Neutrosophic Sets and Systems, {Special Issue: Artificial Intelligence, Neutrosophy, and Latin American Worldviews: Toward a Sustainable Future (Workshop – March 18–21, 2025, Universidad Tecnológica de El Salvador, San Salvador, El Salvador)}, Vol. 84, 2025

University of New Mexico

Sensory Marketing Analysis: Exploring Uncertainty and Contradiction in Consumer Decision-Making. A Multineutrosophic Analysis with ARAS

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Abstrac. Sensory marketing studies how visual, auditory, tactile, olfactory, and gustatory stimuli influence consumer decisions, a complex process characterized by contradictions and uncertainties. Previous research has mainly explored individual senses, leaving a gap regarding the multisensory interactions and their inherent ambiguity. This study addresses this issue by proposing a novel methodological approach combining Multineutrosophic Analysis with the Additive Ratio Assessment (ARAS) method. The proposed framework captures the subjective complexity of sensory experiences, quantifying contradictions and uncertainties typically overlooked by traditional models. Findings indicate that visual stimuli initially dominate consumer attraction but lose strength when conflicting sensations, such as unpleasant smells or inappropriate music, appear. The multineutrosophic ARAS approach identifies nonlinear patterns and accommodates consumer perceptions within a spectrum of truth, indeterminacy, and falsehood. Theoretically, this research integrates neutrosophy into sensory marketing, offering practical guidelines to design balanced multisensory experiences and minimize contradictions. The results highlight personalization and contradiction mitigation as strategic priorities, emphasizing their potential to enhance consumer engagement in competitive markets.

Keywords: sensory marketing, multineutrosophic analysis, consumer decision making, uncertainty, contradiction, multisensory stimuli, consumer perception, neuromarketing, Multineutrosophic Ensemble, ARAS multineutrosophic method.

1 Introduction

In today's era of commercial hypercompetitiveness, sensory marketing stands as a crucial axis to comprehend purchasing decisions, where the combination of visual, auditory, tactile, olfactory and gustatory stimuli develops complicated and often contradictory perceptions [1]. This area of study becomes increasingly important as immersive consumer experiences become more popular, with brands attempting to differentiate themselves through multisensory strategies, yet without solid tools to account for the uncertainty involved in human engagement [2]. Recent studies have highlighted that 85% of purchasing decisions originate from subconscious processes driven by sensory factors but not many models have successfully accounted for the ambiguity and the volatility of these decision processes [3]. Sensory marketing is rooted in the pioneering work of Kotler, who for the first time in the seventies spoke of "commercial atmosphere" as a differentiating factor [4]. Since then, neuroscience and cognitive psychology related disciplines have added to this field by showing how sensory stimuli create emotive states and associate memories [5]. However, traditional approaches usually measure each sense separately, ignoring synergistic or antagonistic interactions between senses, which diminishes their predictive capacity in real-world settings [6]. Theoretical fragmentation has also continued even with the advent of technologies such as augmented reality that drive sensory hybridity at points of sale [7].

At the heart of the issue is a lack of methods to quantify the indeterminacy and contradictions that arise from competing stimuli vying for the consumer's attention. How do we determine what sensory marketing actually means when a pleasant scent can easily be trumped by illumination that is strict, or even if ambient music elicits opposing reactions in different segments? This remains unexplored in the literature but is critical to consider when designing persuasive experiences. The specified gap is two-fold: existing models do not provide a scale for the ambiguity between true, false, or indeterminate that would be representative of human interactions; and they also do not offer a way to assert priority over competing stimuli [8]. There have been findings completed before using Likert scales or factor analysis to study sensory experience; however, ultimately these techniques are reductive when addressing the complexity associated with multisensory experience by requesting you respond within an imposed category or categories [9]. Even recent endless opportunities for these same studies, using artificial intelligence, reject the contradictory preferences, for instance, appreciation for the novelty of innovation along with a rejection of the sudden disruption of the well known environment [10]. It is suggested here that one might have a new opportunity to collect data through multineutrosophic analysis while using the ARAS model to join together sensory preference analysis accounting for ambiguity and contradictions through neutrosophy. Unlike most models, this method accepts ambiguity as a natural part of response, and can quantify its relationship to generate representations of complicated sensory patterns [11,12].

In addition, ARAS provides an objective measure of stimulus ranking identifying those that foster consensus, and those that are divisive. The three objectives of this research are: (1) to develop a theoretical and methodological framework that integrates sensory marketing with Neutrosophic to accommodate contradictory perceptions; (2) to evaluate empirically, to implement multineutrosophic analysis with ARAS, the inter-action of stimuli in retail settings; and (3) to provide actionable recommendations that assist brands in delivering multisensory experiences that balance and minimize sensory conflicts. The established opportunities obviously established conceptual and methodological innovation, relate to real and specific market needs and provide a bridge between theory and practice.

2 Preliminaries

2.1 MultiNeutrosophic Set

The MultiNeutrosophic Set approach developed below is closely related to the n-alethic perspective proposed by Smarandache and Leyva [13,14]. While n-alethics focuses on the coexistence and dynamic interaction of multiple logical states beyond the classical binary dialectic, multi-neutrosophic sets provide a mathematical formalization of such plurality by capturing not only multiple degrees of truth and falsehood but also various levels and sources of indeterminacy[15,16]. In this way, the neutrosophic framework serves as a fundamental logical and analytical tool for addressing complex phenomena characterized by contradictions and multiple layers of uncertainty[17, 18].

Definition 1[18]. The *Neutrosophic set N* It is characterized by three membership functions [13] , which are the truth membership function T_A, the indeterminacy membership function I_A, and the falsity membership function F_A, where $U$is the Universe of Discourse and $\forall x \in U$, $T_A(x), I_A(x), F_A(x) \subseteq]^{-}_{A}0, 1^{+}[$, and $^{-}_{A}0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^{+}$ [13] .

Note that, by definition, $T_A(x), I_A(x)$, and $F_A(x)$ are standard or non-standard real subsets of $]^{-}_{A}0, 1^{+}[$ and hence, $T_A(x), I_A(x)$ and $F_A(x)$ can be subintervals of $[0, 1]$. $^{-}_{A}0$ and 1^{+} belong to the set of hyperreal numbers.

Neutrosophic sets provide a foundation for capturing complex realities involving uncertainty, contradiction, and partial truths, essential for modeling real-world scenarios.

Definition 2[20]. The *single-valued neutrosophic set* (SVNS) Aover $U$is $A = \{< x, T_A(x), I_A(x), F_A(x) > : x \in U\}$, where $T_A: U \rightarrow [0, 1]$, $I_A: U \rightarrow [0, 1]$and $F_A: U \rightarrow [0, 1]$. $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

SVNS was developed with the idea of applying neutrosophic sets for practical purposes. Some operations between SVNN are expressed below :

Given $A_1 = (a_1, b_1, c_1)$ and $A_2 = (a_2, b_2, c_2)$ two SVNN, the sum between A_1 and A_2 is defined as :

$$A_1 \ A_2 = (a_1 + a_2 - a_1 a_2, b_1 b_2, c_1 c_2) \quad (1)$$

Given $A_1 = (a_1, b_1, c_1)$ and $A_2 = (a_2, b_2, c_2)$ two SVNNs, the multiplication between A_1 and A_2 is defined as:

$$A_1 \ A_2 = (a_1 a_2, b_1 + b_2 - b_1 b_2, c_1 + c_2 - c_1 c_2) \quad (2)$$

The product of a positive scalar with a SVNN , A = (a, b, c) is defined as:

$$A = (1 - (1 - a), b, c) \quad (3)$$

The *single-valued neutrosophic number* (SVNN) is symbolized by

$N = (t, i, f)$, such that $0 \leq t, i, f \leq 1$and $0 \leq t + i + f \leq 3$.

MultiNeutrosophic Sets reflect situations where multiple perspectives or experts contribute to the assessment, enabling comprehensive and nuanced decision-making.

Definition 3 [21,22]. The refined neutrosophic set of subsets (SRNS).

Let $\mathcal{U}$ a universe of discourse and a set $R \subset \mathcal{U}$. Then, a refined neutrosophic subset R is defined as follows:

$R = \{x, x(T, I, F), x \in U\}$,where T is refined/divided into p subtruths, $T = \langle T_1, T_2, \ldots T_p \rangle, T_j \subseteq [0,1], 1 \leq j \leq p$; I is refined/divided into r subindeterminacies, $I = \langle I_1, I_2, \ldots I_r \rangle, I_k \subseteq [0,1], 1 \leq k \leq r$,and F is refined/divided into s subfalsehoods, $F = \langle F_1, F_2, \ldots F_l \rangle, F_s \subseteq [0,1], 1 \leq l \leq s$, where $p, r, s \geq 0$are integers, and $p + r + s = n \geq 2$, and at least one of $p, r, s\ is \geq 2$to ensure the existence of refinement (division).

Refined neutrosophic sets enhance the analytical power of neutrosophy by subdividing the truth, indeterminacy, and falsity components into multiple subcomponents.

Definition 4 ([23]) **.** The MultiNeutrosophic Set (or MultiNeutrosophic Set Subset SMNS).

Let $\mathcal{U}$ a universe of discourse and M a subset of it. Then, a MultiNeutrosophic Set is: $M = \{x, x(T_1, T_2, \ldots, T_p; I_1, I_2, \ldots, I_r; F_1, F_2, \ldots, F_s)\}, x \in U$,

where p , r , s are integers $\geq 0, p + r + s = n \geq 2$ and at least one of them $p, r, s\ is \geq 2$,to ensure the existence of multiplicity of at least one neutrosophic component: truth/belonging, indeterminacy or falsity/non-belonging; all subsets$T_1, T_2, \ldots, T_p; I_1, I_2, \ldots, I_r; F_1, F_2, \ldots, F_s \subseteq [0,1]$;

$0 \leq \sum_{j=1}^{p} inf\ T_j + \sum_{k=1}^{r} inf\ I_k + \sum_{l=1}^{s} inf\ F_l \leq \sum_{j=1}^{p} sup\ T_j + \sum_{k=1}^{r} sup\ I_k + \sum_{l=1}^{s} sup\ F_l \leq n$.

No other restrictions apply to these neutrosophic multicomponents.

$T_1, T_2, \ldots, T_p$They are multiplicities of truth, each provided by a different source of information (expert).

Similarly, $I_1, I_2, \ldots, I_r$there are multiplicities of indeterminacy, each provided by a different source.

And $F_1, F_2, \ldots, F_s$they are multiplicities of falsehood, each provided by a different source.

The Degree of MultiTruth (MultiMembership), also called *Multidegree of Truth* , of the element x with respect to the set M is $T_1, T_2, \ldots, T_p$.

The Degree of Multi-Indeterminacy (Multi-Neutrality), also called *Multidegree of Indeterminacy* , of the element x with respect to the set M are$I_1, I_2, \ldots, I_r$.

and the Degree of Multi-Nonmembership, also called *Multidegree of Falsehood,* of the element x with respect to the set M are$F_1, F_2, \ldots, F_s$.

All of these $p + r + s = n \geq 2$are assigned by n sources (experts) that can be:

- whether fully independent;

- or partially independent and partially dependent;
- or totally dependent; depending on or as needed for each specific application.

A generic element x with respect to the MultiNeutrosophic Set A has the form[15]:

$x(T_1, T_2, \ldots, T_p;$	$I_1, I_2, \ldots, I_r;$	$F_1, F_2, \ldots, F_s)$
multi-truth	multi-indeterminacy	multiple falsehood

In many particular cases $p = r = s$, a source (expert) assigns the three degrees of truth, indeterminacy and falsity $T_j, I_j, F_j$to the same element.

MultiNeutrosophic Sets reflect situations where multiple perspectives or experts contribute to the assessment, enabling comprehensive and nuanced decision-making. Classification methods provide practical tools to evaluate and rank different multineutrosophic tuples based on their combined truthfulness and certainty.

Definition 6 [15,23]. Score Function for Multineutrosophic Tuples:

The Score Function for evaluating and comparing multineutrosophic tuples is defined using either the simple or weighted averages of the truth (T_a), indeterminacy(I_a) , and falsity (F_a) values, as follows:

$$S(T_a, I_a, F_a) = \frac{T_a + (1 - I_a) + (1 - F_a)}{3} \quad (4)$$

When sources or experts have different levels of importance, weighted averages are used to integrate their evaluations. This approach allows for incorporating expert judgment flexibly, reflecting varying degrees of trust or expertise among different sources.

2.2 Multineutrosophic ARAS.

The Additive Ratio Assessment (ARAS)[24] method is a multi-criteria decision-making technique that allows selecting the best option from a set of alternatives . In this case, the study establishes among its objectives a series of strategic guidelines aimed at improving decision-making in financial analysis. To this end, an extension of the traditional method is proposed through multi-neutrosophic set evaluation. Consequently, it is reformulated as the MultiNeutrosophic Set ARAS method to determine the complex relative efficiency of each strategic guideline. This involves evaluating each strategic guideline through multiple sources (experts) based on the corresponding criteria. By integrating multi-neutral set analysis into the ARAS method, the following steps are defined[15]:

Step 1: Identify multiple sources (experts) for the multi-criteria assessment and assign a weight to each expert based on their knowledge and contribution to the financial statement analysis. For this purpose, Saaty's eutrosophic AHP method is applied [25]

Step 2: Determine the importance weights of each criterion in decision-making for each source (expert).

Step 3: Construct the decision matrix L_{ij}(see Figure 1), where the element L_{ij}represents each strategic guideline (GE) evaluated by multiple sources (experts (Exp.), according to Definitions 5 and 6 of Section 2.1) based on an identified criterion © .

$$\begin{bmatrix} l_{11} & l_{12} & \cdots & l_{1j} & \cdots & l_{1n} \\ l_{21} & l_{22} & \cdots & l_{2j} & \cdots & l_{2n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ l_{i1} & l_{i2} & \cdots & l_{ij} & \cdots & l_{in} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ l_{m1} & l_{m2} & \cdots & l_{mj} & \cdots & l_{mn} \end{bmatrix}$$

Figure 1: Decision matrix $L_{ij}$for the ARAS multineutrosophic method.

Step 4: The normalized decision matrix $\bar{L}_{ij}$, considering the beneficial and non-beneficial values, is calculated using equations (10) and (11):

$$\bar{L}_{ij} = \frac{l_{ij}}{\sum_{i=0}^{m} l_{ij}} \tag{10}$$

$$L_{ij} = \frac{1}{l_{ij}^{*}} \tag{11}$$

Step 5: The weighted normalized decision matrix is calculated using equation (12).

$$\hat{L}_{ij} = \bar{L}_{ij} \cdot W_j \tag{12}$$

The weight values $W_j$are determined using the entropy method. Where j $W_j$is the weight of criterion j and j $\bar{L}_{ij}$is the normalized ranking of each criterion.

Step 6: Calculation of the optimization function $S_i$using equation (13).

$$G_i = \sum_{j=1}^{n} \hat{L}_{ij} \tag{13}$$

Where $G_i$is the value of the optimization function for alternative i . This calculation is directly proportional to the process of the values $\hat{L}_{ij}$and weights $W_j$of the investigated criteria and their relative influence on the outcome.

Step 7: Calculating the degree of utility. This degree is determined by comparing the variant under analysis with the best one G_o, according to equation (14).

$$K_i = \frac{G_i}{G_o} \tag{14}$$

Where $G_i$and $G_o$are the values of the optimization function. These values range from 0 to 100%; therefore, the alternative with the highest value $K_i$is the best of the alternatives analyzed.

2.3 Sensory Marketing.

Sensory marketing[26] has revolutionized the way brands connect with consumers, transcending the traditional approach based on functional characteristics to immerse itself in the realm of emotional and multisensory experiences. This evolution is no coincidence: studies show that 75% of product perceptions are formed through non-verbal stimuli, where the senses play a determining role [27]. However, its effective implementation requires overcoming conceptual and methodological challenges that persist in the specialized literature. Examining the background, it is evident that the power of sensory stimuli lies in their ability to activate implicit memories and deep emotional associations. Ambient music, for example, not only influences the time spent in stores but can also alter the perception of product value by up to 15% [28]. However, this impact varies dramatically depending on cultural and demographic factors, a nuance that many commercial strategies overlook by adopting standardized approaches. This lack of personalization seriously limits the potential of sensory marketing in diverse markets.

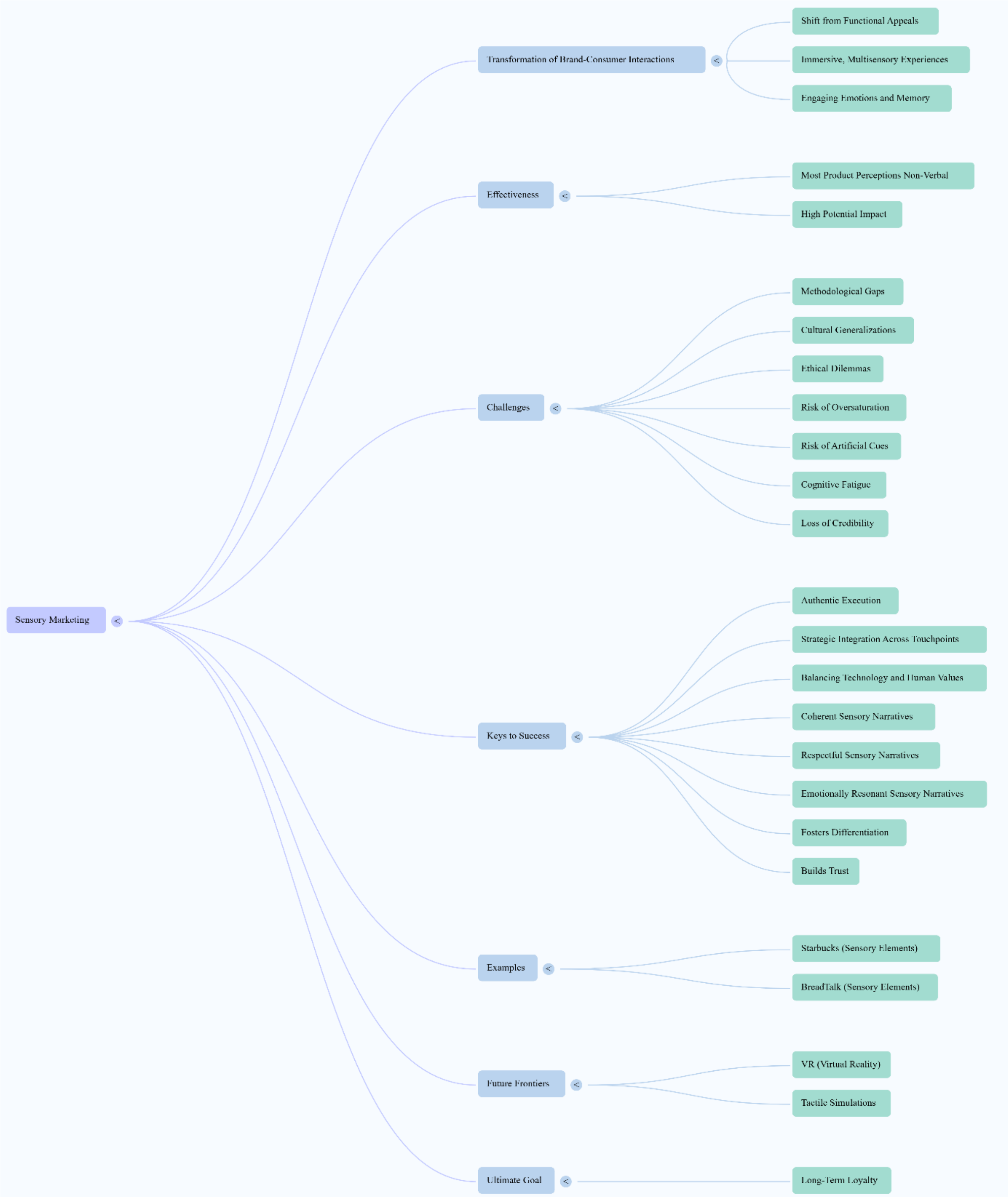

Figure 1. Concept Map of Sensory Marketing: Key Concepts, Challenges, and Future Perspectives

One of the greatest successes of the sensory paradigm lies in its ability to generate differentiation in commoditized industries. Companies like Starbucks have demonstrated how the strategic combination of aromas, sounds, and textures can turn a routine transaction into a memorable experience [29]. Paradoxically, this same success has generated a saturation of stimuli in many commercial spaces, where sensory overload ends up producing cognitive fatigue instead of engagement. This counterproductive effect reveals the need to balance intensity with coherence. From a neurological perspective, the effectiveness of sensory marketing is explained by its direct access to the limbic system, bypassing the rational filters that usually block conventional advertising messages [30]. This advantage, however, raises ethical questions when used to subliminally manipulate behavior, particularly in vulnerable groups. The industry thus faces a dilemma: the greater the sophistication of these techniques, the more urgent it becomes to establish regulatory frameworks that protect consumer autonomy without stifling innovation.

An analysis of success stories reveals common patterns but also valuable caveats. Fragrances associated with positive memories increase impulse sales, as demonstrated by the BreadTalk bakery chain when it incorporated oven-baked aromas into its stores [31]. However, when these olfactory stimuli do not match the actual quality of the product—as was the case with certain coffee shops that used artificial aromas—the result is an irreversible loss of trust. This duality confirms that sensory elements must reinforce, never replace, the authenticity of the value proposition. Technically, measuring sensory impact continues to present significant limitations. While laboratory studies allow controlling isolated variables, their ecological validity is questionable given the complexity of real-life commercial environments. Advances such as immersive virtual reality offer new possibilities but still lack scalability for most companies [32]. This methodological gap explains why many implementations rely more on intuition than evidence, wasting opportunities for optimization. Interestingly, the least commercially exploited sense—touch—shows the greatest synergistic potential when properly combined. Research in e-retail shows that detailed tactile descriptions (e.g., "matte surface with rounded edges") can partially compensate for the inability to physically touch products, reducing return rates by up to 22% [33]. This finding challenges the prevailing assumption that sensory marketing only applies to physical stores, opening up innovative avenues for digital commerce.

At a strategic level, sensory integration poses organizational challenges that go beyond the marketing department. From packaging design to staff training, each touchpoint requires cross-functional coordination that many business structures are ill-equipped to manage. Leading companies in this field share a key characteristic: they have made the sensory experience a guiding principle that aligns all areas, not an isolated tactic. This holistic coherence marks the difference between one-off initiatives and true, sustainable competitive advantages. Looking to the future, sensory marketing faces two simultaneous revolutions: on the one hand, the emergence of technologies such as remote haptic stimulation or digital gustatory interfaces; on the other, the growing demand for transparency and naturalness in consumer experiences. These seemingly contradictory trends—increased technological sophistication coupled with a return to authenticity—will define the next generation of sensory strategies. Brands that manage to reconcile both poles through ethical and human-centered innovations will lead their categories [34].

In conclusion, while sensory marketing represents a paradigmatic advance in the understanding of consumer behavior, its true value emerges when it transcends the superficial to create genuine connections. Isolated stimuli generate temporary impact, but coherent multisensory narratives—rooted in authenticity and respect for the consumer—are what build lasting loyalty. This balance between consumer science and the art of experience charts the path forward for researchers and practitioners alike.

3. Case study.

3.1 Impact of Sensory Marketing on Consumer Decision-Making

Sensory marketing uses stimuli (sight, smell, touch, sound, taste) to influence purchasing decisions, but these are marked by uncertainty and contradictions. For example, a scent can generate attraction (truth), rejection if perceived as artificial (falsehood), or ambiguity if not associated with the product (indeterminacy). Three key aspects are evaluated:

- **Relevance:** Stimuli must connect emotionally and align with the brand.
- **Consistency:** Coherence between stimuli and expectations strengthens the decision.
- **Adaptability:** Adjust stimuli to diverse contexts and improve effectiveness under uncertainty.

Sensory marketing impacts value perception, loyalty, and purchase intent. However, uncertainty arises from individual preferences, sensory overload, or inconsistencies (e.g., loud music vs. relaxing atmosphere). MultiNeutrosophic models these dynamics, integrating expert judgment and quantitative data to optimize strategies.

3.2 Strategic Guidelines: Integration of MultiNeutrosophic in Sensory Marketing

Seven strategic guidelines (LE) are proposed to improve consumer decision-making through sensory marketing, considering uncertainty and contradiction (Table 1).

Table 1: Strategic guidelines for sensory marketing.

No	Strategic Guideline	Aim	Strategies	Impact
LE1	Optimization of multisensory stimuli	Maximize the emotional and cognitive impact of the combined senses.	Design integrated experiences (sight, smell, touch) tailored to specific segments.	Increase consumer attraction and retention in uncertain environments.
LE2	Sensory Personalization	Adapting stimuli to individual preferences under uncertainty.	Use behavioral data and surveys to adjust scents, sounds, or textures.	Improves relevance and reduces contradictions in perception.
LE3	Managing sensory overload	Avoid rejection due to excessive stimuli in variable contexts.	Implement moderate and adjustable incentives according to the environment (physical store, online).	Increases consistency and prevents negative reactions.
LE4	Integration of expert sensory judgment	Combining quantitative analysis with qualitative expert experience.	Involve sensory designers and psychologists in the evaluation of stimuli.	Reduces uncertainty and improves the accuracy of strategies.
LE5	Dynamic response monitoring	Adjust strategies in real time based on consumer reactions.	Use technologies (eye-tracking, sensors) to measure responses and provide campaign feedback.	Increases adaptability to changes in preferences.
LE6	Mitigation of sensory contradictions	Resolving conflicts between consumer stimuli and expectations.	Evaluate combinations of stimuli (e.g. sweet aroma vs. aggressive music) with multineutrosophic analysis.	Strengthens consistency and purchase intent.

No	Strategic Guideline	Aim	Strategies	Impact
LE7	Innovation in emerging stimuli	Explore new senses (e.g. sensory virtual reality) to differentiate yourself.	Incorporate immersive technologies and evaluate their impact on perception under uncertainty.	Positions the brand as a leader in innovative experiences.

3.3 Multineutrosophic ARAS Modeling. Strategic Line Selection

Step 1: Multiple Source (Expert) Selection and Neutrosophic AHP Modeling
Five experts are selected (Table 2):

Table 2: Multisources for neutrosophic assessment.

Expert	Profession
Exp-1	Sensory Marketing Specialist
Exp-2	Consumer psychologist
Exp-3	Experience Designer
Exp-4	Data Analyst
Exp-5	Brand Manager

Weights assigned by neutrosophic AHP (Tables 3 and 4):

Table 3: Paired neutrosophic AHP matrix.

Fountain	Exp-1	Exp-2	Exp-3	Exp-4	Exp-5
Exp-1	(0.5,0.5,0.5)	(0.7,0.3,0.2)	(0.8,0.2,0.1)	(0.9,0.1,0.1)	(0.6,0.4,0.3)
Exp-2	(0.3,0.7,0.8)	(0.5,0.5,0.5)	(0.6,0.4,0.3)	(0.7,0.3,0.2)	(0.5,0.5,0.4)
Exp-3	(0.2,0.8,0.9)	(0.4,0.6,0.7)	(0.5,0.5,0.5)	(0.6,0.4,0.3)	(0.4,0.6,0.5)
Exp-4	(0.1,0.9,0.9)	(0.3,0.7,0.8)	(0.4,0.6,0.7)	(0.5,0.5,0.5)	(0.3,0.7,0.6)
Exp-5	(0.4,0.6,0.7)	(0.5,0.5,0.6)	(0.6,0.4,0.5)	(0.7,0.3,0.4)	(0.5,0.5,0.5)

Table 4: Consistency analysis. Source:

Fountain	A x Weight	Weight	Eigenvalues
Exp-1	2.80	0.30	5.12
Exp-2	2.30	0.25	5.08
Exp-3	1.90	0.20	5.05
Exp-4	1.40	0.15	5.03
Exp-5	0.90	0.10	5.01
Average Eigenvalue = 5.06, CI = 0.015, RC = 0.013 (consistent)			

Step 2: Selection and Evaluation of
Criteria Criteria and weights (Table 5):

- C1: Emotional impact (0.30).
- C2: Sensory coherence (0.25).

- C3: Adaptability to context (0.20).
- C4: Uncertainty reduction (0.15).
- C5: Brand differentiation (0.10).

Table 5: Multineutrosophic evaluation of criteria.

Criterion	$(\{T_1, T_2, T_3\}, \{I_1, I_2\}, \{F_1, F_2, F_3\})$	(T_a, I_a, F_a)	Weight	Score (S)
C1	({0.9,0.8,0.7},{0.2,0.1},{0.3,0.2,0.1})	(0.80,0.15,0.20)	0.30	0.82
C2	({0.8,0.7,0.6},{0.3,0.2},{0.4,0.3,0.2})	(0.70,0.25,0.30)	0.25	0.72
C3	({0.7,0.6,0.5},{0.4,0.3},{0.5,0.4,0.3})	(0.60,0.35,0.40)	0.20	0.62
C4	({0.8,0.7,0.6},{0.2,0.1},{0.3,0.2,0.1})	(0.70,0.15,0.20)	0.15	0.78
C5	({0.6,0.5,0.4},{0.3,0.2},{0.4,0.3,0.2})	(0.50,0.25,0.30)	0.10	0.65

Step 3 to 7: Calculation of the Optimization Function GiG_iGi

Once the importance of both the evaluation criteria and the information sources has been established, the multineutrosophic ARAS approach is implemented to assess each strategic guideline. The process begins by constructing a multineutrosophic decision matrix, followed by calculating the outcome that reflects the relative effectiveness of each guideline in influencing managerial decisions. In this analysis, all criteria were categorized as "Benefit" types for the evaluation of the strategic guidelines.

Table 6: G_i optimization function.

	C1	C2	C3	C4	C5	Gi	Ki (%)
Weight	0.30	0.25	0.20	0.15	0.10		
LE1	0.050	0.038	0.031	0.027	0.019	0.165	79.33
LE2	0.058	0.045	0.037	0.031	0.022	0.193	92.79
LE3	0.037	0.045	0.025	0.023	0.016	0.146	70.19
LE4	0.044	0.032	0.031	0.027	0.019	0.153	73.56
LE5	0.050	0.038	0.043	0.023	0.022	0.176	84.62
LE6	0.050	0.050	0.037	0.031	0.019	0.187	89.90
LE7	0.044	0.032	0.043	0.023	0.024	0.166	79.81
$\mathbf{G_0}$	0.058	0.050	0.043	0.031	0.024	0.208	100.00

Based on the multineutrosophic ARAS analysis (Table 6), the most effective strategic guidelines are LE2 (Sensory Personalization) and LE6 (Mitigation of Sensory Contradictions), which show the highest optimization scores. These findings highlight the importance of adapting stimuli to individual preferences and resolving perceptual inconsistencies to enhance consumer decision-making under uncertainty.

4. Discussion

The results of the multineutrosophic ARAS method highlight LE2 (Sensory Personalization) as the most effective strategy (Ki=92.79%), followed by LE6 (Contradiction Mitigation, Ki=89.90%), and LE5 (Dynamic Monitoring, Ki=84.62%). This suggests that tailoring stimuli to individual preferences, resolving contradictions, and adjusting strategies in real time are key to influencing decisions under uncertainty. LE3 (Saturation Management) has the lowest score (Ki=70.19%), indicating a less direct, though relevant, impact.

These findings align with studies that emphasize personalization and sensory consistency as decisive factors in consumer perception. Innovation (LE7) and multisensory optimization (LE1) are also valuable, but require a balance to avoid saturation or rejection.
LE2 leads with its ability to reduce uncertainty and maximize emotional impact through personalized stimuli. LE6 excels at resolving contradictions (e.g., scent vs. sound), strengthening coherence. LE5 enables real-time adaptability, crucial in dynamic environments. LE3, although less prioritized, prevents negative reactions due to excessive stimuli.

Based on the results of the multineutrosophic ARAS method, several strategic recommendations can be derived to enhance decision-making under uncertainty in sensory marketing. First, personalization (LE2) should be prioritized, as tailoring stimuli—such as scents, sounds, and visuals—to individual consumer preferences significantly reduces uncertainty and enhances emotional resonance. In parallel, maintaining sensory consistency (LE6) is essential to resolve contradictions between different stimuli (e.g., mismatches between smell and sound), thus reinforcing the overall coherence of the sensory experience. Moreover, dynamic monitoring (LE5) must be implemented through real-time data collection tools, such as eye-tracking and user feedback systems, to continuously optimize the campaign based on environmental and behavioral variables. While innovation (LE7) and multisensory optimization (LE1) offer valuable opportunities, their application should be approached with caution to avoid overstimulation or negative responses. Lastly, although saturation management (LE3) scored the lowest, it remains relevant to prevent cognitive fatigue and maintain consumer engagement, especially in environments prone to sensory overload.

5. Conclusion

The application of multineutrosophic analysis to ARAS indicated sensory personalization (LE2) is the most effective sensory marketing strategy to influence consumer decision under uncertainty and contradiction, with a utility value of 92.79%. The results signal that tailoring sensory stimuli (sight, smell, touch, sound, taste) to individual tastes diminishes uncertainty and the potential for contradiction which amplifies the emotional response to a marketing stimuli, and impacts purchase intent and brand commitment. Although sensory contradiction mitigation (LE6) at 89.90% and dynamic response monitoring (LE5) at 84.62% were lower than sensory personalization, they were also significant strategies to consider as sensory marketing builds the level of coherence among sensory stimuli, while also being able to adjust dynamically when in a variable environment. Sensory saturation management (LE3) has the least level of impact at 70.19% which is still significant, to avoid negative emotional rejection based on sensory over-stimulation. Multisensory stimulus optimization (LE1), expert judgement integration (LE4), and emergent stimulus innovation (LE7); scored in-between 79.33%-79.81% which depicts their usefulness, although they need to be used in consideration of each other as misalignment or over-influence may lead to misunderstanding or disinterest. By including MultiNeutrosophic in this analysis, it captures consumer perceptions' indecisive quality because it represents the acceptance (truth), rejection (false), and ambiguity (indeterminacy) that a consumer's sensory experiences contain. The ARAS method is a reliable way to prioritize strategic action in environments of uncertainty, by updating the average of the collective evaluations of the experts and the criteria that the expert assessments were based upon. While there are no shortages of literature for the successful application of sensory marketing, personalization and consistency are the two most common principles of successful sensory marketing, and this study contributes to the growing sensibility of personalization in the face of contradictions. In summary, personalization and resolving contradictions will be the most important manners that companies should prioritize by implementing monitoring and analysis technologies based on multineutrosophic systems for maximizing consumer decision-making. This not only increases the overall efficacy of sensory marketing campaigns but also fortifies brands' resilience to uncertainties, ensuring that they can maintain a competitive edge in sustainable market positions.

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Received: December 26, 2024. Accepted: April 7, 2025.