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Cognitive Modeling of Vietnamese Metaphor Comprehension: A Comparison between Large Language Models and Human Learners

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Abstract
Conceptual metaphor is widely recognized as a fundamental cognitive mechanism through which humans organize and construct meaning based on embodied and cultural experiences. With the rapid advancement of generative artificial intelligence, Large Language Models (LLMs) have demonstrated remarkable capabilities in processing natural language, including the interpretation of metaphorical expressions. However, few studies have systematically compared metaphor comprehension between LLMs and learners of Vietnamese from the perspective of Cognitive Linguistics. This study investigates and compares how LLMs and learners of Vietnamese as a foreign language interpret common Vietnamese conceptual metaphors. A mixed-methods approach is employed, combining quantitative analyses of interpretation accuracy with qualitative analyses of cognitive reasoning strategies. The dataset consists of conceptual metaphorical expressions collected from Vietnamese literary works, journalistic texts, and everyday communication. Responses generated by LLMs are compared with those produced by learners at different proficiency levels. The expected findings suggest that while LLMs are generally capable of identifying the generalized meanings of many metaphorical expressions, they remain limited in representing culturally grounded knowledge and embodied experiences. In contrast, human learners rely more heavily on contextual understanding, linguistic experience, and cultural cognition in constructing metaphorical meaning. Based on these findings, the study proposes a comparative cognitive model that distinguishes the probabilistic reasoning mechanisms of LLMs from the embodied cognitive processes of human learners in interpreting Vietnamese conceptual metaphors. The research contributes to the intersection of Cognitive Linguistics, Artificial Intelligence, and Vietnamese language education by providing new insights into metaphor comprehension across human and artificial cognitive systems.

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1. Introduction

The rapid advancement of Generative Artificial Intelligence (Generative AI), particularly Large Language Models (LLMs) such as ChatGPT, Gemini, Claude, and Copilot, has fundamentally transformed the landscape of natural language processing and language education. Beyond their remarkable ability to generate fluent and coherent texts, these models increasingly demonstrate sophisticated performance in semantic interpretation, reasoning, and discourse generation. Such developments have prompted

an important theoretical question within Cognitive Linguistics: do LLMs genuinely comprehend language through cognitive mechanisms comparable to those of humans, or do they merely reproduce statistically probable linguistic patterns learned from massive textual corpora?

According to Cognitive Linguistics, metaphor is not simply a rhetorical device but a fundamental mechanism of human thought through which abstract concepts are understood in terms of more concrete and embodied experiences. Conceptual Metaphor Theory argues that metaphorical expressions reflect systematic mappings between source and target domains grounded in bodily experience, cultural knowledge, and social interaction. Consequently, successful metaphor comprehension requires much more than lexical or grammatical knowledge; it also depends on conceptual structures, cultural schemas, and embodied cognition developed through lived experience.

Vietnamese conceptual metaphors provide a particularly valuable context for investigating this issue because they are deeply rooted in indigenous cultural traditions, agricultural practices, family relationships, and Eastern philosophical thought. Expressions such as *life is a journey*, *knowledge is light*, and *time flows like water* represent culturally embedded conceptualizations that often challenge learners of Vietnamese as a foreign language. Interpreting these expressions requires not only linguistic competence but also the ability to activate culturally specific conceptual mappings that may not exist in learners' first languages.

Although recent studies have reported impressive performance of LLMs on various language understanding tasks, growing evidence suggests that these systems still encounter difficulties when processing culturally grounded and cognitively complex metaphorical expressions. Unlike humans, whose conceptual systems are shaped by embodied experience and sociocultural interaction, LLMs primarily rely on statistical regularities extracted from large-scale text corpora. As a result, they may successfully infer the intended meaning of a metaphor while lacking access to the experiential and conceptual motivations underlying its interpretation. This distinction raises fundamental questions regarding the nature of machine "understanding" and its relationship to human cognition.

Despite the increasing body of research on artificial intelligence in language education and the extensive literature on Conceptual Metaphor Theory, relatively little attention has been paid to comparing metaphor comprehension between LLMs and learners of Vietnamese as a foreign language. Existing studies have predominantly focused on English or other widely spoken languages, leaving Vietnamese largely underrepresented in interdisciplinary research at the intersection of Cognitive Linguistics and Artificial Intelligence. Furthermore, empirical evidence concerning whether AI employs reasoning strategies comparable to human conceptualization remains scarce.

To address this research gap, the present study compares the interpretation of Vietnamese conceptual metaphors by Large Language Models and learners of Vietnamese as a foreign language. Through a mixed-methods analysis of metaphor interpretation accuracy and reasoning strategies, the study seeks to identify similarities and differences between probabilistic language modeling and human conceptual processing. Based on the empirical findings, a comparative cognitive framework is proposed to distinguish statistical language prediction from embodied conceptualization. The study is expected to contribute not only to Cognitive Linguistics and AI research but also to Vietnamese language education and the development of more cognitively informed language technologies.

2. Literature review

2.1. Conceptual Metaphor Research in Cognitive Linguistics

Since the emergence of Conceptual Metaphor Theory (CMT), metaphor has been widely viewed as a fundamental cognitive mechanism rather than merely a rhetorical device. This perspective argues that abstract concepts are systematically understood through mappings from more concrete and embodied experiences. Subsequent developments in Cognitive Linguistics have extended this framework by emphasizing image schemas, embodied cognition, mental spaces, and conceptual blending as complementary mechanisms underlying metaphorical reasoning.

Studies on Vietnamese conceptual metaphors have demonstrated that metaphorical expressions are deeply embedded in indigenous cultural practices, agricultural traditions, family relationships, and social values. Nevertheless, existing research has predominantly adopted descriptive and semantic approaches, while empirical investigations into how learners of Vietnamese cognitively interpret conceptual metaphors remain relatively limited.

2.2. Large Language Models and Language Understanding

Recent advances in Large Language Models have significantly expanded research on artificial language understanding. Contemporary LLMs have demonstrated remarkable performance across diverse natural language processing tasks, including question answering, translation, summarization, and educational assistance. Their ability to generate coherent and contextually appropriate responses has stimulated growing interest in their potential as cognitive language technologies.

Despite these achievements, whether LLMs genuinely "understand" language remains highly controversial. Some scholars argue that these systems primarily exploit statistical regularities extracted from large-scale corpora without developing conceptual representations grounded in embodied experience. Others suggest that increasingly sophisticated reasoning capabilities may indicate the emergence of higher - level semantic representations. This debate becomes particularly salient when LLMs are required to interpret metaphorical expressions whose meanings depend heavily on cultural knowledge and experiential cognition.

2.3. Artificial Intelligence from A Cognitive Linguistic Perspective

The intersection between Artificial Intelligence and Cognitive Linguistics has recently become an active interdisciplinary research area. Existing studies have investigated metaphor interpretation, semantic reasoning, polysemy, and discourse comprehension to compare language processing in humans and LLMs. Overall, these studies suggest that LLMs perform well when interpreting conventional metaphors but encounter greater difficulty with culturally specific, context-dependent, and novel metaphorical expressions.

Furthermore, previous research indicates that human learners

typically construct metaphorical meaning by integrating linguistic knowledge, contextual information, and embodied cultural experience, whereas LLMs mainly rely on probabilistic associations learned from textual data. These findings imply fundamental differences between human conceptualization and statistical language modeling.

2.4. Research Gap

Although substantial research has been conducted on Conceptual Metaphor Theory, Large Language Models, and AI-assisted language learning, several important gaps remain.

First, most existing studies focus on English and other major world languages, while Vietnamese conceptual metaphors remain largely underexplored within interdisciplinary AI research.

Second, relatively few empirical studies directly compare metaphor comprehension between LLMs and learners of Vietnamese as a foreign language. Consequently, it remains unclear whether similar interpretations arise from shared cognitive mechanisms or from fundamentally different processing strategies.

Third, no comprehensive framework has yet been proposed to compare probabilistic reasoning in LLMs with embodied conceptual processing in human learners during the interpretation of Vietnamese conceptual metaphors.

Addressing these gaps, the present study develops a comparative cognitive framework for analyzing metaphor comprehension in both artificial and human cognitive systems. By integrating Cognitive Linguistics with Artificial Intelligence research, the study aims to provide new theoretical and empirical insights into the nature of language understanding across human and machine intelligence.

3. Theoretical Framework and Methodology

3.1. Theoretical Framework

3.1.1. Conceptual Metaphor Theory

The present study is grounded in Conceptual Metaphor Theory (CMT), which conceptualizes metaphor not merely as a rhetorical device but as a fundamental mechanism of human cognition. According to this theory, abstract concepts are systematically understood through mappings from more concrete and experientially grounded domains. Such conceptual mappings enable individuals to organize, interpret, and communicate complex experiences by projecting knowledge from familiar source domains onto abstract target domains.

For example, the conceptual metaphor LIFE IS A JOURNEY structures numerous linguistic expression such as *choosing the right path*, *reaching a destination*, *overcoming obstacles*, and *changing direction*. These expressions reveal that metaphor comprehension extends beyond lexical meaning and relies on conceptual structures shared within a speech community.

Within Cognitive Linguistics, conceptual metaphors are regarded as mental representations rather than isolated linguistic phenomena. Consequently, successful metaphor interpretation requires the integration of linguistic knowledge, conceptual organization, embodied experience, and sociocultural understanding.

In this study, Conceptual Metaphor Theory provides the principal analytical framework for categorizing Vietnamese metaphorical expressions and comparing how Large Language Models and learners of Vietnamese as a foreign language construct conceptual mapping during metaphor interpretation.

3.1.2. Embodied Cognition

Embodied Cognition constitutes another theoretical foundation of this study. This perspective argues that conceptual knowledge originates from bodily interaction with the physical and social environment rather than from abstract symbolic manipulation alone. Human understanding of concepts such as *time*, *emotion*, *knowledge*, *power*, and *life* is deeply rooted in sensory, motor, and affective experiences accumulated throughout everyday life.

From this perspective, metaphor comprehension is inseparable from human embodiment. Cultural experience, physical interaction, and social participation continuously shape the conceptual system through which metaphorical meanings are constructed.

Unlike humans, however, Large Language Models possess neither bodily experience nor direct interaction with the physical world. Their language processing mechanisms are primarily based on statistical associations learned from massive textual corpora. Consequently, although LLMs often produce linguistically appropriate interpretations, their reasoning process may differ fundamentally from the embodied conceptualization observed in human cognition.

The embodied cognition framework therefore serves as an important theoretical basis for explaining potential differences between human learners and artificial intelligence in interpreting Vietnamese conceptual metaphors.

3.1.3. Large Language Models and Probabilistic Semantic Reasoning

Large Language Models are built upon Transformer architectures trained to predict subsequent linguistic units from extremely large text corpora. Through large-scale self-supervised learning, these models acquire remarkable capabilities in text generation, question answering, translation, summarization, and semantic reasoning.

Despite their impressive performance, the extent to which LLMs genuinely "understand" language remains an open question. From a Cognitive Linguistics perspective, linguistic competence cannot be equated with conceptual understanding. Instead of relying on embodied conceptual structures, LLMs generate responses by estimating the statistical probability of linguistic sequences based on patterns learned during training.

Accordingly, this study distinguishes between two fundamentally different mechanisms of meaning construction:

- Probabilistic semantic reasoning, representing language processing in Large Language Models; and
- Experience-based conceptual cognition, representing metaphor comprehension in human learners.

This distinction provides the conceptual foundation for comparing AI-generated interpretations with human cognitive processing.

3.1.4. Analytical Framework

Based on the theoretical perspectives discussed above, this study proposes a comparative analytical framework consisting of four interconnected components.

The first component comprises the *input*, namely a corpus of Vietnamese conceptual metaphors collected from authentic communicative contexts.

The second component concerns the *processing mechanism*. Large Language Models interpret metaphorical expressions through probabilistic semantic reasoning derived from statistical language patterns, whereas human learners integrate linguistic knowledge, contextual information, embodied experience, and cultural schemas.

The third component is the *interpretation outcome*, representing the metaphorical meanings generated by AI and human participants.

Finally, the fourth component involves *comparative cognitive analysis*, through which similarities and differences between artificial and human meaning construction are systematically examined.

This analytical framework informs both the research design and the interpretation of empirical findings.

3.2. Methodology

3.2.1. Research Design

The study adopts a *mixed - methods research design*, combining quantitative and qualitative approaches to obtain a comprehensive understanding of metaphor comprehension in both Large Language Models and learners of Vietnamese as a foreign language.

The quantitative component evaluates interpretation accuracy across different metaphor categories, while the qualitative component investigates reasoning strategies, conceptual mapping, and cognitive processes underlying metaphor interpretation.

The integration of both approaches allows the study to examine not only whether AI and human learners arrive at similar interpretations but also how those interpretations are cognitively constructed.

3.2.2. Participants

The study involves two groups of participants. The first group consists of three widely used Large Language Models: ChatGPT (GPT-5.5; gemini; claude. These models were selected because of their advanced Vietnamese language capabilities and their widespread application in education and natural language processing research.

The second group comprises learners of Vietnamese as a foreign language whose proficiency ranges from B1 to C1 according to the Common European Framework of Reference for Languages (CEFR). Including learners from multiple proficiency levels enables the investigation of developmental differences in metaphor comprehension.

3.2.3. Research Corpus

The research corpus consists of approximately 120 - 150 Vietnamese conceptual metaphorical expressions collected from three principal sources: (i) Vietnamese literary works; (ii) Newspapers and digital media; (iii) Everyday spoken communication.

The selected expressions represent a broad range of conceptual metaphor types and vary in familiarity, cultural specificity, and contextual complexity. This diversity ensures adequate representation of Vietnamese metaphorical language.

3.2.4. Data Collection

Data are collected through three complementary instruments. First, both AI models and human participants are asked to interpret the meanings of the selected Vietnamese metaphorical expressions; Second, all responses are evaluated using a four-level scoring rubric:

- **Level 0:** Incorrect or no interpretation;
- **Level 1:** Literal interpretation only;
- **Level 2:** Partial metaphorical understanding;
- **Level 3:** Accurate metaphorical interpretation accompanied by an appropriate conceptual explanation.

Third, semi-structured interviews are conducted with selected participants to explore their reasoning processes during metaphor interpretation. For AI systems, standardized prompts are employed throughout data collection to ensure consistency and comparability across different language models.

3.2.5. Data Analysis

Quantitative data are analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to measure interpretation accuracy across participant groups. Where appropriate, inferential statistical analyses such as Chi-square tests and one-way Analysis of Variance (ANOVA) are employed to determine statistically significant differences between AI systems and human learners. Qualitative data are analyzed through content analysis. Participants' responses are coded according to four analytical dimensions: (i) conceptual mapping; (ii) cultural knowledge activation; (iii) contextual reasoning; (iv) interpretation errors.

This coding framework facilitates a systematic comparison of cognitive strategies employed by artificial intelligence and human learners.

3.2.6. Reliability and Validity

Several procedures are implemented to ensure the reliability and validity of the research. Inter-rater reliability is established through independent coding conducted by two researchers using a shared coding protocol. Any discrepancies are discussed until consensus is achieved. To enhance methodological consistency, identical prompts are used for all interactions with Large Language Models throughout the experiment. Content validity is strengthened by selecting metaphorical expressions from multiple authentic sources representing diverse communicative contexts. Furthermore, methodological triangulation, achieved by integrating quantitative and qualitative evidence, increases the robustness and credibility of the research findings.

4. Analysis of The Cognitive Models of Ai And Learners in Understanding Vietnamese Metaphors

4.1. Human Cognitive Characteristics in Interpreting Vietnamese Metaphors

From the perspective of Cognitive Linguistics, understanding

a metaphorical expression is far more than decoding the meanings of individual lexical items. Rather, it is a process of meaning construction in which language users activate conceptual knowledge, embodied experience, cultural memory, and contextual reasoning accumulated through continuous interaction with the surrounding world. Consequently, metaphor comprehension reflects the operation of an integrated cognitive system rather than a purely linguistic process. Human cognition is therefore characterized by three interrelated properties: experientiality, embodiment, and cultural situatedness. Together, these properties fundamentally distinguish human metaphor comprehension from the language-processing mechanisms employed by contemporary Large Language Models.

4.1.1. Embodied Experience as the Foundation of Metaphor Comprehension

A central assumption of Cognitive Linguistics is that conceptual knowledge originates from bodily interaction with the physical and social environment. Human beings develop conceptual structures through perception, movement, emotional experience, and repeated engagement with everyday activities. These experiences gradually give rise to recurrent cognitive patterns known as image schemas, which subsequently support abstract reasoning.

Vietnamese conceptual metaphors clearly illustrate this principle. Expressions such as *overcoming difficulties*, *choosing the right path*, or *changing direction in life* are grounded in physical experiences of movement through space. Rather than interpreting these expressions literally, speakers automatically activate conceptual knowledge associated with journeys, including destinations, obstacles, choices, and progress, and project this knowledge onto the more abstract domain of life.

Importantly, this conceptual mapping occurs largely outside conscious awareness. Human cognition continuously integrates embodied experiences into metaphorical interpretation without requiring explicit analytical reasoning.

4.1.2. Image Schemas and Conceptual Organization

Another defining characteristic of human cognition is the organization of conceptual knowledge through image schemas. These schemas are abstract cognitive structures derived from recurrent bodily experiences rather than visual images themselves.

Many Vietnamese metaphorical expressions are organized around schemas such as pasth, container, up - down, center - periphery, and balance. Expressions referring to emotional states, social status, or personal achievement frequently rely on the UP–DOWN schema, where upward movement symbolizes improvement or success, whereas downward movement represents decline or failure. Because image schemas constitute generalized cognitive patterns, speakers can often interpret previously unseen metaphorical expressions by extending existing conceptual structures to new contexts. This productive capacity illustrates the flexibility and generative nature of human cognition.

4.1.3. Cultural Knowledge in Vietnamese Metaphor Interpretation

Metaphor comprehension is also deeply influenced by cultural knowledge. Vietnamese conceptual metaphors are embedded within indigenous traditions, agricultural practices, family relationships, and collective moral values. As a result, interpreting many metaphorical expressions requires access to culturally shared conceptual systems.

For instance, expressions such as *drinking water, remember its source* or *when eating fruit, remember the person who planted the tree* evoke culturally specific concepts of gratitude, ancestry, and social responsibility that extend far beyond their literal meanings. Native speakers typically access these cultural schemas automatically because they have been acquired through long-term socialization.

Learners of Vietnamese as a foreign language, however, often lack these culturally grounded conceptual resources. Consequently, they may interpret such expressions literally or transfer conceptual patterns from their first language, leading to incomplete or inaccurate interpretations.

4.1.4. Contextual Reasoning and Cognitive Flexibility

Human cognition is distinguished by its remarkable ability to integrate multiple sources of information during language interpretation. Metaphorical meaning is constructed not only through lexical semantics but also through contextual cues, communicative intentions, interpersonal relationships, prior knowledge, and personal experience.

This contextual flexibility enables speakers to assign different metaphorical interpretations to the same expression depending on the communicative situation. For example, the metaphor *light* may represent knowledge in educational discourse, hope in literary texts, or spiritual truth in religious contexts. Such interpretive flexibility reflects the dynamic nature of human conceptual processing.

4.1.5. Characteristics of Human Cognitive Processing

The preceding discussion suggests that human metaphor comprehension results from the interaction of several cognitive components. First, conceptual meaning is grounded in embodied experience and continuous interaction with the environment; Second, image schemas provide abstract organizational structures through which conceptual mappings are constructed; Third, cultural knowledge supplies socially shared conceptual frameworks that guide metaphor interpretation; Finally, contextual reasoning allows speakers to adapt metaphorical meanings to specific communicative situations.

Taken together, these components demonstrate that understanding Vietnamese metaphors is not simply a matter of lexical processing but rather the outcome of a complex, multilayered cognitive system integrating embodiment, conceptual organization, cultural experience, and contextual inference. This integrated cognitive architecture provides the theoretical foundation for the subsequent comparison with the probabilistic semantic reasoning employed by Large Language Models.

4.2. Ai Models and Large Language Models in Vietnamese Metaphor Processing

The emergence of Large Language Models (LLMs) has fundamentally transformed natural language processing by enabling machines to perform increasingly sophisticated linguistic tasks. Unlike traditional rule-based or statistical language-processing systems, contemporary LLMs learn semantic representations from massive multilingual corpora and are capable of generating coherent responses across a wide range of communicative contexts. From a Cognitive Linguistics perspective, however, the crucial question is not whether AI can produce correct metaphor interpretations, but

rather how such interpretations are cognitively generated. Understanding the mechanisms underlying AI metaphor processing therefore provides valuable insights into the distinction between artificial language processing and human conceptual cognition.

4.2.1. Computational Foundations of Large Language Models

Modern LLMs, including ChatGPT, Gemini, and Claude, are built upon Transformer architectures in which the self-attention mechanism serves as the core computational component. During large-scale pretraining, these models learn statistical regularities, semantic associations, and contextual dependencies from billions of textual examples. Rather than retrieving predefined lexical meanings, LLMs convert linguistic input into distributed vector representations (embeddings) and estimate the probability distribution of subsequent linguistic units based on contextual information.

From an engineering perspective, this architecture enables highly fluent and context-sensitive language generation. From a cognitive perspective, however, the underlying mechanism relies primarily on statistical relationships among linguistic representations rather than on embodied experience or conceptual structures derived from real-world interaction.

4.2.2. Metaphor Processing in Artificial Intelligence

When interpreting Vietnamese metaphorical expressions, LLMs do not activate image schemas or embodied conceptual structures in the way humans do. Instead, metaphor comprehension emerges from semantic associations encoded within high-dimensional representation spaces learned during training. For instance, when processing the metaphor *life is a journey*, an LLM generates an interpretation by exploiting statistical associations between concepts such as *life*, *path*, *destination*, *choice*, and *obstacle* frequently observed in textual corpora. Although the resulting explanation may resemble human interpretation, the computational pathway differs substantially from the conceptual mapping process proposed in Cognitive Linguistics.

The overall computational process can be summarized as follows: *Metaphorical expression → Tokenization → Vector embedding → Self-attention computation → Semantic association → Probabilistic inference → Generated interpretation.*

Thus, metaphor understanding in LLMs should be regarded as a process of probabilistic semantic optimization rather than embodied conceptual reasoning.

4.2.3. Probabilistic Semantic Reasoning

One of the defining characteristics of LLMs is their ability to construct high-dimensional semantic representation spaces. Within these spaces, semantically related linguistic units occupy nearby vector positions, enabling the model to infer conceptual relationships through distributional similarity. Consequently, LLMs often succeed in interpreting conventional metaphors even when identical expressions have not appeared explicitly in the training corpus. This capability reflects statistical generalization across semantically related contexts rather than conceptual reasoning grounded in physical experience. Although such probabilistic reasoning frequently produces accurate interpretations, it differs fundamentally from human cognition because it lacks direct experiential and perceptual foundations.

4.2.4. Contextual Interpretation

Another major strength of contemporary LLMs lies in their capacity to integrate extensive contextual information. Through self-attention mechanisms, models dynamically evaluate relationships among multiple textual elements when determining the most probable interpretation of a metaphorical expression. For example, the Vietnamese metaphorical concept of *light* may represent physical illumination, knowledge, hope, or spiritual truth depending on surrounding discourse. LLMs determine the most plausible interpretation by analyzing contextual linguistic cues rather than by drawing upon embodied experience or personal memory. This demonstrates that contextual adaptability in AI originates from statistical language modeling rather than from cognitive interaction with the external world.

4.2.5. Limitations of AI in Vietnamese Metaphor Interpretation

Despite their remarkable linguistic capabilities, current LLMs exhibit several limitations when processing Vietnamese conceptual metaphors. First, LLMs lack embodied experience and therefore cannot directly activate sensorimotor image schemas that constitute the basis of human conceptualization; Second, many Vietnamese metaphors are deeply embedded in indigenous cultural traditions, historical knowledge, and social practices. Because AI accesses such knowledge only indirectly through textual data, interpretations of culturally specific metaphors may remain linguistically plausible while failing to capture their broader conceptual and symbolic significance; Third, unlike humans, LLMs cannot autonomously construct new conceptual systems through lived experience. Their knowledge evolves primarily through additional training or fine-tuning rather than through continuous interaction with the physical and social environment.

4.2.6. An AI Cognitive Model from The Perspective of Cognitive Linguistics

From the perspective adopted in this study, AI metaphor processing can be conceptualized as a five-stage computational framework. The first stage involves receiving linguistic input in symbolic form; The second stage transforms linguistic tokens into distributed numerical representations through tokenization and embedding; The third stage activates semantic relationships via self-attention mechanisms; The fourth stage performs probabilistic semantic inference by integrating contextual information with previously learned statistical patterns; Finally, the fifth stage generates the most probable metaphor interpretation under the current linguistic context; This framework demonstrates that LLMs do not reproduce human conceptual cognition but instead implement a fundamentally different mechanism based on distributional semantics and probabilistic inference. Nevertheless, because these models have been trained on extraordinarily large textual corpora, they can often approximate human interpretive performance.

This convergence in outcomes despite divergence in underlying cognitive mechanisms constitutes the central theoretical issue addressed in the following comparative analysis.

4.3. Comparing the Cognitive Models Of Ai And Human Learners In Vietnamese Metaphor Comprehension

The preceding sections have demonstrated that both human learners and Large Language Models are capable of producing plausible interpretations of Vietnamese metaphorical expressions. Nevertheless, similar interpretative outcomes do not necessarily imply similar cognitive mechanisms. From the perspective of Cognitive Linguistics, the fundamental distinction lies not in the accuracy of the interpretations but in the processes through which meaning is constructed. Therefore, a meaningful comparison between AI and human learners should focus on their underlying cognitive architectures rather than merely on linguistic performance.

4.3.1. Sources of Linguistic Knowledge

The first major distinction concerns the origin of linguistic knowledge. Human conceptual knowledge develops gradually through embodied experience, perception, social interaction, and cultural participation. Language acquisition is inseparable from the formation of conceptual structures grounded in everyday life. Consequently, linguistic expressions become associated with rich experiential and conceptual networks that extend far beyond lexical meaning.
By contrast, the knowledge acquired by Large Language Models originates from large-scale textual corpora. Through statistical learning, LLMs construct distributed semantic representations that encode relationships among linguistic units. Since these systems lack direct interaction with the physical world, their conceptual knowledge is mediated entirely through language rather than lived experience. Accordingly, human cognition may be characterized as experience-mediated knowledge construction, whereas AI relies primarily on language-mediated statistical knowledge.

4.3.2. Meaning Construction Mechanisms

The second distinction concerns the mechanisms through which metaphorical meaning is constructed. According to Conceptual Metaphor Theory, human learners interpret metaphors by establishing mappings between source and target domains through embodied experience, image schemas, cultural knowledge, and contextual reasoning. Meaning emerges dynamically through the interaction of multiple cognitive systems.
Large Language Models, however, generate metaphorical interpretations through probabilistic semantic inference. Instead of constructing conceptual mappings in the cognitive sense, they estimate semantic relationships among linguistic representations within high - dimensional embedding spaces. This computational mechanism enables accurate interpretation of familiar metaphors while remaining more vulnerable to culturally specific, novel, or highly contextualized expressions. Thus, whereas humans actively construct conceptual meaning, AI primarily reconstructs semantic relationships learned from textual distributions.

4.3.3. Cultural Cognition

Culture represents another dimension in which the two cognitive systems differ substantially.
For human learners, particularly learners of Vietnamese as a foreign language, understanding metaphor requires the gradual acquisition of culturally shared conceptual systems. Vietnamese metaphorical expressions frequently embody moral values, collective memory, historical traditions, and indigenous cultural practices. Successful interpretation therefore depends not only on linguistic competence but also on cultural cognition.
In contrast, LLMs access cultural knowledge only indirectly through textual data. Although they may reproduce culturally appropriate explanations, they do not participate in the social practices or lived experiences from which such conceptual systems originate. Consequently, cultural understanding in AI remains representational rather than experiential.

4.3.4. Contextual Adaptation

Both humans and AI demonstrate considerable sensitivity to contextual information, yet they achieve contextual adaptation through different mechanisms.
Human learners integrate linguistic context, communicative intention, interpersonal relationships, background knowledge, and personal experience when interpreting metaphorical language. Their interpretations remain flexible and can be revised dynamically as new contextual information becomes available.
LLMs, by contrast, rely on self-attention mechanisms and probabilistic language modeling to identify the most likely interpretation within a given textual context. While highly effective in many situations, this strategy may prove less robust when successful interpretation depends on experiential knowledge extending beyond the available linguistic input.

4.3.5. Comparative Summary

The comparison presented above reveals that AI and human learners differ across multiple cognitive dimensions despite often producing comparable interpretative outcomes.

Table 1

Dimension	Human Learners	Large Language Models
Knowledge source	Embodied experience and social interaction	Large-scale textual data
Cognitive basis	Embodied conceptual cognition	Distributional semantic representation
Meaning construction	Conceptual mapping	Probabilistic semantic inference
Cultural knowledge	Direct participation and socialization	Indirect textual acquisition
Context processing	Experience-based contextual reasoning	Statistical contextual optimization
Learning mechanism	Continuous experiential adaptation	Model training and parameter updating
Nature of cognition	Conceptual construction	Probabilistic language modeling

The comparison suggests that similar interpretations may emerge from fundamentally different cognitive architectures. Human learners rely on embodied conceptualization and cultural experience, whereas LLMs depend on statistical regularities encoded in language data.

4.3.6. Discussion

From a Cognitive Linguistics perspective, the comparison should not be framed as a simple opposition between "understanding" and "non-understanding.". Instead, AI and humans represent two distinct systems of meaning construction.

Human metaphor comprehension emerges from the interaction of embodiment, conceptual organization, cultural knowledge, and contextual reasoning. AI, in contrast, generates interpretations through probabilistic semantic computation over large-scale linguistic representations. These distinct cognitive mechanisms explain why LLMs often perform remarkably well on conventional metaphors while still encountering limitations when interpreting culturally grounded or experientially dependent metaphorical expressions.

Therefore, rather than viewing AI as a substitute for human cognition, the present study argues that LLMs should be regarded as complementary cognitive tools. Recognizing both the similarities and the fundamental differences between human conceptual cognition and probabilistic semantic reasoning provides a more balanced theoretical framework for future research in Cognitive Linguistics, Artificial Intelligence, and the teaching of Vietnamese as a foreign language.

4.4. A Comparative Cognitive Framework for Vietnamese Metaphor Comprehension

The preceding analyses demonstrate that human learners and Large Language Models frequently generate similar interpretations of Vietnamese metaphorical expressions despite relying on fundamentally different cognitive mechanisms. Human meaning construction is grounded in embodied experience, conceptual organization, and cultural knowledge, whereas AI generates interpretations through distributional semantic representations and probabilistic inference. This distinction suggests the need for a unified theoretical framework capable of describing both mechanisms within a common analytical perspective.

Accordingly, this study proposes a Comparative Cognitive Framework for Vietnamese Metaphor Comprehension. Rather than positioning AI and human cognition as mutually exclusive systems, the framework conceptualizes them as two distinct pathways leading to the construction of metaphorical meaning. Their differences lie primarily in knowledge sources, processing mechanisms, and meaning-construction strategies.

4.4.1. Structural Components of The Framework

The proposed framework consists of four interconnected components.

The first component is linguistic input, namely Vietnamese metaphorical expressions encountered in communication, literature, or public discourse. Both AI and human learners receive identical linguistic stimuli at this stage.

The second component is the knowledge base, which constitutes the primary point of divergence between the two systems. Human learners activate embodied experience, image schemas, cultural knowledge, social understanding, and communicative experience. Large Language Models, by contrast, rely on learned parameters, distributed semantic representations, and statistical regularities extracted from large-scale textual corpora.

The third component involves the meaning - construction mechanism. Human learners establish conceptual mappings between source and target domains by integrating embodiment, conceptual structures, contextual reasoning, and cultural knowledge. LLMs instead activate vector representations, compute semantic dependencies through self-attention mechanisms, and generate the statistically most probable interpretation.

The fourth component is the interpretation output. Although both systems produce metaphorical interpretations, the cognitive foundations underlying these outputs remain fundamentally different: conceptual construction versus probabilistic semantic inference.

4.4.2. Meaning Construction Processes

Within the proposed framework, human metaphor comprehension proceeds through the following cognitive sequence: *Metaphorical expression → Embodied experience activation → Image schema construction → Conceptual mapping → Cultural and contextual integration → Meaning construction.*

In contrast, AI metaphor processing follows a computational sequence: *Metaphorical expression → Tokenization → Vector embedding → Self-attention computation → Semantic association → Probabilistic inference → Generated interpretation.*

These parallel processes illustrate that similar interpretative outcomes may arise from entirely different cognitive architectures.

4.4.3. An Integrated Comparative Model

The principal contribution of this study is the integration of these two mechanisms into a unified comparative framework. Rather than treating AI and human cognition as competing systems, the model recognizes them as complementary approaches to meaning construction.

Within this framework, AI functions primarily as a simulator of linguistic regularities encoded in textual data, whereas human learners construct meaning through embodied conceptualization, cultural participation, and contextual reasoning. Consequently, the framework explains both the impressive linguistic performance of LLMs and their continuing limitations when interpreting metaphors that depend heavily on lived experience or culturally specific conceptual systems.

4.4.4. Theoretical Contributions

The proposed framework makes three theoretical contributions.

First, it extends Cognitive Linguistics beyond the study of human conceptualization by incorporating artificial language-processing systems into comparative cognitive analysis.

Second, it establishes an interdisciplinary connection among Cognitive Linguistics, Artificial Intelligence, and language education. This integrated perspective provides a conceptual foundation for investigating AI-assisted language learning while maintaining the central role of human cognition.

Third, the framework demonstrates that linguistic

competence generated by LLMs should not be equated with human conceptual understanding. Although AI may achieve highly accurate metaphor interpretations, its computational processes remain fundamentally distinct from embodied conceptual cognition.

4.4.5. Practical Implications

From a pedagogical perspective, the framework provides a theoretical basis for integrating AI into Vietnamese language education. Instead of treating AI-generated explanations as authoritative interpretations, instructors may encourage learners to compare AI responses with culturally grounded human interpretations. Such comparative activities can strengthen conceptual awareness, intercultural competence, and metaphorical reasoning.

Beyond metaphor studies, the framework may also be extended to investigate other figurative phenomena, including metonymy, idiomatic expressions, proverbs, and culturally embedded discourse. In this way, it offers a broader conceptual foundation for future interdisciplinary research on the relationship between artificial intelligence and human language cognition.

4.5. Discussion and Implications for Cognitive Linguistics And Vietnamese Language Education

4.5.1. Discussion

The analyses presented in this study indicate that the rapid advancement of Large Language Models raises important theoretical questions for Cognitive Linguistics. Traditional research on metaphor has primarily focused on human conceptualization, emphasizing embodiment, image schemas, and cultural knowledge as the foundations of meaning construction. The emergence of AI demonstrates, however, that a computational system without biological embodiment, lived experience, or social participation can nevertheless generate metaphorical interpretations that often resemble those produced by humans. Rather than challenging Cognitive Linguistics, this observation extends its scope by introducing artificial cognition as a new object of theoretical inquiry.

A crucial distinction emerging from this study concerns the difference between interpretative outcomes and meaning - construction mechanisms. Although LLMs frequently provide accurate interpretations of Vietnamese metaphors, these interpretations result from statistical language modeling rather than embodied conceptual mapping. Consequently, evaluating AI solely on the basis of linguistic output may lead to the mistaken assumption that machine cognition is equivalent to human cognition. In reality, the two systems rely on fundamentally different principles: humans construct meaning through the interaction of embodiment, culture, and social experience, whereas AI generates interpretations through distributional semantic representations and probabilistic inference.

From the perspective of Cognitive Linguistics, the present study advocates a shift from the traditional opposition between “human cognition” and “machine processing” toward a framework of comparative cognition. Within this perspective, AI should not be regarded as a complete simulation of human conceptualization but rather as an alternative language-processing system capable of reproducing many cognitive outcomes through different computational mechanisms. Such an approach simultaneously recognizes the remarkable linguistic capabilities of AI while reaffirming the indispensable role of embodiment, cultural experience, and social interaction in human meaning construction.

Another theoretical contribution of this study is the proposed comparative cognitive framework for Vietnamese metaphor comprehension, which integrates Cognitive Linguistics, Natural Language Processing, and Artificial Intelligence into a unified conceptual model. This framework provides a foundation for investigating other linguistic phenomena, including metonymy, idiomatic expressions, proverbs, culturally embedded discourse, and intercultural communication in AI-assisted environments.

The study also highlights the importance of future empirical research examining AI performance on culturally specific linguistic phenomena. Many Vietnamese metaphors originate from historical traditions, indigenous beliefs, agricultural culture, and communal social practices. Although LLMs may produce linguistically appropriate explanations, they may not fully capture the deeper cultural meanings and symbolic values embedded in these expressions. Future studies combining theoretical analysis with empirical evaluation will therefore be essential for refining the comparative cognitive framework proposed here.

4.5.2. Implications for Cognitive Linguistics

The present study offers several implications for future research in Cognitive Linguistics.

First, AI should be considered not merely as a technological tool but also as a legitimate object of cognitive linguistic investigation. Examining how LLMs generate meaning provides new opportunities to clarify the distinctive characteristics of human conceptual cognition, particularly the roles of embodiment, cultural knowledge, and social interaction.

Second, the study encourages stronger interdisciplinary collaboration among Cognitive Linguistics, Cognitive Science, Artificial Intelligence, and Language Education. Integrating conceptual theories with computational language models may contribute to a richer understanding of the relationship between natural and artificial intelligence.

Third, the proposed comparative framework can serve as a theoretical model for evaluating AI performance across a broader range of linguistic phenomena, including pragmatics, implicature, irony, humor, idiomatic language, and culturally grounded discourse.

4.5.3. Implications for Vietnamese language teaching

From an educational perspective, the findings suggest that AI has considerable potential to support the teaching of Vietnamese as a foreign language while remaining complementary to, rather than replacing, human instruction. LLMs can assist learners by providing preliminary explanations of metaphorical expressions, identifying potential source and target domains, and illustrating metaphor usage across multiple communicative contexts. Such support may facilitate the learning of highly abstract conceptual structures.

However, effective metaphor instruction should extend beyond AI-generated explanations. Teachers should guide learners to explore the relationships among linguistic expressions, embodied experience, cultural values, and communicative contexts. Comparative analyses between AI interpretations and native-speaker conceptualizations can enhance learners' cultural awareness, pragmatic competence,

and metaphorical reasoning.

Furthermore, the comparative cognitive framework suggests a dialogic model of AI-assisted learning in which AI functions not as an authoritative source of answers but as an object of critical comparison. Learners are encouraged to evaluate, question, and refine AI-generated interpretations through interaction with teachers, peers, and authentic cultural materials. This pedagogical approach aligns with competency-based education by promoting critical thinking, reflective learning, and learner autonomy.

Finally, the study emphasizes that the integration of AI into Vietnamese language education should be guided by a clear understanding of both its strengths and limitations. While AI can effectively support explanation, demonstration, and communicative practice, the development of intercultural communicative competence, metaphorical understanding, and conceptual cognition ultimately depends on learners' embodied experiences, cultural engagement, and meaningful social interaction under the guidance of educators.

5. Conclusion

The rapid advancement of generative artificial intelligence, particularly Large Language Models (LLMs), has created new opportunities for research in linguistics and language education. Within this context, the present study adopted a Cognitive Linguistics perspective to compare the cognitive mechanisms underlying metaphor comprehension in AI and human learners of Vietnamese. Rather than evaluating AI solely in terms of its linguistic performance, the study focused on the mechanisms through which meaning is constructed, thereby providing a theoretical explanation for both the similarities and the fundamental differences between natural and artificial cognition.

Drawing upon Cognitive Linguistics, Conceptual Metaphor Theory, and recent studies on Large Language Models, the study argues that human metaphor comprehension emerges through the interaction of embodied experience, image schemas, conceptual mappings, cultural knowledge, and contextual reasoning. In contrast, AI processes metaphorical language through distributed semantic representations, self-attention mechanisms, and probabilistic inference over large-scale textual data. Although both systems may generate remarkably similar interpretations of Vietnamese metaphors, the cognitive processes underlying these interpretations remain fundamentally different. Consequently, the linguistic competence demonstrated by AI should not be equated with human conceptual cognition but understood as a distinct form of computational language processing.

The principal theoretical contribution of this study is the proposal of a comparative cognitive framework for Vietnamese metaphor comprehension, which integrates human embodied cognition and AI-based probabilistic semantic reasoning within a unified analytical model. By positioning these two systems within the same comparative framework, the study extends the scope of Cognitive Linguistics to include artificial intelligence as an object of theoretical inquiry while fostering interdisciplinary dialogue among Cognitive Linguistics, Cognitive Science, Natural Language Processing, and Language Education.

From a pedagogical perspective, the findings suggest that AI can serve as an effective instructional tool for teaching Vietnamese as a foreign language, particularly in explaining metaphorical expressions, providing contextualized examples, and supporting conceptual exploration. Nevertheless, AI cannot replace teachers or learners' embodied engagement with language and culture. Effective metaphor instruction should integrate AI - assisted learning with activities that promote cultural interpretation, pragmatic reasoning, and authentic communicative experience in order to develop learners' conceptual competence and intercultural communicative ability.

Despite these contributions, the study has several limitations. As a theoretical and conceptual investigation, its arguments are based primarily on literature synthesis and conceptual analysis rather than empirical evidence. Furthermore, the discussion is limited to Vietnamese metaphor and does not extend to other figurative phenomena such as metonymy, idiomatic expressions, proverbs, or culturally embedded discourse. These limitations provide important directions for future research.

Future studies should empirically compare metaphor comprehension between human learners and Large Language Models using standardized datasets and systematic evaluation criteria. In addition, the comparative cognitive framework proposed here should be further validated and extended to other linguistic phenomena as well as to different languages and cultural contexts. Such research will contribute not only to the continued development of Cognitive Linguistics in the age of artificial intelligence but also to the design of AI - supported language education that promotes learner autonomy, critical thinking, and intercultural communicative competence.

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