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Applications of Neutrosophic Logic in Psychology and Human Behavior: A Systematic Review

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Abstract: This systematic review examines how neutrosophic logic has been applied in psychology and behavioral science, with particular attention to the representation of psychological indeterminacy through the Truth, Indeterminacy, and Falsity triad. Following a PRISMA-based search strategy, records were identified from Scopus, Web of Science, PubMed, PsycINFO, Google Scholar, ResearchGate, and specialized neutrosophic sources. After screening and eligibility assessment, 30 studies were included in the qualitative synthesis. The reviewed literature indicates that neutrosophic approaches have been used mainly in psychological assessment, behavioral decision-making, clinical diagnostic support, sentiment/perception analysis, and theoretical modeling of ambivalence. The findings suggest that neutrosophic tools may complement classical and fuzzy approaches by explicitly modeling neutrality, hesitation, contradiction, and incomplete information. However, the current evidence remains uneven, with many studies being conceptual, computational, or preliminary rather than clinically validated. Future research should prioritize empirical validation, transparent reporting, reproducible tools, and accessible software for researchers and practitioners.

Keywords: Neutrosophic Logic; Neutropsyche; Human Behavior; Indeterminacy; Systematic Review; Psychometrics; Cognitive Dissonance; Decision-Making; PRISMA; TIF Triad

1. Introduction

1.1. Limitations of Classical Psychological Approaches in Explaining Human Behavior

Traditional psychological approaches often rely on Boolean logic or classical crisp sets to differentiate between psychological states, for example rational and irrational thinking. However, such differences are complex and cannot always be captured through a simple true/false distinction or by a strict membership/non-membership decision. Fuzzy logic improves on Boolean logic by allowing degrees of truth or membership, yet it remains limited when a psychological state contains uncertainty, neutrality, hesitation, or conflicting evidence. These dimensions are particularly

important in decision-making situations involving stress, incomplete information, and subjective ambivalence.

Current psychometric models frequently treat ambiguous or inconsistent responses as measurement error. Acciarini et al. (2021) compare traditional psychometric models with stochastic descriptions of human behavior and show that decision processes may include contradictions. Berthet (2022) similarly argues that psychological measurement often contains cognitive noise or ambivalence. A more comprehensive framework should therefore be able to represent contradictory, neutral, and uncertain information without reducing it to error alone.

1.2. Theoretical Foundations of Neutrosophic Logic and Its Interdisciplinary Applications

Florentin Smarandache introduced Neutrosophic Logic as an extension of classical and fuzzy approaches. In this framework, a proposition is evaluated through three independent components: Truth (T), Indeterminacy (I), and Falsity (F). These components form the foundation of neutrosophic modeling and have been applied in several disciplines, including psychology, where the emerging concept of Neutropsyche attempts to describe human tendencies and behavior through a triadic structure.

Recent publications have explored neutrosophic concepts in cultural psychology, cognitive science, psychological ambivalence, and the modeling of human tendencies as dynamic systems. Examples include works by Christianto and Smarandache (2024), Wang and Smarandache (2025), and Smarandache (2026). These studies provide the theoretical background for examining whether neutrosophic logic can contribute to the analysis of complex behavioral data.

1.3. Research Objectives and Research Questions of the Systematic Review

This systematic review synthesizes the growing literature at the intersection of neutrosophic logic and behavioral science. By following PRISMA-oriented procedures, the study evaluates how neutrosophic tools have been used to model human behavior and psychological indeterminacy.

The primary research objectives are:

- To identify the limitations of classical and fuzzy logic in selected psychological literature.
- To analyze applications of neutrosophic sets in personality, emotions, decision-making, and assessment.
- To determine the theoretical contribution of Neutropsyche to contemporary psychological modeling.

This review is guided by the following research questions:

1. How does neutrosophic logic represent psychological indeterminacy compared with classical and fuzzy models?
2. In what ways have neutrosophic Likert scales and related assessment tools been used to improve behavioral data extraction?
3. What gaps remain in the integration of neutrosophic logic into clinical and social psychology?

2. Materials and Methods (PRISMA)

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The methodology was designed to support a transparent and reproducible synthesis of the literature concerning applications of neutrosophic logic in psychological and behavioral sciences.

2.1. Literature Search Strategy and Databases Used

A comprehensive search was performed in major international databases to identify relevant studies published between 2014 and 2026. The databases searched included Scopus, Web of Science,

PubMed, and PsycINFO. Additional searches were conducted through Google Scholar, ResearchGate, and specialized neutrosophic sources to identify recent or field-specific publications. The archives of Neutrosophic Sets and Systems were also manually consulted to include foundational works by Smarandache and collaborators.

The search strategy used Boolean operators AND/OR with terms appearing in titles, abstracts, and/or keywords, including: neutrosophic logic, Neutropsyche, indeterminacy, neutrosophy, human behavior, decision-making, psychological assessment, and neutrosophic sets.

2.2. Inclusion and Exclusion Criteria for Study Selection

Inclusion criteria were defined as follows:

- Studies applying neutrosophic logic, neutrosophic sets, or neutrosophic probability structures to psychological theories, behavioral models, social science diagnostics, or decision-making.
- Peer-reviewed journal articles, conference papers, and book chapters presenting a clear mathematical or conceptual framework.
- English-language publications accessible to the international community of neutrosophic and behavioral-science researchers.
- Studies explicitly addressing one or more T, I, and F components in relation to human cognition, behavior, or assessment.

Exclusion criteria were defined as follows:

- Purely mathematical works on neutrosophic topology, abstract algebra, or geometry without application to human behavior, psychology, or decision-making.
- Editorials, blog-style material, raw unpublished data, and unpublished student theses.
- Duplicate records, repeated versions of the same study, or preliminary records superseded by a later publication.

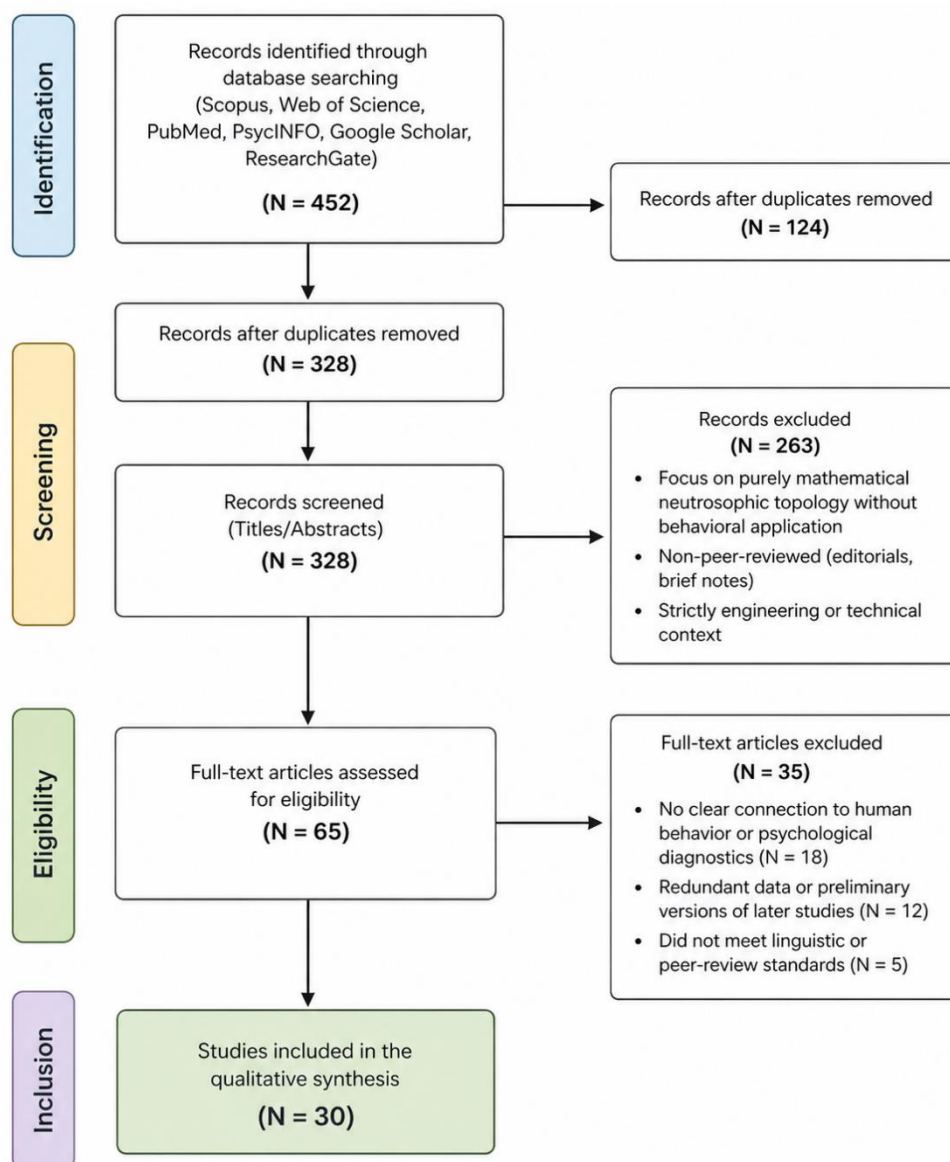
2.3. Study Selection Process and Data Extraction

The selection process consisted of four stages: identification, screening, eligibility assessment, and inclusion.

1. Identification: records were identified through database searches and supplementary searches, then imported into reference management software.
2. Screening: titles and abstracts were screened for relevance to neutrosophic logic, behavioral science, and psychological applications.
3. Eligibility: full-text articles were assessed against the inclusion and exclusion criteria. Particular attention was given to studies addressing behavioral decision-making, psychological assessment, and diagnostic ambiguity.
4. Inclusion: 30 studies met the criteria and were included in the qualitative synthesis.

For each included study, data were extracted using a structured form covering authorship, year of publication, neutrosophic method used, psychological domain, and contribution to the modeling of human behavior or cognition. Extracted methods included single-valued neutrosophic sets, interval neutrosophic sets, neutrosophic Likert scales, and neutrosophic multi-criteria decision-making approaches.

Figure 1. Study selection process (PRISMA).



3. Results

3.1. General Characteristics of the Selected Studies

The final synthesis included 30 papers addressing non-binary or neutrosophic approaches to behavioral and psychological modeling. The publication pattern suggests increased attention after 2020. Earlier papers were largely theoretical and focused on the concept of Neutropsyche and its implications, while more recent studies have increasingly addressed empirical applications, decision-making frameworks, and software-assisted neutrosophic data analysis.

The reviewed studies came from different research contexts and included journal articles, conference papers, and specialized book chapters. The collection reflects an interdisciplinary literature rather than a mature clinical evidence base. Therefore, the findings should be interpreted as a structured synthesis of current applications and theoretical directions rather than as proof of clinical superiority.

3.2. Applications of Neutrosophic Logic in Psychological and Behavioral Studies

Three main areas of application were identified in the reviewed literature:

- Psychological assessment and measurement: neutrosophic scales, particularly Neutrosophic Likert Scales, have been proposed to allow respondents to express agreement, disagreement, neutrality, and uncertainty more explicitly than in classical Likert formats.
- Clinical diagnosis and decision-making: neutrosophic multi-criteria decision-making methods have been applied to problems involving overlapping symptoms and incomplete information. For example, Gomez and Ludeña (2023) applied neutrosophic reasoning to anxiety diagnosis, while Abdel-Basset et al. (2019) used neutrosophic MCDM in professional selection contexts relevant to psychology.
- Organizational and social behavior: studies such as Nabeeh (2023) and Al Awadh (2022) used single-valued neutrosophic sets to model decision-maker behavior under uncertainty in professional and organizational contexts.

3.3. Main Findings on the Contribution of Neutrosophic Logic to Understanding Human Behavior

Across the 30 reviewed studies, neutrosophic logic appears to contribute mainly by formalizing indeterminacy rather than treating it only as random error. The following findings summarize the main contributions identified in the selected studies.

1. Ambivalence can be represented as a measurable component. Classical models often treat ambivalence as an exception or outlier, whereas neutrosophic approaches model it through the I component within a triadic structure.
2. Neutrosophic sets may refine sentiment and perception analysis by separating neutral or indeterminate responses from positive and negative polarities. Reported accuracy gains should be interpreted cautiously because they depend on datasets, models, and validation procedures.
3. The Neutropsyche and related personality models describe psychological traits as dynamic tendencies rather than fixed binary categories.
4. Neutrosophic models may be useful in difficult or crisis situations where information is incomplete, contradictory, or uncertain, because they explicitly encode the unknown component instead of forcing a binary classification.

Table 1. Summary of representative studies and their contributions to behavioral science.

Author(s) and year	Neutrosophic tool/model	Psychological domain	Key contribution to psychology
Smarandache (2016, 2026)	Neutropsyche; neutrosophic personality	Theoretical psychology	Introduced and developed a triadic structure (T, I, F) for modeling human tendencies as dynamic systems.
Patro and Smarandache (2024)	Neutrosophic Likert Scale	Psychometrics	Proposed a scale format that allows respondents to express uncertainty or neutral feelings during assessment.
Gomez and Ludeña (2023)	Neutrosophic MCDM/TOPSIS	Clinical diagnosis	Applied indeterminacy to the interpretation of overlapping symptoms in anxiety-related diagnostic support.

Wang and Smarandache (2025)	Single-valued neutrosophic sets	Cognitive science	Formalized the representation of psychological ambivalence and states of uncertainty.
Nabeeh (2023)	Integrated SVNS decision-making	Organizational behavior	Modeled decision strategies under professional uncertainty and multi-criteria constraints.
Dhamodharan (2024)	Neutrosophic sentiment analysis	Social psychology	Separated neutral sentiment from positive and negative polarities in perception analysis.
Şahin (2022)	Neutrosophic uncertainty modeling	Cognitive psychology	Discussed limitations of binary logic in explaining gray areas of behavior and risk perception.
Duran et al. (2021)	Confirmatory neutrosophic analysis	Well-being and life satisfaction	Converted the Satisfaction with Life Scale into a neutrosophic form and compared confirmatory analysis results.
Berthet (2022)	Cognitive-bias framework	Behavioral economics	Interpreted cognitive biases as responses to uncertain or incomplete information rather than only as errors.
Heredia et al. (2024)	AHP, Delphi, and neutrosophic logic	Crisis management	Integrated expert judgment and neutrosophic logic for decision-making in complex environments.

4. Discussion

4.1. Interpretation of Findings in the Context of Contemporary Psychological Theories

This systematic review indicates that neutrosophic logic can function as a bridge between mathematical formalization and the complexity of human cognition. In classical interpretations of cognitive dissonance, two conflicting beliefs or facts may produce psychological tension. A neutrosophic interpretation adds an explicit indeterminate component, allowing the model to represent hesitation, uncertainty, or the subjective feeling of not knowing how to decide.

The analysis of personality traits also suggests that rigid boundaries between traits may be insufficient for describing actual psychological variability. In this context, the neutrosophic component of indeterminacy can represent ambiguous or unstable responses without immediately classifying them as error. This perspective is consistent with recent discussions of cognitive biases, where some responses may reflect processing under uncertainty rather than simple irrationality.

4.2. Theoretical and Conceptual Contributions of Neutrosophic Logic to Psychology

Smarandache (2016, 2026) proposed the Neutropsyche model to represent human tendencies and behaviors through a triadic structure. The theoretical value of this framework lies in moving from binary opposition toward a model that can include truth, falsity, and indeterminacy simultaneously. This is particularly relevant in psychological contexts where respondents may agree with an item, disagree with it, and still retain some degree of uncertainty or neutrality.

For psychological assessment, neutrosophic scales may provide a more detailed structure for collecting data on perceptions, attitudes, experiences, and evaluations. In clinical or diagnostic contexts, neutrosophic multi-criteria decision-making can support the interpretation of overlapping symptoms when available information is incomplete or uncertain. These contributions remain promising, but they require stronger empirical testing before broad practical adoption.

4.3. Limitations of the Current Literature and Future Research Directions

Despite growing interest, the literature remains limited. Many studies are still theoretical, computational, or based on preliminary applications. There is a lack of large longitudinal clinical studies comparing traditional psychological diagnostic methods with neutrosophic frameworks under controlled conditions.

A second limitation concerns usability. Neutrosophic methods may require mathematical knowledge that is not common among behavioral researchers and clinicians. Future work should therefore focus on transparent validation studies, open datasets when possible, user-friendly software, and reporting standards that make neutrosophic models easier to evaluate and reproduce.

5. Conclusions

This systematic review examined how neutrosophic logic can be used to model aspects of human behavior that are difficult to capture through binary or fuzzy approaches alone. The reviewed studies show that the Truth-Indeterminacy-Falsity triad may be useful for representing ambivalence, uncertainty, and neutrality in psychological assessment, behavioral decision-making, and theoretical personality modeling.

The use of Neutrosophic Likert Scales and neutrosophic multi-criteria decision-making methods suggests a possible direction for instruments that preserve uncertain or neutral information rather than eliminating it during analysis. Nevertheless, the field requires stronger empirical evidence, clearer methodological standards, and accessible computational tools.

Future research should prioritize empirical validation in clinical and social psychology, comparative studies against existing psychometric models, and software that allows researchers to apply neutrosophic methods without excessive computational barriers.

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