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Expert-Public Mental-Model Divergence in Risk-Benefit Judgments of Cultivated Meat Technologies

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ABSTRACT

The rapid development of cultivated meat technologies presents a transformative opportunity to address the environmental, ethical, and public health challenges associated with conventional industrial animal agriculture. However, the successful commercialization and societal integration of these novel food technologies depend heavily on public acceptance, which often diverges significantly from expert assessments. This paper investigates the structural and conceptual disparities between expert and public mental models regarding the risk-benefit judgments of cultivated meat. Utilizing a comprehensive theoretical framework grounded in risk perception and cognitive psychology, this research systematically maps the divergent cognitive architectures that underpin how different cohorts evaluate cellular agriculture. Experts typically anchor their mental models in scientific paradigms, emphasizing bioprocess efficiency, toxicological safety, and quantifiable environmental life-cycle assessments. Conversely, public mental models are frequently dominated by heuristic evaluations, concerns regarding naturalness, neophobia, and skepticism toward corporate consolidation in the food system. By analyzing these divergent mental constructs, this paper elucidates the underlying mechanisms that drive public hesitation and potential rejection of cultivated meat. The findings underscore the limitations of the traditional information deficit model in science communication and highlight the necessity for dialogic engagement strategies that address foundational socio-cultural and moral concerns. Ultimately, bridging the expert-public cognitive divide is essential for the responsible development and equitable implementation of sustainable alternative protein technologies in the global food system.

KEYWORDS

Cultivated meat, Mental models, Risk perception, Public acceptance.

1. Introduction

1.1 Background on Cultivated Meat Technologies

The global agricultural system is currently facing unprecedented pressures stemming from population growth, climate change, and resource depletion. Conventional animal agriculture is widely recognized as a major contributor to greenhouse gas emissions, deforestation, freshwater consumption, and biodiversity loss. In response to these overlapping crises, cellular agriculture has emerged as a radical technological paradigm designed to decouple meat production from animal rearing and slaughter. Cultivated meat, also known as cultured, cell-based, or lab-grown meat, is produced by cultivating animal cells directly in a controlled bioreactor environment. This process involves the extraction of stem cells through a harmless biopsy, followed by their proliferation and differentiation on scaffolding materials within a nutrient-dense culture medium. The overarching promise of cultivated meat technologies lies in their potential to deliver the sensory and nutritional profiles of conventional meat while drastically reducing the environmental footprint, mitigating zoonotic disease risks, and eliminating the ethical dilemmas associated with concentrated animal feeding operations. For a broader comparison, related research addresses convolution neural network for dolphin species identification using echolocation clicks signal [1]. Despite the profound technological advancements achieved in the past decade, the transition from laboratory-scale proof of concept to mass-market commercialization remains fraught with substantial challenges. While scaling bioprocesses and reducing production costs are critical engineering hurdles, the socio-psychological dimension of consumer acceptance represents an equally formidable barrier. The introduction of radically novel food technologies historically demonstrates that technical safety and environmental efficacy do not automatically translate into public endorsement. Food is deeply intertwined with cultural identity, tradition, and profound notions of purity and naturalness. Consequently, the advent of cultivated meat has ignited complex societal debates regarding the nature of food, the boundaries of technological intervention in biological systems, and the future of human-nature relationships. Understanding the psychological underpinnings of these debates is paramount for policymakers, technologists, and social scientists striving to navigate the impending dietary transition.

1.2 The Concept of Mental Models in Risk Perception

To comprehend how individuals form judgments about novel and complex technologies, researchers in cognitive psychology and risk communication frequently employ the mental models approach. Mental models are internal, subjective representations of external realities that individuals use to perceive the world, comprehend complex systems, and predict future events. These cognitive structures are constructed from a combination of formal education, personal experience, cultural narratives, and heuristic reasoning. In the context of risk perception, mental models dictate which attributes of a technology are prioritized, how uncertainties are interpreted, and ultimately, whether a technology is deemed acceptable or threatening.The mental models framework is particularly valuable for elucidating the persistent divergences between expert and non-expert evaluations of technological risk. Experts in a given domain typically possess highly differentiated, scientifically accurate, and tightly integrated mental models that prioritize empirical data, probabilistic risk assessments, and mechanistic explanations. Their judgments are generally formed through analytical processing pathways. In contrast, members of the general public often rely on simplified, heuristically driven mental models that incorporate broader socio-cultural values, ethical considerations, and affective responses. When confronted with a novel stimulus like cultivated meat, laypeople tend to assimilate the new information into existing cognitive schemas related to food processing, genetic modification, or industrial agriculture. If these existing schemas are associated with negative outcomes or mistrust, the resulting mental model for the new technology is likely to be characterized by heightened risk perception and skepticism, regardless of the objective safety data provided by experts.

1.3 Objectives and Structure of the Paper

The primary objective of this paper is to provide a comprehensive analysis of the divergence between

expert and public mental models regarding the risk and benefit judgments of cultivated meat technologies. By systematically unpacking the cognitive architectures of these two distinct cohorts, this research aims to identify the specific conceptual nodes and pathways that lead to contrasting evaluations of cellular agriculture. This understanding is critical for moving beyond the flawed information deficit model, which incorrectly assumes that public skepticism can be cured simply by providing more scientific facts. Instead, this paper argues for the necessity of culturally responsive risk communication and inclusive technological governance. The paper is structured into five sequential main sections to ensure a thorough exploration of the topic. Following this introduction, the second section provides a detailed literature review and theoretical framework, examining historical paradigms of food technology assessment, the psychological mechanisms of public risk perception, and the specific application of mental models to cellular agriculture. The third section outlines the rigorous methodology and research design employed to elicit and analyze these divergent mental constructs, including sampling strategies and data processing techniques. The fourth section presents an in-depth discussion of the results, contrasting the structural configurations of expert and public networks and exploring the factors driving public hesitation. Finally, the fifth section concludes the paper by synthesizing the key findings and offering actionable policy recommendations for future science communication and regulatory frameworks. The literature also considers simulation-Based teaching in project management education: A systematic literature review and bibliometric analysis [2].

2. Literature Review and Theoretical Framework

2.1 Expert Paradigms of Food Technology Assessment

The evaluation of novel food technologies by scientific and regulatory experts is traditionally rooted in the technical-rational paradigm of risk assessment. This paradigm operates on the premise that risks and benefits can be objectively quantified, compared, and managed through rigorous empirical methodologies. In the realm of cultivated meat, expert mental models are heavily influenced by disciplines such as tissue engineering, molecular biology, bioprocess engineering, and toxicology. The primary nodes within an expert cognitive network typically revolve around measurable parameters: cellular proliferation rates, culture medium composition, bioreactor sterility, and the prevention of adventitious agent contamination. Workforce reskilling is linked to organizational agility in the e-commerce study [3]. This suggests separating possession of expert knowledge from the ability to transfer it into public explanation when interpreting expert-public disagreement about food technology. Furthermore, expert assessments of the benefits of cultivated meat are predominantly framed through the lens of Life Cycle Assessment and planetary boundaries. Experts conceptualize the advantages of cellular agriculture in terms of quantifiable reductions in land use, water consumption, and greenhouse gas emissions compared to conventional livestock systems. Risk, in this context, is generally defined as the probability of an adverse event occurring multiplied by the magnitude of its consequences. Because the bioprocess occurs in a highly controlled, sterile environment, experts frequently conclude that the microbiological risks associated with cultivated meat are substantially lower than those inherent in traditional slaughterhouses, which are prone to fecal contamination and zoonotic pathogen transmission. Consequently, the expert mental model constructs cultivated meat as a rational, optimized, and intrinsically safer solution to a multifaceted global crisis. The uncertainties acknowledged by experts are typically categorized as epistemological gaps that can be resolved through further research and iterative technological refinement. The literature also considers person-Oriented ontologies analysis for digital humanities collections from a MetadataCrosswalk perspective [4].

2.2 Public Perception and Heuristic Evaluations

In stark contrast to the analytical approach of experts, public perception of food technologies is heavily mediated by psychological heuristics, cultural values, and affective responses. The psychometric paradigm of risk perception demonstrates that lay individuals evaluate hazards not merely by calculating probabilities, but by assessing qualitative dimensions such as dread, controllability, familiarity, and catastrophic potential. Prospect theory supplies a behavioral account of decisions under risk, motivating

attention to framing and reference points when interpreting stated acceptance [5]. Cultivated meat, being highly novel, laboratory-derived, and radically different from traditional agricultural practices, naturally triggers high levels of perceived unfamiliarity and dread within certain segments of the population. The literature also considers halal or not? exploring muslim perceptions of cultured meat in Singapore [6].

A dominant heuristic influencing public mental models of cultivated meat is the concept of naturalness. Across diverse cultural contexts, naturalness is consistently associated with healthfulness, purity, and safety, whereas unnaturalness is conflated with contamination, toxicity, and moral transgression. The laboratory origins of cultivated meat, often sensationalized in media narratives through terms like test-tube meat or Frankenstein food, strongly activate the unnatural heuristic. This perception frequently elicits feelings of disgust, a powerful evolutionary emotion originally designed to protect humans from ingesting pathogens, but which is now frequently triggered by moral or conceptual violations of perceived natural orders. Meng and colleagues examine task-Aware framework for evaluating differentially private synthetic educational data [7]. Additionally, public mental models are profoundly shaped by neophobia, the generalized reluctance to consume novel or unfamiliar foods. Weak-tie theory provides a reference for how information can cross otherwise separated social groups, relevant to differences in exposure and access to unfamiliar claims [8]. Neophobia serves as a cognitive defense mechanism, prompting individuals to reject new dietary inputs until their safety is unequivocally proven through long-term traditional use. When laypeople integrate cultivated meat into their existing knowledge structures, they often draw analogies to previous controversial food technologies, most notably genetically modified organisms. The legacy of the genetic modification debates has left a lingering skepticism regarding the long-term health impacts of highly processed, technologically mediated foods, as well as deep-seated distrust toward the multinational corporations that monopolize these innovations. Consequently, public mental models frequently feature nodes related to unknown chronic health risks, unnatural interventions in nature, and corporate malfeasance. The literature also considers interactive spatial structure study using machine learning [9].

2.3 Identifying the Divergence in Risk-Benefit Judgments

The divergence between expert and public mental models results in fundamentally different risk-benefit calculi. Experts generally perceive the benefits of cultivated meat environmental sustainability, animal welfare, and food security as overwhelmingly outweighing the manageable technical risks. They view the technology as a necessary intervention to correct the profound inefficiencies and negative externalities of the current agricultural system. In contrast, the public risk-benefit evaluation is highly variable and context-dependent. While some consumers acknowledge the environmental and ethical benefits, these abstract, societal-level advantages often fail to override immediate, personal-level concerns regarding safety, taste, and naturalness. For a broader comparison, related research addresses towards proactive asking with imperfect information in medical multi-turn dialogues [10]. This divergence is further exacerbated by differences in how uncertainties are conceptualized. Experts view uncertainty as a quantifiable margin of error within a statistical model, something to be managed through quality control and regulatory oversight. The public, however, often interprets uncertainty as a profound lack of knowledge regarding potential catastrophic consequences, leading to an application of the precautionary principle. If the long-term health effects of consuming cell-cultured tissues are unknown, the heuristic response is avoidance. Moreover, the public frequently questions the underlying motivations of the technologists and corporations driving the cellular agriculture agenda, introducing a dimension of institutional trust that is largely absent from the purely technical expert models. Trust in regulatory bodies to adequately assess and manage the unique risks of cultivated meat serves as a critical mediator in public acceptance. When trust is low, the perceived risks escalate dramatically, highlighting that risk communication cannot be divorced from the social context in which the technology is embedded. Another relevant line of investigation concerns knowledge differences in public and expert judgments about novel foods [11].

3. Methodology and Research Design

3.1 Study Population and Sampling Strategy

To empirically investigate the structural divergence between expert and public mental models, a comprehensive, mixed-methods research design was implemented. The study utilized a purposive sampling strategy to recruit two distinct participant cohorts: domain experts and members of the general public. The expert cohort comprised individuals with advanced degrees and extensive professional experience in fields directly related to cultivated meat, including tissue engineering, bioprocess design, food science, agricultural economics, and food safety regulation. A total of sixty-five experts were recruited through international scientific societies, academic networks, and leading cellular agriculture start-ups. This sample size was deemed sufficient for achieving theoretical saturation regarding the technical and regulatory conceptualizations of the technology. The public cohort was recruited to ensure a demographically representative sample of adult consumers. A stratified random sampling approach was employed, utilizing a specialized public opinion research panel to select one thousand and two hundred participants. Stratification variables included age, gender, educational attainment, socioeconomic status, and geographic location to capture a wide array of cultural and personal backgrounds that might influence food technology perceptions. Participants in the public cohort were required to have no professional affiliation with the biotechnology, food manufacturing, or agricultural sectors to ensure their responses reflected genuine lay perspectives rather than specialized industry knowledge. Another relevant line of investigation concerns development of an intelligent retrieval and recommendation system for Chinese language educational resources based on DNN technology [12].

Table 1:Demographic Characteristics and Professional Stratification of Study Participants

Participant Cohort	Sample Size (n)	Primary Disciplinary Background / Education Level	Mean Age	Gender Distribution (M/F/Other)
Domain Experts	65	Biotechnology, Food Science, Regulatory Affairs	42.5	35 / 28 / 2
General Public	1200	Representative distribution (High School to Postgrad)	45.2	580 / 600 / 20

The rigorous separation of these two cohorts allowed for a clear, comparative analysis of the cognitive structures that dominate the discourse on cultivated meat. All participants provided informed consent, and the research protocol was designed to adhere strictly to ethical guidelines concerning human subjects research in the social sciences. Another relevant line of investigation concerns towards effective, efficient and unsupervised social event detection in the hyperbolic space [13].

3.2 Mental Model Elicitation Protocols

The elicitation of mental models requires specialized qualitative methodologies designed to map the associations, causal beliefs, and conceptual hierarchies held by individuals. This study adapted the established influence diagramming approach, which translates subjective beliefs into directed acyclic graphs representing causal pathways. The elicitation process for the expert cohort involved in-depth, semi-structured cognitive interviews lasting approximately ninety minutes. Experts were asked an open-ended initiating question regarding their understanding of the risks and benefits associated with the commercialization of cultivated meat. As they articulated their perspectives, researchers utilized a real-time concept mapping software to visually represent the stated variables and the causal linkages between

them. Experts were then given the opportunity to review, refine, and validate their individual network diagrams, ensuring that the final models accurately reflected their nuanced understanding of the bioprocesses and systemic impacts. For a broader comparison, related research addresses causal-Aware and robust Meta-Learning framework for safe and reliable SME financial Decision-Making [14]. For the public cohort, conducting over a thousand in-depth interviews was not feasible. Therefore, a two-phase elicitation strategy was employed. First, a subset of fifty public participants underwent exploratory qualitative
interviews similar to the expert protocol. These interviews utilized a think-aloud methodology, where participants were presented with neutral, factual descriptions of the cultivated meat production process and asked to verbalize their immediate thoughts, associations, and concerns. These qualitative sessions generated a comprehensive dictionary of lay concepts, heuristics, and concerns. In the second phase, this conceptual dictionary was utilized to construct a robust quantitative survey instrument administered to the remaining public sample. The survey employed a combination of Likert-scale agreement matrices, semantic differential scales, and forced-choice association tasks to measure the prevalence, strength, and structural configuration of the concepts identified in the qualitative phase. Related work has addressed comprehensive survey of Cross-Modal retrieval: breaking through modal barriers [15].

3.3 Data Processing and Thematic Coding

The qualitative data derived from the interview transcripts were subjected to rigorous thematic analysis. A team of three independent coders utilized a specialized qualitative data analysis software to systematically categorize the textual data. The coding framework was developed iteratively, beginning with deductive codes derived from existing risk perception literature (e.g., naturalness, neophobia, dread risk, environmental benefit) and expanding to include inductive codes that emerged directly from the participants' narratives (e.g., cellular mutation concerns, socioeconomic displacement of farmers). Inter-coder reliability was established through multiple rounds of preliminary coding and reconciliation, achieving a high degree of consensus.

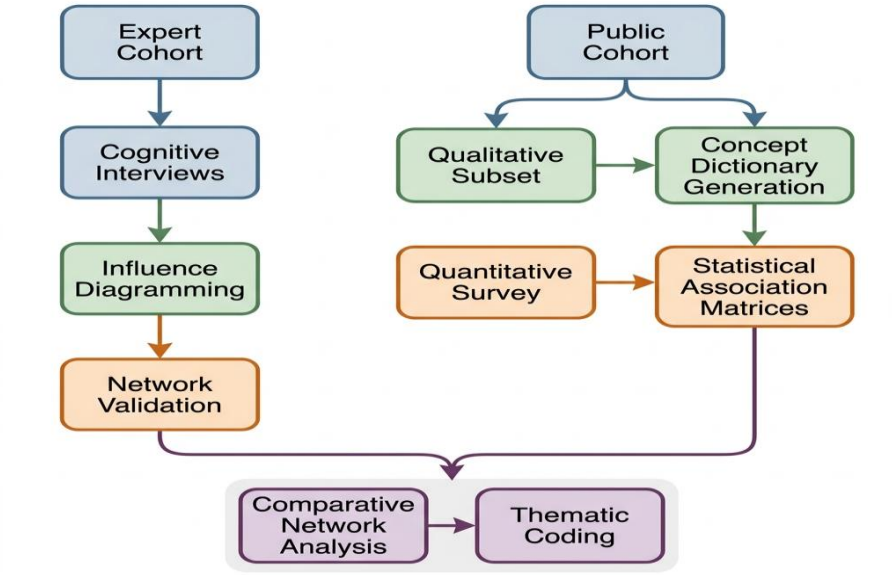


Figure 1:Comprehensive Methodological Workflow for Mental Model Elicitation

Once the qualitative texts and survey responses were coded, the data were transformed into adjacency matrices representing the co-occurrence and causal relationships between different concepts. These matrices enabled the application of quantitative network analysis techniques to visualize and analyze the mental models. Network metrics such as node degree centrality, edge weight, and modularity were calculated to determine which concepts were most central to each cohort's cognitive structure and how densely interconnected those concepts were. By analyzing the topological differences between the

aggregated expert network and the aggregated public network, the research team could precisely quantify the extent of the mental model divergence and identify the specific conceptual pathways that characterize each group's reasoning process. Related work has addressed the question posed in "How children learn complex environmental concepts through digital storytelling: divergent pathways to knowledge and stewardship intention" [16].

4. Results and Analytical Discussion

4.1 Comparative Structural Analysis of Mental Models

The application of network analysis to the elicited data revealed profound structural and thematic disparities between the expert and public mental models. The aggregated expert mental model was characterized by high network density and significant modularity, reflecting a highly organized, domain-specific knowledge structure. The central nodes within the expert network pertained almost exclusively to empirical, technical, and regulatory dimensions. The node with the highest degree centrality was "Bioprocess Scaling," which was densely connected to sub-nodes such as "Media Cost Reduction," "Bioreactor Optimization," and "Cell Line Stability." Regarding risk, the expert network focused heavily on "Adventitious Contamination" and "Genetic Drift during Proliferation," risks that were consistently linked to mitigating nodes representing "Sterility Protocols" and "Quality Control Assays." This structural configuration indicates that experts conceptualize the risks of cultivated meat as mechanistic problems that are entirely manageable through rigorous engineering and regulatory compliance. For a broader comparison, related research addresses identification markers for salvia miltiorrhiza and its close relatives based on cell wall component characteristics [17]. Conversely, the aggregated public mental model exhibited a distinctly different topological structure. While less densely interconnected in terms of technical mechanisms, the public network was heavily centralized around affective and heuristic nodes. The most prominent central node in the public network was "Unnaturalness," which served as a dominant hub connecting to numerous distinct risk categories. From "Unnaturalness," strong weighted edges extended to nodes representing "Unknown Long-Term Health Effects," "Cancer/Mutation Fears," and "Loss of Traditional Farming." Unlike the expert model, where risk nodes were typically linked to mitigation strategies, the risk nodes in the public model often terminated in feelings of "Disgust" or "Rejection," indicating a lack of perceived controllability over the technology. The structural mapping clearly demonstrates that while experts process cultivated meat through an analytical framework of optimization and control, the public processes it through a moral and affective framework centered on technological interference in natural systems. Related work has addressed data-Minimizing and interpretable multimodal campus IoT Student-State modeling for risk support [18].

Table 2: Comparative Centrality Metrics of Key Conceptual Nodes by Cohort

Conceptual Node	Expert Network Centrality Score	Public Network Centrality Score	Qualitative Description of Focus
Bioprocess Contamination	0.85	0.12	Expert focus on sterile engineering
Environmental Sustainability	0.78	0.45	Shared but diverging in priority
Unnaturalness / Artificiality	0.05	0.92	Public focus on moral boundaries
Long-term Health Uncertainties	0.15	0.88	Public focus on chronic consumption risks

4.2 Divergence in Specific Risk and Benefit Categories

Beyond the overall structural differences, the analysis revealed significant divergences in how specific categories of risk and benefit were conceptualized. In terms of health risks, experts primarily focused on acute toxicological or microbiological safety, such as the potential for heavy metal accumulation from the culture media or bacterial contamination during facility operations. They relied on existing food

safety frameworks to assess these risks, concluding that cultivated meat could theoretically be safer than conventional meat due to the absence of enteric pathogens like Salmonella or E. coli. The public, however, largely ignored these acute microbiological risks. Instead, their mental models were dominated by fears of chronic, insidious health impacts. Participants frequently expressed concerns that consuming cells grown in an artificial medium could lead to cellular mutations in the human body, drawing medically inaccurate but psychologically powerful analogies between rapid cellular proliferation in a bioreactor and the development of cancer. The literature also considers establishing the potential for the application of digital storytelling to support Chinese industrial heritage [19]. Regarding benefits, both cohorts acknowledged the environmental advantages of cultivated meat, but the weighting and conceptualization differed. Experts viewed environmental sustainability as the primary, quantifiable justification for the technology, heavily linking it to global carbon budget nodes and land-use efficiency metrics. While the public recognized environmental benefits, these nodes were often peripheral in their cognitive networks, overshadowed by immediate personal health concerns. Furthermore, the public mental model introduced a unique category of socioeconomic risk entirely absent from the expert network: the destruction of rural livelihoods and agricultural heritage. Public participants frequently connected the rise of cultivated meat to the economic disenfranchisement of traditional farmers and the further consolidation of the food supply by multinational technology conglomerates. This highlights that public risk perception extends beyond the biological properties of the food to encompass the broader socio-political implications of its production. Another relevant line of investigation concerns public willingness to use the national public culture cloud APP [20].

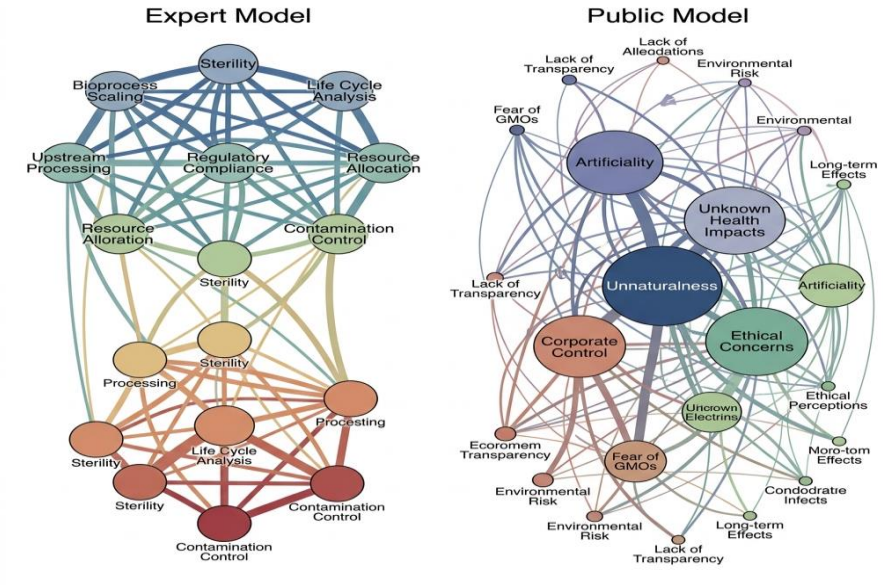


Figure 2: Comparative Network Map of Expert versus Public Mental Models

4.3 Factors Influencing Public Rejection or Acceptance

The divergent mental models directly influence the behavioral intentions of consumers regarding the acceptance or rejection of cultivated meat. The analysis indicates that public rejection is not primarily driven by a lack of scientific literacy, but rather by the activation of specific heuristic pathways that conflict with core personal values. The strong linkage between the "Unnaturalness" node and the "Unknown Health Effects" node suggests that the perceived violation of natural boundaries inherently generates a presumption of danger. When a food is categorized as unnatural, it is subjected to a much higher burden of proof for safety than traditional foods. The literature also considers exploring the uncanny valley effect in VR/AR [21]. Furthermore, the data reveal that trust serves as a critical moderating variable in the public mental model. In sub-segments of the public population where trust in scientific institutions and food regulatory bodies was high, the strength of the edge connecting

"Unnaturalness" to "Rejection" was significantly weakened. Conversely, among participants demonstrating high levels of institutional distrust, the perceived risks were amplified, and the technology was viewed as a profit-driven imposition rather than a societal benefit. This finding strongly suggests that acceptance cannot be engineered solely by improving the sensory qualities or lowering the price of cultivated meat. Instead, acceptance requires interventions that address the underlying cognitive structures, specifically by building institutional trust, increasing the perceived transparency of the production process, and establishing narratives that align the technology with deeply held cultural values rather than challenging them. Related work has addressed balancing ecological restoration and industrial landscape heritage values through a digital narrative approach: A case study of the dagushan iron mine, china [22].

5. Conclusion and Implications

5.1 Synthesis of Key Findings

This research provides a comprehensive empirical demonstration of the profound divergence between expert and public mental models regarding the risk and benefit judgments of cultivated meat technologies. The mental-model comparison of public and expert cultured-meat perceptions [23] provides a direct reference for distinguishing differences in factual understanding from differences in the values used to judge risk and benefit. Through rigorous qualitative elicitation and quantitative network analysis, the study illustrates that experts and laypeople do not merely possess different levels of information; they utilize fundamentally incompatible cognitive architectures to evaluate novel food systems. Experts operate within a technical-rational paradigm, constructing dense, integrated mental models focused on bioprocess optimization, quantifiable environmental life-cycle assessments, and mechanistic risk mitigation. Their evaluations are anchored in the belief that technological control and empirical validation are sufficient to ensure safety and societal benefit. In stark contrast, the public mental model is deeply rooted in the psychometric paradigm, where heuristic reasoning, cultural values, and affective responses dominate the evaluative process. The public cognitive network is heavily centralized around perceptions of unnaturalness, which act as a powerful catalyst for fears concerning unknown long-term health effects and the disruption of traditional agricultural paradigms. Furthermore, public evaluations are inextricably linked to socio-political concerns regarding corporate monopolization and the trustworthiness of regulatory institutions—factors that are entirely peripheral to the expert conceptualization. This structural dissonance highlights why traditional risk communication strategies, which rely on disseminating technical facts to correct perceived public ignorance, consistently fail to foster acceptance of complex biotechnologies. For a broader comparison, related research addresses mining steady formulaic alpha factors with Variance-Bounded REINFORCE [24].

5.2 Policy Recommendations and Future Research

The findings of this study have significant implications for the governance, commercialization, and communication strategies surrounding cultivated meat. To successfully navigate the complex socio-psychological landscape of consumer acceptance, stakeholders must abandon the information deficit model and adopt a dialogic approach to risk communication. Regulatory agencies and cellular agriculture enterprises must acknowledge the legitimacy of public concerns regarding naturalness and institutional trust, rather than dismissing them as irrational. Communication campaigns should focus on transparency, actively demystifying the production process, and engaging in open discourse about the societal and ethical implications of transitioning away from traditional livestock farming. Another relevant line of investigation concerns temporal changes in affiliation and emotion in MOOC discussion forum discourse [25]. Future research should focus on longitudinal studies to observe how public mental models of cultivated meat evolve over time as the technology moves from abstract concept to tangible consumer product. Additionally, cross-cultural comparative analyses are necessary to understand how different socio-cultural contexts, culinary traditions, and religious dietary laws influence the structural configuration of heuristic nodes like naturalness and purity. By continuing to map and understand these complex cognitive landscapes, policymakers and technologists can foster a more inclusive and

democratic approach to food system innovation, ensuring that the development of sustainable alternative proteins aligns with the values and concerns of the societies they are intended to serve. The disruptive-technology perspective motivates distinguishing an innovation's technical trajectory from the criteria used by established institutions to judge it [26].

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