The neurocognitive interaction between food and emotions: a thematic research

Leyla Baydeniz
Balikesir University, Balikesir, Turkey
Erdem Baydenïz
Aydın Adnan Menderes University, Aydın, Türkiye, and
Barış Demirci
Eskişehir Osmangazi University, Eskisehir, Turkey

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Abstract

Purpose – This study synthesizes contemporary neurogastronomy research on the neurocognitive mechanisms underlying food–emotion interactions. By drawing on neuroscience, psychology and culinary studies, the review constructs a thematic map of current scientific understanding and identifies gaps with implications for research and practice in hospitality and gastrotourism contexts.

Design/methodology/approach – A systematic thematic literature review was conducted following Braun and Clarke (2006) six-phase framework. Studies published between January 2024 and October 2025 were retrieved from Web of Science, Scopus, PubMed, ScienceDirect and Google Scholar using the search terms "neurogastronomy," "food emotion," "multisensory integration" and "flavor perception" in combination with "emotion," "affect," "limbic system" and "amygdala." Of 47 records identified, 20 peer-reviewed articles met the inclusion criteria following title, abstract and full-text screening. Quality assessment was conducted using criteria adapted from the Mixed Methods Appraisal Tool and Critical Appraisal Skills Program.

Findings – Six themes were identified: theoretical foundations of neurogastronomy as an interdisciplinary field; neural architectures involving limbic-prefrontal networks in food evaluation; multisensory integration producing emergent flavor percepts that exceed individual sensory inputs; bidirectional food–emotion relationships operating through gut-brain, expectancy and memory pathways; cultural modulation of neural food responses through developmental plasticity; and methodological innovations including neuroimaging, neuromarketing tools and multimodal assessment. Approximately, 75% of reviewed studies drew on Western populations, limiting cross-cultural generalizability. Flavor perception functions as a brain-constructed phenomenon shaped by predictive coding, with emotional responses reflecting coordinated amygdala, orbitofrontal cortex and hippocampal activity.

Originality/value – This study provides the first thematic synthesis of the 2024–2025 neurogastronomy literature, integrating fragmented findings across neuroscience, psychology and culinary domains into a coherent multilevel framework. It identifies actionable directions for culinary education, hospitality experience design, gastrotourism practice, public health and ethical neuromarketing and establishes a research agenda prioritizing cross-cultural validation, longitudinal investigation and naturalistic study designs.

Keywords Neurogastronomy, Food–emotion interactions, Gastrotourism, Hospitality experience design, Neuromarketing, Multisensory dining, Thematic review

Paper type Research article

Introduction

Food consumption and emotional experience are inseparably linked through neurocognitive processes that operate across multiple levels of brain function. Rather than reflecting the intrinsic properties of food, eating experiences are shaped primarily by how the brain interprets, integrates and assigns meaning to sensory input, a process involving sensory processing systems, emotional regulation networks and memory mechanisms working in concert (Casiraghi *et al.*, 2025). Neurogastronomy research has made clear that flavor perception is not a product of isolated sensory channels but emerges from their integration, which fundamentally changes how we think about food-related emotion (Ucuk *et al.*, 2025; Yılmaz, 2025).

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The term neurogastronomy was introduced by Gordon Shepherd in a 2006 Nature publication, where he argued that flavor is a construction of the brain rather than a property of food itself (Lloyd-Parkes and Filipponi, 2025). The field draws together gustatory, olfactory, visual, tactile and auditory processing, recognizing that the brain synthesizes these inputs into a unified perceptual experience carrying substantial emotional weight (Casiraghi *et al.*, 2025). Visual presentation alone, for instance, can alter the brain's flavor construction: the same food, when plated more attractively, activates reward-related circuits more strongly than when presented plainly (Ucuk *et al.*, 2025). For the hospitality sector, this matters, as dining satisfaction is partly a function of what the brain expects and constructs before the first bite.

Emotional responses to food engage brain regions tied to affective evaluation, memory and hedonic computation (Casiraghi *et al.*, 2025). Neuroimaging work on organoleptic properties shows that different food presentations produce distinct neural activity patterns even when the chemical composition of food is held constant (Berčík *et al.*, 2025). The orbitofrontal cortex draws on hunger state, prior experience and cultural background to generate feelings of liking or wanting that steer food choices (Casiraghi *et al.*, 2025). Much of this occurs below the level of conscious awareness, which has direct implications for experience design in restaurants and tourism contexts, where atmospheric and sensory cues reach guests through channels they may not consciously register.

Researchers have expanded their methodological toolkit accordingly. EEG, fMRI, eye-tracking, galvanic skin response measurement and facial expression coding are now used alongside traditional sensory evaluation to capture both deliberate and automatic food-related responses (Berčík *et al.*, 2025). Ucuk *et al.* (2025) showed that visual modifications to food presentation produced measurable changes in brain activity, while FaceReader technology has allowed cross-cultural comparisons of olfactory emotional response that self-report scales cannot easily achieve (Berčík *et al.*, 2025). These tools have brought neuroscientific rigor to questions long treated as subjective, such as how a dish looks, smells or sounds when eaten.

Cross-modal interactions are central to this picture. Plate geometry, color and arrangement shape emotional reactions captured through macrofacial coding, while background music influences perceptions of traditional dishes and overall dining satisfaction (Vukolić *et al.*, 2025). These effects are not merely additive; information across sensory channels combines to produce experiences that diverge from what any single modality would predict. Restaurant designers and gastrotourism operators who treat sound, light and plating as independent variables may therefore be missing the combined perceptual effects their choices produce.

Cultural background adds another layer of complexity. Bibliometric analyses of neurogastronomy confirm that the field has grown rapidly since 2006, with mounting interest in how culture shapes flavor perception and food-related emotion (Yılmaz, 2025; Süzer and Ceylan, 2025). Neural responses to food are stronger for culturally familiar items, reflecting learned associations with reward, safety and social memory. Yet Süzer and Ceylan (2025) observe that neurogastronomy has not been well absorbed into culinary training or hospitality education, creating a gap between what laboratories know and what practitioners do. For operators serving internationally diverse guests, a central concern in gastrotourism, this gap translates directly into missed opportunities for culturally calibrated experience design.

Neuromarketing has extended these insights into commercial food contexts. Cognitive and affective responses to food-related marketing can be measured objectively through neuroscientific methods (Adelaiv *et al.*, 2024), and color has been shown to activate multiple sensory modalities simultaneously through mechanisms operating outside conscious awareness (Erkocaaslan and Ay, 2025). How menus are designed, how dishes are named and described and how physical environments are arranged all carry neurocognitive consequences that go beyond what guests would report if simply asked (Vasile *et al.*, 2024; Sadikzade and Turhan, 2024).

Four limitations constrain the current body of work. The research base is predominantly Western, limiting what can be said about diverse culinary traditions and international tourist markets (Yılmaz, 2025). Integrative frameworks connecting neural, psychological and sociocultural levels are still underdeveloped (Casiraghi *et al.*, 2025). Methodological variation across studies complicates direct comparison. The distance between laboratory findings and applied practice in culinary education or food service also remains wide (Süzer and Ceylan, 2025). These gaps define the scope of the present review.

This study conducts a systematic thematic synthesis of the 2024–2025 neurogastronomy literature using Braun and Clarke (2006) six-phase framework. It aims to (1) identify core themes in the neurocognitive mechanisms underlying food–emotion interactions; (2) examine how cultural, sensory and contextual factors modulate these processes; (3) evaluate the methodological approaches employed in recent research; and (4) develop an integrative framework that connects neuroscientific, psychological and sociocultural findings to practical questions in hospitality and gastrotourism. The analysis is organized around six thematic domains, closing with a discussion of what the evidence means for researchers and practitioners working across diverse international contexts.

Theoretical foundations of Neurogastronomy

Neurogastronomy emerged as a distinct interdisciplinary field following Gordon Shepherd (2006) Nature publication, which proposed that flavor is a brain-constructed phenomenon rather than a direct reflection of peripheral sensory input. Shepherd's framework challenged conventional sensory science by showing that flavor perception engages broader neural networks than virtually any other human behavior, requiring coordinated activation across the gustatory, olfactory, visual, somatosensory and auditory cortices. This shift reframes eating as a fundamentally neurocognitive event in which the brain actively constructs subjective flavor percepts through multisensory integration, rather than passively receiving signals from peripheral organs.

The practical significance of this reframing extends well beyond the laboratory. If flavor is constructed centrally, then the conditions surrounding eating, including the visual environment, background sound, service style and cultural framing, become legitimate variables in shaping guest experience. For hospitality and gastrotourism contexts, this means that the sensory architecture of a dining space is not merely aesthetic but functionally consequential for how food is perceived and emotionally experienced.

Bibliometric analyses confirm neurogastronomy's rapid expansion since 2006, with growth in both publication volume and methodological sophistication. Yet Süzer and Ceylan (2025) identify a persistent implementation gap: despite 2 decades of research, neurogastronomy remains insufficiently integrated into academic curricula and professional culinary training. Their qualitative investigation of gastronomy academics found that theoretical interest exists but practical application is limited. This disconnect raises questions about real-world impact and suggests that translational barriers continue to constrain the field's potential for industry uptake.

The theoretical core of neurogastronomy rests on the principle that taste perception is governed by the brain rather than by food's physical properties alone. Sensory interactions, emotional associations and cultural conditioning all shape the gastronomic experience, and information from the five senses is processed in corresponding brain regions through mechanisms that are not independent but mutually modifying. This integrative perspective stands against reductionist approaches that examine sensory modalities in isolation, emphasizing instead the emergent properties arising from their convergence.

A recurring concern in the bibliometric literature is geographic concentration. Analyses tracing neurogastronomy's evolution from 2006 to 2024 reveal that the field remains predominantly Western-centric, with limited representation of non-Western culinary traditions and cultural contexts (Yılmaz, 2025). Neural mechanisms identified in Western populations consuming culturally familiar foods may not translate universally across diverse dietary practices and flavor landscapes. Cross-cultural validation is therefore not a peripheral concern but a prerequisite for any claims about universal neurogastronomic principles, a point particularly relevant for gastrotourism research that aims to generalize findings across international markets.

Neural architectures of food-emotion processing

Neuroimaging research has begun to map the distinct neural systems involved in food evaluation. Using representational similarity analysis of fMRI data, Avery *et al.* (2015) identified two functionally dissociated networks: a prefrontal system (bilateral inferior frontal gyrus, medial frontal gyrus, pre-supplementary motor area) encoding food healthfulness and regulatory control, and a limbic system (bilateral insula, orbitofrontal cortex, amygdala, ventral striatum) representing hedonic value and affective responses. This dissociation suggests that food decisions emerge from competition between bottom-up hedonic drives and top-down cognitive control, with individual variation in network dominance potentially accounting for differences in eating behavior.

Cross-cultural neuroimaging work adds further complexity. Wang *et al.* (2016) examined neural activation in adults viewing culturally familiar vs unfamiliar food images, finding stronger responses to indigenous foods in regions associated with craving, taste perception, attention, reward and visual processing, including the cerebellum crus, superior temporal gyrus, supramarginal gyrus, middle temporal gyrus, inferior parietal lobule, posterior insula and occipital areas. These findings suggest that culture shapes not only food preferences but the underlying neural architecture through which food stimuli are processed, raising questions about the ecological validity of using standardized food image sets in cross-cultural neuroimaging studies. For hospitality and gastrotourism researchers, this has concrete implications: sensory interventions calibrated for one cultural group may produce different neural and behavioral responses in another.

These findings carry an important caveat, however. Both the Avery *et al.* (2015) and Wang *et al.* (2016) studies relied on passive viewing of food images rather than actual consumption. Whether the prefrontal-limbic dissociation and cultural modulation effects persist in naturalistic eating contexts, where gustatory, olfactory and interoceptive feedback dynamically update neural representations remains an open question. As Casiraghi *et al.* (2025) argue, eating involves continuous bidirectional communication among sensory, affective and cognitive systems rather than discrete separable processes, and ecologically valid paradigms capturing the temporal dynamics of real meal consumption may reveal coordination patterns that static laboratory tasks cannot.

Research on conditioned taste learning has shed light on a related mechanism: how the amygdala maintains flavor representations across extended time intervals. Zimmerman *et al.* (2025) demonstrated that the amygdala responds preferentially to novel flavors across all stages of post-ingestive learning, including consumption, delayed malaise and memory retrieval. When gastric malaise occurred hours after flavor exposure, delayed signals selectively reactivated flavor-specific neural ensembles in the amygdala, with reactivation magnitude predicting the subsequent strengthening of aversive food memories. This resolves a longstanding problem in food learning research: how the brain assigns illness to a specific flavor consumed much earlier when multiple foods have been eaten in the interim.

The generalizability of these findings to humans and to positive food associations warrants caution. Zimmerman *et al.* (2025) worked exclusively with rodent models using lithium chloride-induced malaise. Whether similar amygdala reactivation mechanisms support the formation of positive food preferences, such as comfort food associations tied to safety and social belonging, has not been directly tested. Individual differences in amygdala reactivity may also explain why some people form lasting food aversions after a single negative experience while others do not, a question relevant to understanding disordered eating in clinical populations.

Complementary evidence comes from hippocampal research. Décarie-Spain *et al*. (2025) identified specialized neurons in the ventral hippocampus that store meal memories and regulate subsequent eating behavior. When these circuits are disrupted, through distraction, brain injury or memory impairment, individuals show increased eating because they cannot accurately recall prior meals. The authors suggest this finding could inform obesity interventions targeting memory consolidation of food-related cues. However, as they acknowledge, human eating behavior is shaped by sociocultural factors, emotional needs and food environment structures that extend beyond hippocampal memory circuits, and purely neurobiological models will remain incomplete without accounting for these broader determinants.

Multisensory integration: beyond simple additive effects

Flavor perception does not arise from the sum of individual sensory signals. Instead, information from one modality systematically alters processing in others, producing percepts that cannot be predicted from any single input alone. Ucuk *et al*. (2025) showed, using EEG and emotion recognition, that the same food presented in visually enhanced formats elicited distinct neural activity patterns compared to plainer presentations. Participants also reported altered flavor perceptions and greater willingness to pay for the visually appealing versions, despite the foods being chemically identical. For restaurant and hospitality operators, this has a straightforward implication: plating and presentation are not decorative decisions but variables with measurable consequences for how guests perceive taste and value.

The Ucuk *et al*. (2025) findings should nonetheless be interpreted with some caution. The study used a within-subjects sequential design, which introduces order effects and the possibility that participants inferred the study's aims and adjusted their responses. The laboratory setting also limits what can be said about repeated real-world exposure; habituation may reduce cross-modal effects over time, meaning the observed impact on willingness to pay may not persist across multiple dining visits to the same establishment.

Color's role in flavor perception has received separate attention. Visual cues linked to specific taste expectations activate multiple sensory modalities simultaneously, operating through mechanisms below conscious recognition thresholds (Erkocaaslan and Ay, 2025). This pattern is consistent with predictive coding accounts, in which the brain generates top-down expectations of flavor based on appearance, and gustatory input primarily confirms or revises those predictions rather than constructing flavor from scratch. An alternative reading, however, is that these effects reflect learned color-flavor associations accumulated across the lifespan rather than hardwired neural architecture. Distinguishing these accounts requires developmental data on when and how cross-modal associations form, a gap in the current neurogastronomy literature that limits theoretical resolution.

When multiple modalities align, their combined effect exceeds what any single channel produces. Studies examining congruent visual, auditory and textural cues report enhanced sweetness and overall palatability, suggesting that coherent multisensory environments produce qualitatively different experiences than inconsistent ones. For hospitality experience design, this points toward the value of coordinating all sensory elements of a dining space rather than managing them independently.

Music's influence on dining represents a growing line of inquiry. Vukolić *et al*. (2025) examined how background music shapes perceptions of traditional Serbian dishes and overall dining satisfaction, finding that the auditory environment has a meaningful impact on food evaluation. The mechanisms behind this effect remain unclear: music may alter gustatory processing through direct neural crosstalk, or it may shift mood in ways that indirectly color food evaluation through affective priming. Separating these pathways requires experiments that independently vary music and mood while tracking flavor judgments, a level of methodological control not yet achieved in published work. There is also the question of cultural transfer: music that enhances satisfaction with traditional Serbian dishes may not generalize to other culinary contexts, and its effect may be tied to culturally specific associations rather than any universal acoustic property.

Emotional regulation through eating: mechanisms and limitations

The relationship between emotion and eating runs in both directions. Morse and Garcia (2025) and Liang *et al*. (2025) reviewed evidence that certain foods influence mood through the diet–gut–brain axis, neurotransmitter modulation and neuroinflammation pathways, with polyphenols, omega-3 fatty acids, and probiotics receiving particular attention. However, O'Donovan *et al*. (2019) note that effect sizes from controlled feeding studies frequently shrink in free-living conditions, where food choices are embedded in psychological, social and environmental complexity. Focusing on specific nutrients also risks overlooking the synergistic effects of whole dietary patterns, a methodological limitation that narrows the practical applicability of nutrient-level findings to real food service and public health contexts.

Positive food associations are a core feature of everyday eating, with meals linked to pleasure, well-being and social celebration. The challenge for hospitality and gastrotourism operators is to activate these associations in ways that also support healthier choices. Neurogastronomic approaches, such as optimizing the sensory presentation and contextual framing of nutritious foods, offer one avenue, but the evidence base for scaling such strategies to diverse consumer populations remains thin.

Comfort food research complicates purely nutritional accounts of food-emotion links. Wu *et al*. (2025) found that what drives comfort food consumption during stress is not the nutritional composition of the food but the expectation that it will improve mood. This shifts the explanatory weight from pharmacology to psychology: any palatable food associated with safety, warmth or social memory can function as a comfort food. For practitioners, this means that the meaning and context attached to a dish may matter more than its ingredients, a point relevant to menu storytelling and the cultural framing of food in tourism settings.

Li *et al*. (2025) observed that consuming pleasurable foods produced short-term improvements in cognitive task performance, alongside decreased theta and alpha band activity in frontal EEG regions, consistent with dopaminergic reward activation. These acute effects are real, but their interpretation requires care. Whether cognitive benefits extend beyond the immediate post-meal window is unknown, and evidence from the processed food literature suggests that longer-term exposure to high-palatability diets may impose cognitive costs that offset short-term gains. Acute and chronic effects of palatable food on cognition need to be held apart analytically, a distinction not always maintained in the existing literature.

The gut–brain axis has emerged as a mechanistic framework connecting diet to mood and cognition. Nutritional patterns shape gut microbiota composition, and those microbiota communicate bidirectionally with the brain through multiple signaling pathways. Cultural dietary traditions generate distinct microbiota profiles, which may contribute to differences in mood, cognition and neurological vulnerability across populations. Cultures with traditionally high-fiber diets, for example, may exhibit different gut–brain signaling dynamics than those with fiber-poor, highly processed food environments, suggesting a biological route through which culture shapes brain function over developmental time.

Whether gut–brain interventions alone can produce meaningful mental health outcomes is an open question. Research indicates that Western-style diets impair mood through gut and hormonal pathways, and that exercise partially offsets these effects, yet poor diet quality independently constrains neurogenesis regardless of physical activity (Morse and Garcia, 2025; Liang *et al*., 2025). This suggests that nutritional quality cannot be substituted for by other lifestyle factors and that multi-component interventions addressing diet, gut health and behavioral variables simultaneously may be necessary. Studies examining such combined approaches remain scarce.

Cultural modulation: universal mechanisms or learned associations?

Whether cultural differences in food-related brain responses reflect culturally specific learned associations or universal mechanisms shaped by experience remains an unresolved question. Berčík *et al.* (2025) used FaceReader technology to compare emotional responses to food aromas in Spanish and Slovak consumers, finding systematic cross-cultural differences. These results suggest that early food exposure leaves lasting imprints on neural representations. The study's limitation is its geographic scope: both populations share broadly European dietary backgrounds, and whether the observed differences scale to more distant comparisons, such as East Asian versus Western food cultures with fundamentally different flavor principles, cannot be inferred from these data alone.

The developmental framing of cultural influence is important here. Culture shapes food systems, food systems shape eating habits and eating habits shape brain development through repeated activation of sensory and reward circuits across childhood and adolescence. Early food experiences forge neural pathways that are not limited to taste preference but extend to emotional response, habit formation and cultural identity. This feedback loop, in which brain function and cultural food practice mutually reinforce each other over time, underscores why cross-cultural comparisons in neurogastronomy are both methodologically demanding and theoretically essential.

Implicit rather than explicit processes appear to govern much of this cultural shaping. Culturally specific flavor preferences are built up through accumulated exposures that operate largely outside deliberate attention, and capturing them requires methodologies sensitive to unconscious neural responses rather than self-report alone. This has implications for how neurogastronomy research designs its stimuli and outcome measures in cross-cultural studies.

The gastrotourism literature introduces an additional layer of complexity. Lloyd-Parkes and Filipponi (2025) argue that neurogastronomy can help explain how cultural authenticity shapes food experiences for tourists, yet this application carries ethical risks. Using neuroscientific methods to engineer a sense of authenticity through controlled sensory cues risks commodifying cultural food traditions and detaching food experiences from the social and historical meanings that give them significance. Sutton and Vournelis (2025) caution that treating food as an abstraction for laboratory study may strip it of precisely the contextual richness that makes it meaningful to the people who produce and consume it. This tension between scientific analysis and cultural integrity is not easily resolved and represents a genuine ethical boundary for neurogastronomy's applied work (Arnett *et al.*, 2022).

Methodological advances and persistent limitations

Each of the methods now standard in neurogastronomy research carries trade-offs that shape what can and cannot be concluded from the resulting data. EEG captures neural timing with high resolution but offers limited spatial localization. fMRI maps brain regions with precision but reflects hemodynamic changes that lag behind neural activity, making it poorly suited to fast-unfolding processes. Avery *et al.* (2015) used representational similarity analysis with fMRI to detect distributed network patterns invisible to univariate approaches, though RSA rests on the assumption that neural representational geometry corresponds to psychological similarity, an assumption that should be tested rather than taken as given.

The combination of methods addresses some of these gaps. Ucuk *et al.* (2025) simultaneously collected sensory ratings, EEG data and emotion recognition output, triangulating subjective, neural and behavioral measures around the same stimulus. Dishes rated as visually appealing produced both more positive emotional responses and higher taste ratings, with neural data providing a level of objectivity that self-report alone cannot. This kind of multimodal triangulation is increasingly seen as a methodological standard for neurogastronomy work, particularly in applied hospitality research where behavioral and experiential outcomes both matter.

FaceReader has gained traction as a neuromarketing tool for quantifying emotional responses to food stimuli, including in cross-cultural comparisons of olfactory preference (Berčík *et al.*, 2025). Its limitations deserve acknowledgment, however. Facial expression captures only a subset of emotional experience, and people who do not express emotion facially will be systematically undercounted. Cultural display norms also influence expressiveness in ways that may not be adjusted for by algorithms trained predominantly on Western faces, raising questions about measurement equivalence across the populations relevant to international gastrotourism research.

Flavor enhancement technologies have opened new experimental possibilities. Huang *et al.* (2024) reviewed emulsion-based strategies for modifying flavor perception, showing that specific physical properties of food systems can be manipulated to alter sensory experience independently of chemical composition. These tools allow more precise experimental control over stimulus variables and may eventually enable neurogastronomy researchers to isolate specific sensory drivers of emotional response in ways that simple plate presentation studies cannot.

Neuromarketing applications have grown accordingly. Research by Sadikzade and Turhan (2024) and Adelaiv *et al*. (2024) shows that menu design, plating aesthetics and food marketing materials can be evaluated through neuroscientific methods, producing insights that behavioral surveys do not capture. The ethical dimension of this work is substantial and underexplored. Vasile *et al*. (2024) examine how unconscious sensory and emotional mechanisms drive food decisions, but offer limited analysis of what this means for consumer autonomy when the same techniques are deployed commercially. Establishing ethical standards for neuromarketing applications in food and hospitality contexts is now an urgent practical requirement, not merely an academic concern.

Research on visual cortex food selectivity adds a further methodological consideration. Chang *et al*. (2025) identified cortical regions that respond preferentially to food stimuli, suggesting dedicated circuits for food recognition that developed partly through social learning. The social context in which food is presented may therefore influence neural responses independently of the food's sensory properties, a confound that standard stimulus sets used in laboratory neurogastronomy research do not typically control for.

Synthesis: toward integrative frameworks

The body of research reviewed here makes clear that food-emotion interactions cannot be adequately captured by any single level of analysis. Neural, psychological, sociocultural and contextual factors all contribute, and they interact rather than operate in parallel. Casiraghi *et al*. (2025) make the point directly: eating involves continuous bidirectional communication among sensory, affective and cognitive systems, and the field needs analytical tools that track this dynamic unfolding over real meal time rather than drawing inferences from static stimulus exposures. Few published studies have yet achieved this.

The neurocultural dimensions of food are as central as its neurobiological ones. Flavor is tied to emotional memory in ways that shape not just what people prefer but what they seek out, return to and share with others. Theoretical frameworks that separate neural mechanism from cultural meaning are therefore incomplete by design. The field needs models that hold both levels together, and the hospitality and gastrotourism literature is well positioned to generate them, given its focus on lived experience in culturally diverse, real-world settings.

The translation gap documented by Süzer and Ceylan (2025), between what neuroscience laboratories know and what culinary educators and food service practitioners do, will not close without deliberate effort. Laboratory findings need to be tested in naturalistic settings, communicated in formats accessible to practitioners, and evaluated for scalability across cultural and economic contexts. The intersection of neuroscience and food holds genuine potential for innovation in culinary education, experience design and public health, but that potential depends on whether the field can develop the implementation infrastructure to support it.

Method

This review adopts a critical realist epistemological stance, following Bhaskar (1975), which holds that neurocognitive processes exist independently of observation while scientific knowledge of those processes remains socially constructed. This position supports a balanced interpretation that acknowledges neurobiological patterns found consistently across populations, such as amygdala involvement in aversive food learning, alongside cultural specificities, such as differential reward circuit responses to familiar vs unfamiliar cuisines. Critical realism also prompts attention to how Western-centric research paradigms may universalize findings that are culturally bounded, a concern directly relevant to this field given its geographic concentration.

Research design

This study employed a systematic thematic literature review to identify and synthesize patterns across recent neurogastronomy research. A thematic review is appropriate when the goal is conceptual integration across heterogeneous study designs rather than statistical aggregation of effect sizes (Braun and Clarke, 2006). Unlike narrative reviews, which may selectively foreground particular studies, or meta-analyses, which require methodological homogeneity, thematic reviews can bring together neuroimaging, psychophysiological, behavioral and qualitative studies within a coherent analytical framework.

This design involves more interpretive judgment than systematic reviews with fixed coding schemes, which is a limitation that should be acknowledged. The procedures described below were structured to maximize transparency, though alternative thematic organizations remain possible depending on the theoretical lens applied.

Data sources and search strategy

Searches were conducted across five databases: Web of Science, Scopus, PubMed, ScienceDirect and Google Scholar. These were selected for their complementary coverage of neuroscience, food science, psychology, and hospitality research. The full search string applied was: (“neurogastronomy” OR “food emotion” OR “multisensory integration” OR “flavor perception”) AND (“emotion” OR “affect” OR “limbic system” OR “amygdala”)

Boolean operators were used throughout. Wildcard truncation (e.g. “gastronom*”, “percept*”) was applied where supported by the database interface to capture variant forms. Searches were conducted in English only; non-English publications were excluded.

The primary temporal boundary was January 2024 to October 2025, reflecting neurogastronomy’s rapid methodological and theoretical evolution during this period, including the uptake of representational similarity analysis in fMRI studies. Seminal earlier works cited extensively in recent publications, specifically Shepherd (2006, 2012), were retained as foundational references. Database searches were supplemented by citation chaining and forward tracking of key articles. Grey literature and non-peer-reviewed sources were excluded.

Inclusion and exclusion criteria

Studies were included if they (1) investigated neurocognitive mechanisms of food–emotion interactions using neuroimaging, psychophysiological or behavioral methods; (2) examined multisensory integration in flavor perception; (3) addressed cultural or contextual modulation of food-related brain responses; and (4) were published in peer-reviewed journals between 2024 and 2025.

Studies were excluded if they (1) focused exclusively on clinical eating disorders without addressing normative eating processes; (2) examined only peripheral gustatory or olfactory physiology without a neural or central processing component; (3) investigated nutrition–cognition relationships without an emotional or affective dimension; (4) were published in outlets identified as predatory or lacking rigorous peer review; or (5) were inaccessible after reasonable retrieval efforts.

Screening and study selection

Initial database searches identified 47 records. After duplicate removal, 38 unique records remained. Title and abstract screening against the inclusion and exclusion criteria reduced this to 26 candidates for full-text review. Full-text assessment excluded a further six records: three focused solely on peripheral sensory physiology, two were inaccessible and one was published in a predatory outlet. A final set of 20 peer-reviewed articles met all inclusion criteria and were carried forward to thematic analysis. Figure 1 presents the screening process as a PRISMA-style flow diagram.

Thematic analysis procedure

Analysis followed Braun and Clarke (2006) six-phase framework: (1) familiarization with the data, (2) initial code generation, (3) theme searching, (4) theme review, (5) theme definition and naming and (6) report production. All 20 included articles were read in full, with preliminary notes recorded during initial reading.

Coding combined inductive and deductive approaches. Deductive codes were derived from established neuroscience frameworks and included brain regions (amygdala, orbitofrontal cortex, hippocampus), cognitive processes (multisensory integration, emotional regulation, predictive coding) and methodological categories (fMRI, EEG, FaceReader). Inductive codes emerged from patterns in the data and included cultural authenticity tensions, neuromarketing ethics and the gap between laboratory findings and applied practice.

Candidate themes were refined through iterative grouping, with each revision assessed for internal coherence within themes and adequate distinction between them. As a sole analyst,

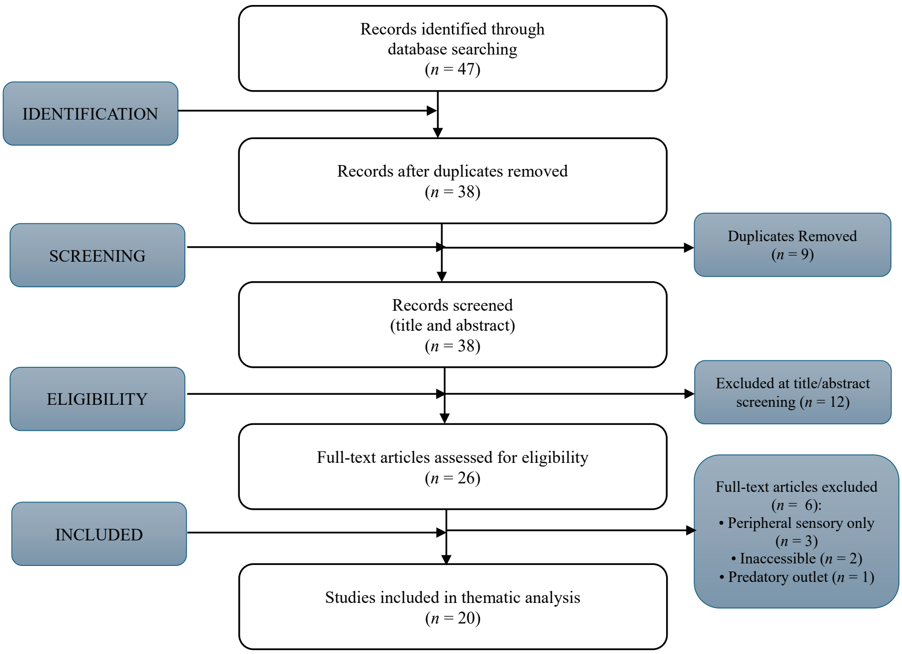

Figure 1. Prisma flow diagram

bias from a cognitive neuroscience background may have favored neurobiological over sociocultural interpretations. This was addressed by actively seeking contradictory evidence and foregrounding cultural and contextual perspectives throughout the analysis, including studies critical of Western-centric assumptions. Readers should nonetheless note that single-researcher coding precludes formal inter-rater reliability assessment.

Six final themes were identified: (1) Theoretical Foundations of Neurogastronomy, (2) Neural Architectures of Food–Emotion Processing, (3) Multisensory Integration, (4) Emotional Regulation Through Eating, (5) Cultural Modulation and (6) Methodological Advances. Each theme is discussed with attention to convergent findings, internal contradictions, methodological limitations and gaps relevant to both scholarly understanding and applied hospitality contexts.

Quality assessment

Study quality was assessed using criteria adapted from the Mixed Methods Appraisal Tool (MMAT) and the Critical Appraisal Skills Program (CASP), modified for neuroscience study designs. Dimensions assessed included: clarity of research objectives, appropriateness of study design relative to those objectives, adequacy of sampling and participant characteristics, rigor of data acquisition and instrument validation, consideration of confounding variables, transparency in reporting limitations and clarity of conclusions.

Formal numerical quality scores were not assigned. Recent methodological commentary has questioned whether composite quality scores add analytical value beyond the component judgments themselves, and whether excluding studies on quality grounds risks systematic removal of null findings, which are disproportionately represented in lower-tier outlets (Morse and Garcia, 2025; Liang *et al*., 2025). Quality considerations were therefore incorporated into the interpretation of findings, with specific methodological limitations of individual studies noted where they bear on the conclusions drawn.

Findings

Overview of thematic structure

Systematic thematic analysis, following Braun and Clarke (2006) six-phase iterative framework, identified six core themes characterizing neurocognitive food–emotion interactions (Table 1). These themes emerged through inductive and deductive coding processes, representing recurrent patterns across methodologically diverse investigations. The thematic architecture reflects multiple analytical levels: from foundational theoretical frameworks through empirical neurocognitive mechanisms to applied methodological and cultural considerations.

The six themes exhibit hierarchical and lateral relationships rather than existing as isolated categories. Theoretical foundations provide epistemological grounding for empirical investigations of Neural Architectures and Multisensory Integration. These mechanistic themes directly inform understanding of Emotional Regulation and Cultural Modulation. Methodological Innovations enable investigation across all empirical domains while simultaneously being shaped by theoretical commitments regarding what constitutes valid knowledge about food–emotion relationships (Figure 2).

Subthematic organization and conceptual interconnections

Each central theme encompasses multiple subthemes reflecting distinct yet interrelated conceptual territories (Table 2). These subthemes emerged through iterative refinement, ensuring internal homogeneity (coherence within subthemes) and external heterogeneity (distinction between subthemes).

Neural architectures encompass three interrelated subthemes that highlight functional specialization. Hedonic Valuation pertains to the orbitofrontal mechanisms responsible for

Table 1. Overview of core themes and analytical focus area

Main theme	Analytical focus	Representative keywords/ Concepts	Cognitive-affective dimensions
1. Neural architectures of food-emotion processing	Brain structures, neural connectivity, emotional encoding	Amygdala, Hippocampus, OFC, Insula, Limbic System, Reward Circuitry, Memory Encoding, Hedonic Valuation	Emotional salience, reward anticipation, affective tagging, motivation control
2. Multisensory integration and flavor construction	Cross-modal perception, sensory congruence, neurocognitive synthesis	Visual Cues, Olfactory Processing, Texture, Color-Flavor Congruity, Auditory Context, Cross-modal Attention, Flavor Illusion	Perceptual fusion, affective enhancement, sensory coherence
3. Emotional regulation through eating	Mood regulation, stress response, hedonic consumption	Comfort Food, Dopamine Pathways, Emotional Eating, Reward-Seeking, Satiety Mechanisms, Cortisol Modulation	Stress buffering, transient pleasure, hedonic adaptation, craving cycles
4. Cultural and contextual modulation	Cultural conditioning, social learning, contextual framing	Culinary Memory, Authenticity, Cultural Familiarity, Symbolic Foods, Identity, Ritual Eating	Learned emotional associations, cultural memory encoding, belonging and nostalgia
5. Methodological innovations in Neurogastronomy	Technological convergence, multimodal data integration	fMRI, EEG, FaceReader, Eye-tracking, GSR, Neuromarketing Analytics, RSA	Cognitive-affective synchronization, implicit response measurement, neuroaesthetic mapping
6. Theoretical foundations and emerging frameworks	Epistemological synthesis, interdisciplinarity	Neurogastronomy, Critical Realism, Sensory Cognition, Affective Neuroscience, Embodied Experience, Flavor Psychology	Integrative understanding, conceptual alignment, embodied cognition

computing subjective pleasure. Emotional encoding involves the amygdala's role in assigning affective significance. Memory association refers to hippocampal processes that consolidate associations between foods and autobiographical contexts. These mechanisms are interconnected through a web of dense reciprocal connectivity, with circuits linking the amygdala, orbitofrontal cortex and hippocampus that mediate the emotional significance that foods acquire through experience.

Multisensory integration encompasses visual-olfactory fusion (how sight and smell combine to generate unified flavor percepts), texture-emotion coupling (tactile mouthfeel influences affective responses) and cross-modally expectation (predictions from one modality alter processing in others). The visual dominance effect, in which visual information can override gustatory signals, exemplifies predictive coding mechanisms by which the brain generates top-down expectations that filter bottom-up sensory input.

Emotional regulation differentiates comfort eating (consumption motivated by affect management goals), mood food (specific items believed to enhance emotional states) and stress-induced overeating (hyperphagic responses to negative affect). These patterns reflect dopaminergic reward system activation, providing a transient hedonic boost, and cortisol modulation, buffering stress responses. However, reliance on food for emotional regulation constitutes a short-term adaptive strategy that may become maladaptive through habituation and metabolic consequences.

Cultural modulation operates through cultural familiarity (preferential responses to traditional cuisines), authenticity (evaluations of cultural genuineness), and ritualized eating (symbolic consumption practices). These phenomena reflect associative learning, in which

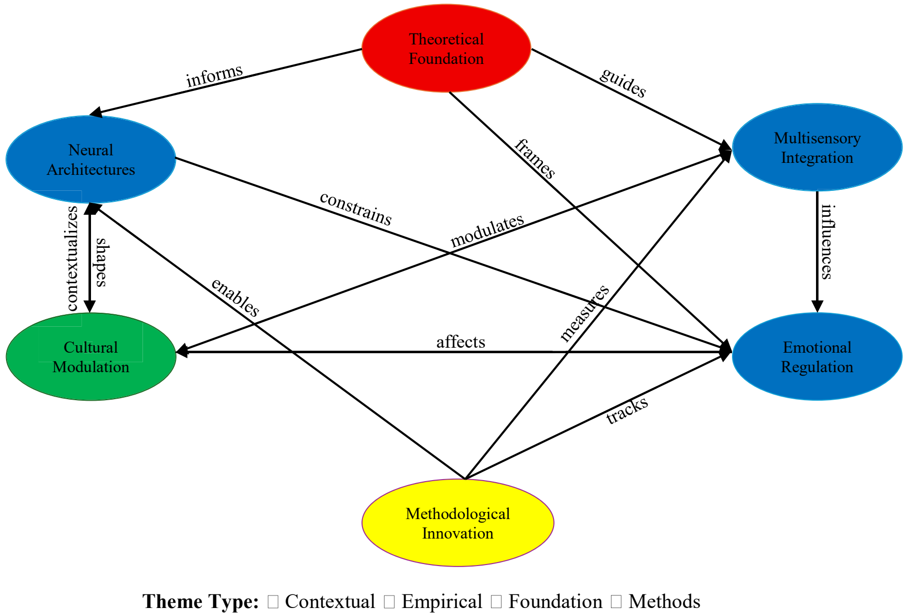

Figure 2. Thematic map of neurocognitive food–emotion interactions. **Note:** Node size indicates conceptual centrality; arrows show directional influences

Table 2. Subthemes and interconnections between cognitive and emotional processes

Main theme	Subthemes	Key processes	Conceptual links
Neural architectures	Hedonic Valuation; Emotional Encoding; Memory Association	Reward computation, affective learning	Amygdala ↔ OFC ↔ Hippocampus connectivity mediates emotional salience of food
Multisensory integration	Visual-Olfactory Fusion; Texture-Emotion Coupling; Cross-modal Expectation	Predictive coding, sensory weighting	Visual dominance effect enhances or suppresses gustatory perception
Emotional regulation	Comfort Eating; Mood Food; Stress-Induced Overeating	Dopamine release, cortisol inhibition	Food as short-term emotion regulator but long-term maladaptive mechanism
Cultural modulation	Cultural Familiarity; Authenticity; Ritualized Eating	Associative learning, cultural conditioning	Food memories encoded as identity markers within limbic-hippocampal networks
Methodological innovation	Neuroimaging; Psychophysiological Measures; Neuromarketing	Multimodal data triangulation	Integrative use of behavioral + neural + affective indicators
Theoretical foundation	Embodied Cognition; Sensory Symbolism	Cognitive-affective synthesis	Sensory experiences as vehicles for emotional and cultural meaning

repeated pairings between specific foods and cultural contexts create neural representations that function as identity markers encoded within limbic-hippocampal memory systems.

Neurocognitive-emotional mapping framework

Table 3 synthesizes findings regarding specific brain structures mediating food-emotion interactions. This mapping framework integrates anatomical, functional and affective dimensions, illustrating how distributed neural systems coordinate to generate subjective eating experiences.

The amygdala functions as an emotional significance detector, rapidly evaluating whether a food stimulus warrants approach or avoidance. Its privileged access to olfactory information, bypassing the thalamic relay, enables immediate affective tagging before conscious processing. This mechanism explains why food aromas trigger instantaneous emotional reactions and vivid autobiographical memories.

The orbitofrontal cortex computes hedonic value by integrating multisensory food properties with internal state signals (hunger, satiety) and learned associations. OFC activity distinguishes “liking” (consummatory pleasure) from “wanting” (appetitive motivation), explaining dissociations in which individuals crave foods they ultimately do not enjoy consuming.

The hippocampus encodes episodic memories linking specific foods with particular contexts, people and emotional states. These associations shape future food preferences and eating behaviors, and hippocampal damage can lead to overeating due to the inability to recall recent meals accurately.

The insula processes interoceptive signals conveying internal bodily states, including taste sensations, visceral fullness and autonomic arousal. Insular activity generates conscious awareness of disgust, craving and satisfaction, bridging physiological and psychological dimensions of eating.

The ventral striatum mediates reward learning through dopaminergic signaling. Repeated pairings between food consumption and dopamine release strengthen preferences and motivate seeking behaviors, forming the neurobiological basis of food cravings.

The prefrontal cortex exerts executive control, enabling deliberate decision-making and inhibition of prepotent responses. Prefrontal-limbic interactions determine whether eating behaviors reflect automatic hedonic drives or goal-directed self-regulation, explaining individual differences in dietary self-control (Figure 3).

Table 3. Neurocognitive-emotional mapping framework

Brain region/System	Primary cognitive function	Associated emotional role	Food-related implication
Amygdala	Emotional salience detection	Fear, pleasure, reward sensitivity	Determines affective valence of food cues
Orbitofrontal cortex (OFC)	Hedonic valuation and decision-making	Pleasure computation, liking vs wanting	Integrates sensory reward and motivation
Hippocampus	Memory encoding and retrieval	Contextual emotional memory	Links food with autobiographical experiences
Insula	Interoception and taste processing	Disgust, craving, awareness	Processes internal states linked to taste satisfaction
Ventral striatum/ Nucleus accumbens	Reward learning	Anticipation, motivation	Reinforces preference and craving behaviors
Prefrontal cortex	Executive control and regulation	Self-regulation, planning	Modulates impulsive eating and goal-directed food choices

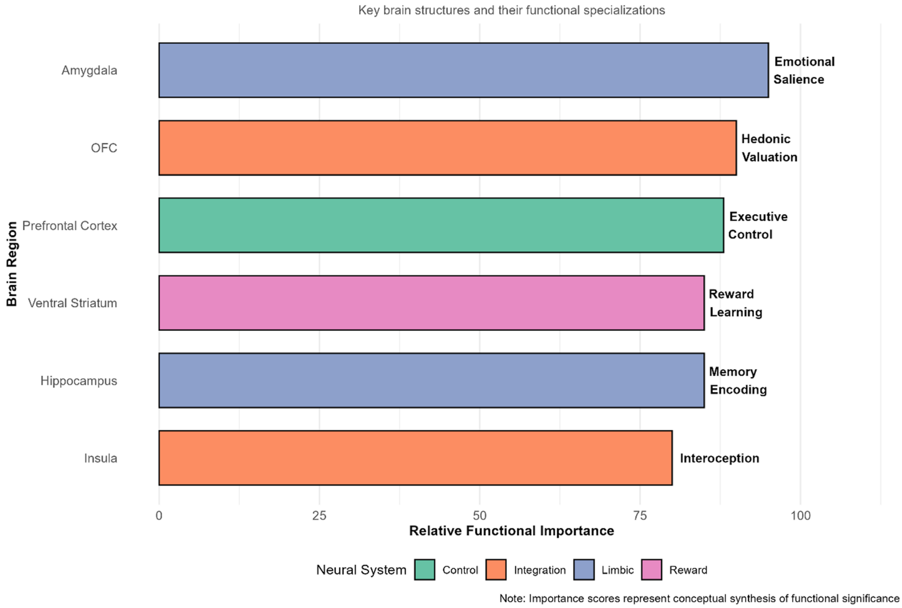

Figure 3. Neurocognitive architecture of food-emotion processing

Multisensory integration mechanisms

Table 4 delineates how distinct sensory modalities contribute to flavor construction and emotional food responses. Food perception emerges not from isolated sensory channels but through coordinated cross-modal integration, producing unified multisensory gestalts.

Visual information initiates expectation formation, with occipital processing projecting to OFC and amygdala. Color, shape and presentation style can predict likely flavor characteristics. When visual cues conflict with gustatory input (e.g. orange-flavored green jelly), the visual dominance effect often overrides taste perception, demonstrating top-down predictive coding.

Olfactory processing maintains a unique connection to the limbic system through direct projections from the olfactory bulb to the amygdala and hippocampus. This anatomical

Table 4. Multisensory modulators of flavor and emotion

Sensory modality	Primary neural pathway	Cognitive effect	Emotional outcome
Visual	Occipital → OFC → Amygdala	Expectation formation, flavor prediction	Aesthetic pleasure, visual dominance in evaluation
Olfactory	Olfactory Bulb → Amygdala/ Hippocampus	Associative memory, affective priming	Nostalgia, comfort, emotional immediacy
Auditory	Temporal Cortex → Limbic Pathways	Contextual enhancement, rhythm-mood coupling	Relaxation, anticipation, congruence with meal type
Gustatory	Gustatory Cortex → Insula → OFC	Taste coding, intensity evaluation	Satisfaction, disgust, craving
Tactile (Texture)	Somatosensory Cortex → OFC	Texture discrimination, novelty detection	Surprise, preference formation

shortcut facilitates rapid emotional priming and the retrieval of associative memories. Distinct food aromas can immediately evoke childhood memories, cultural identities and feelings of comfort or disgust with an intensity that is unparalleled by other sensory modalities.

Auditory context, including background music, ambient noise and food-related sounds such as sizzling and crunching, modulates the dining experience through pathways from the temporal cortex to the limbic system. Research on rhythm-mood coupling shows that musical tempo and genre can influence eating pace, portion choices and hedonic evaluation. A harmonious alignment between the auditory atmosphere and the type of meal enhances overall satisfaction.

Gustatory processing follows the established pathway from the gustatory cortex to the insula and then to the orbitofrontal cortex (OFC). The insula generates conscious awareness of taste, while the OFC assesses its hedonic value. The five basic tastes, sweet, salty, sour, bitter and umami, combine with somatosensory input to create complex flavor profiles, which can elicit feelings of satisfaction, disgust or craving, depending on learned associations and the individual's current physiological state.

Tactile discrimination of texture, processed in the somatosensory cortex and relayed to the OFC, plays a crucial role in food acceptability. Novel textures can provoke surprise and curiosity, while familiar textures offer reassurance. Textural incongruence, such as unexpectedly mushy or gritty foods, tends to elicit disgust responses, whereas preferred textures enhance hedonic evaluation and encourage consumption (Figure 4).

Cultural and contextual influences

Table 5 synthesizes how cultural factors modulate neurocognitive food–emotion relationships. Culture shapes not only which foods are consumed but also the neural mechanisms through which foods acquire emotional significance.

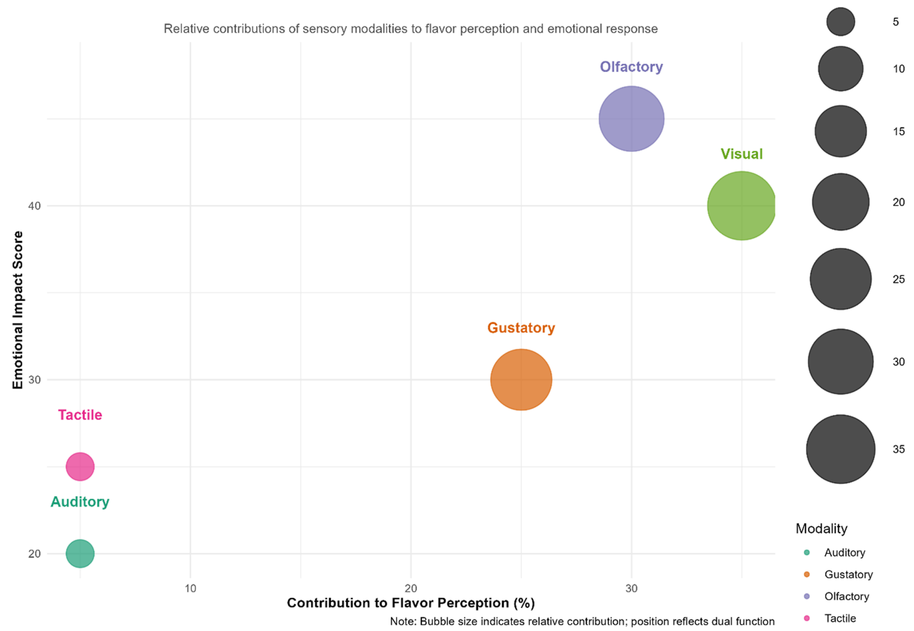

Figure 4. Multisensory integration in flavor and emotion

Table 5. Cultural and contextual influences on food–emotion link

Cultural factor	Neurocognitive mechanism	Behavioral manifestation	Emotional correlate
Familiarity with local cuisine	Enhanced activation in reward circuits	Preference for traditional foods	Comfort, belonging
Ritualized consumption	Memory-emotion coupling	Symbolic meals, celebration	Pride, nostalgia
Authenticity perception	Cognitive-affective congruence	Evaluation of “realness” in dishes	Trust, satisfaction
Globalization and hybrid foods	Cognitive dissonance in flavor expectation	Curiosity or aversion	Mixed affect, novelty response

Cultural familiarity modulates reward circuit activity, with culturally congruent foods eliciting stronger ventral striatum and OFC responses than unfamiliar cuisines. This enhanced activation reflects learned associations accumulated through repeated exposures during critical developmental periods. Familiar foods trigger feelings of comfort and belonging by activating neural representations encoding social and cultural identity.

Ritualized consumption practices from holiday meals to religious fasting exemplify memory-emotion coupling. Symbolic foods consumed during celebrations become associated with specific emotional states (joy, reverence, nostalgia) through hippocampal encoding. Subsequent encounters with these foods reactivate associated memories and affective states, explaining why particular dishes evoke powerful nostalgia or pride.

Authenticity perception involves cognitive-affective congruence between expected and experienced food characteristics. When foods meet cultural authenticity criteria, the match between prediction and reality generates trust and satisfaction. Conversely, perceived inauthenticity produces cognitive dissonance, manifesting as disappointment or skepticism regardless of objective flavor quality.

Globalization and hybrid foods create cognitive tension by violating established flavor expectation patterns. Fusion cuisines combining elements from multiple traditions may elicit curiosity (when novelty is valued) or aversion (when tradition is prioritized). This mixed affective response reflects a conflict between a neophilic drive toward novelty and a neophobic preference for familiarity, with outcomes varying across individuals and cultural contexts.

Methodological innovations and integration

Table 6 characterizes emerging methodological patterns enabling the investigation of unconscious and implicit dimensions of food-emotion processing that elude traditional self-report measures.

fMRI provides excellent spatial resolution for localizing neural activity but captures only slow hemodynamic responses, missing rapid temporal dynamics. Its strength lies in identifying which brain structures activate during specific food-related tasks.

EEG offers millisecond-level temporal precision, enabling tracking of rapid affective responses and attention shifts. However, poor spatial resolution limits precise anatomical localization. EEG excels at capturing emotional reactions as they unfold in real-time.

Eye-tracking reveals visual attention allocation and salience detection but provides limited information about accompanying emotional states. Integration with facial expression analysis or self-report addresses this limitation.

FaceReader and Emotion AI tools enable objective quantification of emotional responses through automated facial expression analysis. While powerful for neuromarketing applications, these tools exhibit culturally sensitive biases, as facial expression norms vary across cultures. Cross-cultural validation remains essential.

Table 6. Emerging methodological patterns in neurogastronomy research

Methodological tool	Primary measurement domain	Strengths	Limitations	Integration potential
fMRI	Spatial localization of neural activity	High spatial precision	Limited temporal resolution	Combines well with EEG or self-report
EEG	Temporal dynamics of neural response	Millisecond-level timing	Poor spatial accuracy	Excellent for affective response tracking
Eye-tracking	Visual attention, salience mapping	Real-time attentional data	Lacks emotional depth	Complements emotion recognition tools
FaceReader/ Emotion AI	Facial expression analysis	Objective emotional data	Culturally sensitive biases	Useful for neuromarketing and cultural comparison
Self-report and Surveys	Conscious perception, satisfaction	Subjective insight	Bias, social desirability	Anchors physiological data
Multimodal integration	Cross-method synthesis	Holistic understanding	Data complexity	Represents neurogastronomy standard

Self-report and surveys access conscious perceptions and satisfaction judgments unavailable through physiological measures alone. However, social desirability bias and limited introspective access to unconscious processes constrain validity. Self-report data anchor and contextualize physiological findings.

Multimodal integration combining neuroimaging, psychophysiological, behavioral and self-report measures represent the contemporary neurogastronomy standard. Triangulation across methods enables a holistic understanding while compensating for individual technique limitations. However, managing and synthesizing complex multimodal datasets requires sophisticated analytical frameworks (Figure 5).

Table 7 integrates findings into a multilayered systems model depicting food–emotion interactions as emergent properties of coordinated activity across sensory, cognitive, affective, motivational and cultural domains.

Evaluation leads to avoidance. Prefrontal self-regulation mechanisms help modulate these dominant responses, allowing eating behavior to be guided by deliberative choice rather than automatic impulses.

The cultural layer encompasses all preceding processes within symbolic frameworks, imbuing them with social meaning and identity. Cultural norms, ritual practices and standards of authenticity influence sensory processing, shape memory encoding, modulate affective responses and restrict behavioral options.

The integrative output, or subjective food experience, arises from the dynamic interaction across all layers. This complex architecture elucidates why seemingly straightforward questions like “Do you like this food?” require integrating neural, cognitive and cultural elements, resulting in experiences that cannot be distilled into a single layer or process (Figure 6).

Conclusion and discussion

This thematic review synthesized neurogastronomy research published between 2024 and 2025, organizing findings across six themes: theoretical foundations, neural architectures, multisensory integration, emotional regulation, cultural modulation and methodological

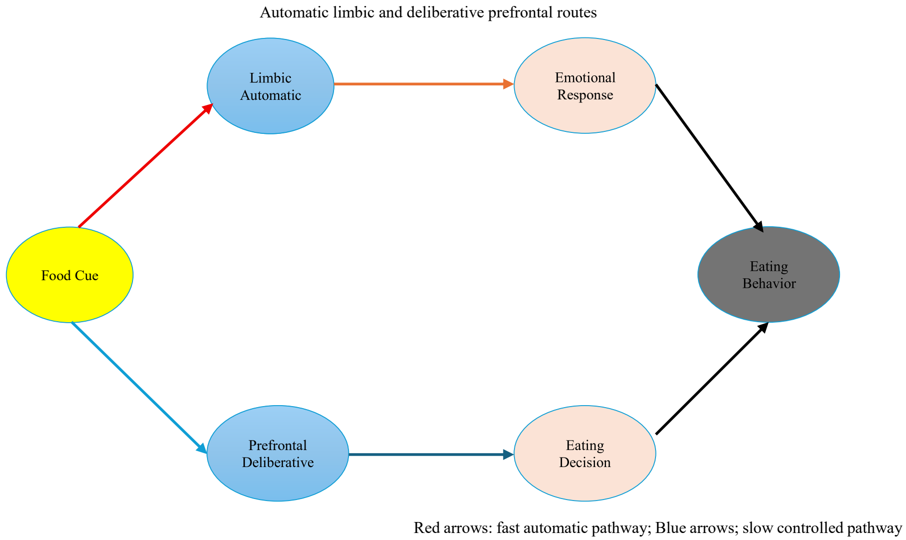

Figure 5. Dual pathways in emotional regulation of eating

Table 7. Synthesized conceptual model of neurocognitive food-emotion system

Systemic layer	Representative processes	Outcome dimension
Sensory layer	Visual, Olfactory, Gustatory, Tactile, Auditory Inputs	Flavor Perception
Cognitive layer	Prediction, Memory, Expectation	Perceptual Coherence
Affective layer	Valence, Arousal, Hedonic Evaluation	Emotional Response
Motivational layer	Desire, Craving, Self-Regulation	Eating Behavior
Cultural layer	Symbolism, Ritual, Authenticity	Social Meaning and Identity
Integrative output	Neural-Cognitive-Cultural Interaction	Subjective Food Experience

innovations. Across these domains, a consistent picture emerges: flavor perception is constructed in the brain through predictive coding, in which top-down expectations interact with sensory inputs from multiple modalities rather than any single channel. Emotional responses to food engage a coordinated network spanning amygdala salience detection, orbitofrontal hedonic valuation and hippocampal memory consolidation, with cultural background shaping all three through experience-dependent plasticity.

Several gaps recur throughout the literature. Approximately 75% of included studies drew on Western populations, which limits what can be said about the generalizability of identified mechanisms to the diverse culinary traditions and tourist markets that hospitality research must address. Laboratory settings, though useful for controlling confounds, do not replicate the social, temporal and contextual dynamics of real eating environments. Translation from neuroscientific findings to practical application in culinary education, food service and gastrotourism remains weak. Methodological heterogeneity across studies, including variation in neuroimaging protocols, stimulus formats and outcome measures, further complicates systematic comparison.

The dual-systems architecture of prefrontal control and limbic evaluation, documented by Avery *et al.* (2015), reveals more dynamic competition between systems than earlier inhibitory models suggested (Kaye *et al.*, 2013). Limbic activation can capture prefrontal resources under

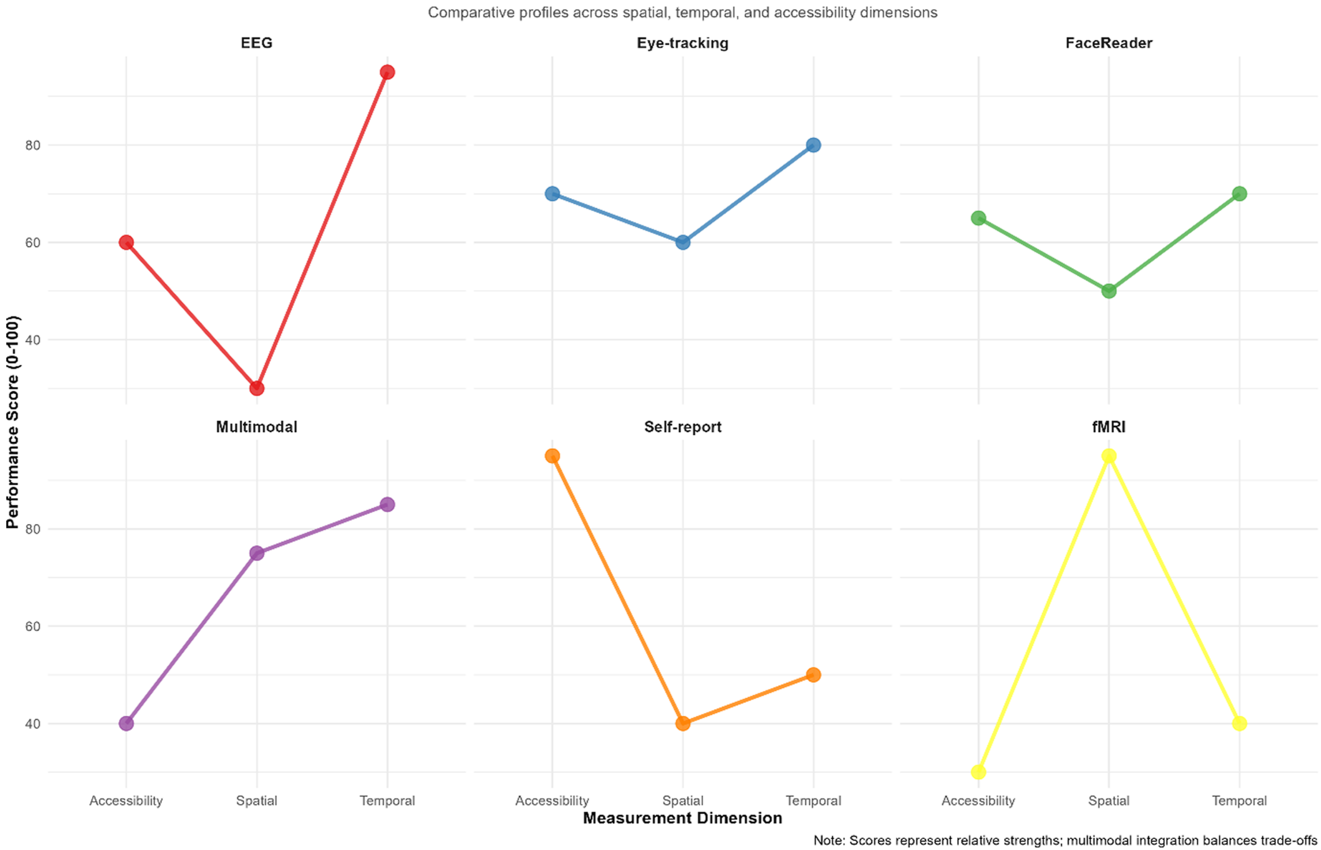

Figure 6. Methodological landscape in neurogastronomy research

stress, a finding relevant to understanding why guests make different food choices in high-arousal dining contexts than in calm ones. Zimmerman *et al*. (2025) identification of amygdala-based flavor memory maintenance extends Garcia and Koelling (1966) behavioral observations by specifying the neural mechanism, while Décarie-Spain *et al*. (2025) hippocampal meal memory circuits complement this by linking memory consolidation to eating regulation. Translation to human contexts remains uncertain, however, given the differences between rodent feeding environments and the socially embedded eating experiences typical of restaurant and tourism settings.

Multisensory findings confirm Spence (2015) framework while extending it beyond olfactory–visual interactions. Ucuk *et al*. (2025) demonstrated visual effects on neural activity and willingness to pay; Vukolić *et al*. (2025) and Berčík *et al*. (2025) added auditory and olfactory dimensions. The cross-cultural universality of these mechanisms cannot be assumed, given the geographic concentration of the evidence base. On emotional regulation, Morse and Garcia (2025) gut–brain pathway research advances correlational work, but Wu *et al*. (2025) expectancy findings suggest that comfort food effects may operate largely through psychological meaning rather than nutritional content, a point that shifts how hospitality operators might think about menu narrative and emotional resonance. These two accounts are not yet reconciled in the literature.

Cultural modulation findings support the view that neural differences in food processing reflect learned associations rather than fixed biological variation. Berčík *et al*. (2025) Spanish-Slovak comparison provides direct evidence, though restricting analysis to two European cultures limits the conclusions that can be drawn. Yılmaz (2025) bibliometric analysis documents the persistence of Western centrism as a structural feature of the field rather than a peripheral concern. Standardized protocols, shared databases and open science practices would support more cumulative knowledge building, particularly across the international collaborations that cross-cultural gastrotourism research requires.

Theoretical implications

Five contributions stand out from this synthesis. First, the evidence supports multilevel systems frameworks in which food–emotion interactions arise from coordinated activity across sensory, cognitive, affective, motivational and cultural levels. These levels do not operate in sequence; each influences the others through bidirectional connections that generate feedback over time, and no single level offers a sufficient account on its own.

Second, predictive construction frameworks gain support from the reviewed evidence. The brain generates expectations about incoming sensory input based on prior experience, context and cultural knowledge, and gustatory signals primarily confirm or revise those expectations rather than passively registering objective food properties. Visual dominance effects, expectancy-driven comfort food consumption and context-dependent flavor enhancement all fit this account.

Third, the bidirectionality of food-emotion relationships requires models that represent adaptive and maladaptive feedback loops explicitly. Foods influence emotion through multiple pathways, while emotional states shape food selection, and these cycles play out differently across acute eating occasions and longer dietary patterns. Hospitality and gastrotourism frameworks that treat food preference as a stable individual characteristic underestimate this dynamic.

Fourth, cultural embeddedness means that culture shapes neural mechanisms through experience-dependent plasticity rather than acting as an external modifier of fixed biology. This challenges implicit universalism in neurogastronomy research and calls for frameworks in which cultural variation is treated as foundational rather than as a complicating footnote.

Fifth, conscious and unconscious processes operate in parallel rather than in sequence. Models that assume either deliberate control or automatic responding as the default misrepresent the competitive interaction between these systems, which varies across individuals, contexts and emotional states.

Practical implications

Integrating neurogastronomy into culinary programs would give students evidence-based foundations for plating, sensory design and cross-cultural adaptation of dishes. This includes understanding why visual presentation affects neural responses, how auditory environment shapes taste perception and why the same dish may be experienced differently by guests from different food cultures. Implementation requires faculty development and accessible pedagogical formats; partnerships between academic neuroscience and culinary schools offer the most direct route.

For restaurant and tourism operators, the reviewed evidence points toward coherent multisensory environment design as a strategic variable rather than an aesthetic one. Coordinating lighting, sound, plating and service sequencing can produce qualitatively different guest experiences than managing these elements independently. Operators serving internationally diverse guests face the additional task of calibrating sensory environments to culturally variable expectations, which the current evidence base does not yet fully support but identifies as a priority.

Neurogastronomic principles can inform interventions aimed at improving dietary quality, including environmental nudges based on multisensory cues, expectancy-based reframing of healthy foods and strategically timed messaging. Any such application must account for cultural food traditions and avoid designs that inadvertently promote disordered eating patterns.

Memory-based and expectancy-targeted interventions, including exposure therapies addressing maladaptive food associations and mindfulness approaches strengthening interoceptive awareness, draw directly on the mechanisms reviewed here. Translating these from non-clinical laboratory findings to patient populations requires disorder-specific validation, particularly given that eating disorders involve neural and psychological processes that may differ substantially from normative samples.

Neuroscientific consumer research offers food and hospitality businesses more objective insight into emotional responses to products, menus and environments than behavioral surveys alone. The ethical dimension of this application is substantial. Deploying neuroscientific methods to influence purchasing decisions through unconscious channels without disclosure raises questions of consumer autonomy that the field has not yet adequately addressed. Transparent guidelines specifying what disclosures are required and what applications cross into manipulation are now necessary rather than optional.

Limitations

Several constraints bound this review’s conclusions. The 2024-2025 temporal focus ensures currency but limits historical context; mechanisms identified in recent studies gain additional interpretive weight when situated within longer intellectual trajectories, and future reviews should aim to balance recency with genealogical depth.

The geographic concentration of the evidence base, with approximately 75% of sources drawn from Western settings, is the most consequential limitation. Whether the neural and behavioral patterns identified here reflect universal mechanisms or culturally specific adaptations cannot be determined from this corpus alone. Addressing this requires not only sampling from more diverse populations but also designing studies in genuine collaboration with non-Western research communities rather than simply applying Western protocols in new settings.

Language restrictions to English and Turkish likely excluded relevant contributions from East Asian, Latin American and other research communities, introducing systematic gaps in the geographic coverage of the synthesis. Single-researcher coding, despite the systematic procedures employed, introduces subjectivity that collaborative coding teams would reduce. Publication bias toward positive findings, and the underrepresentation of null results, may inflate the apparent consistency of some reviewed mechanisms. The gap between controlled laboratory paradigms and naturalistic eating contexts remains a pervasive methodological limitation across the field, not only this review; mobile EEG and wearable physiological sensors offer a partial solution that should be adopted more widely in future primary research. Methodological heterogeneity across included studies complicated direct comparison and limited the precision of thematic synthesis, a problem that standardized reporting protocols and shared data infrastructure would help resolve.

Recommendations for future research

Cross-cultural comparative research is the field's most pressing need. Studies using identical protocols across populations with fundamentally different flavor traditions, including Indigenous communities, immigrant groups navigating multiple food cultures and societies undergoing dietary transition, would clarify which mechanisms are universal and which are culturally adaptive. Genuine collaboration with these communities as research partners rather than sample sources is essential for both scientific validity and ethical practice.

Longitudinal developmental studies tracking participants from infancy through adulthood would shed light on when food–emotion associations form, whether critical periods of heightened plasticity exist, and how aging changes multisensory integration. These studies are resource-intensive but would provide the kind of causal evidence that cross-sectional designs cannot.

Naturalistic investigations using mobile EEG, wearable physiological sensors and ecological momentary assessment would test whether laboratory findings hold in real dining environments, including the social, temporal and environmental complexity of restaurant and gastrotourism settings. Validation against laboratory benchmarks, rather than simple replacement, is the appropriate methodological goal.

Precision approaches examining individual variation in genetic profiles, early experience and neural biomarkers would support personalized interventions rather than population-level averages. Machine learning applied to multimodal data may identify individual-level patterns not visible to traditional group comparisons.

Ethical framework development for neuromarketing applications in food and hospitality is overdue. Required elements include disclosure standards for the use of neuroscientific consumer research, protections for consumer autonomy, regulatory consideration of unconscious influence techniques and governance structures with meaningful stakeholder input. These frameworks should be developed through interdisciplinary collaboration involving ethicists, regulators, consumer advocates and industry representatives rather than by any single sector.

Finally, integrating neurogastronomy with food system sustainability research would extend the field's practical reach. Examining whether sensory optimization can increase acceptance of plant-based foods, reduce portion dissatisfaction or strengthen the perceived authenticity of sustainable local cuisines connects neurogastronomic insights to food policy questions with broad public relevance.

References

Adelaiv, A., Martiniuc, C. and Dascalescu, G. (2024), "Analysis of visual brand identity in the fast-food sector: a neuromarketing study", *Revista de Ciencias*, Vol. 28 No. 2, pp. 45-67, doi: 10.35742/rcci.2024.29.e300.

Arnett, A.B., Peisch, V. and Levin, A.R. (2022), "The role of aperiodic spectral slope in event-related potentials and cognition among children with and without attention deficit hyperactivity disorder", *Journal of Neurophysiology*, Vol. 128 No. 6, pp. 1546-1554, doi: 10.1152/jn.00295.2022.

Avery, J.A., Kerr, K.L., Ingeholm, J.E., Burrows, K., Bodurka, J. and Simmons, W.K. (2015), "A common gustatory and interoceptive representation in the human mid-insula", *Human Brain Mapping*, Vol. 36 No. 8, pp. 2996-3006, doi: 10.1002/hbm.22823.

Berčík, J., Mravcová, A., Sendra Nadal, E., López Lluch, D. and Farkaš, A. (2025), "FaceReader as a neuromarketing tool to compare the olfactory preferences of customers in selected markets", *Spanish Journal of Marketing*, Vol. 29 No. 1, pp. 67-89, doi: 10.1108/SJME-03-2023-0050.

Bhaskar, R. (1975), *A Realist Theory of Science*, Leeds Books, London.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77-101, doi: 10.1191/1478088706qp063oa.

Casiraghi, C., Fici, A., Bilucaglia, M., Rossi, C., Zito, M. and Russo, V. (2025), "Processing every bite: a neuroscientific analysis of the eating experience and its cognitive and emotional dynamics", *Current Psychology*, Vol. 44 No. 3, pp. 1247-1268, doi: 10.1007/s12144-025-08104-3.

Chang, S., Zhang, X., Cao, Y., Pearson, J. and Meng, M. (2025), "Imageless imagery in aphantasia revealed by early visual cortex decoding", *Current Biology*, Vol. 35 No. 3, pp. 591-599, doi: 10.1016/j.cub.2024.12.012.

Décarie-Spain, L., Heck, A.L., Gerson, J.O., Giuliano, C., Arnold, M., Stein, L.M., Parent, M.B., Kesby, J.P., Tsan, L., Stevenson, R.J., Francis, H.M., Smail, M.A., Hayes, M.R., Kanoski, S.E. and Benoit, S.C. (2025), "Ventral hippocampus neurons encode meal-related memory and regulate food intake via lateral hypothalamus projections", *Nature Communications*, Vol. 16, 3876, doi: 10.1038/s41467-025-59687-1.

Erkocaaslan, E. and Ay, M. (2025), "Color flavor illusion: the role of visual stimuli in food choices", *ART/icle: Sanat ve Tasarım Dergisi*, Vol. 5 No. 1, pp. 1-18, doi: 10.56590/stdarticle.1588455.

Garcia, J. and Koelling, R.A. (1966), "Relation of cue to consequence in avoidance learning", *Psychonomic Science*, Vol. 4 No. 1, pp. 123-124, doi: 10.3758/BF03342209.

Huang, L., Dai, Y., Zhang, F., Zhang, L., Zheng, B. and Zhang, Y. (2024), "Insights into the enhancement of food flavor perception: strategies, mechanism and emulsion applications", *Food Science and Human Wellness*, Vol. 13 No. 5, pp. 2410-2424, doi: 10.26599/FSHW.2022.9250199.

Kaye, W.H., Wierenga, C.E., Bailer, U.F., Simmons, A.N. and Bischoff-Grethe, A. (2013), "Nothing tastes as good as skinny feels: the neurobiology of anorexia nervosa", *Trends in Neurosciences*, Vol. 36 No. 2, pp. 110-120, doi: 10.1016/j.tins.2013.01.003.

Li, H., Li, S., Matsuo, K. and Okamoto, T. (2025), "Brain activity during a cognitive task after consuming food of varying palatability", *Frontiers in Psychology*, Vol. 16, 1522812, doi: 10.3389/fpsyg.2025.1522812.

Liang, Y., Zhao, Q., Ye, Z., Chen, J., Chen, S., Ye, X. and Cheng, H. (2025), "Bridging food and mood: what foods are defined as 'mood foods', and how do they modulate our emotions?", *Trends in Food Science and Technology*, Vol. 161, 105059, doi: 10.1016/j.tifs.2025.105059.

Lloyd-Parkes, E. and Filipponi, T. (2025), "Authenticity and commercialisation: a dialogical, autoethnographic exploration of the tensions in gastrotourism", *Gastronomy*, Vol. 3 No. 3, p. 11, doi: 10.3390/gastronomy3030011.

Morse, M.B. and Garcia, B. (2025), "Food and mood: current evidence on mental health and the microbiota-gut-brain axis", *Current Psychiatry Reports*, Vol. 27 No. 11, pp. 1-10, doi: 10.1007/s11920-025-01636-2.

O'Donovan, F., Carney, S., Kennedy, J., Hayes, H., Pender, N., Boland, F. and Stanton, A. (2019), "Associations and effects of omega-3 polyunsaturated fatty acids on cognitive function and mood in healthy adults: a protocol for a systematic review of observational and interventional studies", *BMJ Open*, Vol. 9 No. 6, e027167, doi: 10.1136/bmjopen-2018-027167.

Sadikzade, R. and Turhan, K.N. (2024), "A review of neuromarketing applications in gastronomy", *2024 Medical Technologies Congress (TIPTEKNO)*, IEEE, pp. 1-4, doi: 10.1109/TIPTEKNO63488.2024.10755261.

Shepherd, G.M. (2006), "Smell images and the flavour system in the human brain", *Nature*, Vol. 444 No. 7117, pp. 316-321, doi: 10.1038/nature05405.

Shepherd, G.M. (2012), *Neurogastronomy: How the Brain Creates Flavor and Why it Matters*, Columbia University Press, London.

Spence, C. (2015), "Multisensory flavor perception", *Cell*, Vol. 161 No. 1, pp. 24-35, doi: 10.1016/j.cell.2015.03.007.

Sutton, D. and Vournelis, L. (2025), "'I don't like the taste of that smell!' the edible and the non-edible in Greece: within reach but beyond the bite", *The Senses and Society*, Vol. 20 No. 2, pp. 1-7, doi: 10.1080/17458927.2025.2508106.

Süzer, Ö. and Ceylan, G.A. (2025), "Nörogastronominin mevcut durumu ve geleceği: akademisyenler özelinde bir değerlendirme", *Uluslararası Güncel Turizm Araştırmaları Dergisi*, Vol. 9 No. 1, pp. 80-87, doi: 10.30625/ijctr.1652134.

Ucuk, C., Percin, N.S., Cevik, C., Al, T. and Kara, I. (2025), "Can the image of food mislead the brain? Neurogastronomy research with EEG and emotion recognition", *International Journal of Gastronomy and Food Science*, Vol. 39, 101097, doi: 10.1016/j.ijgfs.2024.101097.

Vasile, A., Martiniuc, C. and Dascalescu, G. (2024), "Neuromarketing and food decisions: an interdisciplinary analysis of the influence of sensory and emotional stimuli on consumer behavior", *Annals of the University of Oradea, Economic Science Series*, Vol. 33 No. 1, pp. 234-247.

Vukolić, D., Gajić, T., Popović, A., Trebovac, T.A. and Knežević, S. (2025), "Guest perceptions of the role of music in gastronomic experiences", *International Journal of Gastronomy and Food Science*, Vol. 42, 101327, doi: 10.1016/j.ijgfs.2025.101327.

Wang, Y., Dong, D., Todd, J., Du, J., Yang, Z., Lu, H. and Chen, H. (2016), "Neural correlates of restrained eaters' high susceptibility to food cues: an fMRI study", *Neuroscience Letters*, Vol. 631, pp. 56-62, doi: 10.1016/j.neulet.2016.08.017.

Wu, F., Vartanian, L.R. and Faasse, K. (2025), "Why do we eat comfort food? Exploring expectations regarding comfort food and their relationship with comfort eating frequency", *Nutrients*, Vol. 17 No. 14, p. 2259, doi: 10.3390/nu17142259.

Yılmaz, M. (2025), "Development of food flavor perception in gastronomy: a bibliometric study on neurogastronomy", *Safran Kültür ve Turizm Araştırmaları Dergisi*, Vol. 8 No. 1, pp. 89-108.

Zimmerman, C.A., Gonzalez, M.V., Li, J.Y., Tye, K.M., Keppler, E.F., Meares-Garcia, J.B., Guthman, E.M., Fetcho, R.N., McMannon, B., Lee, J., Hoag, A.T., Lynch, L.A., Janarthanan, S.R., López Luna, J.F., Bondy, A.G., Falkner, A.L., Wang, S.S.H. and Witten, I.B. (2025), "A neural mechanism for learning from delayed postingestive feedback", *Nature*, Vol. 642 No. 8068, pp. 700-709, doi: 10.1038/s41586-025-08828-z.

Corresponding author
Erdem Baydenïz can be contacted at: erdembydeniz@gmail.com