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Research Article

Imagery-Topology in Grammar Construction and Lexical Semantic Structure

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ABSTRACT

This study investigates the complex interplay between cognitive and linguistic realms, introducing the imagery-topology hypothesis as a cornerstone in understanding language. We aim to uncover the role of topology-imagery in shaping universal lexical semantics, grammatical structures, and the integration of cultural elements in linguistic frameworks. Employing this hypothesis, we analyze the spatial aspects in lexical meanings, explore spatial arrangement in grammatical structures, and examine cultural influences within linguistic models. Our findings highlight the vital role of imagery- topology in cognitive development and their significant impact on language comprehension. The study presents two novel models conceptualized through the prism of language's imagery-topology, which serve as robust tools for tackling complexities in universal linguistics.

Keywords: Lexical meaning; Grammatical structure; Imagery; Topology; Culture

INTRODUCTION

The investigation of lexical semantic change in lexical entities and their grammatical functions constitutes a pivotal aspect of research in the domains of semantic linguistics, cognitive linguistics, psychological linguistics, and interdisciplinary studies involving psychology. The harmonization of cognitive dimensions in both lexical and clausal units stands as a pivotal element in resolving pertinent linguistic issues. The complexity of lexical semantics and the asymmetry of sentence structures make the application and understanding of vocabulary, translation studies, and second language acquisition particularly challenging.

The primary theoretical framework addressing this issue is exemplified in the practical application of various metaphorical concepts, which deepen our understanding of lexical semantic content and sentence structure. Notably, the container schema concept proposed by Lakoff plays a crucial role in understanding lexical semantic change and subsequent sentence structure comprehension. The spatial structure of the container schema has become an important aspect of linguistic interpretation and research. However, the specifics of how image schemas function within individual words and sentence structures have not been sufficiently addressed.

Research questions: What are the underlying cognitive patterns of the diverse changes in lexical semantics and grammatical structures?

Research task: Construct two models using imagery-topology to analyze lexical semantic structure and sentence grammatical structure.

The structure of the paper underscores the critical role of topology in elucidating the complexities of lexical semantic and grammatical structures. The second section introduces the theoretical foundation of the research, focusing primarily on lexical semantics and grammatical structure studies. The third section expounds on the paper's core hypothesis-the topology-imagery. The fourth and fifth section discusses the general Grammatical Construction Model (GCM) and the universal Lexical Semantic Structure Model (LSSM). Through empirical research, it analyzes the role of topology-imagery in lexical semantics and grammatical structures [1-5].

Lexical semantic change

Polysemy and monosemy, along with synonymy and antonymy, represent critical semantic classification phenomena within the intricate domain of lexical semantics. We observe phenomena such as lexical broadening and narrowing within the semantic hyponymy associated with polysemy. Furthermore, in the context

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of lexical semantic change, both synchronous polysemy and diachronic semantic shifts are prevalent. These shifts are driven by the dynamic and varied use of language by practitioners across diverse scenarios and cultural contexts, leading to the emergence of context-specific meanings. Consequently, the complexity of lexical semantics has always been a challenging aspect of linguistic research.

To address the issue of lexical semantics, the research unfolds from both macro and micro perspectives. In the realm of linguistic research focused on lexical item concepts, studies on semantic atoms or sememes alongside semantic space and semantic field provide a comprehensive dissection of lexical meaning. This exploration ranges from micro to macro levels through decomposition and composition approaches. Semantic atoms, identified as the most fundamental units in the lexical semiotic set, are crucial for differentiating and contrasting lexical entities across and within individual languages. The process of lexical semantic decomposition, however, underscores that the number of semantic atoms is not exhaustive, and the polysemous descriptions of the same lexical entity can vary. Furthermore, semantic spaces in lexical semantics categorize lexical entities nominally. This approach offers a resolution to the complexities and diversities in the shifts of lexical meaning. However, an analysis of the surface-level, multi-category sematic maps reveal inconsistencies and significant disparities in semantic spaces across various lexical entities [6-8].

Additionally, the research does not limit itself to this straightforward classification but expands from a cognitive perspective. From a cognitive perspective, the fundamental mechanisms that orchestrate shifts within lexical semantic change are metonymy and metaphor. These mechanisms are situated within the experiential gestalts, which encompass experiential knowledge anchored in embodied experience. Variations in embodied experiences significantly influence the differentiation and profiling of domains within conceptual metaphors. These variations manifest in the distinct profiles of these domains. Moreover, the expression of lexical items is shaped by these embodied experiences, individual contexts, and personal knowledge. These factors interweave with the diverse cognitive structures that drive individuals in their usage of lexical entities. In conclusion, differences in cognition, emotion, sensation of speakers, and scenario all influence the variation and understanding of lexical semantics.

Syntactic issues of grammar construction

In linguistic research, the nuances of verb transitivity and intransitivity, perfective and imperfective aspects, and the intricacies of noun number and case including unique grammatical features in languages such as Russian and German-defy uniform standardization across linguistic spectrums, thereby introducing a layer of grammatical complexity. This complexity is further augmented by the diverse array of word orders, including Subject-Verb-Object (SVO), Subject-Object-Verb (SOV), Verb-Object-Subject (VOS), Object-Subject-Verb (OSV), and Free Word Order. These variances in grammatical structures necessitate a sophisticated understanding of the interplay between syntactic semantic function and traditional grammatical units, grounded in the event structures of the physical world. This grounding aids in the formulation of grammatical constructions with specific patterns. During the research process, it becomes evident that while these patterns encapsulate the structured forms of lexical entities, the diversity and intricacy of these patterns are also starkly highlighted.

In the linguistic exploration of the cognitive schema of clausal units, research into construction grammar primarily focuses on the analysis and comparison of sentence structure patterns, placing significant emphasis on their semantic functions. Construction grammar represents a metaphorical expansion of the traditional, simplistic categorization of grammar. This theoretical framework necessitates the formulation of diverse constructions to facilitate the analysis of intricate verb syntax. Despite its complexity, this approach proves advantageous for delving into the nuances of original grammatical structures, offering a lens through which higher-level cognitive processes can be applied to understand the underpinnings of grammatical structures. However, the inherent complexity in sentence structure combinations gives rise to a multitude of diverse patterns, necessitating intricate and detailed analyses. This paradigm shifts underscores the dynamic and evolving nature of grammatical theory, reflecting a deepening comprehension of language structure and its cognitive foundations [9-12].

Cognitive grammar, as conceptualized by Langacker, Lakoff, Talmy, Fauconnier and others, interprets the physical world through a cognitive lens, treating language as a symbolic representation of tangible realities. This approach is characterized by features like topology, which demonstrate notable cross-linguistic uniformity, addressing the intricate challenge of processing syntactic structure at an advanced level. Studies focusing on spatical aspects play a crucial role in shaping syntactic structure, incorporating fundamental elements such as figures, ground, and reference objects. In this context, Talmy's work on motion and path serves as an essential foundation for understanding spatial construction within sentences. Building on this, the "post-Talmian" exploration of motion typology by Zlatev, Jordan, Blomberg, and David extends Talmy's initial findings, offering additional insights, such as the delineation of verb boundaries. This body of research exemplifies the ongoing evolution of cognitive linguistic theory, shedding light on the complex interplay between cognitive processes and linguistic expression.

Basic hypothesis: Topology-imagery in languages

Cognitive development and language: The evolution of cognition and language does not progress at a uniform pace. Piaget outlines different stages of cognitive development that give rise to variations in cognitive capabilities. Regarding the dynamic interrelation between cognition and language, language functions as an instrumental catalyst in directing cognitive development, particularly when cognitive progression lags behind linguistic development. In such instances, linguistic knowledge becomes a guiding force for cognitive evolution. Conversely, should cognitive development advance beyond the bounds of existing linguistic knowledge, the cognitive mechanism seeks commonalities and disparities across

languages. This search often leads to the emergence of novel semiotic elements for expression, even in the face of lexical gaps within the language system, as illustrated in Figure 1. Similar research by Skarabela, et al. in "Learning Dimensions of Meaning: Children's Acquisition of 'But'" indicates that children's understanding of vocabulary, such as the word "but," develops progressively with their cognitive growth. Although they might use the word in the early stages, it does not imply a complete comprehension of its meaning. Their full understanding of such terms emerges as their cognitive abilities expand over time.

Pishghadam's Emotioncy theory, with its six-level emotioncy matrix, highlights the role of individual experiential differences in shaping expressions. This theory proposes that individuals' emotional responses and interpretations of a concept vary depending on the sensory channels through which they receive information. This concept diverges from the Sapir-Whorf hypothesis by focusing on the influence of sensory experiences on language. Based on the theory it is posited that cultural variances within social factors, including educational backgrounds, gender, and social class, are intricately linked to the cognitive development of speakers' mental representations. For example, the diversity in color term categorization is not merely a matter of linguistic repertoire but is influenced by the cognitive limitations of a given community, leading to restricted expression in color vocabularies. This viewpoint contrasts with the Sapir-Whorf hypothesis, which asserts that language dictates thought.

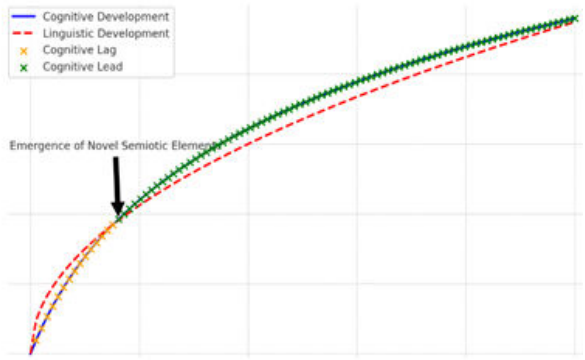


Figure 1: Approximate comparison of linguistic and cognitive development.

Imagery-topology and language: Pre-humans had already honed their ability to create cognitive maps for spatial orientation, as well as ordered schemas to enhance tool-making and foraging skills, as noted by Palmer, Thompson, Parkin, et al. From a biological perspective, spatial relations, as discussed by Lakoff, play a significant role in cognitive development, laying a foundational framework that partly influences the expression and utilization of linear language. The cognitive landscape of human beings is intrinsically spatial, as succinctly encapsulated by Levinson: "human beings think spatially." Imagery, a pivotal cognitive function of the brain, capitalizes on the sensory-motor circuitry, as expounded by Gallese and Lakoff. The existence of mirror neurons in various brain regions, as detailed by Tendahl and Gibbs, underpins the abstract transposition from the tangible world to the realm of mental representation, a concept further elaborated by Lakoff and Gallese and Lakoff in their works.

Language understanding requires spatial representation, which includes the projection of real-world visual information, auditory information, and haptic information into language through spatial cognition. Metaphorical thinking provides spatial representation of real-world phenomena but can also be more abstract, reflected in semantic expressions in language and even in sentence structure. Metaphorical mappings maintain the cognitive topology, which is the image-schema structure, of the source domain. As a result, all inferences from the source domain, stemming from its cognitive topology, are retained in the mapping. The general principle is that all metaphors remain consistent with their cognitive topology, meaning that each metaphorical mapping retains the image-schema structure. In Lakoff's research, one of the key image-schemas is the container schema. for example, in the phrase "out of anger," anger is conceptualized as a container with an inside, an outside, and boundaries.

Topology-imagery in lexical semantic model

Lexical entries encapsulate a wealth of cognitive, knowledge-based, and linguistically symbolic information. They serve as portals to an intricate conceptual architecture. Lexical concepts extend beyond mere definitional meaning to include a semantic valuation, thus contributing to the body of lexical knowledge.

Lexical peculiarities form a composite of informational substance. The semantic evolution of words, sculpted by an array of influences within cultural progression, give rise to multifaceted variances in intensity and scope. Consequently, the harmonization of lexical meanings and the execution of comparative analyses to delve into the depths of lexical knowledge necessitate standardized dimensions. The dimensions of a lexical item, delineated by its cognitive evolution and its narrative within cultural history, can be broadly stratified into a scientifically informed high-level cognitive-physical dimension, a communal cultural dimension, and a personalized individual dimension, each reflecting distinct nuances (Figure 2). For any given concept of lexical entities, it invariably integrates a scientific apprehension of the term, connotations derived from cultural and ethnic contexts, and personal emotional resonances.

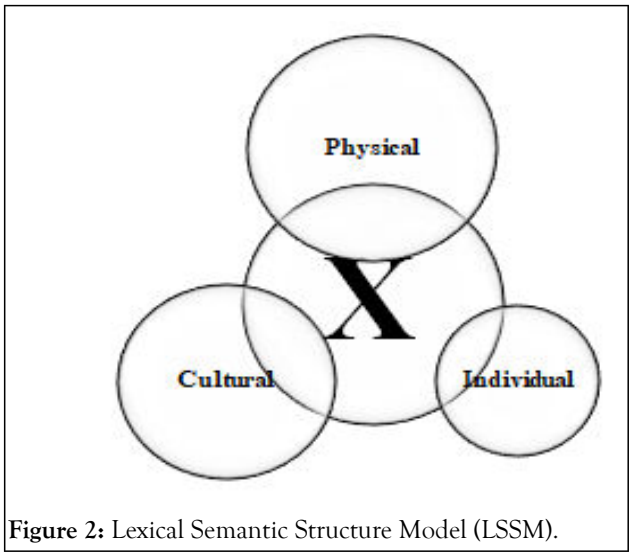


Figure 2: Lexical Semantic Structure Model (LSSM).

The conceptualization of expressions is profoundly influenced by cultural dynamics, with social contexts acting as a critical backdrop that shapes these conceptual variances. Givón notes that social entities, which span the spectrum from individuals to nation-states, communities, counties, and religious groups, demonstrate variable referential values across these diverse social units. Even within a single community, shared understandings, deeply embedded in cultural heritage, often emerge. Social roles, incorporating sociodemographic factors like social background, gender, and age, have been shown to significantly affect linguistic variant selection. Moreover, within these tripartite dimensions, the semantic weight of identical lexicon is non-uniform. Depending on the situational context, lexical meanings demonstrate a "prototype classification", highlighting the fluidity of semantic interpretation. For example, the lexical entity "bread" fundamentally denotes a type of food within the physical dimension, a concept universally recognized in scientific taxonomy. Yet, when interpreted through the cultural lens, "bread" assumes connotations with broader societal constructs such as "standard of living" or "earnings." Within the individual dimension, the non-basic meaning of "bread" may evoke a spectrum of affective responses, ranging from positive to negative, contingent upon personal predilections and experiences.

The development and evolution of lexical semantics, as well as the diversity of lexical meanings, are inherently tied to cognitive adjustments humans make based on the fundamental meanings of words. New semantic meaning evolves from a combination of cultural history, personal experiences, feelings, emotions, and knowledge. Broadly, these can be categorized into four types:

- Scenarios that reflect collective or individual memory.
- Personal emotions.
- Sensations.
- Cognition (Figure 3).

These categories can be constructed through more abstract topological dimensions (one-dimensional and two-dimensional). Consequently, the secondary meanings and metaphorical interpretations of words are deeply rooted in individual or collective cognition. On a deeper level, they rely on fundamental human cognitive processes. One of these basic cognitive processes is topology, which provides a framework for understanding these cognitive adjustments.

As a fundamental cognitive approach, topology offers solutions for these adjustments. For instance, the one-dimensional, non-closed topology image and the two-dimensional, closed topology form basic cognitive models. Antonyms in vocabulary, for example, can be visualized as two points on a one-dimensional line in topology. Similarly, relative spatial concepts like up, down, left, and right are constructed based on two-dimensional spatial cognition. In metaphors, the frequent associations of happiness with "up" and sadness with "down" illustrate this. These spatial metaphors create a topological distinction between emotions, where the spatial orientation (up or down) corresponds to the semantic difference between happiness and sadness.

In summary the semantic delineation of lexical items bifurcates into basic meaning and non-basic (figurative) Meaning. The semantic richness of a lexicon is contingent upon the level of cognitive development, with the foundational meaning of identical lexical items potentially fluctuating among individuals at disparate cognitive stages. Nonetheless, the scientific elucidation of lexical items progressively refines in tandem with scientific advancements. Moreover, the imagery associated with the same lexical terms varies across different ethnicities, social groups, and individuals, resulting in semantic diversities. It is imperative to underscore that in the era of globalization, cultural interchange is instrumental in both refining and standardizing basic meanings on a global scale and fostering a reciprocal appreciation and comprehension of non-basic meanings (Table 1).

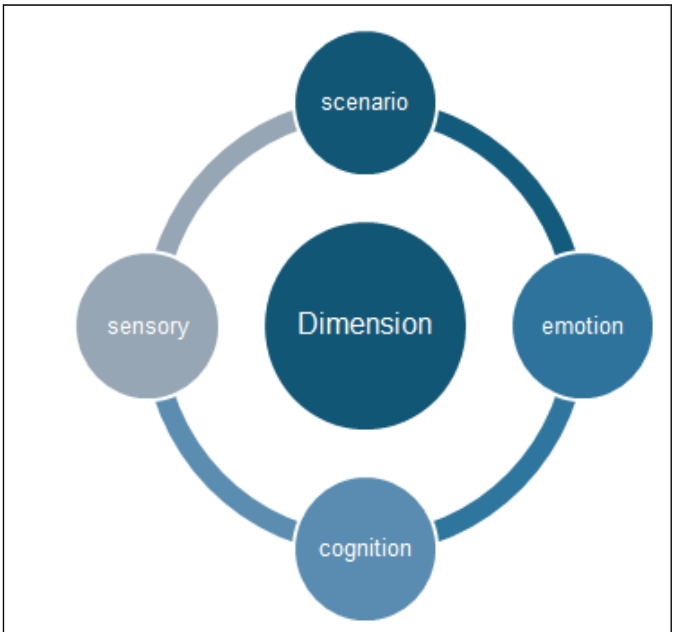


Figure 3: Imagery-topology in lexical meanings.

Table 1: Components of lexical semantic structure model.

Linguistic level	**Lexical meaning**
	Basic meaning (Physical aspect in LSSM)
	Non-basic (Figurative) meaning (Cultural and individual aspects in LSSM)
Cognitive level	**Imagery-topology in lexical meanings**
	Cognitive dimension: 1-D; 2-D
	Basic cognitive semantic field category: Scenario, Cognition, Sensory, Emotion

MATERIALS AND METHODS

Methods

To investigate the role of imagery-topology in lexical semantics, we examined the relationship between the diversity of lexical meanings and the basic cognitive semantic field categories, as well as cognitive dimensions. The diversity of lexical meanings is calculated by counting the number of senses that each word has in the dictionary using WordNet.

Materials

The study utilizes a wordlist of 1,000 words from the English Web 2021 (enTenTen21) corpus available on SketchEngine (https://app.sketchengine.eu) as test subjects.

Procedure

Using the Natural Language Toolkit (NLTK), we download WordNet data to construct semantic fields for the 1,000 words. Each semantic field contains 1,000 lexical elements. We then train a semantic field classification model using BERT on the 4,000 words (including those in the semantic fields). The model is applied to classify the semantic fields of the original 1,000 words based on the learned patterns.

Furthermore, each word is checked for the presence of antonyms. Words with antonyms are marked as 1-D, while those without are marked as 2-D. Finally, we use nltk to calculate the number of hypernyms for the 1,000 words. This comprehensive approach allows for a detailed classification of semantic fields, as well as an understanding of antonym presence and hierarchical relationships within the selected vocabulary.

RESULTS

Table 2 provides the descriptive statistics for each combination of semantic field category and dimension category. The mean, standard deviation, and sample size for each group are displayed. This data helps in understanding the distribution and central tendencies of number of senses across different categories (Figure 4).

Table 2: Descriptive statistics.

Semantic field category	Dimension category	Count	Mean	Min	0.5	Max
Cognitive category	1	232	11.03	0	9	47
Cognitive category	2	496	7.18	0	6	70
Emotional category	1	1	7	7	7	7
Emotional category	2	1	14	14	14	14
Scenario reconstruction	1	60	8.93	1	6	52
Scenario reconstruction	2	205	5.64	0	4	30
Sensory category	1	2	2.5	1	2.5	4
Sensory category	2	3	11	4	11	16

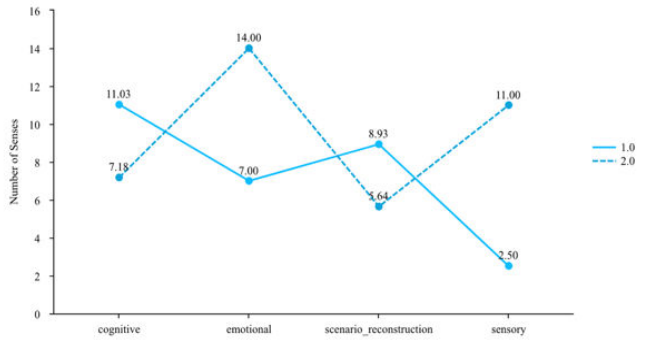


Figure 4: Comparison of the number of senses evoked across four categories cognitive, emotional, scenario reconstruction, and sensory under two conditions.

A two-way ANOVA was conducted to examine the effects of semantic field category and dimension category on the dependent variable. The results are summarized in the Table 3. I n the analysis process, we considered the differences in the semantic hierarchy of the words by including the number of hypernyms as a covariate. The purpose of this approach was to account for the semantic hierarchy of the vocabulary, thereby improving the predictive power of the model.

Table 3: Two-way ANOVA results.

Source	Sum of squares	df	Mean square	F	p
Intercept	130.541	1	130.541	27.779	0.000**
Semantic field category	88.898	3	29.633	6.306	0.000**
Dimension category	123.782	1	123.782	26.341	0.000**
Hypernyms count	46311.16	1	46311.16	9855.048	0.000**
Residual	4671.037	994	4.699		
R^2: 0.914					

Note: *p<0.05, **p<0.01

The ANOVA results indicated a significant main effect for semantic field category (F (3,994)=6.306, p=0.000), suggesting that different semantic field categories significantly influence the dependent variable. Similarly, there was a significant main effect for dimension category (F (1,994)=26.341, p=0.000), indicating that the presence or absence of antonyms (1-D or 2-D) also has a significant impact.

The variable hypernyms count had a highly significant effect (F (1,994)=9855.048, p=0.000), demonstrating that the number of hypernyms is a strong predictor of the dependent variable. The intercept was also significant (F (1,994)=27.779, p=0.000), which suggests that the baseline level of the dependent variable is non-zero.

The model explains a substantial portion of the variance in the dependent variable, as indicated by an R^2 value of 0.914. This high R^2 value signifies that approximately 91.4% of the variability in the dependent variable can be accounted for by the combined effects of semantic field category, dimension category, and hypernyms count.

In summary, the two-way anova revealed significant effects of both semantic field category and dimension category on the dependent variable, with hypernyms count being a particularly strong predictor. These findings underscore the importance of considering both semantic and dimensional classifications when analyzing lexical semantics, as well as the influence of hierarchical lexical relationships.

The significant main effects suggest that semantic field category and dimension category independently influence number of senses. However, the non-significant interaction effect implies that the impact of one factor does not depend on the level of the other factor.

To further explore the significant main effects, a Tukey's HSD post-hoc test was performed. The results identify specific group differences (Figure 4).

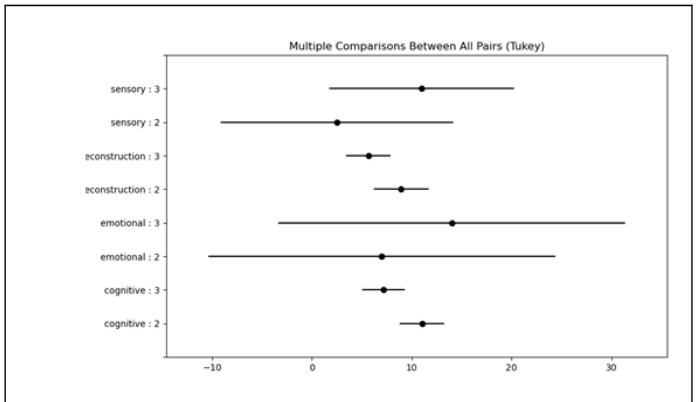


Figure 4: Tukey's HSD post-hoc comparisons.

Topology-imagery in grammar construction model

Perception functions as a foundational aspect of human cognition, furnishing experiential and perceptual substrates for imagery formation. Physical world representations are transposed into the mental realm, crafting maps that draw upon real-world imagery to establish metaphorical mappings for spatial categorization.

Higher-level cognitive processes form maps with details, namely topology. Common components of spatial concepts include the referent (figure), relatum (landmark/ground, and axial reference system (directed axes) (*i.e.*, point of view Dokic and Pacherie,). In absolute frames of reference, the origin of the coordinate system can act as the relatum. In relative frames, the observer's position may influence axial direction, and in intrinsic frames, the relatum's structure becomes the axial system. Event description in sentences involves describing or speculating about events that have or have not occurred. Objects are based on the real physical world, making spatial property a fundamental aspect of syntactic content. A universal fundamental system of spatial schemas focuses on verbs of motion and path, studying the spatial properties of verbs in different languages, such as Verb-Frames (Verb-path+Verb-manner), Satellite-Frame (Verb-manner+Satellite-path), and Equpolltly-Frame (Verb-manner +Verb-path, Manner-Path-Verb, coverb-manner+coverb-path +verb-generic). Essentially, the direction concept of verbs, nouns, and adverbs involves affixes and ø (semantic function in lexical entities). additionally, prepositions/adpositions are common.

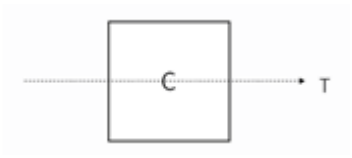
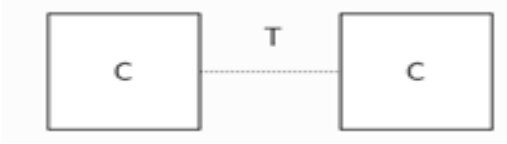
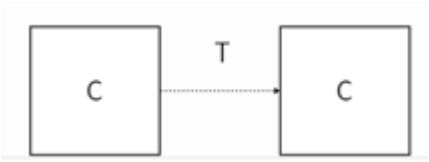
The imagery-topology in syntax centralizes motion and its connoted participants within three primary information continents (Tables 4-5): The trajectory of motion container linker (t), the participant of events–objects in container (c), which can be omitted if contextually extraneous. motion (t) serves as the information linkage, with markers denoting distinct grammatical attributes. Due to the cognitive economy, marker prevalence varies linguistically. Linked containers undergo state transitions, accentuating patient status changes in Beavers' prominence representation and Dowty's proto-patient framework. The lexicon-grammar interplay is rigorously analyzed, focusing on the variation in grammatical information that odifiers encapsulate within containers.

Container linker types, predicated upon locational shifts in the context of motion, can be systematically classified into three primary categories. The initial category represents the most elemental form, characterized by a singular container without destination trajectory. The second category, commonly manifested within typical metaphorical locations, deviates from the former by incorporating an intangible trajectory interlinking dual containers. An exemplar of this is the locution "time[c] is[(t)] money[c]," which navigates through the conceptual territories of time and money with the latter lacking a tangible trajectory in the physical dimension. This typology illuminates a defining feature of metaphors: the trans-domain mappings they facilitate. The tertiary category is distinguished from the second by the inclusion of a conspicuously discernible physical trajectory, enhancing the spatial explicitness of the metaphorical expression. The final typology encompasses expressions involving at least two primary containers. Distinct from the second type, this category is characterized by linkers that exhibit a manifest trajectory indicative of locational change, such as expressions like "come to," "enter into," and "penetrate," which align with this classification (Tables 4 and 5). These linkers serve to articulate the motion between containers, delineating a clear path of movement within the spatial framework of the sentence.

Table 4: Components of the grammar construction model.

Basic information-Container/Linker	Syntactic role
Trajectory dimension-Container linker (T)	Predict
Participant dimension-Participant container (C)	Subject
	Object
	Complement
	Attributive
	Adverbial

Table 5: The grammar construction model.

1	 No destination trajectory	C – T
2	 Intangible trajectory: copular verb/ omitted. (including metaphorical expressions)	C – (T)– C
3	 Normal trajectory	C – T – C – C

Example 1

1a: A girl hit him on the head. C1-T-C2.

1b: A girl hit him on the head with her umbrella. C1-T-C2-C3.

1c: A girl asked John to hit him. C1-T-C2-C3

In example 1a, two principal participant containers and a singular surrounding container are identified. In example 1b, an additional participant container the tool is incorporated into the syntactic structure, coexisting with the principal participant container. In example 1c, a triad of principal containers is presented, within which the third principal container encases a surrounding container, delineating a complex relational structure. This configuration is illustrated in Figure 2. The locative preposition "on" functions as a spatial marker in both instances, with the addition of "with" in the latter case to introduce the tool (Figure 5).

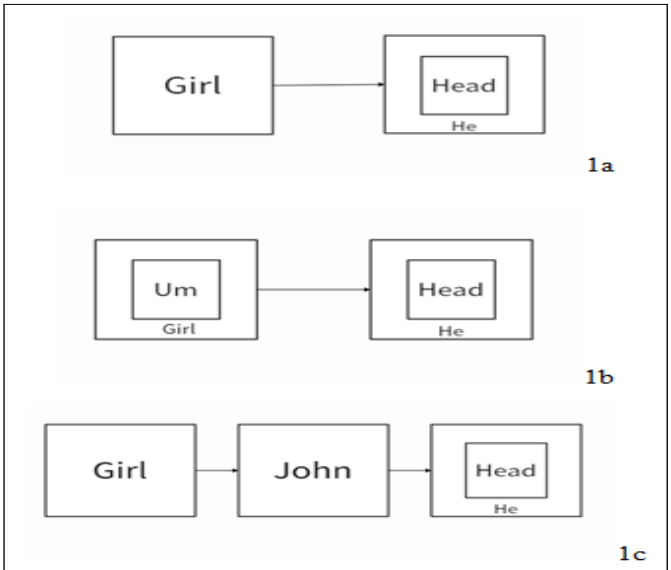


Figure 5: Sentences: A girl hit him on the head (with her umbrella).

Example 2:

2a: A [beautiful] girl hit him on the head. MP-T-[P-S].

2b: A girl hit him on the head [hard]. P-MT-[P-S]

2c: A girl hit him [on the head] [on the street]. [P-T-[P-S]]- MSS

2a belongs to MP, 2b to MT, and 2c to MS.

In this exemplification, Modifiers function as supplements to the information contained within the primary containers, manifesting in the forms of adjectives (as in 2a), adverbs (as in 2b), and prepositional phrases (as in 2c), respectively.

Example 3:

3a: He gave [her a present]. P-T-[P-P]

3b: [He] gave [a present] to [her]. P-T-P-(T)-P

In example 3a, we discern two containers: 'he' and a compound container comprising "she" and "present." Contrastingly, in example 3b, three distinct containers are evident: "he," "she," and "present," with the preposition "to" demarcating the relational interstice between containers. This syntactic structure is frequently subjected to analytical scrutiny within sentence construction comparisons, underscoring the nuanced aspects of status alteration. In 3a, the focal point is the alteration in the state of "she" (possession), whereas in 3b, the spotlight is on the transition in the state of 'present' (transference).

The formulation of overarching principles for cross-linguistic grammatical structure necessitates an augmented cognitive engagement. This entails the meticulous crafting of Typology-Imagery within sentence composition, engendering a cognitive map that interweaves real-world referents with syntactic organization. Such a process substantially enriches the corpus of linguistic knowledge.

Statistical analysis revealed that the translation structures corresponding to sentences containing the Chinese character exhibited significant variability in both parallel corpora. When disregarding the differences in function words and relaxing the criteria for comparison, less than half of the corresponding sentences in both language pairs could be identified as direct translations (Figure 6). This is depicted in the first chart, which shows the percentage of corresponding words in Chinese, English, and Russian, with a noticeable decline in the correspondence from Chinese to English and further to Russian.

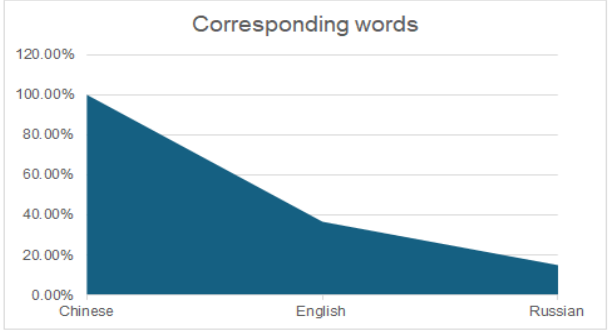


Figure 6: Corresponding words in English and Russian translation.

After processing the data and categorizing the sentences from the perspective of imagery-topology, the proportion of corresponding structures increased. Despite the complexity of Chinese sentence structures, this approach allowed for a higher alignment rate, surpassing half of the cases. The second chart illustrates the corresponding topology types for Chinese-English and Chinese-Russian pairs, showing a marked improvement in the identification of corresponding structures when considering the imagery-topology framework (Figure 7).

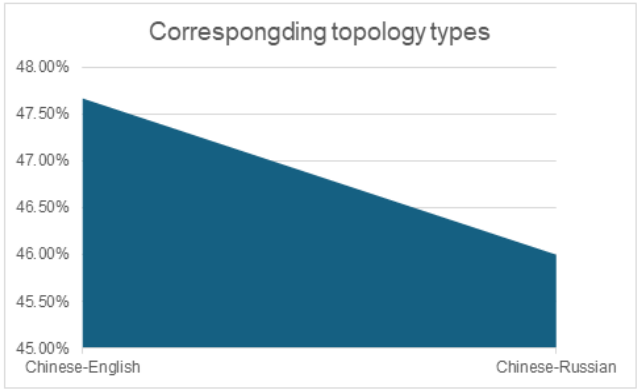


Figure 7: Corresponding topology patterns in English and Russian translation.

These findings suggest that a more nuanced approach, which takes into account the cognitive and topological aspects of language, can significantly enhance the accuracy of identifying corresponding structures in parallel corpora. This highlights the importance of considering both linguistic and cognitive dimensions in translation studies.

Topology-imagery in cultural factors in languages

In advancing cross-linguistic studies on universal grammatical and lexical semantic structures, the inclusion and careful consideration of cultural factors become imperative. Palmer, in his seminal work on cultural linguistics, posits that a comprehensive understanding of culture is inextricably linked to a deep understanding of cognition. Cultural schematics, both at the micro and macro levels, delineate cultural concepts as entities that can be dissected and reconstituted. The integration of cognitive foundations particularly spatial functionality into lexical concepts involves a dimensional analysis, as seen in constructs like the degree of emotion. Sensory relativism contributes to the semantic richness and variance of lexical items, with concepts materializing through parameterized schemas. In syntactic structures, this application encompasses the delineation of container-linkers. Discourse-level organization of pertinent information relies on spatial functionality, encompassing the distribution of given/new information, topic-related data, and the interrelation of textual frameworks–though this is not expounded upon in the present discussion.

"It is crucial that we exercise more caution than previously in categorizing linguistic entities as optional" (s). Cognition-

grounded concepts, particularly those within the topology-imagery scope, bridge linguistic expressions with their cultural backdrop encompassing customs, politics, society, religion, geography, and environment (Figure 8 and Table 6). Geographical milieus are mirrored in the cultural semantics of vocabulary and linguistic markers within sentences, where signifiers, signifieds, and referents interplay, with the referent being environmentally conditioned. For instance, "bread" embodies diverse cultural significations across ethnicities. In Chinese lexicon, "bread" is not synonymous with "wages" or "living standards," given the staple role of rice and noodles. Yet, with cultural evolution, "bread" has come to symbolize "material abundance," epitomizing the adage "where there is bread, there is a good life."

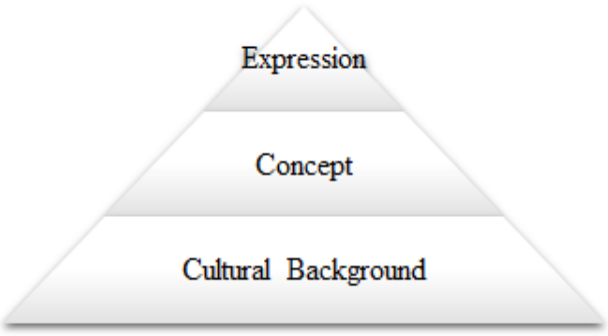


Figure 8: Connection between expression and cultural factors.

Table 6: Summary.

Level	Subtype	Lexicon/phrase	Sentence	Text
Language	Unties	Lexical item/phrase	Sentence	Sentences/paragraphs
	Structures	Lexical semantic structure	Syntactic structure	Information structure
Concept	Profiles	Imagery-Topology: Container (personal emotion, sensory and cognition in scenario) and Dimensions	Imagery-Topology: Container and Linker (trajectory)	Imagery-Topology: Distribution of information
Cultural background	Factors	Customs, politics, society, religion, geography, environment		

Additionally, words representing tastes such as "sweet" and "sour" both belong to the dimension 1 (image schema line) as two points and show similarities in cognitive and flexible metaphorical use. However, traditional Chinese Confucian and Taoist thought advocates for the taste "bitter," positioning it near the positive emotional pole close to "sweet" on the line due to its esteemed value. Religious and philosophical underpinnings significantly shape cognitive and communicative patterns. Embodying Confucian and Taoist principles, Chinese culture values subtlety and indirectness. This cultural ethos is echoed in the language's concise expressions and a notable dearth of grammatical markers. Spatial marking in language demonstrates considerable variability.

Cultural schemas within the same ethnic group exhibit similarities while inherently possessing variability related to individual differences. However, in the context of globalization, the increased mutual inclusivity of cultures and the broadening of human cognition enable higher-dimensional general cultural schemas to encompass lower-dimensional ethnic features. This inclusivity facilitates a more extensive understanding and acceptance of cross-cultural concepts, gradually diminishing cultural barriers as cognition improves and cultural exchange intensifies. Hence, cultural schemas embedded within languages are instrumental in the linguistic examination of extralinguistic influences on expression. They provide a nuanced lens through which the impact of cultural factors on language can be discerned and understood.

CONCLUSION

Our study presents significant advancements in linguistics by exploring the imagery-topology hypothesis and its application to lexical semantic and grammatical structures. Addressing our research questions, we have elucidated the intricate relationships between lexical semantics, conceptual metaphors, and topology within linguistic frameworks. We demonstrated how spatial concepts and imagery-topology influence cognitive schemas in both lexical semantic and grammatical structures and identified culturally marked cognitive factors in various languages. The two innovative models developed–the grammar construction model and the Lexical semantic structure model–highlight the essential role of spatial concepts in cognitive development and their profound impact on linguistic comprehension. These models serve as effective tools in addressing challenges in universal linguistics, offering new perspectives for future research aimed at understanding the spatial cognitive underpinnings of language.

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