

The Semantics of Stative Locative Events in Vietnamese: A Spatial Exploration

Ly Ngoc Toan

Department of Legal English, Ho Chi Minh City University of Law, Vietnam

Abstract—This study utilizes mathematical formalism and Figure-Ground argument mapping to categorize stative locative events in Vietnamese as surjective or bijective. Bijective events exhibit a one-to-one mapping of Figures and Grounds, while surjectives allow a single Figure to map onto multiple Grounds. Through analysis of Vietnamese sentences, the paper demonstrates how bijective and surjective locatives encode deterministic and ambiguous spatial relations between Figures and Grounds, respectively. This novel distinction aids in enhancing the understanding of locative event typologies and provides an explanatory model for cross-linguistic analysis. The proposed integrated formal framework combines predicate logic, set theory, and lexical semantics to account for complex locative meanings, with significant applications in computational and theoretical linguistics, as well as cognitive science.

Index Terms—stative locatives, bijective events, surjective events, figure and ground, formal semantics

I. INTRODUCTION

The investigation of stative locative events is crucial in understanding the interplay between language, cognition, and spatial representation. This study examines the semantics of stative locative prepositions (SLPs) and verbs (Vs), drawing from works by Keenan and Faltz (1985), Crow (1989), Nam (1995), Kratzer (2004), and Gehrke (2008). A stative locative event can be defined as a linguistic expression delineating a static state of being situated within a spatial locus, lacking dynamic action or positional change. The goal is to investigate the factors affecting how stative locative occurrences happen in language by understanding the lexical semantics of SLPs and verbs as building blocks from which stative locative events are composed. Event recognition is crucial, as these elements interact within verb phrases following semantic composition rules. The main research question is: "How do Vietnamese people use language to express static spatial relationships between entities?" The observation motivating this study is that Vietnamese has a large and diverse set of spatial expressions. Understanding these phrases' workings is essential for cognitive science, linguistic theory, and natural language processing. Gaining insights into static locative events illuminates the intricate relationship between language and cognition, impacting theoretical linguistics and real-world applications. It contributes significant knowledge to both domains and is particularly relevant in Vietnamese linguistics, facilitating cross-linguistic comparisons and contributions to cognitive linguistics. While previous studies have paved the way for comprehending stative events, a gap persists in understanding these constructs' manifestation in Vietnamese. This research endeavor constitutes a semantic exploration into spatial locative expressions as they manifest in Vietnamese linguistic constructs.

II. LITERATURE REVIEW

The literature reviewed underscores the multifaceted nature of locative expressions, emphasizing their pivotal role as linguistic vehicles for expressing spatial relations. Vietnamese, with its rich spatial vocabulary, emerges as a fertile ground for exploring the semantics of locative expressions. Cultural and environmental influences, as well as variations in proficiency and exposure, add layers of complexity to the study. This extensive literature review provides a robust foundation for the present investigation into the semantics of locative expressions in Vietnamese.

A. Figure and Ground

Talmy (1975) laid the theoretical groundwork for this study in his seminal work, directing attention to the centrality of conceptual organization within sentence structure. He introduced the pivotal figure/ground dichotomy from visual perception: The figure object is a moving or conceptually movable point whose path or site is the salient issue. The ground object is a stationary reference-point, against which the figure's path or site is characterized.

Talmy (1975) extended this construct to linguistic analysis, proposing the figure-ground distinction fundamental in perception is equally salient in linguistic expression. In language, the figure is the foregrounded information in focus, while the ground is the background. He argued these categories are assignable in motion events with one moving object (figure) and one stationary (ground), highlighting how they contribute meaning by organizing information. Talmy (1975) emphasized the arrangement of figure and ground influences the mental representation of described events/situations.

Jackendoff (1983) adopted Talmy's framework to analyze spatial prepositional phrases (PPs), arguing PPs decompose into ontological categories like PLACE/PATH and functions like TO/FROM/IN/ON. He showed figure/ground relations like Jon hung the paintings (figure) on the wall (ground).

In positional research, the figure/ground concepts (trajector/landmark in cognitive linguistics) are employed consistently. Nam (1995) notably disassembled PP conceptual structures into distinct locative (Place) and directional (Path) components, influencing spatial expression analyses. This study focuses on stative locative events, expressions associated with Place functions, examining semantics of specific spatial PP and verb combinations. Understanding static locative events illuminates the language-cognition relationship, impacting linguistics and applications like NLP. While previous studies paved the way, a gap persists in understanding these constructs' manifestation in Vietnamese. This research explores spatial locative expressions in Vietnamese linguistic constructs like "Nam is in the garden" and "The children are swimming in the pool".

B. Stative Locative Events

The notion of events presented by Talmy (1983, 2000b) differs from Davidson's (2001) view of events as concrete particulars in the world. Talmy sees events as cognitive constructions formed by the human mind's capacity to bound segments of spatiotemporal continuity into unified, discrete representations. Jackendoff (1990) proposed a taxonomy classifying events into ontological categories like actions, processes, and states, and distinguished bounded and unbounded events, developing hierarchical conceptual structures to link events' syntactic and semantic properties to underlying representations.

Drawing on Talmy and Jackendoff, a stative locative event can be defined as a subtype of state event encoding the persistent spatial configuration between an entity/figure and its reference ground/landmark, contrasting with dynamic actions tracing the same semantic roles across space.

Nam (1995) delineates predicate modifiers and predicate extensors in argument structure analysis. Locative PPs can serve as predicate modifiers when combined with single-place predicates, specifying localized context without increasing valency, or as predicate extensors augmenting the predicate's argument structure by allowing an additional argument slot.

Based on Nam's (1995) syntactic properties of argument construction, this study categorizes stative locative events into two mathematical types: **bijjective events** and **surjective events**. A bijjective event refers to a one-to-one mapping process where a single argument is mapped onto another single argument as in Figure (a). In contrast, a surjective event denotes a mapping process where one argument is mapped onto one or more other arguments as in Figure (b). This concept can be formally represented as follows:

Definition of bijjective event

Let X and Y be two sets representing syntactic arguments. A bijjective mapping $f: X \rightarrow Y$ satisfies the condition that for every element y in Y , there exists exactly one element x in X such that $f(x) = y$. This represents a one-to-one correspondence between the sets X and Y .

Definition of surjective event

On the other hand, a surjective mapping $f: X \rightarrow Y$ satisfies the condition that for every element y in Y , there exists at least one element x in X such that $f(x) = y$. Here, the mapping covers or surjects onto the entire set Y .

This conceptualization is illustrated in Figure 1.



Figure 1. Stative Locative Events

This study has formally defined stative locatives as state events encoding enduring figure-ground relations. Adopting Nam's predicate semantics, two mathematical categories are proposed - bijjectives as one-to-one argument mappings and surjectives as one-to-many mappings. This theoretical groundwork enables analyzing compositional semantics of stative locatives cross-linguistically.

C. Previous Work on Stative Locatives

This section reviews foundational analyses of locatives by Creary et al. (1989) and Nam (1995) to identify limitations motivating a new integrated framework. While their seminal treatments captured key properties through unified and Boolean semantic models, they had shortcomings in explanatory scope. Creary et al. overlooked temporal aspects of

dynamic locatives and syntactic variations. Nam primarily focused on static locatives with limited exploration of verb types. A novel synthesized framework is needed to address these gaps and account for complex locative semantics.

Creary et al. (1989)

Jackendoff (1983) made foundational observations about parallels between locatives and nominals, including establishing discourse referents. Building on this, Creary et al. (1989) proposed a unified semantic analysis of locatives as denoting regional entities, accounting for locative-nominal parallels like anaphoric "there" while using modern formal semantics. However, it did not capture locatives' lack of scope ambiguities compared to nominals. Additionally, Creary et al. argued locatives should be treated as arguments rather than adjuncts, proposing iterative locatives conjoin to jointly modify an event, contrasting with an adjunct analysis allowing iterative readings. However, their approach focused only on static locatives, without considering time-dependence, and modeling locatives as denoting singular regions fails to fully capture semantic complexity. The present work disputes locatives as universally arguments, citing their omittability, verbs taking multiple locative types, and standard intersective semantics suggesting adjunct status.

Nam (1995)

Extending Keenan and Faltz's (1985) boolean semantic framework for locatives, Nam (1995) provided new evidence for the intersective semantics of static locatives, demonstrating through syntactic analyses that static locatives combine compositionally with the verb phrase via boolean semantics to yield the clause's full semantics. However, Nam uncovered limitations in Keenan and Faltz's notion of orientation, revealing that locatives can locate subjects or objects, a complexity their simpler model failed to capture. Additionally, Nam broke new ground by extending boolean semantic analysis to directional locatives, discovering consistent verb type constraints on orientation patterns and integrating boolean and lexical semantics to generate theoretical insights. Nam's qualitative syntactic findings and quantitative lexical semantic results revealed deeper complexities than previous models, and his integrated approach addressing prior limitations substantially advanced formal semantic analysis of locatives.

D. Previous Studies in Vietnamese

Nguyễn Đình Hòa (1997) proposed a classification of Vietnamese spatial prepositions into topological categories such as *trong* "in", *trên* "on", projective types like *trước* "in front of", *sau* "behind", and metric categories including *gần* "near" and *xa* "far". He argued that understanding the semantics of these prepositions is essential for interpreting the meanings of locative constructions. Hanske (2013) further explored verb - preposition interactions in Vietnamese, which delves into how different verb types constrain the use of spatial expressions. He observed that stative verbs such as *ngồi* "to sit" and *đứng* "to stand" typically select topological prepositions, while motion verbs like *đi* "to go" and *chạy* "to run" are more compatible with metric or projective prepositions. These constraints, he argued, arise from the inherent spatial semantics of the verbs themselves. Both scholars highlighted that analyzing preposition meaning and verb lexical semantics is fundamental to understanding the semantics of Vietnamese locative expressions and their internal structural dynamics.

III. METHODOLOGY

This study employs a mixed methods approach combining corpus analysis and experimental elicitation tasks to comprehensively investigate stative locative event semantics in Vietnamese. Corpus analysis captures the diversity of language use, while experimental tasks provide controlled insights into cognitive processes, offering a nuanced understanding of the complex interplay between lexical verbs, prepositions, argument structure constructions, and cognitive processes in forming stative locative semantics.

A. Corpus Analysis

This study utilized corpus analysis to investigate stative locative constructions in Vietnamese discourse, combining a large annotated Vietnamese Treebank corpus and a specialized 2000-sentence corpus of informal language. Quantitative analysis of the Treebank revealed common patterns of locative phrases, prepositions, and verbs, while close reading of the conversational data enabled qualitative analysis of nuanced spatial semantics. By leveraging the Treebank's breadth and the specialized corpus's depth, the study captured distributions and intricacies, providing empirical grounding to comprehensively investigate stative locative semantics and develop a robust theoretical framework accounting for complexities in expressing static spatial relationships in Vietnamese.

B. Participant Recruitment

To comprehensively investigate the research question, 25 native Vietnamese speakers with diverse backgrounds representing the three main dialect regions (Northern, Central, and Southern), linguistic proficiency levels, ages, education levels, and origins were recruited. This diversity allowed exploring the impact of linguistic background on stative locative expression and aimed to capture potential preposition and locative phrase usage differences across dialects, skill levels, and language segments. The diverse participant pool ensured a range of linguistic perspectives, contributing to the findings' generalizability and reflecting broader patterns and variations in static spatial expression across Vietnamese.

C. Experimental Elicitation Tasks

The awareness that controlled tasks can offer unique insights into real-time cognitive processes linked with stative locative constructions led the researcher to the adoption of experimental tasks. This recognition is the driving force behind the incorporation of experimental tasks. While corpus analysis is able to capture language use in its natural state, experimental tasks offer a controlled setting in which unique locative constructs can be elicited in a variety of circumstances. The data collected from eye-tracking and reaction time provide a dynamic view on cognitive processing, offering information on how participants interpret and produce stative locative utterances. The experimental method is not meant to take the place of corpus analysis; rather, it is intended to complement it by offering a more concentrated investigation of cognitive characteristics that may not be entirely reflected in natural language usage.

D. Data Analysis

This study utilizes three analytical frameworks to analyze the data: Talmy's Figure-Ground model, Jackendoff's event structure representation, and Nam's predicate argument structure theory. Talmy's framework categorizes linguistic elements into figures and grounds, revealing patterns in how they are encoded across locative expressions. Jackendoff's representation decomposes expressions into conceptual primitives, providing insight into the conceptual building blocks underlying stative locatives. Nam's theory distinguishes predicate modifiers from extensors, revealing how locative phrases modify predicates' argument structures. These frameworks offer complementary perspectives on figure-ground relationships, conceptual structures, and syntactic interactions, providing a comprehensive analytical approach to understanding stative locative semantics in the corpus.

TABLE 1
ANALYTICAL FRAMEWORKS

Frameworks	Key Concepts	Applications
Talmy	Figure vs. ground distinction	Reveals figure-ground patterns
Jackendoff	Decomposes expressions into conceptual primitives	Elucidates conceptual structures
Nam	Distinguishes predicate modifiers vs. extensors	Shows argument structure changes

IV. FINDINGS AND DISCUSSION

A. Stative Locative Prepositions in Vietnamese

An examination and classification of locative prepositions in the Vietnamese language is undertaken by employing the two theoretical frameworks: (i) frames of reference as expounded by Talmy (1983); and (ii) the arguments of predicates proposed by Nam (1995).

(a). Frames of Reference

This framework is central to the analysis of how languages delineate spatial relationships and how speakers cognitively represent and articulate the relative placements of objects within a given spatial context. Table 3 provides a succinct summary of the stative locative prepositions found in Vietnamese, along with their respective semantic attributes. To be more convenient, these prepositions are provided in the two versions including in Vietnamese and the equivalence of English.

TABLE 2
CLASSIFICATION OF SLPS IN TERMS OF FRAMES OF REFERENCE

Intrinsic frame of reference		Relative frame of reference	
Vietnamese	English	Vietnamese	English
Trên	On	Phía trên	Above
Trong	In	Phía dưới	Under
		Phía trước	In front of
		Phía sau	Behind

1. Intrinsic Frame of Reference

The intrinsic frame of reference of stative locative prepositions, namely *trên* and *trong*, is pivotal for understanding spatial relationships within the Vietnamese linguistic context. The identification of semantic properties of these prepositions relied on the inherent attributes and properties of objects to delineate their relative positions. In this paradigm, spatial arrangements are defined by the innate characteristics of the objects themselves, devoid of external reference points. Examine the following example.

- (1) Cuốn sách ở **trên** bàn.

'The book is on the table.'

In Vietnamese, the preposition *trên* 'on' encapsulates the intrinsic frame of reference. Here, the concept of *trên* is intricately tied to the physical attributes of both the book and the table, underscoring the profound influence of intrinsic characteristics in spatial descriptions. This cognitive framework permeates spatial language in Vietnamese, contributing to the unique linguistic expression of spatial relationships in the culture.

Likewise, the preposition *trong* "in" is a locative term in Vietnamese, denoting containment or inclusion within a

defined spatial area. It is used to express that an object or entity is situated inside or within another object or space. When *trong* is employed in a sentence, it conveys the idea of being enclosed or contained within a particular entity, whether it be a physical object, a place, or an abstract concept. This preposition is integral in expressing various spatial relationships, such as being inside a room, container, or a larger conceptual framework. To illustrate this point, consider the following example.

- (2) Cô ấy đang ở **trong** phòng.
'She is in the room.'

In this example, *trong* is used to indicate that the subject *cô ấy* is located within the defined space of the room. Also, the preposition *trong* emphasizes the containment of the subject within the spatial boundaries of the room.

2. Relative Frame of Reference

The relative frame of reference of locative prepositions in Vietnamese such as *phía trên*, *phía dưới*, *phía trước*, *phía sau* helps in understanding how spatial relationships are conceptualized and communicated. In this frame, spatial arrangements are determined by the position of one object in relation to another. Specifically, it emphasizes the observer's perspective as a crucial factor in defining spatial relationships.

The preposition *phía trên* signifies a position or direction that is higher in relation to an object or a surface. Furthermore, it is used to describe something situated at an elevated position as in (3a). Meanwhile, *phía dưới* denotes a location or direction that is lower in relation to an object or a surface and signifies something positioned beneath or at a lower level as in (3b).

- (3) a. Cái hộp đặt **phía trên** bàn.
'The box is placed above the table.'
b. Con mèo đang nằm **phía dưới** giường.
'The cat is lying beneath the bed.'

Next, *phía trước* pertains to a location or direction that is positioned ahead or in front of a particular object. This preposition signifies something situated in the forward direction as in (4a). Conversely, *phía sau* refers to a location or direction that is situated behind or at the rear of an object or a surface and signifies something positioned in the backward direction as illustrated in (4b).

- (4) a. Cậu bé đứng **phía trước** lớp học.
'The boy is standing in front of the classroom.'
b. Ngôi nhà nằm **phía sau** hàng cây.
'The house is behind the trees.'

(b). Spatial Relationships

This section examines the stative locative prepositions in the spatial relationships, which are grouped into two subcategories such as *topological locatives* and *orientational locatives*. Topological locatives describe properties unaffected by transformations, providing a stable framework for spatial descriptions. Orientational locatives offer insights into how language communicates direction in relation to fixed points. Together, these concepts illuminate the fundamental principles guiding the linguistic expression of spatial information. Table 4 summarizes the classification of stative locative prepositions in terms of spatial relations.

TABLE 3
CLASSIFICATION OF SLPs IN TERMS OF SPATIAL RELATIONSHIPS

Spatial relationships	Prepositions		Quantity	Frequency
Topological invariants	Tại	At	4	257
	Trên	In		
	Trong	On		
Orientational locatives	Phía trước	In front of	6	185
	Phía sau	Behind		
	Phía trên	Above		
	Phía dưới	Behind		
	Phía phải	On the right of		
	Phía trái	On the left of		

1. Topological Locatives

The topological locatives in Vietnamese are grounded in geographical concepts and properties, denoting elemental relations between spatial regions, aligning with the concept of topological invariants. The three prominent topological locatives, *tại*, *trên*, and *trong*, respectively embody the notions of intersection, inclusion, and tangential association, enabling precise articulation of subtle spatial configurations and relationships within linguistic discourse. These locatives exhibit noteworthy prevalence across Vietnamese genres and textual compositions, though distinguishing between intersection and inclusion can be challenging.

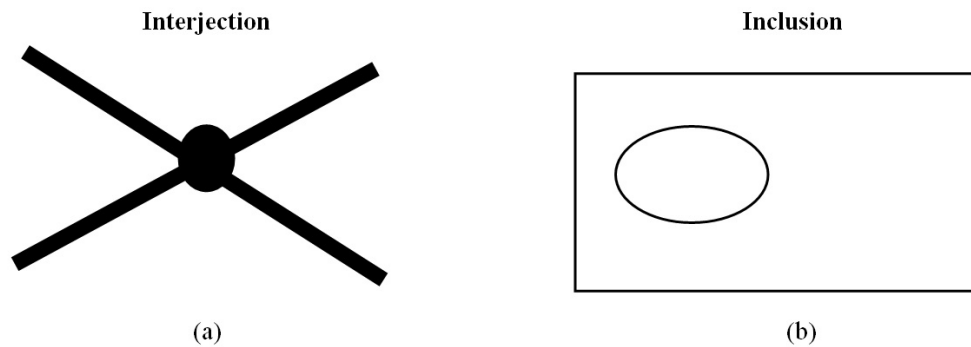


Figure 2. Locatives of Interjection and Inclusion

Tại

The topological locative *tại* denotes an intersecting spatial relation between separate regions in Vietnamese, conveying proximity with a region located amid the Figure and Ground where the absence of a shared empty space indicates their intersecting condition. *Tại* embodies the particular topological invariant of intersection - where two regions partially overlap without one being wholly contained inside another, differing from inclusion which entails complete enclosure. By encoding this fundamental topological concept of intersection, not mere closeness, *tại* enables nuanced expression of topological configurations in Vietnamese.

Definition:

$\langle F G \rangle \in \parallel \text{t\grave{a}i} \parallel \text{iff } p [F] \subseteq \text{PROX} [G]$

- (5) Hoa ở **tại** cơ quan của cô ấy.
'*Hoa is at her office.*'

This example exhibits the spatial relationship between the Figure (Hoa) and the Ground (her office). The symbol $\langle F G \rangle$ consists of the spatial relationship subsisting between the Figure and the Ground. The stative locative preposition is conventionally denoted by the symbol \parallel , while the variable p designates the positional attribute ascribed to each respective object or event. The symbol \subseteq signifies the inclusivity of the Figure within the spatial domain defined by the Ground. Additionally, the notation $\text{PROX} [G]$ conveys that the Figure maintains a proximate spatial relation in relation to the Ground.

In summary, the locative *tại* in Vietnamese specifically expresses an intersecting relationship between distinct spatial zones. The differentiation of *tại* from proximity is vital, as it disambiguates the technical topological meaning. This illustrates how Vietnamese grammar semantically distinguishes locatives based on precise geometrical concepts like intersection. The ability to explicitly encode invariant topological invariants enables articulate description of spatial configurations and scenes.

Trong

The preposition *trong* in Vietnamese encodes a specific type of spatial relationship characterized by inclusion or containment. More specifically, *trong* signifies an asymmetric relationship between two distinct regions - a figure and a ground - where the figure is fully encompassed within the interior boundaries of the ground. This containment is delimited by precise spatial parameters inherent to the ground object. While *trong* prototypically expresses this inclusive relationship, there are several noteworthy prepositional alternatives in Vietnamese that provide more nuanced specifications. For instance, *bên trong* can denote containment with respect to the inner side or region of the ground. *Phía trong* emphasizes the directional notion of being positioned inside the ground. Finally, *phía ngoài* encodes the opposite orientation, specifying the exterior side or outer region of the ground object. Crucially, these alternatives are not completely interchangeable with *trong*. While they share the general characteristic of expressing inclusion, each alternative highlights a unique spatial perspective or orientation. Their distinctions underscore the importance of examining how subtle variations in locative terminology can reveal different construals of the same basic relationship between figure and ground.

Definition:

$\langle F G \rangle \in \parallel \text{trong} \parallel \text{iff } p [F] \subseteq \text{INTER} [G]$

- (6) Bọn trẻ đang ở **trong** vườn.
'*The children are in the garden.*'

In this context, the locative *trong* plays a vital role in elucidating the complex spatial relationship between the Figure, represented by *bọn trẻ* "children", and the Ground, identified as *vườn* "garden". Specifically, *trong* signifies that the designated point p within the Figure constitutes an internal component situated within the boundaries of the broader spatial entity, the Ground. This delineates a containment relationship, with the Ground enveloping and encircling the Figure in an inclusive manner. Beyond functioning as a static spatial descriptor, *trong* conveys a nuanced relational disposition, providing a linguistic vehicle to articulate not merely the Figure's location, but also its interaction and configuration vis-à-vis the encompassing Ground. The precise usage of *trong* in this way establishes a sophisticated framework for analyzing the intricate spatial dynamics and relationships between the Figure and Ground in this context. The semantics of the preposition underscore *trong's* vital capacity to encode the complex notion of inclusive interiority

that defines the Figure-Ground relationship.

Trên

The stative locative term *trên* in Vietnamese, denoting "on" in English, consists of a multifaceted semantic dimension. Specifically, it encodes the notion of tangentiality or contiguity between two entities, signifying direct surface contact unaltered by continuous elastic deformation. When employed in spatial contexts, *trên* denotes a configuration where one entity lies atop and in immediate contact with the surface of another entity, exhibiting a resilient contiguous relationship despite potential deformations. In this way, *trên* embodies both the geometrical contiguity of adjacent entities sharing a common boundary and the physical support of the upper entity relying on the lower surface for stability. This contrasts with a pure intersecting relationship defined solely by the absence of an empty region between entities, without requiring direct surface contact. The complex semantics of *trên* underscore its capacity to encode nuanced notions of both contiguity and support that persist despite elastic deformations in the Figure-Ground relationship.

Definition

$\langle F G \rangle \in \parallel \text{trên} \parallel \text{iff } p [F] \subseteq \text{TANG} [G]$

- (7) Con mèo ở **trên** hàng rào.
'The cat is on the fence.'

In this example, the locative *trên* plays a vital role in elucidating the complex spatial relationship between the Figure, represented by *con mèo* "the cat", and the Ground, characterized as the *hàng rào* "fence". *Trên* specifically denotes a state of tangentiality and direct surface contact between the Figure and the Ground. This signifies a contiguous and uninterrupted adjacency, where the cat shares an immediate common boundary with the fence despite continuous deformation. Moreover, *trên* delineates that the designated spatial point within the Figure constitutes a component tangentially connected to the broader spatial entity of the fence serving as the Ground. This dual perspective highlights *trên's* capacity to encode nuanced notions of resilience, contiguity and connection between Figure and Ground. The semantics of *trên* underscore its vital role within the Vietnamese spatial lexicon in providing precise delineation of complex Figure-Ground relationships. While semiformally *trên* may potentially overlap with other locatives, its usages in specific linguistic contexts and tests can further reveal its distinct semantic contributions. Overall, *trên* establishes a refined framework for comprehending the intricate spatial dynamics at play in relational scenarios like this illustrative instance.

2. *Orientational Locatives*

The orientational locatives in the Vietnamese linguistic framework assume a pivotal role in establishing spatial orientation, encompassing *trước/sau*, *phải/trái*, and *trên/dưới*. These locative expressions serve as fundamental linguistic constructs employed to delineate directional relationships within a given spatial context.

Trước/sau

The orientational locatives *trước* and *sau* in Vietnamese provide a clear and distinct means of establishing anterior and posterior spatial orientations. *Trước* pertains to the forward or anterior position of an object or entity in relation to a reference point. Conversely, *sau* designates the rearward or posterior orientation, indicating the position behind a reference entity. This complementary pair of locatives is particularly significant in contexts necessitating precise spatial description or navigation, such as providing directions or delineating object arrangements. The availability and mutual exclusivity of *trước* and *sau* enables subtle specification of relative positioning between entities while also contributing to the linguistic variety within Vietnamese spatial semantics. Their binary contrast allows for unambiguous differentiation between front and back orientations, thereby enhancing the language's capacity to convey detailed spatial information.

Definition:

$\langle F G \rangle \in \parallel \text{trước/sau} \parallel \text{iff } p [F] \subseteq \text{EXTER} [G, \text{ANTER/POSTER}]$

- (8) a. Cây bàng ở **trước** trường của tôi.
'The banyan tree is in front of my school.'
b. Cây bàng ở **sau** trường tôi.
'The banyan tree is behind my school.'

This pattern elucidates the spatial correlation between the Figure, denoted as *cây bàng*, and the Ground, designated as *trường tôi*, signified by the notation $\langle F G \rangle$. This correlation is contingent upon the condition that the position, denoted as 'p', of the Figure must occupy an external position in relation to the Ground, situated either anteriorly or posteriorly in comparison to the Ground's location.

Bên phải/ bên trái

The orientational locatives *bên phải* and *bên trái* in Vietnamese serve to establish lateral spatial orientations, specifically indicating rightward and leftward positions relative to a reference point. *Bên phải* denotes a rightward orientation, signifying the side or direction positioned to the right of the established reference. Conversely, *bên trái* designates a leftward orientation, referring to the side or direction to the left of the reference. This complementary pair is highly useful in contexts necessitating precise spatial descriptions or navigation instructions by enabling unambiguous communication of lateral positioning. The availability of *bên phải* and *bên trái* as mutually exclusive terms enriches the Vietnamese language's capacity to convey detailed spatial information. Their juxtaposition

underscores Vietnamese's ability to articulate nuanced orientation relationships between entities, while enhancing practical utility in situations involving spatial localization, positioning and direction. In summary, the lateral locative pair *bên phải* and *bên trái* provides lexical distinction between rightward and leftward orientations relative to a reference point. Their binary nature both enhances specificity in spatial description and highlights Vietnamese's sophistication in encoding spatial semantics.

Definition

$\langle F G \rangle \in \text{ || bên phải/ bên trái || iff } p [F] \subseteq \text{EXTER} [G, \text{RIGHT/LEFT}]$

- (9) a. Những người lính ở *bên phải* chiếc xe tải.
'The soldiers are on the right of the lorry.'
b. Những người lính ở *bên trái* chiếc xe tải.
'The soldiers are on the left of the lorry.'

The spatial configuration, designated as $\langle F G \rangle$, elucidates the positional alignment between the Figure, represented as *Những người lính*, and the Ground, characterized as the *chiếc xe tải*. Within this relational framework, the Figure possesses the flexibility to assume a placement either to the right or the left of the Ground. In adherence to this relational construct, the specific location denoted as 'p' pertaining to the Figure is required to manifest as an external facet. This implies that it must be situated in such a manner that it exists distinctly apart from the Ground. Furthermore, 'p' must be positioned either to the right, indicated as option (15a), or to the left, designated as option (15b), in relation to the Ground for the stipulated relation to be considered valid.

Phía trên/ phía dưới

The Vietnamese orientational locatives *phía trên* and *phía dưới* convey the information about vertical spatial relationships between a Figure and a Ground. *Phía trên* denotes a configuration where the Figure is positioned at a higher elevation or upper level compared to the Ground object serving as reference. This term provides invaluable linguistic means to describe the vertical arrangement of objects or points within a given space. Conversely, *phía dưới* refers to a spatial relation where the Figure is located at a lower level or position relative to the Ground. It serves as a crucial tool for articulating the depth or height of elements within a particular spatial context. These complementary locative terms play a fundamental role in diverse contexts necessitating precise communication of vertical positioning, ranging from providing directions to discussing architectural configurations. The availability of *phía trên* and *phía dưới* enables nuanced specification of relative elevations and levels between figures and grounds, while enriching the vocabulary for vertical spatial relations in Vietnamese.

Definition

$\langle F G \rangle \in \text{ || phía trên/ phía dưới || iff } p [F] \subseteq \text{EXTER} [G, \pm \text{VERT}]$

- (10) a. Bức tranh ở *phía trên* cửa sổ.
'The picture is above the window.'
b. Bức tranh ở *phía dưới* cửa sổ.
'The picture is under the window.'

In Vietnamese, the orientational locatives *phía trên* and *phía dưới* are characterized by their spatial relationship between the Figure (referred to as *bức tranh*) and the Ground (referred to as *cửa sổ*), denoted as $\langle F G \rangle$. To be classified as such, this relationship must adhere to specific criteria. Firstly, the location "p" of the Figure must pertain to its external aspect in relation to the Ground. Secondly, both *phía trên* and *phía dưới* locatives convey the vertical orientation between the Figure and Ground. Nevertheless, *phía trên* designates the upper vertical section relative to the Ground, whereas *phía dưới* pertains to the lower portion relative to the Ground.

B. Stative Locative Events in Vietnamese

This section classifies stative locative constructions in Vietnamese into bijective and surjective event types based on the mapping between Figure and Ground arguments. The mathematical conceptualization reveals differences in determinism, ambiguity, and multiplicity in the localization relationships denoted. By examining argument mappings as formal bijective or surjective functions, this analysis uncovers key semantic distinctions encoded in the spatial language. Table 5 provides a comprehensive overview of Vietnamese verbs, along with subcategories indicating serialization capability with linguistic elements for stative locative events (+) or incapability (-).

TABLE 4
VERB CLASSIFICATIONS IN VIETNAMESE

Types of verbs		Stative locative events	Quantity
Placement		+	6/6
Judgment		+	3/6
Intention		+	5/5
Psychology		+	2/5
Communication		+	3/3
Housing		+	7/7
Attaching		+	3/3
Position		+	5/5
Entertainment		+	14/14
Sports		+	26/26
Dative	Goal	+	21/21
	Source	-	0/9
Perception	Vision	+	8
	Hearing	+	1
	Smell	+	1
	Taste	-	0/1
	Touch	+	2
Motion	Path	-	0/38
	Manner	+	224/ 224
	Cause	+	88

(a). *Bijjective Stative Locative Events*

Definition:

A bijjective event refers to a locative construction that denotes a one-to-one mapping between two sets of syntactic arguments, a Figure (X) and a Ground (Y). Formally, this can be defined as follows:

Let X and Y be sets representing distinct syntactic arguments in a clause. A locative mapping $f: X \rightarrow Y$ is bijjective if:

1. f maps each element x in X to exactly one element y in Y .
2. For each element y in Y , there exists exactly one element x in X such that $f(x)=y$.
3. There is a one-to-one correspondence between elements in X and elements in Y under the mapping f .

This means a bijjective locative event unambiguously maps a Figure to a Ground. There is no surjectivity or multiplicity in the mapping. In Vietnamese, lexical verbs license bijjective locative constructions including placement, judgment, intention, psychology, communication, housing, attaching, position, entertainment, and sports often denote bijjective events. For example:

Consider sentence (26):

- (11) Tôi bơi ở trong hồ.
'I swim in the lake.'

Let $X = \{\text{tôi}\}$ represent the set of Figure arguments, containing the single element 'Tôi'.

Let $Y = \{\text{trong hồ}\}$ represent the set of Ground arguments, containing the single element 'ở trong hồ'.

The locative preposition 'ở/at/in' denotes a function f that maps elements of set X to elements of set Y :

$f: X \rightarrow Y$

This function f has the following properties that characterize a bijjective mapping:

- f is injective: Each element of X maps to a unique element of Y . There are no two distinct elements x_1 and x_2 in X such that $f(x_1) = f(x_2)$. This is satisfied because X contains only a single element 'Tôi'.
- f is surjective: For each element y in Y , there exists at least one element x in X such that $f(x) = y$. This is satisfied because for the single element 'ở trong hồ' in Y , there exists a corresponding element 'I' in X that maps to it under f .
- f is one-to-one: Each element of X is mapped to exactly one element of Y . The single element 'I' maps to a single element 'ở trong hồ'.
- f is onto: Each element of Y has exactly one element of X mapping to it. There are no unfilled elements in the range Y .

Therefore, the locative preposition 'ở' denotes a bijjective mapping between the sets X and Y in this example. It unambiguously maps the Figure 'Tôi' to the Ground 'Hồ' in a one-to-one correspondence. There is no surjectivity or multiplicity in the mapping. This provides a formal semantic analysis of the deterministic, unambiguous locative relationship denoted by the preposition in this simple sentence. The bijjectivity captures the precise localization of the Figure relative to the Ground.

(b). *Surjective Stative Locative Events*

Definition

A surjective event refers to a type of locative construction in which a Figure argument (set X) maps surjectively onto one or more Ground arguments (set Y).

Formally, this can be defined as follows:

Let X and Y be syntactic argument sets representing the Figure and Ground. A locative mapping $f: X \rightarrow Y$ is surjective if:

1. For each element y in set Y, there exists at least one element x in set X such that $f(x)=y$.
2. The mapping f covers or surjects onto the entire set Y.

This means a single Figure argument can map ambiguously to multiple Ground elements under a surjective mapping. The localization relationship expresses multiplicity rather than a one-to-one correspondence. In Vietnamese, the verbs of dative, intension, attaching, social interaction, co-motion and perception denote this event. We can analyze the example sentence as follows:

(12) Tôi nhìn thấy anh ấy ở trong vườn.
'I saw him in the garden.'

Let $X = \{\text{Tôi, anh ấy}\}$ be the set containing the Figure arguments 'Tôi' and 'anh ấy'.

Let $Y = \{\text{vườn}\}$ be the set containing the single Ground argument 'vườn'.

The locative preposition ở establishes a mapping f from X to Y:

$$f: X \rightarrow Y$$

f maps:

$$f(\text{Tôi}) = \text{vườn}$$

$$f(\text{anh ấy}) = \text{vườn}$$

This satisfies the definition of a surjective mapping:

- For the single element 'garden' in set Y, there exist two elements 'Tôi' and 'anh ấy' in set X that both map to 'vườn' under f .
- The mapping f surjects onto the entire set Y.

Therefore, similar to the previous example, the locative expression establishes a surjective mapping between the Figure set X and the Ground set Y. Both 'Tôi' and 'anh ấy' map ambiguously to the single Ground element 'vườn'. The surjectivity arises from the multiplicity of having two Figures localize to the same Ground. This introduces ambiguity in the semantic mapping denoted by the preposition ở. The analysis demonstrates the flexibility of surjective locative constructions in Vietnamese.

C. Concept-Oriented Stative Locative Events

This section elucidates a semantic attribute inherent to locative expressions in the Vietnamese language. Within this framework, locative expressions manifest as functions pertaining to the conceptual categories, which are located, wherein they facilitate the identification of the spatial placement of said conceptual categories. This process of ascertaining the locational attributes of conceptual categories is largely contingent upon the linguistic attributes of verbs and prepositions. Table 6 is a summary of expressions denoting conceptual categories in a state of being located within the Vietnamese linguistic context.

TABLE 5
 ARGUMENT ORIENTATIONS OF SLES

Linguistics elements	Argument orientations of stative locative events			
	Figure	Ground	Figure-Ground	Figure and Ground
	Bijective events		Surjective events	
Verbs	judgement, position, entertainment, sports, manner motion	cause motion, placement, communication, psychology, housing,	dative	intension, attaching, social interaction, co-motion, perception
Total	5	5	1	5
Prepositions	trên, trong, phía trên, phía dưới, phía trước, phía sau	trên, trong, phía trên, phía dưới, phía trước, phía sau	trên, trong, phía trên, phía dưới, phía trước, phía sau	trên, trong, phía trên, phía dưới, phía trước, phía sau

(a). Figure- Oriented Stative Locative Event

This pattern examines a linguistic phenomenon particular to Vietnamese known as a figure-oriented stative locative event. In this construction, the primary focus is determining and elucidating the stationary position or location of a designated object or entity, referred to as the Figure. The Figure's precise location is established through the use of stative locative prepositions that pinpoint its position relative to a contextual reference or Ground. Vietnamese contains five distinct semantic verb groups that can denote this type of stative locative event: judgement verbs like *cho rằng* "to judge/consider", position verbs like *như nằm* "to lie", entertainment verbs like *xem* "to watch", sports verbs like *chơi* "to play", and manner of motion verbs like *múa* "to dance". The capacity of these disparate verbs to participate in the stative locative construction reveals its productivity in Vietnamese for encoding fixed locational relationships. Linguistic research has identified these five categories as central to this phenomenon through extensive analysis of Vietnamese grammar patterns and lexical semantics in this domain. Their possibilities illuminate the subtlety of Vietnamese in statively expressing Figure-Ground localizations.

(13) Ông chủ trích nhân viên mình trước đám đông.
'The boss criticized his employees in front of the crowd.'

Example exemplifies the concept of a figure-oriented stative locative event in Vietnamese. In this instance, the sentence portrays a scenario where the Figure, represented by the *Ông chủ* 'the boss', takes on the role of presiding over a gathering, indicated by *trước đám đông* 'in front of the audience'. This underscores the linguistic pattern's focus on elucidating the stationary position or location of the Figure in relation to its surroundings. While the specific stative locative prepositions are not explicitly mentioned, the context implies their presence, as the boss is positioned in front of a crowd. The verb *trì trịch* 'presiding over' falls under the category of position, highlighting the Figure's specific action and position of authority. This example vividly showcases how Vietnamese employs this linguistic structure to precisely convey static positions or locations of objects or entities, demonstrating the language's capacity for nuanced spatial descriptions.

(b). *Ground- Oriented Stative Locative Event*

In contrast to previous event types, ground-oriented stative locatives encode the location of the Ground or landmark argument within the relational predicate. That is, ground-oriented functions uniformly treat sets of coordinates in binary relations as specifying the spatial context of the ground element.

For instance:

- (14) Anh ấy đặt quả bóng **trên** bàn.
'He put the ball on the table',

The locative prepositional phrase *trên bàn* 'on the table' exemplifies a ground-oriented stative locative. It identifies the location of the ground argument *bàn* 'table' in relation to the figure *quả bóng* 'ball'. Crucially, this ground-oriented locative entails that the table holds a particular spatial configuration within the relation, rather than simply modifying the action of ball placement. Therefore, ground-oriented stative locatives encode the localization of the reference object or landmark itself, contrasting with figure-oriented locatives that specify the position of the located entity. In Vietnamese, there are five miscellaneous types of verbs denoting this event including cause motion, placement, communication, psychology and housing.

(c). *Figure and Ground -Oriented Stative Locative Event*

Stative locative prepositional phrases in Vietnamese specify the location of both a Figure and a Ground participant independently. There are four major lexical classes of verbs that license this type of construction: intention, attachment, social interaction, and co-motion. For example:

- (15) Lan gặp Hùng trong cơ quan.
'Lan met Hung in the office.'

The locative prepositional phrase *trong cơ quan* 'in the office' in (15) expresses the location of both the Figure (Lan) and the Ground (Hùng) simultaneously. This yields a surjective semantic interpretation, as demonstrated by the decomposed clauses in (16):

- (16) a. Lan ở trong cơ quan.
'Lan is in the office.'
b. Hùng ở trong cơ quan.
'Hung is in the office.'

The stative locative *trong cơ quan* 'in the office' relates both the Figure and Ground to the same spatial Ground (the office) independently, rather than expressing motion or directionality. The surjective nature of the locative construction in (1) arises compositionally from the ground-locating function of the preposition *trong* 'in' applied to two discourse referents. Thus, the lexical semantics of certain stative verbs in Vietnamese interact with the semantics of locative prepositional phrases to allow independent and simultaneous spatial predication of Figure and Ground. This demonstrates the complex interplay between a language's lexical classes, verb semantics, and function of spatial particles in giving rise to particular locative event types.

(d). *Figure- Ground Oriented Event*

The Figure-Ground oriented locative event expressed in example (17) demonstrates surjective semantics, as the stative locative prepositional phrase *ở Hà Nội* 'in Hanoi' refers to the location of three distinct arguments - the Figure *Tôi* 'I', the secondary Figure *cái áo khoác* 'the coat', and the Ground *anh ấy* 'him'.

- (17) Tôi mua cho anh ấy cái áo khoác ở Hà Nội.
'I bought him a coat in Hanoi.'

The surjectivity arises because the ground-locating PP potentially expresses two distinct situational meanings:

Interpretation 1: The PP locates both the Figure *Tôi* and the secondary Figure *cái áo khoác* in relation to the spatial Ground *Hà Nội*, as in (18):

- (18) a. Tôi ở Hà Nội.
'I am in Hanoi.'
b. Cái áo khoác ở Hà Nội.
'The coat is in Hanoi.'

Interpretation 2: The PP locates the secondary Figure *cái áo khoác* and the intended recipient Ground *anh ấy* in Hanoi, as in (19):

- (19) a. Cái áo khoác ở Hà Nội.
'The coat is in Hanoi.'
b. Anh ấy ở Hà Nội.
'He is in Hanoi.'

The ambiguity arises from the stative semantics of the verb *mua* 'to buy' and the ground-locating function of the preposition *ở*. The surjectivity demonstrates how a single PP in Vietnamese can locate multiple arguments in a clause independently, arising from the complex interaction between lexical semantics and locative syntax. Further research could investigate what factors determine the contextual interpretation of the locative semantics in examples like (19) - whether it is determined by information structure, plausibility, or other pragmatic principles. This phenomenon highlights the importance of understanding the mapping between semantic roles and syntactic expression in explaining locative event types cross-linguistically.

V. CONCLUSION

In conclusion, this study has proposed a novel mathematical formalism of stative locative events in Vietnamese using the concepts of bijective and surjective mappings. Through exemplary analysis of authentic sentences, the classification of locative constructions based on Figure-Ground argument mapping reveals clear semantic differences between bijective and surjective events. The findings demonstrate how bijective locatives unambiguously map arguments one-to-one, while surjective locatives permit flexible many-to-one mappings between a Figure and multiple Grounds. This novel typology based on mapping surjectivity provides valuable insights into the determinism, ambiguity, and multiplicity encoded in Vietnamese spatial language. This research paper shows how the different parts of a language's vocabulary, its word meanings, the purpose of prepositions, and the building blocks of argument structure all work together to create spatial meanings. Using mathematical functions to look at locative meanings is one way to do this. To study static locative events across languages in the future, the integrated formal method that combines predicate logic, set theory, and grammar might be helpful. The bijective/surjective difference has made it much easier to understand the different types of stative locative events and how their syntax and meaning are put together.

In the future, the ramifications of these results will extend beyond the field of linguistics, with substantial applications in the fields of computational and theoretical languages, as well as neuroscience. Not only does this research contribute to our understanding of Vietnamese spatial language, but it also paves the way for cross-linguistic studies on how languages conceptualize and linguistically reflect persistent spatial relationships. This finding opens the door for more research into how natural languages think about and store long-lasting spatial relationships and configurations between things in a way that is both geometrical and linguistic.

REFERENCES

- [1] Creary, L. J., Gawron, M., & Nerbonne, J. (1989). *Reference to locations*. In *Proceedings of the 27th annual meeting of the Association for Computational Linguistics* (pp. 42-50).
- [2] Crow, J. S. M. (1989). *Towards a semantics for English spatial expressions* (Doctoral dissertation). University of Texas at Austin, Austin, TX.
- [3] Davidson, D. (1967). *Essays on Actions and Events*. Oxford: Oxford University Press, USA.
- [4] Gehrke, B. (2008). *Ps in motion: On the semantics and syntax of P elements and motion events* (Doctoral dissertation). University of Utrecht, Duitsland.
- [5] Hanske, T. (2013). Serial verbs and change of location constructions in Vietnamese. In D. Hole & E. Löbel (Eds.), *Linguistics of Vietnamese: An International Survey* (pp. 185–214). Berlin, Boston: De Gruyter Mouton.
- [6] Jackendoff, R. (1983). *Semantics and cognition*. Cambridge, MA: MIT Press.
- [7] Jackendoff, R. (1990). *Semantic structure*. Cambridge, MA: MIT Press.
- [8] Keenan, E. L., & Faltz, L. M. (1985). *Boolean semantics for natural language*. Dordrecht, Netherlands: D. Reidel.
- [9] Kratzer, A. (2004). *Building resultatives* (Unpublished doctoral dissertation). University of Massachusetts, Amherst, MA.
- [10] Nam, S. (1995). *The semantics of locative prepositional phrases in English* (Doctoral dissertation). University of California, Los Angeles, CA.
- [11] Nguyễn Đình Hòa. (1997). *Vietnamese. Tiếng Việt không phấn son* [Vietnamese Without Makeup]. Amsterdam: John Benjamin Publishing Company.
- [12] Nguyễn Đăng Liêm. (1973). *Cases and Clauses in Vietnamese*. Honolulu: University of Hawaii Press.
- [13] Talmy, L. (1983). How language structures space. In H. Pick & L. Acredolo (Eds.), *Spatial orientation: Theory, research, and application* (pp. 225–282). New York, NY: Springer.
- [14] Talmy, L. (1975). Figure and ground in complex sentences. In *Proceedings of the First Annual Meeting of the Berkeley Linguistics Society* (pp. 419-430).
- [15] Talmy, L. (2000). *Toward a cognitive semantics: Vol. 2. Typology and process in concept structuring*. Cambridge, MA: MIT Press.



Ly Ngoc Toan is an esteemed teacher of English with over 25 years of experience. Holding a doctoral degree in English language, he currently serves as a faculty member at the University of Law. His primary interests lie in teaching and researching language, areas in which he has made significant contributions. His dedication to profession and passion for linguistic exploration have earned him widespread respect within the academic community.