How do Architects and Civil Engineers Conceptualize Space? A Cognitive Discourse Analysis of their Thought Patterns

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Abstract

This study investigated how space and spatial parameters are conceptualized by civil engineers and architects. To achieve this objective, civil engineers and architects were tasked with planning, designing, and describing a residential project using their professional software. Under the methodological framework of Cognitive Discourse Analysis (CODA), think-aloud protocols were used to gain insight into the participants' cognitive processes while performing the task. Their design descriptions were then followed by a set of retrospective questions. This linguistic data was then further examined in light of space conceptualization parameters. The findings revealed significant differences and similarities in the ways civil engineers and architects conceptualize space. In the case of architects, space is an enclosure of planes but on the other side, it is an absence of rigid volumes. Rigid volumes can be bulky or dense forms but for architects' space does not have to have calculated dimensions. Architects are more concerned with the 3-D structure of the spaces. Both, however, conceptualize space by keeping the user's or client's specific requirements – safety and privacy – in mind. Moreover, both are concerned about the materiality and haptics of the building too. The findings of this study may help us to understand how different professions play an important role in shaping the spatial structures of individuals within the environment.

Keywords: *Space, language, thought, CODA, architects, civil engineers*

Introduction

Human language not only determines thoughts (Batool et al., 2025; Zlatev & Blomberg, 2015) but also reflects patterns of thought. Whenever we use language, we make meaningful choices from our linguistic repertoire (Khalfan et al., 2020; Shaheen et al., 2018; Zehra et al., 2017). These linguistic choices are related to the ways we think about the external world (Batool et al., 2024; Jan et al., 2023; Khawar et al., 2021). Boroditsky (2011) states that the way we perceive the world influences the way we think and speak about it which further expresses what and who we are (Botticelli & Koh, 2016). Cognitive linguists believe that our conceptual structures and organizations are manifested in language (Batool et al., 2022). Talmy (2000) proposed that language has a significant relationship with space and linguistic expressions encoding thought. According to Evans and Green (2006), language achieves variations by encompassing different aspects of the conceptualization of space. Therefore, variations across different languages point towards variations in conceptual structures (Jan et al., 2022; Batool et al., 2024).

One of the factors contributing to linguistic variation can be the varied embodiment – specific environment or experience (Batool & Shehzad, 2018; Barrett, 2011). Therefore, spending a long time in one professional environment may shape the thinking patterns of individuals and may affect an individual's linguistic repertoire. According to Rapoport (1990, p.298) environments are thoughtfully built so to think and act accordingly. As Winston Churchill (as cited in Pearson & Richards, 1994, p.2) once said, "First we shape our buildings and afterward our buildings shape us." This statement reflects the active role of the environment. It explains that we do not only examine our surroundings but we breathe in them which suggests the predictable effect of one's environment.

Researchers have studied the relationship between language, space, and cognition by taking various groups as their participants (Batool et al., 2024; Noreen et al., 2024). Research has shown that spatial cognition is divergent across various professional groups (Tenbrink et al., 2011 & 2014; Lee et al., 2016, 2019; Cialone et al., 2018). Studies have been conducted to analyze the relationship between the design cognition and spatial language of architects, sculptors, and painters since the conceptualization of space is part of their professional demands. Architectural designs incorporate diversified tasks such as creativity and aesthetics. Complex building requires conceptualizing not only as a prerequisite of the spatial situation and the expectations for the functionality of the building but also the future users' perception of the complete configuration along with issues of intelligibility and navigability. Whereas it is assumed that civil engineers are more involved in designing, construction, and supervision. Thus, all the features of their spatial understanding have been gained through the language these professionals use. Hence it can be said that an individual's perception and conceptualization of space is the product of his experiences which are reflected through linguistic expressions.

Thought patterns have their basis in certain parameters. These parameters configure spatial scenes as they are structured on specified parameters. For instance, Talmy (2000) has defined a framework to study the conceptualization of spatial events according to three parameters i.e. figure and ground relationship, the relative proximity of figure with reference to ground, and the reference frames. There is always an asymmetrical relationship that is created by all the elements of the spatial environment about each other. All the spatial entities work together to make a whole. The first parameter defines that one entity becomes more prominent, termed a figure, as compared to the other one that acts as a ground or a reference object (Talmy, 2000). Talmy further divides reference objects as primary and secondary. The primary is explicitly a lexical item whereas the secondary object can be implied. The Second parameter is the relative proximity of the figure with respect to ground in linguistic variations. Schematically, proximity can be in contact, adjacent, or at some distance to the ground. The third parameter, that is evident in the linguistic features of speakers, is reference frames. He identifies four reference frames in all natural languages and divides them into two main categories: reference frames having primary reference objects and reference frames having both primary and secondary reference objects (PRO & SRO) respectively. The second type is also divided into two main types: encompassive and external secondary reference objects. An encompassive secondary reference object is termed as field-based, considering cardinal points (north, south, east, west) of Earth as a secondary object. External SROs are of two types: guidepost-based and projector-based SRO. Guidepost-based SRO is any non-animate entity external to PRO, and projector-based, SRO is an animate entity.

Civil engineers and architects are said to be highly accustomed to the understanding of the parameters of space due to their professional demands. Research studies have been conducted to investigate their spatial understanding in multiple contexts. Recently an important development in this research area was shown by the study of Cialone and colleagues (2018). They have examined architects, sculptors, and painters to understand the spatial expertise of each in their professional setting. The study addresses the mental representations involved in perceiving and depicting spatial cognition within each discipline. It was an attempt to investigate how professional training and expertise influence the spatial depiction. A study conducted by Lee et al (2016) also provides relevant data on exploring the relationship between spatial cognition and spatial language by engaging the participants in design design-making process in a parametric environment. The major goal of the study was to address the design cognition in function when Australian and Swedish architects were performing the task individually. Another empirical study by Alias (2000) attempted to analyze the spatial visualization ability and problem-solving ability of Civil Engineers. The researcher investigated the relationship between teaching and learning spatial visualization and problem-solving. Though the relationship between language and thought was not discussed in the study, however, the study indicates that civil engineers are taught and trained to describe and use spatial structures and visualizations as compared to other professional groups. On the other hand, quite a few studies have been conducted to address the relationship between language and thought of architects' groups but in their specified contexts (Tenbrink et al., 2011 & 2014). There is little to no evidence that civil engineers are taken into consideration from this perspective, despite the fact that prior research does provide information regarding the spatial cognition of people from different professions. Additionally, there is a dearth of empirical evidence to examine the cognitive processes of civil engineers and architects as a group. Although the two fields are thought to have a lot in common in terms of spatial planning and analytical capabilities, the professional knowledge and talents needed to complete such a cognitive activity are different. The current research is an attempt to study the spatial cognition of civil engineers and architects by examining their linguistic patterns. It has investigated the language of architects and civil engineers that informs us about their thought patterns and spatial understanding (conceptualization) to solve complex cognitive processes e.g. planning, designing, or describing. For this purpose, verbalizations of both professional groups were collected, annotated, categorized, and finally analyzed using CODA.

Language has the tendency to segregate spatial scenes and to study these parameters through language. Cognitive Discourse Analysis or CODA (Tenbrink, 2015) is a major breakthrough and an established methodological framework in the discipline of cognitive linguistics. In the present study, CODA is used to study the similarities and differences between the thought patterns of architects and civil engineers. CODA is a systematic analysis that provides evidence for the cognitive processes and representation in an unconstrained language data (Tenbrink, 2015). The core application areas of CODA are mental representation and complex cognitive processes. Mental representation means how we think about a scene, and how we perceive or remember events (Batool et al., 2025; Naqvi, 2017). On the other hand, complex cognitive processes pertain to more complicated challenges such as problem-solving or decision-making. Therefore, when one expresses thoughts while dealing with such a challenge, the language will reflect on aspects he has given first thought, those that are taken for granted, those taken seriously, and vice versa (Tenbrink, 2020).

In the present study, verbal protocols are used to elicit the cognitive processes of architects and civil engineers. Verbal protocol analysis in CODA is established in a different way from the traditional verbal protocol analysis in cognitive psychology. In traditional psychology, the focus is only on the content and linguistic expression which has been rarely considered. CODA, on the other hand, points to the cognitive significance of specific linguistic features that are used to express certain concepts. These insights can be further used to operationalize, validate, and interpret content categories: if a particular type of content is expressed regularly in a particular way or can be used as evidence for building another conceptual category of its own. Verbal data on the other hand provides the underlying intentions of the participants, thus contributing to the understanding of the level at which the errors occurred.

Thus, in the present study, CODA is used to provide insight into the conceptualization of space and cognitive processes of civil engineers and architects involved in a task requiring their professional expertise in planning and designing a residence or house. Furthermore, a retrospective report is taken from each participant after the task to triangulate the results of the study. In order to meet the objectives of the study, the following methodology is designed.

Methodology

The present study sought a combination of quantitative and qualitative methods. A quantitative analysis was conducted using Corpus-based analysis. After that, results were transcribed, annotated, and analyzed using Cognitive Discourse Analysis (CODA). Thus, it is a mixed-method approach to research revealing cognitive processes through linguistic data.

Participants: The participants for this research were five Civil Engineers and five Architects. All were professionals in their fields. In the architect's group, four participants were female whereas one was male. In the civil engineers' group, two female and three male civil engineers were selected. The rationale behind using civil engineers and architects together for this research is that both are involved in designing space and make greater use of spatial elements in their language as both fields may be considered as the spatial professions (Cialone et al., 2017). Moreover, various studies have already been conducted on architects but the understanding of space from a civil engineer's perspective was remained unexplored. Therefore, the study investigated the crucial difference in the conceptualization of space from the civil engineers and architects' perspectives. As generally it is believed that both professions are parallel and work together, it is also expected that their way of conceptualizing space may be the same too.

Procedure: Architects and civil engineers were contacted by mutual permission from their social circles and personal sources. The participants were duly informed that their personal information and participation will be kept confidential as it serves academic purposes only. Later a consent form was formally presented and filled before they participated in the research process. They were thoroughly explained the purpose and procedure of the research study. Researchers noted that for architects it was easier to understand the purpose of research as compared to civil engineers. The reason might be the extensive 3-D and spatial visualization education that they receive during their training. Moreover, it might be due to their professional demands.

Tasks

To explore the spatial conceptualization and its differences, all the participants were instructed to perform a set of tasks. They were ensured that the purpose of the tasks was not to evaluate their performance in any way. Tasks were divided into the following steps:

Step 1: Researchers scheduled online meetings on MS TEAMS and Zoom. Each Participant was requested to share his/her screen on the computer. He/she was requested to open his/her software for planning, designing, and describing a Residence (Figures A, B, C &D). The purpose of taking online sessions was twofold. One, it was easy for the researcher as well as the participants to save the audio and video of their task. The second reason was the prevailing situation of COVID-19 and the closure of institutions to maintain social distancing.

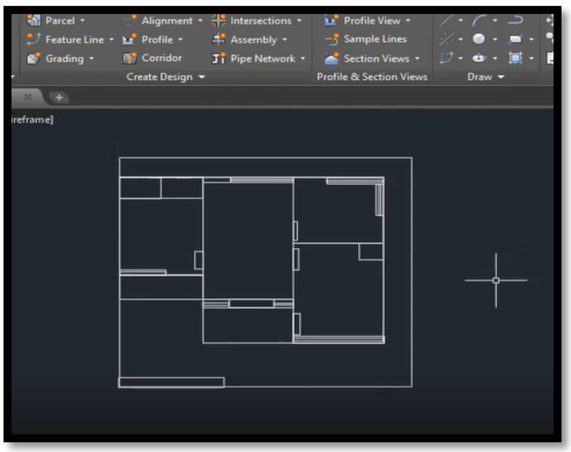
Step 2: Participants were instructed to think aloud while performing the task or answering questions. The definition of thinking aloud was also shared with the participants. Thinking aloud was centered around the following questions. These questions were formulated to elicit the required data from the participants.

1. How many rooms you are going to design for the house? Please specify the reason for designing a specific number of rooms.
2. How, do you believe, the space for the specific house should be conceptualized to construct different rooms such as kitchen, drawing room, T.V lounge, bathrooms, bedrooms, etc? Please

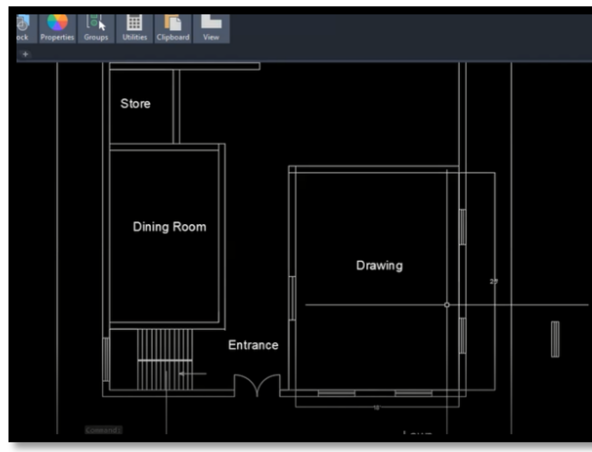
specify the reason for planning/designing different rooms in a specific way you have planned/designed them.

3. Why do you want to utilize the space for designing the HOUSE in a specific manner and not another?

During online meetings, the researchers mostly remained passive unless the participant had any ambiguities or if they left out any answer or detail for the data required. The meetings lasted for 20 to 30 minutes approximately.



A



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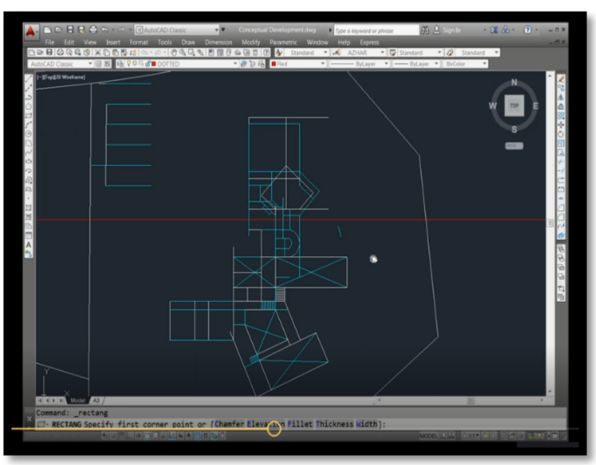

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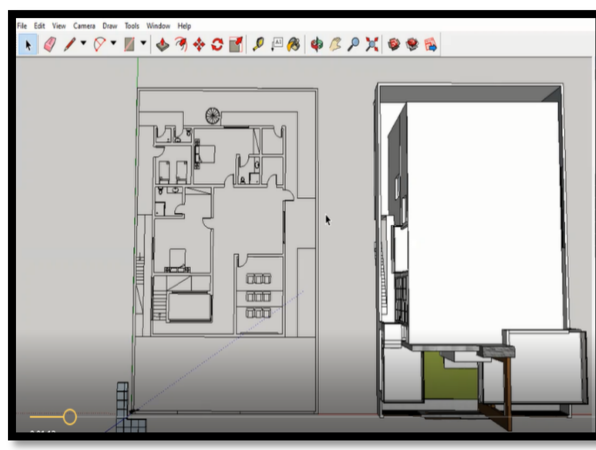

D

Figure 1: *Planning/Designing of the task by the participants using their soft wares A &B are the designs of residence designed by Civil Engineers C &D are designs of residence by Architects*

Step 3: After the performance of the task, the participants were requested to give a retrospective report. For this purpose, three additional questions were asked from them. The following questions were posed to triangulate the results of the study:

a. What important things as an architect/civil engineer do you keep in mind before, during and after designing the specific residence?
b. How do you make use of space for designing residence?
c. What is space for you?

The following steps of Cognitive Discourse Analysis were followed:

Transcription: The data obtained from the MS Teams meetings was transcribed. Hesitations, pauses, and hedges were not considered because they were not required for the study. However, everything that was said by the participants was transcribed. Since no software was available to the researcher, so all the videos were transcribed manually and with the help of the dictate option on MS Word.

Content Analysis: Content was further analyzed for the anecdotal evidence and to identify crucial linguistic features relevant to the two groups of participants.

Linguistic features annotation: Linguistic features were then annotated and identified according to the categories suggested by the think-aloud data. All the Categories and criteria were then defined and operationalized into corpus-based software AntConc 3.5.8 to study the context and frequency of defined lexical items.

Corpus-based analysis: Data obtained from verbal protocols may require a longer time to analyze. Thus, to manage the data within time a corpus-based software AntConc 3.5.8 version was utilized. The corpus-based approach is used with an already conceived theoretical framework in mind (Lindquist, 2009). Moreover, corpus data is more objective and reliable as compared to subjective analysis of any kind of text. Thus, the rationale behind selecting a corpus-based methodology is to make the study and results of the data more authentic and vocal. Furthermore, it is stated by Tenbrink, (2015) that CODA can be applied along with other methods and theoretical frameworks. Due to time constraints, corpus-based analysis was conducted to identify the linguistic features according to definitions and the frameworks defined in the literature review.

Results

In the tasks, both groups were given a set of questions to plan, design, and then describe their residential projects or designs; however, they were free to conceptualize their number of rooms, floors, and the overall elements of the project. This freedom helps in contemplating how two different groups of individuals having different exposure to space can conceptualize the same task differently. It was expected that this freedom of thought and vocalization would probably give us some points of differences in their thinking patterns for utilizing space according to their qualification and professional demands.

In the following, we are reporting the results of civil engineers and architects separately with the frequencies in Section II; then we will move towards the comparison between the two groups.

Section I: Spatial Parameters

Category 1: a. Figure and Ground Segregation

Civil Engineers

According to Talmy (2000), a figure is usually represented as prominent as compared to the reference object or less prominent entity which is termed as ground. In the following examples from the data, space is segregated into figure and ground. The figure is underlined, and the ground is bracketed. According to Talmy, it looks usually odd if we reverse the positions of figure and ground in a sentence. Such sentences are grammatically well-formed but semantically odd.

2 House. So I have to provide ***some circulation space*** ***towards [the back of my house]***. Civil Engineers file.txt

7 small lawn I'll provide the big large windows towards ***the lawn*** ***in [the front of the house]*** too Civil Engineers file.txt

9 and kitchen it's ***an open counter*** ***towards [the lounge]*** So we have about 27 feet of available Civil Engineers file.txt

5 preference that there should be ***a master bedroom*** ***on [the ground floor]*** as well so Civil Engineers file.txt

1 dressing here because ***here is the door for the [entrance of the room]*** so let me draw this door Civil Engineers file.txt

Architects

1 outside environment. We have placed ***<u>these vertical louvers</u>*** here for [**sunlight],** it will be diffused and filtered Architects file.txt

1 between various family members. Similarly, how ***<u>this corridor</u>*** extends towards [**the outside]. You** can see this gar Architects file.txt

4 important to complete a whole façade. I created ***<u>the stairs</u>*** at [**the basement]** at the backside because to like Architects file.txt

6 we have Level 3 on our site we provided **<u>these stairs</u>** in the [**middle of the house]** which are private for families Architects file.txt

b. Primary Reference Object (PRO) and Secondary Reference Object (SRO)

Languages also allow to segregation of spatial scenes into not only figure and ground but also primary and secondary reference objects to locate the figure properly. In the following examples from the data, PROs are underlined and SRO is in brackets. Here, the secondary reference object is the Earth, which is implied in the spatial expression of the west wall and the east side. Moreover, in these examples, the west and the east sides of the Earth provide an orientational frame that encompasses the PROs, the bedrooms, and the house, which in turn locate the figure, two openings, and the bedrooms. It is thus noted here that the direction orientation imposed by the SRO the Earth, that the Figure two openings and the location of the bedrooms with respect to the PROs the bedrooms and the house, is established.

2 openings on the West wall *two openings* on [**the West]** wall of **<u>the bedrooms</u>** and one opening in the Civil Engineers file.txt

4 and will try to keep *the bedrooms* towards [**the East side]** of **<u>the house</u>** and will try to keep the drawing room Civil Engineers file.txt

Architects

In architects' data, it was found that in most instances the primary references are implied or may be missing. However, in line 5 PRO *the house* was used with SRO which is *the Earth* to locate figure *rooms.*

2 like the bathrooms and ***the kitchen*** towards **West** and let's talk about the open spaces so Architects file.txt

3 at such and ***the bedrooms*** should have preferably **East** facing light a lot of the eastern South Architects file.txt

5 the house ***so ideally rooms*** were placed **on the south end** [**of the house]** so that maximum light can Architects file.txt

Category 2: Relative Proximity

The second parameter is the relative proximity of the figure which is encoded in linguistic expressions with respect to ground that is typically immovable.

a. Contact: Figure is in physical contact with the reference object.

Civil Engineers

12 I might not be able to place ***my window on the right hand side of the wall***. Now all my planning has Civil Engineers file.txt

24 place my dining table here, sofas and ***tv placed on this wall*** and you can have an open kitchen Civil Engineers file.txt

26 making ***two openings on the West wall of the bedrooms*** and one opening Civil Engineers file.txt

Architects

27 u enter inside this is ***the brick pattern placed on the middle of the lobby*** so when you see Architects file.txt

37 for making it more inviting we placed ***a mirror on the top of the roof.*** So this pattern is Architects file.txt

b. Adjacency: Figure can be adjacent to the reference object.

Civil Engineers

1 behind that we're going to have ***a <u>kitchen</u> right next to <u>it</u>*** so that there is an is Civil Engineers file.txt

2 just ***at the start of the <u>entrance</u> at the right side*** I will provide ***the <u>drawing room</u>*** for easy Civil Engineers file.txt

Architects

5 office area which should be <u>right from entrance</u> and ***next was their <u>private spaces</u>*** like bedrooms Architects file.txt

6 materials as a <u>paint flat plane surface</u> ***next we have <u>wooden tiles</u>*** which we used in contrast Architects file.txt

c. At some distance: Figure will be at some distance to the reference object.

Civil Engineers

3 that now so I am selecting <u>5 feet corridor</u> ***from left and right side?*** which is the extra space provided Civil Engineers file.txt

10 have decided to make ***<u>the drawing room</u> in the front of the <u>house</u>*** with it becomes a part Civil Engineers file.txt

11 ***the <u>big large windows</u> towards the <u>lawn</u>*** in the front of the house too for a good scenery of Civil Engineers file.txt

Architects

36 side of the house ***so ideally <u>rooms</u>*** *were placed on* ***the south end of the <u>house</u>*** so that maximum Architects file.txt

14 We had ***<u>a road</u> on one side*** and we have second road over here Architects file.txt

Category 3: Reference Frames

a. Ground-Based Reference: a ground-based reference frame involves primary reference only. In the given example, *it* referred to the *dining room*, which is PRO, it employs the intrinsic geometry of the reference object to refer to the figure. No secondary reference object is involved.

Civil Engineers

1 that we're going to have ***a kitchen (figure) right next to it*** (dining room, PRO*)* so that there is an is in Civil Engineers file.txt

Architects

In this example, architect conceptualized side as a PRO, side may be having right, left, back, front that is used to locate the figure *the dining room* without the presence of SRO.

29 get together and then ***the dining room (figure) would be towards the side*** (PRO) all of these are connected to the Architects file.txt

b. Field-based: This type of reference frame involves both PRO and SRO. It is characterized by encompassing SRO. In this example, *the Earth* is used as secondary reference object, indicated by a cardinal direction, West. It is relative to direction that points towards PRO, *the bedrooms,* to locate the figure *two openings*.

Civil Engineers

2 openings on the West wall *two openings* on the **West** wall of [**the bedrooms]** and one opening in the south wall Civil Engineers file.txt

Architects

In majority of the examples from the data the architects appear to conceptualize SRO, the Earth in the form of cardinal points (east, west, north and south) but usually omitting the PRO. Like in the following example *the west* indicates the SRO *the Earth,* but no PRO is present.

19 these places like *the bathrooms and the kitchen* towards the **West** and let's talk about the open spaces Architects file.txt

c. **Guide-post based**: This reference frame involves external SRO which is non-animate entity *the lawn* in the following example identifies the portion of the PRO, *the house* with respect to which *big large windows* are localized. However, we can see that in this example, in addition to external SRO, encompassing SRO is also used by using *the front* of the house, providing the asymmetric orientation (front-back opposition), due to which it is possible to identify the location of figure *the big large windows.*

Civil Engineers

5 I'll provide *the big large windows* towards **<u>the lawn</u>** in ***the front*** [**of the house]** too for a Civil Engineers file.txt

Architects

In the following example, figure which *is the kitchen side* is localized with respect to the PRO which <u>is *the other side*</u> (confusion) and *the bed side* may conceptualize as an external SRO. However, reference frames are vaguely conceptualized by the architect or may have used lot of descriptive terms to identify figure. If we try to map it out diagrammatically, (Figure 2),

22 in the floor plan and this is *the kitchen side* **<u>with the bed side</u>** [**<u>on the one side</u>**] and a dry kitchen on the other side. Architects file.txt

Figure 2: *Design showing guide-post based reference frame (*Bedroom side, Kitchen side)

d. Projector-based: reference frame also involves SRO, the external SRO is animate entity, speaker in this example because he is projecting his location as a frame of reference.

Civil Engineers

10 I'll provide *the windows* on **the right side [of the building]** for better lightning in Civil Engineers file.txt

Architects

In the following example, *wide open stairs* are at the left of the speaker, however PRO is implied here in both the cases which is *house* or *the entrance* of the house (Figure 3).

2 when we enter into the house we have *wide open stairs* at **the left** and then the lobby and then we have guest Architects file.txt

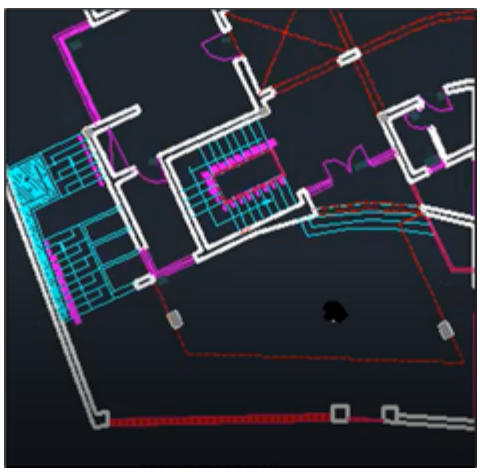

Figure 3 :*Conceptualizing stairs in projector-based frame of reference* (**Stairs)**

Section II: Spatial terms for Design Elements

In this section, linguistic elements indicating spatial features for the designs are identified. For this purpose, examples from think aloud are tabulated in Table 1 below. It provides a comprehensive account of all the spatial linguistic categories referred by either civil engineers or architects in their design description.

Table 1: Lexical categories encoding spatial features for design elements

Category	Explanation	Examples of Linguistic markers/indicators/frequency of occurrence Number of occurrences			
		Civil engineers		Architects	
Category 4	**Flat Geometry** Linguistic choices representing geometrical terms.	Rectangle 11, square 3, line 10, center 3, inch 3, feet 36, elevation 6, design 9, grids 1	edge 2, ground 5, corner 8, rectangular 2, sides 2, fourth 1, façade 4, whole 2, bottom 1, graphically 1,	Rectangular 3, circle 1, circular 1, lines 3, angles 1, squares 3, ground 24, c enter 1, corner 4, side(s) 44, edge 3, length 3, shape 2, elevation 1,	design 22, whole 19, Geometry 5, horizontal 4, vertical 3, plane(s) 5, flat 1, axonometric 1, façade 1, bottom 6, height 5, upper 4
Category 5	**Materiality/Safety** Lexical items related to material, haptics or safety of the spaces described.	Windows 18, wall 37, brick 5, solid 1, door 37, tv 12, glass 4,	cupboards 3, shelf 3, closet 2, stove 2, bamboo 1, refrigerator 1 peeping 1, privacy 12	wooden 2, stainless steel 1, brick 3, doors 3, wood 3, Privacy 9, private 9,	window(s) 16,
Category 6	**Deictic Terms** Linguistic terms related to personal and spatial deixis.	**Pronouns**: I 192, we 97, they 12, them 7		**Pronouns**: I 43, we 202, they 42, them 3, their 16,	

		Spatial deixis: Here 107, there 29		**Spatial deixis:** here 43, there 28	
Category 7	**Transformation of the spaces** Reference to the imagined three-dimensional or two-dimensional transformation of the depicted space.	"to make the drawing room…" "to make the entire wall…" "to place my door…." "to place my windows…" "to place another room…"		"void is created to make it more lighter…" "To make it more visual…" 'to make it more dynamic…" "We draw their boundary…"	
Category 8	**Transformation of space considering visual sense of light**. Lexical items used for lightening and illumination	Ventilation 10, light 9, lightening 4, daylight 3, skylight 2,	sunlight 2, ventilated 2, illuminate 1, solar 1, ventilator 1	Light 38, sun 10, sunlight 5, ventilation 2, sky 1, day 5,	louvers 2, airy 1, breathing, cooling 1, ventilators 1,
Category 9	**Representation of space as a bordered reality** Linguistic indicators for depicting bordered reality of space.	**Civil Engineers** Space 60 "Little piece of space…" "Extra space provided…" "the space for cupboards…" room(s) 119, house 52, bathroom 18, bedrooms 17, lounge 12, stairs 10, washroom 8,	corridor 5, lawn, porch 5, laundry 4, garden 1	Space 51, "Very small space…" "Porosity in the space…" Room(s) 39, house 66, building 7, plot(s) 8, walls 5, balcony(s) 5, kanal 4, bathrooms 3, basement 3, boundary 2,	corridor 2, enclosed, landscape 2, lawn(s) 4, marla 2, staircases 4, store 2, washrooms 2, courtyard, frame 1, gallery, garage 1, storeroom 1, terrace 1 nook 1

Category 10	**Linguistic indicators for space aesthetics** Linguistic indicators (Adjectives) used to enhance the aesthetics of spaces	Back 16, front 20 Bigger 3, large 3, aesthetic 2, symmetry 2, translucent 2, antique 1, green 1, luxurious 1	Back 12, front 11, end 3 Perforated 3, spacious 4, secluded 3, separated 3, solid 8, void(s) 8, composite 2, diffuse 2, dry 2, envelope 2, extended 2, extreme 2, illusion 2, larger 2, largest 2, lighter 2, lightness 2, linearity 2, proximity 2, royal 2, tactility 2, traditional 2,	aligned, amazing 1, colors, comfortable 1, contours 1, curvilinear 1, dominant, fluidity 1, massive 1, ornamental 1, porous, porosity 1, symmetric 1, weightlessness 1, warmth, wholistic 1, simplicity 1

Analysis & Discussion

The linguistic data obtained from thinking aloud was analyzed using Cognitive Discourse Analysis, introduced by Tenbrink (2015). According to Tenbrink, there is no theoretical limit to the analysis of linguistic features that should be attended to because there is no limit to the cognitive processes. However, to delimit the study only those linguistic features need to be identified that are relevant to the research questions in hand. Moreover, the analytical framework followed for this research was proposed by Cialone et al. (2018) which was further adapted according to the results of the study. Data that emerged from the corpus analysis was further analyzed from the concordance lines. Relevant linguistic features were then identified and analyzed to find the differences between the two groups of spatial professionals. All the categories related to space were informed by Talmy's (2000) theoretical framework for studying linguistic patterns in the conceptualization of space. In addition to this category, the design elements relating to space were proposed by Cialone et al. (2018). From the think-aloud data and retrospective reports following spatial linguistic categories are designed that explain the conceptualization of space by Civil engineers and architects.

Section I: Spatial Parameters

Category 1: Figure and ground segregation was identified with the help of prepositions such as *near, primary and the secondary reference object*

Category 2: Proximity: it includes the element of closeness between figure and ground. It is mostly included by the help of given linguistic choices. For instance

Contact: Linguistic expressions *such **on** the left, **on** the front side, **on** the back, right, left-hand side* encoding that figure is in physical contact with the reference object.

Adjacency: Linguistic items such as *next to*, *in front of, behind, on one side of, beside, on the right/left of* showing that figure is adjacent to reference object.

At some distance: Lexical items that refer to the location of figure at some distance to the primary or secondary reference object or the ground such as *to the left/right of the, off from the front/near of the.* It also involves mentioning of distance in numbers such as 5 feet corridor.

Category 3: Reference frames

Ground-based (PRO): *next to the*

Field-based (PRO+SRO): Earth is the secondary reference object, *to the west, east, north, south of the*

Guide-post based: e.g *on the kitchen side of the house* with external inanimate entity as SRO

Projector-based: e.g. *to the left of the house* Here SRO is the external animate entity, speaker in this case

Section II; Design Elements

Category 4: Flat Geometry. Linguistic features representing geometrical terms. These are linguistic indicators such as nouns, verbs, adjectives used by the designer to conceptualize visual space.

Category 5: Materiality. Lexical features related to material or haptics of the spaces described.

Category 6: Deictic Terms. Linguistic terms related to personal and spatial deixis. Pronouns are included in personal deixis whereas terms like here and there also indicate position of a landmark.

Category 7: Transformation of the spaces. Reference to the imagined three-dimensional or two-dimensional transformation of the depicted space.

Category 8: Transformation of space considering visual sense of light. Lexical items used for lightening and illumination.

Category 9: Representation of space as a bounded reality. Linguistic indicators for depicting bordered reality of space.

Category 10: Linguistic indicators (Adjectives) used to enhance the aesthetics of spaces.

Both Civil engineering and architectural science perform and demand operations in space. For engineers, the primary focus is given to the construction, building, and economical management of a space. In this regard, they will look into methods, management strategies, materials, fabrication, and cost. Contrary to this, architects concentrate more on designing and building space to enhance its aesthetics. The primary focus is to design space in a well-organized way to enhance its beauty and make it more appealing. It is why in architects' data; it was found that in most instances the primary references are implied or may be missing. However, Tenbrink et al. (2011) in their study findings argued that architects reframed or conceptualized the perceived spatial scene flexibly according to the requirements of the tasks. Also, in the think-aloud data, civil engineers' verbalizations were found less elaborative and detailed contrary to the architect.

Caballero and Casakin (2022) in their study analyzed verbal descriptions of the architects and 150 written project justifications and the real-time discussions of sixty master's students engaged in collaborative design tasks. The results suggest that expert designers express not only geometric structures but also the tactile, thermal, and emotional characteristics of a space. They use elaborative descriptions with linguistic choices that provide sensory, emotional, ans user-oriented experience to the listener. Such descriptions play a crucial role in influencing how listeners mentally visualize and engage with the proposed design. The study further shows that architects frequently utilize multisensory metaphors (such as characterizing surfaces as "craggy" or interiors as "enveloping") that add focus on spatial description, elicit sensory expectations, and facilitate collaborative decision-making. The architect's language not only visualize but also evoke feelings associated with that space. The research highlights the importance of a curriculum that specifically teaches students to connect perceptual understanding with accurate descriptive language.

According to Evans and Green (2006), the nature of environment, experience, and learning have major contributions in shaping human cognition. It has a number of basic commonalities but some experiential and environmental factors can bring variation in cognition that can ultimately affect the use of language. The results displayed by the research emphasize the point that although both professions are dealing with space however their perception of space can differ due to their professional demand. Perhaps this is why similarities and differences are noticed in their spatial conceptualization. For instance, in given Table 1, the linguistic categories related to flat geometry, materiality, and deictic terminologies are seen in the language of both groups. This reflects the fact that the concept of basic spatial parameters exists in both groups. Also, both possess similar spatial knowledge about the functionality of space in terms of its geometrical features, orientation, and materiality.

On the other hand, think-aloud data suggest that both differ in the way they look/ perceive/ understand/ space. In other words, they differ in the spatial perspective they take into account while considering space. Littlejohn (1963) states that sometimes space is not understood as a quantitative measure or isotopic but it is categorized in qualitative terms with experience (social, professional) as its basis. For example, Cardinal points 'east is not merely a cardinal point for plotting position but it is a direction of existence (Littlejohn, 1967, p. 334). Similarly, in engineering science, the same orientation element 'East' shows a cardinal direction and location of a specific object/figure with respect to the ground but architects can also associate emotional and physical symbolism with the particular direction. In our data, For example, table 1 highlights the difference in their representation of space as a broader reality. For example, an individual in the civil engineers' group made intentional use linguistic expression 'little piece of space' which indicates that space is being treated like a measurable unit. That is why linguistic items in category 7 revealed that civil engineers conceptualize space more in the shape of nouns, concrete units, and rigid volumes. Such as walls, doors, windows, lawns, rooms, etc. It was speculated that civil engineers are more concerned with the 2-D structural components of the building. Therefore, their idea of transforming and designing space is associated with turning a wide space into different measurable significant sections.

Contrary to this, architects project space as a spatial reality more associated with user personal space. Hence, the idea of privacy and personal space is mostly considered by architects rather than civil engineers. Moreover, the corpus data also suggested that 'privacy and private' is mostly mentioned by architects as compared to civil engineers i.e. 18 vs 12. Their perspective of designing space is concerned with aesthetics, interior, and exterior design of the building while treating space as a personal space. It is why in the linguistic data of architects' the use of adjectives is more evident as these emphasize the features of available space for a desirable spatial transformation e.g. 'to make it more dynamic, to make it more visual'(see category 10, table 1). Hence, it can be said that architects' conceptualization of space concerns more concerned with the social use of space where the user's comfort, and peace are taken into account. As Pearson and Richards (1994) state that architect's comfort and utility are universal principles although they are relative and possess cultural values. They believe that structures or spaces we create are a result of social or cultural influence.

Conclusion

The results of the research study highlight a clear distinction in how civil engineers and architects conceptualize and verbalize space based on their professional roles and cognitive orientations. Civil engineers approach space in functional, measurable, and structural terms, emphasizing concrete units and practical design elements. In contrast, architects focus on the aesthetic and experiential dimensions of space, treating it as a flexible, user-centered reality. This is reflected linguistically in their frequent use of adjectives to enhance spatial appeal and address personal, social, and emotional aspects such as privacy and comfort. Thus, while both disciplines engage with spatial design, their differing priorities such as functionality versus aesthetics, are evident in their language use and cognitive framing of space. In architectural science, scholars consider space as a socially symbolic and socially functional entity (Franz et al. 2005). The spatial parameters encoded in linguistic categories emerged from thinking aloud data of both civil engineers and architects also emphasize the point that conceptualization of space is inherent in cognition but it differs according to the experience and environment of the individual. For one space may mean rigid structures but for another space might be just an illusion or idea. Evans and Green (2006, p.64) also assert that the nature of the environment and experience also contribute to designing human cognition.

This exploratory research holds substantial significance as it bridges a notable research gap by jointly examining the spatial conceptualization and thought patterns of civil engineers and architects. The findings underscore distinct professional orientations e.g. functional and structural for engineers, and aesthetic and user-centered for architects, revealed through linguistic indicators and cognitive framing. The study not only contributes to theoretical understanding but also offers practical implications. It suggests enhancements in educational strategies for teaching spatial concepts and supports the development of targeted training programs to improve spatial communication and visualization skills in both academic and professional contexts. The studies of Goldin-Meadow et al. (2017), Gero et al. (2016), and Uttal et al. (2013) also offer a comprehensive understanding of how spatial cognition training can be incorporated into the education of architectural and engineering science. The findings of the present study offer support to incorporate spatial cognition and link spatial thinking patterns with the current teaching material of such fields. The results can further assist in skill refinement for space design-oriented fields. Future research may expand this comparative framework to include other creative disciplines, such as fashion designing and visual arts, to further explore how professional experiences shape spatial thinking.

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