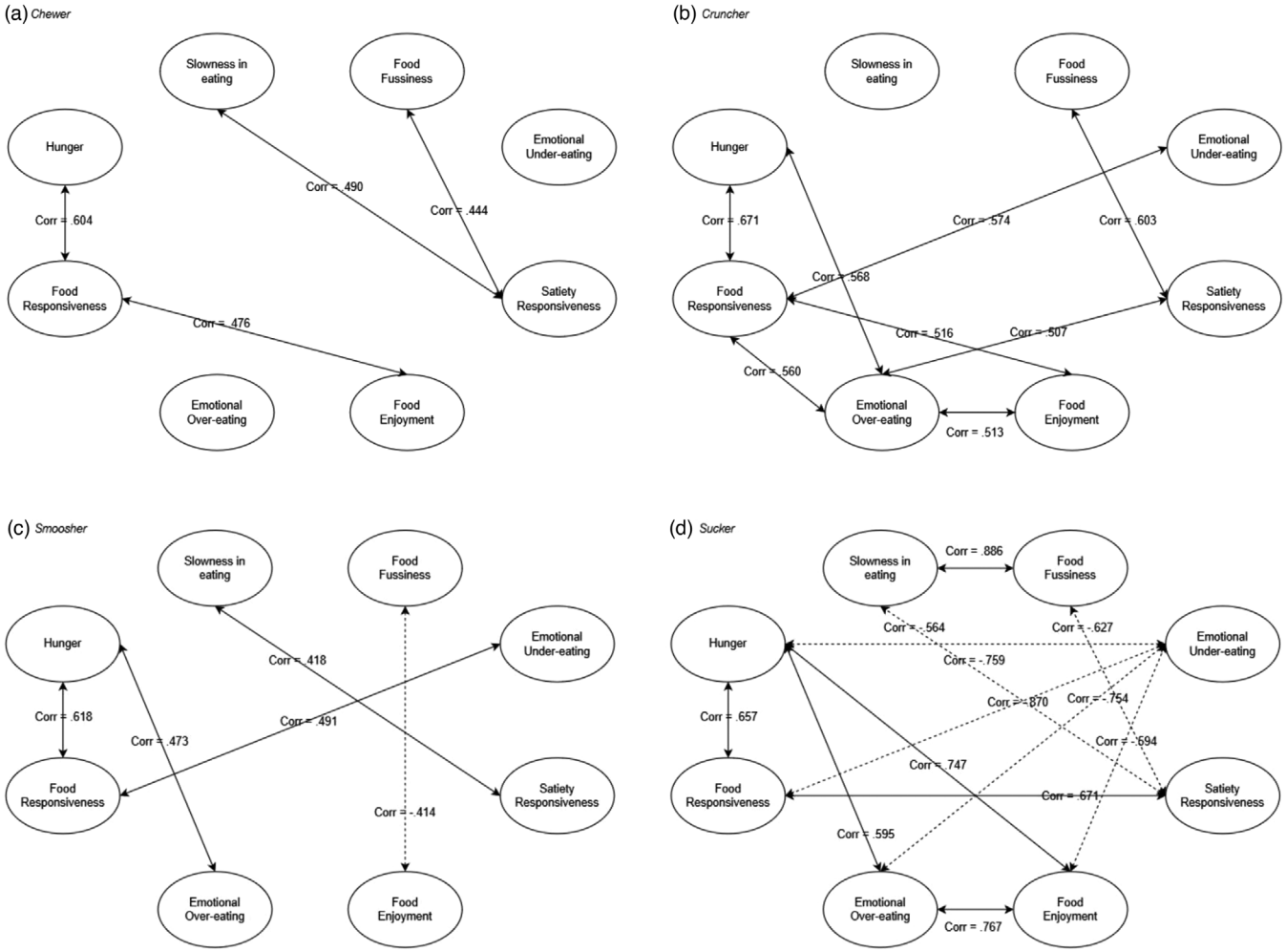

FIGURE 5 Food approach–avoidance eating behavior models obtained using Partial Least Squares-Confirmatory Factor Analysis (PLS-CFA), for different grouped mouth behavior categories: (a) Chewer, (b) Cruncher, (c) Smoosher, and (d) Sucker.

responsiveness, for Chewers and Smooshers ($\rho > .4$), but this correlation was not observed in Crunchers. Interestingly, slowness in eating showed a negative correlation with satiety responsiveness in Suckers ($\rho = -.564$).

Food fussiness was positively correlated with satiety responsiveness in Chewers and Crunchers ($\rho > .4$) but negatively correlated for Suckers ($\rho = -.627$). Interestingly, a negative correlation was found between food fussiness and enjoyment for Smooshers ($\rho = -.414$).

Food responsiveness was positively correlated with emotional under-eating for Crunchers and Smooshers ($\rho > .49$), whereas a negative correlation was found for Suckers ($\rho = -.870$). Additionally, positive correlations were found between food responsiveness and food enjoyment for Chewers ($\rho = .476$), indicating that these individuals are more responsive to food cues and are also more likely to find enjoyment in eating. Furthermore, a positive correlation was found between food responsiveness and emotional overeating for Crunchers ($\rho = .560$), suggesting that these individuals are highly influenced by food cues and are more prone to engage in emotional eating behaviors.

4 | DISCUSSION

4.1 | Cultural context plays an important role in determining preferred mouth behavior classifications

The findings from this study highlight the significant influence of cultural context on determining preferred mouth behavior classifications. For the first time, Chewers and Crunchers were among the predominant groups in Malaysia (Figure 2). These findings aligned with a previous survey conducted in the United States conducted by Jeltema et al. (2015), with among 500 participants age among 15–65. The authors found that Chewers (43%) and Crunchers (33%) were the predominant groups, whereas Suckers were the smallest group at 8%.

In our study, 32% of the population was made up Smooshers and Suckers. This starkly contrasts findings reported by Cattaneo et al. (2020), who grouped Smooshers and Suckers as soft processing group. They reported that 77% of Chinese consumers predominantly favored soft processing eating behavior (i.e., Smooshers and Suckers). This inconsistency can likely be attributed to the fact that in Cattaneo's

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study, the food scenarios and images presented to both the Danish and Chinese participants were of Danish (or Western) origin. These food selections may not have been widely consumed or familiar to the Chinese population in their study, which could introduce a bias due to unfamiliarity (Plaza et al., 2019). This significant difference in the prevalence of Smooshers and Suckers between our study and Cattaneo et al.'s study underscores the potential influence of cultural factors on preferred mouth behavior. It suggests that cultural norms, dietary habits, and exposure to different food types may contribute to variations in mouth behavior classifications among different populations.

4.2 | Understanding the relationship between eating behavior for each preferred mouth behavior category

Our study focused on the approach and avoidance behaviors exhibited by Chewers, shedding light on the factors that drive their eating habits. Emotional overeating and hunger were the top two approach behaviors for Chewers. Conversely, slowness in eating and satiety responsiveness were the two key factors influencing avoidance behaviors among Chewers. It is important to note that Jeltema et al. (2015) defined Chewers as consumers who like foods that can be chewed longer. Chewers can be further classified into two groups based on the length of chewing time (i.e., short and long Chewers). However, the actual length of chewing time in our study was not measured. Fogel et al. (2018) indicated that participants with a slower eating rate or long Chewers tend to have higher scores for slowness in eating and satiety responsiveness. Slower eaters took smaller bites, consume food at a slower pace, and have a slower in reducing food into a swallowable bolus compared to fast eaters. This is likely to contribute to chewing less per gram of food consumed and by having a higher threshold for acceptable bolus properties (e.g., food particle size) (McCrickerd & Forde, 2017). These findings provide valuable insights into the eating behaviors of Chewers and highlight the importance of considering the role of chewing time and eating rate in future research. By understanding the factors that influence Chewers' approach and avoidance behaviors, we can better tailor interventions to promote healthier eating habits and satiety regulation among this specific group.

This study revealed between the factors influencing approach and avoidance behaviors in both Chewer and Cruncher categories. Hunger and emotional overeating were found to be among the two highest factors driving approach eating behaviors for both groups. Additionally, slowness in eating and satiety responsiveness were identified as influential factors for avoidance behaviors in both groups as well. These results are not surprising as Chewers and Crunchers share a similar mode of mouth action, both favoring the use their teeth to break down foods (Jeltema et al., 2015). It may be possible that the majority of Crunchers in our study were *long Crunchers*, similar to Chewers as explained the previous discussion.

Crunchers were also driven by food responsiveness in the approach eating behavior and food fussiness in the avoidance eating behavior. These findings align with the observation that Crunchers tend to exhibit a more forceful in their bite and prefers foods that breaks up (i.e., fracture) on biting (de Wijk et al., 2003).

Food responsiveness showed a high weighting and influenced the approach eating behaviors of Smooshers. Food responsiveness roughly translates to the ability to eat more food despite being full. It has been shown consistently in other studies that semi-solid foods, which are mostly present in the Smoosher category, have low satiating efficiency (Bolhuis et al., 2014; de Graaf, 2011; Forde et al., 2013). The cephalic phase response, which is responsible for feelings of fullness and satisfaction, has been shown to be lower for liquids and semi-solid foods compared to solid foods.

Food fussiness was identified as a strong predictor of avoidance eating behavior in Smooshers. A previous study involving 432 Malaysian consumers found that the rice- and flour-based dishes were among the top 10 highly consumed dishes (Tarmizi et al., 2020). This could potentially explain why the Smoosher group in our study were fussy eaters, as they have limited food choices available to them in Malaysia. The dry and hard nature of the rice- and flour-based staple foods in Malaysia suited Crunchers and Chewers, who have high chewing efficiencies and saliva flow rate, to swallow boluses safely (How et al., 2021; How et al., 2023). However, this may not be the case for Smooshers who typically have lower chewing efficiencies, less powerful biting forces, and lower saliva flow rates (Kim & Vickers, 2020). These observations suggest that future studies should further investigate the potential link among participants' oral processing physiological properties, mouth behavior, and eating behavior in future studies.

The approach and avoidance behaviors within the Suckers category showed a complex relationship (Figure 5). However, it is important to note that the number of participants who identified as Suckers in the study was small ($n = 5$) compared to the other mouth behavior groups. This small sample size increases the likelihood of participants having similar patterns of eating behaviors, which in turn increases the chance for most attributes to correlate with each other in a causal analysis. Due to the limitations of the small population size, it is prudent to exercise caution when interpreting the network built for Suckers. The reliability and generalizability of the findings may be compromised. As a result, further discussion on the network of approach and avoidance behaviors within the Suckers category will not be pursued in this study.

4.3 | Limitations

It is important to acknowledge that this study is purely observational in nature and relies on subjective ratings. The correlation between participants' oral processing and eating behavior is derived from advanced statistical analysis. To further enhance the validity of the classification of preferred mouth behavior, it would be beneficial to incorporate mechanistic-based studies that involve oral processing models. These models could assess factors such as salivary flow rate, chewing efficiency, and bolus formation (see How et al., 2021, 2022; How et al., 2023). By including these mechanistic studies, a more comprehensive understanding of the relationship between oral processing and eat-

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ing behavior can be achieved. Additionally, the use of more complex machine learning algorithms for classification as suggested in other studies (Kantono et al., 2022; Ming et al., 2021; How et al., 2023) could also provide further insight and improve the accuracy of the classification process.

Another limitation of this study is the relatively small number of respondents of other ethnicity. Considering that Malaysia is a multiracial country with rich cultural diversity, the recruitment of only 209 participants may not fully capture the full range of eating behaviors within the population. The study's sample was overrepresented by younger Malay ethnicity (aged 18–25), comprising approximately 60%–80% of the participants. This overrepresentation could potentially affect the generalizability of the findings and limit the extent to which the results can be applied to the broader Malaysian population.

4.4 | Commentary on AEBQ structure

In the study conducted by Hunot-Alexander et al. (2022), two versions of the AEBQ were tested using Factor Analysis. One version included eight factors, including hunger, and the other version had a seven-factor model that excluded the hunger subscale. Results revealed that the seven-factor structure, without the inclusion of hunger subscale, yielded a better model by providing a better fit. Interestingly, another study by He et al. (2021) found that the eight-factor model, which included hunger, yielded a better model fit compared to a seven-factor model, where food responsiveness and hunger items were combined into one subscale. Although the main goal of this study does not revolve around investigating AEBQ, findings in our study indicate an opportunity for future research to explore additional hunger subscales in AEBQ. Further investigation into the factors contributing to hunger and its relationship to eating behaviors could provide valuable insights into the complexities of appetite regulation and its impact on individuals' food choices and consumption patterns.

5 | CONCLUSIONS

The results in this study highlight the importance of considering cultural context to enhance our understanding of preferred mouth behavior and eating habits within the Malaysian population. This is particularly important as the Asian population remains understudied in the field of food behavior. Among Malaysians—Chewer, Cruncher, and Smoosher mouth behavior categories were prevalent.

Interestingly, Chewers and Crunchers exhibited similar emotional overeating tendencies, as well as hunger and slowness in eating and satiety responsiveness, when compared to Smooshers and Suckers. These similarities could be due to the fact that Chewers and Crunchers both utilize their teeth to break down foods. The slower eating rate of Chewers and Crunchers may also explain the higher weight given to satiety responsiveness.

Smooshers in the study had higher food responsiveness compared to other preferred mouth behavior groups. This may be due to the low satiety efficiency of semi-solid and liquid foods. Findings also showed that Smooshers are fussy eaters, possibly due to the limited availability of soft food choices in Malaysia. Further research investigating the physiological factors such as oral processing behavior (How et al., 2023), temporal sensory behavior using temporal dominance of sensations method (Chadha et al., 2022), and the influence of external factors to provide higher ecological validity (Ding et al., 2019) may be of interest for all the four groups of preferred mouth behavior. By considering these factors, researchers can continue to expand their understanding of preferred mouth behavior and its impact on eating habits, which can inform public health interventions and improve overall dietary habits in a specific population. Recognizing and accounting for these cultural nuances will enhance the generalizability and applicability of the findings in diverse populations.

AUTHOR CONTRIBUTIONS

Syahmeer How and Alifdalino Sulaiman: Conceptualization; methodology; formal analysis; investigation; resources; writing—original draft; writing—review and editing; visualization; supervision; project administration; funding acquisition. **Kevin Kantono**: Conceptualization; methodology; software; formal analysis; data curation; writing—review and editing; visualization; supervision; project administration. **Pia I. Hedelund and Aishwarya Ventrakamani**: Validation; writing—original draft; writing—review and editing; visualization. **Nazimah Hamid**: Validation; writing—original draft; writing—review and editing. **Adlin Najihah Azhar**: Conceptualization; methodology; formal analysis; writing—review and editing; investigation; resources; writing—original draft; visualization.

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CONFLICT OF INTEREST & ETHICS STATEMENT

The authors declare that they have no conflicts of interests or personal relationships that could have appeared to influence the work reported in this paper. This study received approval by the Ethics Committee for Research involving Human Subjects of University Putra Malaysia (JKEUPM-2022-443). Participants were provided information package and provided written informed consent prior to the start of the study.

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