RESEARCH REPORT

FOLLOWING LOCATIONS ACROSS LANGUAGES: **SPATIAL MEANINGS AND CONCEPTS** IN CROSS-LINGUISTIC PERSPECTIVE

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ABSTRACT

Because meaning involves connections between the forms of language and the conceptual system, it can be fruitfully examined from either of two different perspectives. Taking linguistic forms as a starting point, meaning can be examined through the lens of lexical semantics, through questions about what semantic features are encoded by individual lexical items. In addition, by taking the conceptual system as a starting point, meaning can be probed through the examination of concepts and connections within the conceptual system, as distributed over the semantic system of a language or languages. Using topological spatial relations as a test case, I take a cross-linguistic perspective on both these lines of questioning in this paper, uncovering insights into the nature of meaning as an interplay between linguistic forms and conceptual understanding.

RESUMO

Como o significado envolve conexões entre as estruturas da linguagem e o sistema conceitual, ele pode ser examinado a partir de duas perspectivas diferentes. Considerando as formas linguísticas como ponto de partida, o significado pode ser analisado pelas lentes da semântica lexical, através da indagação sobre quais características semânticas são codificadas por itens lexicais individuais. Por outro lado, se tormarmos o sistema conceitual como

ponto de partida, o significado pode ser investigado por meio do exame de conceitos e conexões dentro do sistema conceitual, distribuídos pelo sistema semântico de uma ou mais línguas. Usando relações espaciais topológicas como um caso-teste, adoto uma perspectiva translinguística em ambas as linhas de questionamento neste artigo, revelando insights sobre a natureza do significado como uma interação entre formas linguísticas e compreensão conceitual.

KEYWORDS
Spatial Semantics; Conceptual Universals; Cross-Linguistic Comparison.

PALAVRAS-CHAVE
Semântica Espacial; Universais Conceituais; Comparação Translinguística.

INTRODUCTION

In addition to providing the means by which speakers communicate about ideas and about the world of experience, words present a connection between a language and a speaker's conceptual system. Meaning resides, in a fine-grained, focused way, in the packets of information that are connected to the meanings of individual lexical items, with speakers drawing upon this information when deciding whether – and with what degree of confidence – to use a given term in a given situation. At the same time, meaning also resides, in a coarser, more diffuse way, in the broader conceptual system that is made up of the totality of knowledge gleaned from our interactions with the world. Due to its breadth, this system provides the flexibility to engage, linguistically and non-linguistically, with the world around us.

A central question about the nature of meaning addresses the ways in which these two systems are related. Equally important are questions about the universality or language specificity of lexical and conceptual systems (see Levinson; Meira; The Language and Cognition Group, 2003; Li; Gleitman, 2002; Pinker, 1994; *inter alia*). Critically, these questions are intertwined: the more closely coupled lexical and conceptual meaning turn out to be, the more variation in one will constrain the possibility of universality in the other. For this reason, a clearer understanding of the relation between lexical meanings and the conceptual system writ large requires examination of both, within a single domain, in cross-linguistic perspective.

One fruitful domain for this investigation is the domain of topological spatial relations: relations between two objects, in small-scale space, that do not make use of additional conceptual structures such as perspective and frames of reference (Feist, 2000; Miller; Johnson-Laird, 1976). This domain presents an ideal testing ground because, on the one hand, we see the same physical world regardless of the language we speak, making topological relations equally accessible to all observers. In addition, the various spatial uses of a single term may not be perceived to encode very different situations by native speakers (cf., Nerlich; Clarke, 2003), suggesting a perceived unity of meaning associated with each lexical item. At the same time, languages vary substantially in how they categorize topological spatial relations (Bowerman; Choi, 2001; Levinson; Meira; The Language and Cognition Group, 2003). For example, the four scenes presented in Figure 1 could all be described using the same spatial preposition, *em*, in Brazilian Portuguese (J. Leite, personal communication, 18 Oct 2024 and 23 Oct 2024). In contrast, all four scenes are distinguished in Italian, which describes each with a different spatial preposition (Feist, 2000). Other patterns are found in Korean, which separates the four scenes into three categories (Feist, 2000), and in Moroccan Arabic, which makes use of four spatial prepositions which overlap in their application (Bouabida, in prep). Of note, while all four scenes would typically be described with the same preposition in Brazilian Portuguese, none of the other three languages included a term which was applicable to all four scenes, and each language evidenced a unique pattern of categorizing these four spatial scenes.

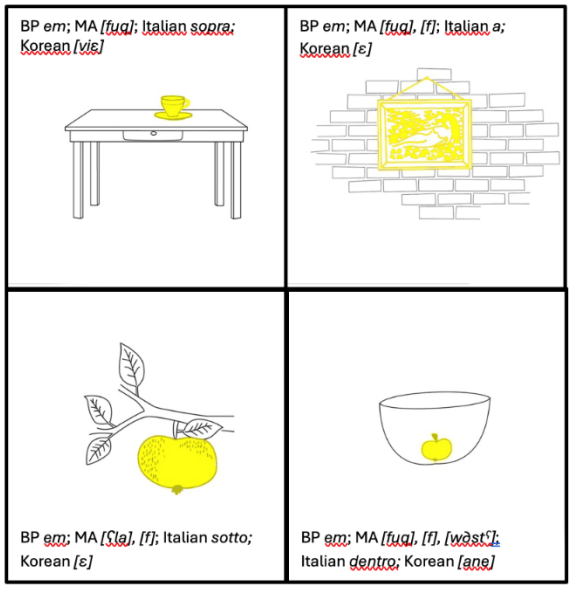

Figure 1. Prepositions describing four spatial scenes (from Bowerman; Pederson, 1992) in Brazilian Portuguese, Moroccan Arabic, Italian, and Korean.

As these examples suggest, translation equivalents of spatial terms are often used to describe quite different sets of situations, resulting in incomplete overlaps in their meanings (Bouabida; Feist, 2025; Feist, 2013). These incomplete overlaps in meaning suggest that, even though the meanings of our spatial terms seem natural to us, they might not be as natural – or as given by nature – as first appears.

In this paper, I will be asking what these patterns of usage suggest about spatial meaning as considered both from the bottom-up perspective of individual lexical items and the meanings they encode and from the top-down perspective of concepts and the systems in which they are defined and organized. I will begin in Section 1 with an examination of the meanings of individual spatial relational terms across languages, asking with a larger sample of scenes and languages whether individual words tend to encode different meanings, or to package together concepts in measurably different ways, as suggested by the examples above. Following this, in Sections 2 and 3 I will ask what cross-linguistic differences in the meanings of topological spatial relational terms tell us about the conceptual system. If the meanings of spatial relational terms differ across languages, as suggested by the examples above, this raises two related questions about the conceptual system and its connection to individual lexical items. First, are there conceptual universals in this domain which languages may draw upon in different ways in their spatial semantic systems? Second, are the conceptual systems underlying systems of spatial terms in different languages in fact different from one another? The first question explores the conceptual system at a coarse-grained level, asking whether there are concepts – potentially quite abstract – that are common to the spatial terms of a wide variety of languages (Section 2). The second question shifts this exploration to a more fine-

grained level, asking whether the concepts encoded in individual languages are organized and packaged in distinct ways by each language and, indeed, whether these concepts may themselves qualitatively differ across languages and cultures (Section 3).

1. SPATIAL MEANINGS IN INDIVIDUAL LEXICAL ITEMS

As a first step towards understanding the meanings associated with topological spatial terms, I asked how speakers of sixteen typologically diverse languages describe a small set of spatial scenes (Feist, 2000). These scenes, drawn from the Topological Relations Picture Series (Bowerman; Pederson, 1992), each depicted two objects: one (the Figure) colored in yellow and the other (the Ground) left in black and white (see Figure 1). The task of the participants was to tell me, for each picture, where the Figure was located relative to the Ground. The spatial relational terms in each description were then isolated and indexed to the pictures that elicited them for further analysis. In this way, the meanings of the spatial relational terms were analyzed through their extensional ranges, without introducing biases connected to their translations.

In order to achieve a representation of the meanings exemplified by each picture, the next step was to create a common attribute-based representation of each spatial scene through which to ask whether the uses of the elicited spatial terms are sensitive to any semantic attributes. To that end, I coded each picture for the presence or absence of a small set of semantic attributes (Feist, 2000): *verticality, contact, inclusion, functional relation, support, relative size, animacy,* and *Ground control*. Following this, for each term, I grouped together the set of pictures that the term had been used to describe, then examined each set to identify any attributes that were either true of all pictures in the set or false of all pictures in the set. This resulted in characterizations of the meanings of each of the elicited terms via the coded attributes, creating a partial semantic decomposition of each spatial term (cf., Katz; Fodor, 1963; Levin, 1993; Talmy, 1985, 2000) driven by an examination of the extensional range of the term rather than by an intuition-based analysis of the term's meaning.

This led to the identification of eight spatial relational meaning types (Feist, 2000, p. 98):

a) Figure higher than Ground
b) Figure higher than Ground, no contact
c) Figure lower than Ground, with contact
d) Ground supports Figure with contact
e) Contact
f) Inclusion of Figure by Ground
g) Absence of inclusion of Figure by Ground
h) Generalized spatial term (no attribute values encoded)

These eight meaning types were distributed in different patterns across the sixteen languages in the sample. Set (f) was the most widely used, including twenty-one terms drawn from all sixteen languages. The next most frequent meaning types were set (b), including fourteen terms drawn from eleven languages, and set (d), including eleven terms drawn from nine languages. Two meaning types, set (a), including six terms drawn from six languages, and set (h), including seven terms drawn from five languages, were of intermediate frequency. Finally, three low frequency meaning types were identified: set (c), including two terms drawn from two languages; set (e), including two terms drawn from one language; and set (g), including one term drawn from one language.

These meaning types reveal both cross-linguistic similarities and cross-linguistic differences. First, I found that the meanings of the individual spatial relational terms in these sixteen languages draw upon a small set of semantic attributes: the eight identified meaning types drew upon only four of the semantic attributes that were coded for each picture. This suggests some measure of cross-linguistic semantic similarity, as a small set of concepts was used to structure the meanings associated with spatial terms across these sixteen languages. However, the attributes appear in different combinations in the meanings of the different terms, mirroring the differences in extensional range noted earlier, and only one meaning type (set (f)) occurred in all sixteen languages in the sample, whereas three of the eight meaning types were extremely infrequent. This suggests that languages may draw from a common set of concepts which are combined in language-specific ways to give rise to the meanings of the individual lexical items used to talk about spatial location.

2. SEEKING UNIVERSALITY IN A COMMON CONCEPTUAL CORE

These observations highlight the interplay between a potentially universal conceptual core and the varied ways in which these concepts are used as the building blocks of lexical meanings across the world's languages. To better understand the possible universality of this conceptual core, we will first ask, statistically speaking, whether there might be a common conceptual space that languages draw upon in the semantic structuring of topological spatial terms, organized around a small set of semantic attributes, as might be expected based on the broad applicability of a small set of semantic attributes observed above in the meanings of individual terms across a diverse set of languages.

One way to search for potential conceptual universals in semantic data is to determine whether it is possible to construct a semantic map that will accommodate the naming patterns in the languages sampled (Haspelmath, 2003; Levinson; Meira; The Language and Cognition Group, 2003). A semantic map represents an organization of a set of concepts (spatial scenes, in our case) such that each category, as defined by a lexical item (spatial terms, in our case) maps onto a connected region in the conceptual space. Thus, a semantic map represents a hypothesis about a

universal conceptual space underlying a set of lexical items available across languages, both in terms of the concepts included and in terms of their organization within the conceptual space.

Despite their promise, semantic maps are limited in the type of data they can readily accommodate (Croft; Poole, 2008; Feist, 2008). Because they require a perfect fit, semantic maps cannot account for the possibility of alternative conceptualizations. However, as demonstrated by the usages of Moroccan Arabic spatial prepositions to describe the pictures in Figure 1, speakers may choose to describe a single scene using a variety of terms, leading Feist (2023) to argue that spatial relations "are amenable to a variety of alternate conceptualizations, with the choice of a spatial relational term serving to emphasize some factors while downplaying others" (p. 11). As such, a representation of the concepts underlying spatial relational terms must account for naming patterns whereby a single scene can be considered part of more than one category within each language's system.

In addition, semantic maps are computationally intractable for large data sets (Croft; Poole, 2008; Feist, 2008) such as this one, which contains over 1200 individual picture descriptions. Thus, in order to retain the insights available from a semantic map model, I have turned in my work to multidimensional scaling (MDS). Like a semantic map, MDS allows for the visualization of concepts in a low-dimensional space such that scenes that can be described by the same lexical item are positioned near one another, while scenes that require different lexical items are less closely positioned. MDS improves upon the semantic map model in a number of ways. First, because the space is constructed based on statistical patterns in the usage data, MDS is suited to larger datasets than can be accommodated by hand. In addition, the analysis takes the words used to name relations as evidence about similarity and constructs a conceptual space to accommodate the patterns in the data. If two scenes can be described by the same spatial relational term in some language (e.g., a picture on a wall and an apple on a branch in Korean; see Figure 1), this is evidence of some measure of underlying similarity, suggesting that the two scenes are relatively close in conceptual space. This is so whether or not the term in question is the only term speakers might choose to describe the relation, thus allowing MDS to seamlessly account for alternate conceptualizations of a single scene. In contrast, if two scenes are described by different spatial terms in some language (e.g., a picture on a wall and an apple on a branch in Italian; see Figure 1), this is evidence that the scenes involve a conceptual distinction that is salient to speakers, suggesting some distance between the scenes in conceptual space. By adjusting the distances between each pair of scenes in order to accommodate both their similarities and their differences, as revealed by the naming patterns in the languages sampled, MDS arrives at an optimal placement for each scene relative to the other scenes in the set. Finally, in addition to revealing a qualitative organizational structure that is consistent with the usage data, like semantic maps do, in MDS, distances and dimensions are potentially semantically interpretable (Croft; Poole, 2008; Feist, 2008), allowing generalizations to arise more naturally from the patterns in the data.

In order to find out whether there are conceptual universals underlying the usage patterns of topological spatial terms across languages, I expanded the dataset to include twenty-four languages, drawn from eleven language families (Feist, 2008). The procedure was the same as in the earlier study: participants were shown simple drawings, with the Figure highlighted in yellow while the Ground was left in black and white, and they were asked, for each picture, to tell me the location of the yellow object with respect to the other object. The spatial terms were then identified in each description and indexed to the pictures that had elicited them, resulting in a matrix indicating, for each of the twenty-nine pictures in the set, which of the 110 spatial terms was used by speakers in descriptions of the picture (Feist, 2008, 2010).

The lowest dimensional space that accommodates the data from all twenty-four languages is a two-dimensional solution (Figure 2), with 97.56% correct classification and an APRE of 0.834[1] (Feist, 2008). Along the vertical axis, the pictures were found to have varied with respect to the vertical position of the Figure relative to the Ground, with pictures such as a cloud over a mountain and a lamp over a table anchoring the upper end, while pictures such as laundry hanging from a clothesline and an apple on a branch anchored the lower end. The horizontal axis was anchored at the left end by pictures such as a cup on a table and a cat on a mat, and at the right end with pictures such as an owl in a hole in a tree and an apple in a bowl, suggesting that this axis is sensitive to changes in the degree to which the Ground controls the location of the Figure (see Feist, 2008, for further discussion).

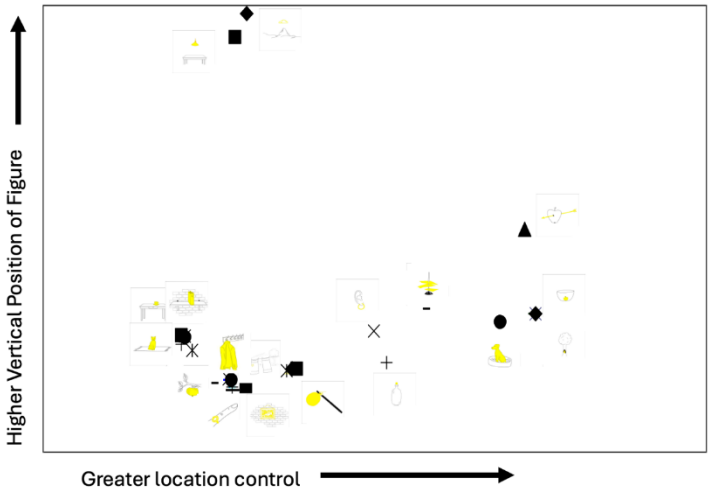

Figure 2. MDS solution in two dimensions (adapted from Feist, 2008).

1 Evaluation of an MDS solution involves two fitness statistics: the percent classification indicates the proportion of pictures that are optimally placed in the solution space, while the APRE takes errors into account and compares the solution to a null model where all tokens are placed in the majority category (see Croft; Poole, 2008, for further discussion).

The existence of a common, low-dimensional conceptual space defined by a small set of semantic attributes underlying the usage patterns of spatial terms across these twenty-four languages suggests that there may be conceptual universals in this domain (cf., Croft; Poole, 2008; Feist, 2008; Levinson; Meira; The Language and Cognition Group, 2003). These conceptual universals take the form of concepts that play a role in structuring spatial semantic systems across languages – at least at an abstract level – echoing the findings from the earlier, more qualitative examination of the naming patterns and possible spatial relational meaning types described above.

3. A CLOSER LOOK AT CONCEPTUAL SYSTEMS: IS FINE-GRAINED VARIATION CONFINED TO THE LEVEL OF INDIVIDUAL LEXICAL ITEMS?

Looking from the bottom up, the patterns revealed by the analysis of individual lexical items provide evidence of both cross-linguistic variation and cross-linguistic similarities at the level of individual lexical items. On the other hand, looking from the top down, the MDS analysis revealed a common conceptual space that accommodates the naming patterns across a diverse set of languages, suggesting that there are cross-linguistic semantic similarities at a more abstract, conceptual level. Taken together, these findings raise questions about the conceptual system at more concrete levels of representation. Is cross-linguistic variation limited to fine-grained details of lexical encoding (cf., Landau *et al*., 2017), or might there be deeper differences in the nature of the topological concepts underlying the meanings of spatial relational terms (cf., Bowerman, 1996)? Given the evidence of a common abstract conceptual space (Feist, 2008), do individual languages directly draw upon that common conceptual system in the structuring of their spatial semantic systems, or is it instead the foundation upon which more fine-grained, language-specific conceptual systems, connected to the semantics of individual spatial terms, are built? To address these questions, in what follows, we'll look at two focused comparisons: first, we will compare the topological spatial systems of English and Mandarin Chinese, then the systems of English and Moroccan Arabic. In each case, we will ask whether the conceptual systems underlying the usage patterns in the spatial terms in the two languages can be one and the same.

3.1. ENGLISH AND MANDARIN CHINESE

The first focused comparison examines MDS solution spaces based on data from Zhang (2013), who collected descriptions of 116 simple drawings from twenty-five speakers of Canadian English and twenty-five speakers of Mandarin Chinese. As with the studies conducted by Feist (2000, 2008),

each picture included one object colored in yellow and another in black and white (see Zhang, 2013, for the complete set of pictures), and participants were asked to describe the location of the yellow object with respect to the black and white one for each picture. This resulted in the elicitation of 5800 picture descriptions, in which thirty-eight English spatial terms and thirty-six Mandarin Chinese ones appeared. As with the prior work (Feist, 2008), these spatial terms were indexed to the pictures that had elicited them, and the resulting matrices were used to conduct separate MDS analyses for the two languages (Feist; Zhang, 2019).

In English, the lowest dimensional fit which provided a high degree of correct classification and a high APRE was the two-dimensional fit, with 97.7% correct classification and an APRE of 0.765 (Figure 3). Looking at the horizontal axis, we see that the left end of the axis is anchored by pictures such as a fish in a fishbowl, a ball under an upside-down bowl, and a muscle in a leg; while the right end is anchored by pictures such as a city on the seashore and a hose lying across a tree stump. This suggests that this dimension organizes scenes along a continuum from location of the Figure at the interior of the Ground to location of the Figure in contact with an outer surface of the Ground. Turning to the vertical axis, the topmost pictures include a ball under an upside-down bowl, a dog sitting beside a doghouse, and a city on the seashore; whereas the bottommost pictures include a muscle in a leg and a gate in a fence. This suggests that this dimension organizes scenes according to the degree of connection, or alienability, between the Figure and Ground, as well as according to the degree of control that the Ground exerts over the location of the Figure.

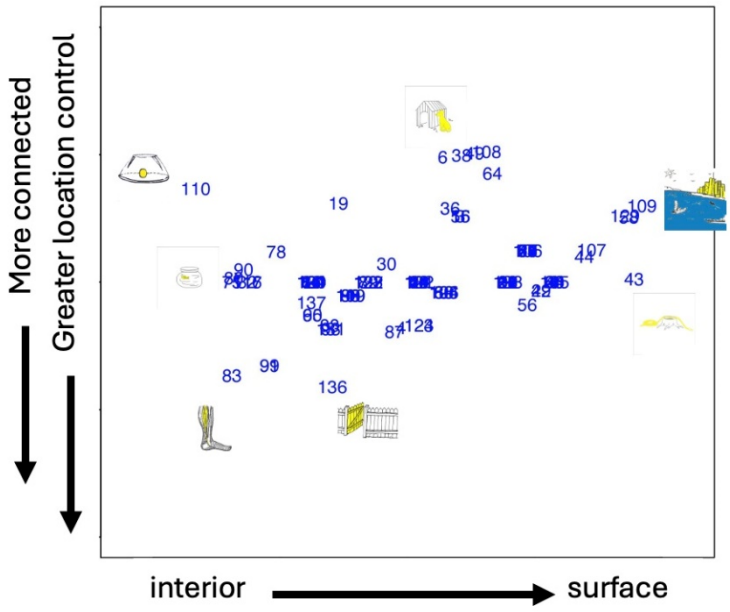

Figure 3. Two-dimensional MDS solution for English (adapted from Feist; Zhang, 2019).

As with English, the lowest dimensional space that gave a high degree of correct classification for the Mandarin Chinese data was the two-dimensional fit, with 98.8% correct classification and an APRE of 0.889 (Figure 4). Looking at the distribution of pictures along each axis, we can begin to extract a semantic representation of the axes, as we did for the English MDS solution. Turning first to the horizontal axis, we see that the left end is anchored by pictures such as a circle inside a rectangle and a ball under an upside-down bowl; whereas the right end of the axis is anchored by pictures such as a city on the seashore and a hose lying across a tree stump. This echoes the English inclusion – surface contact dimension, but surfaces somewhat differently. Comparing the leftmost pictures across the two languages, we see that they contrast in that Mandarin Chinese includes a two-dimensional scene of a circle inside a rectangle, whereas English includes scenes depicting full inclusion in three dimensions, such as a fish in a fishbowl and a muscle in a leg. Furthermore, the two languages overlap in the inclusion of the scene of a ball underneath an upside bowl, which could be conceptualized either as the ball surrounded by the bowl's rim or by the ball located within the bowl's interior. Thus, the best examples of inclusion in Mandarin Chinese appear to instantiate inclusion in two dimensions, while the best examples in English appear to instantiate inclusion in three dimensions. Turning to the vertical axis, the topmost pictures include a ball under an upside-down bowl and a ball under a chair, while the bottommost pictures include a bump in a road and a lightbulb in a socket. This suggests that this dimension organizes scenes according to the degree of connection, or alienability, between the Figure and Ground.

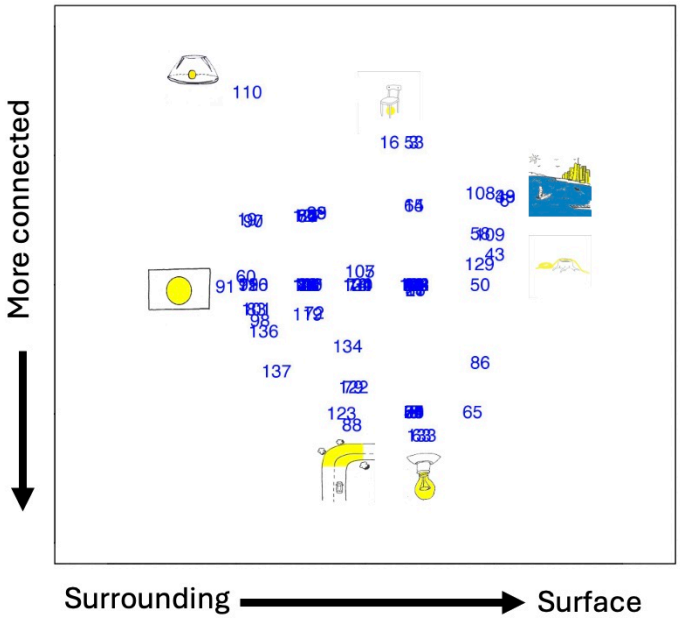

Figure 4. Two-dimensional MDS solution for Mandarin Chinese (adapted from Feist; Zhang, 2019).

Moving beyond this qualitative comparison between the two-dimensional solution spaces in English and Mandarin Chinese, we calculated the correlations between the pictures' positions along the axes in the spaces for the two languages. In line with the overlaps in the qualitative observations, the horizontal axes were highly correlated, $r = .75$, $p < .0001$, while the vertical axis was substantially less so, $r = .36$, $p < .0001$.

Our comparison of the conceptual spaces addressed the question of whether there is variation in the nature of the spatial concepts, as opposed to differences in the lexical packaging of a single set of spatial concepts. We found that both languages encode an inclusion-surface contact continuum along one dimension, which was highly correlated between the two languages, suggesting some measure of cross-linguistic conceptual overlap. However, the anchors for the dimensions differed, with the most representative scenes on the inclusion end of the English dimension instantiating three-dimensional inclusion, while the most representative scenes on the inclusion end of the Mandarin Chinese dimension instantiated two-dimensional inclusion. In addition, both languages encode alienability along one dimension. However, this dimension was less correlated across the two languages than was the inclusion-surface contact dimension. This lower correlation may be due to the connection between alienability and control in the English solution space, a connection which was absent in the Mandarin Chinese one. Taken together, these results suggest substantial overlap of broad abstract concepts between the English and Mandarin Chinese conceptual spaces, coupled with meaningful differences in the details, suggesting that the concepts themselves may overlap incompletely across these two cultural groups.

3.2. ENGLISH AND MOROCCAN ARABIC

Building on these findings, Feist and Bouabida (2024) conducted a second focused comparison, between English and Moroccan Arabic. This comparison used data from Bouabida (in prep), who collected descriptions of 118 simple drawings from twenty-five speakers of Moroccan Arabic and compared this data set to descriptions of the same 118 drawings from twenty-seven speakers of Canadian English collected by Zhang (2013). As with the other studies, each picture included one object colored in yellow and another in black and white, and participants were asked to describe the location of the yellow object with respect to the black and white one. This resulted in the elicitation of 6136 picture descriptions in which forty-one English spatial terms and nine Moroccan Arabic ones appeared. These spatial terms were indexed to the pictures that had elicited them, and the resulting matrices were used to conduct separate MDS analyses for the two languages (Bouabida, in prep; Feist; Bouabida, 2024).

In English, the lowest dimensional fit which provided a high degree of correct classification and a high APRE was the two-dimensional fit, with 97.58% correct classification and an APRE of 0.721 (Figure 5). Looking at the horizontal axis, we see that the left end of the axis is anchored by pictures

such as people in shade, planets in a solar system, and a house surrounded by a fence; while the right end is anchored by pictures such as a city on the seashore, a tree in front of a house, and hair on a forehead. This suggests that this dimension organizes scenes along a continuum from location of the Figure at the interior of the Ground to location of the figure in contact with an outer surface of the Ground, echoing the organization of pictures along the horizontal axis in the prior English and Mandarin Chinese solution spaces. Turning to the vertical axis, the topmost pictures include a dog next to a doghouse and a man beside a fire; while the bottommost pictures include a belt on a dress and kids in a street. This suggests that this dimension organizes scenes according to the amount of support that the Ground provides against the force of gravity along with the degree of control that the Ground exerts over the location of the Figure.

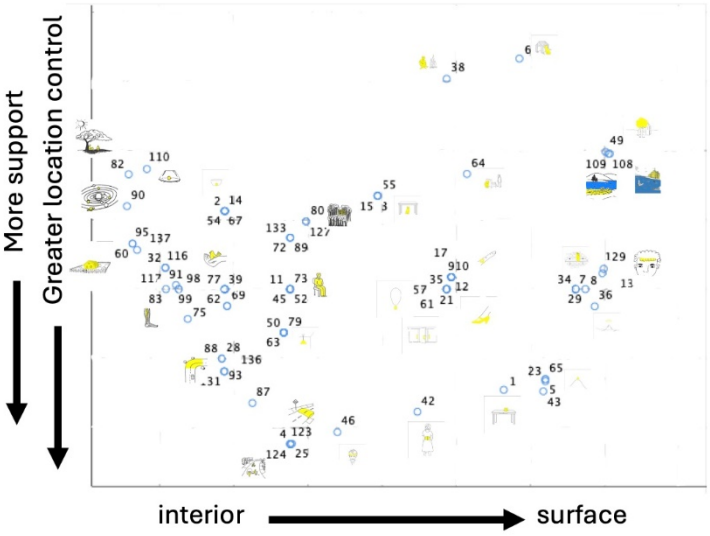

Figure 5. Two-dimensional MDS solution for English (adapted from Feist; Bouabida, 2024).

Turning to Moroccan Arabic, as with English, the lowest dimensional space that gave a high degree of correct classification was the two-dimensional fit, with 97.94% correct classification and an APRE of 0.902 (Figure 6). As with the Mandarin Chinese conceptual space, the distribution of the pictures in the Moroccan Arabic space is quite different from the distribution in the English space. Looking at the horizontal axis, we see that the left end is anchored by a picture of a ball under a bowl, while the rightmost picture shows a hose draped over a tree stump. As with the horizontal axes in the other solution spaces, this suggests that this dimension encodes a continuum from interior location to surface contact. Turning to the vertical axis, the topmost pictures include a cork in a bottle, a sailboat on the water, and an apple in a bowl; while the bottommost pictures include people in shade and a city by the sea. This suggests that this dimension organizes scenes according to the degree of control that the Ground exerts over the location of the Figure.

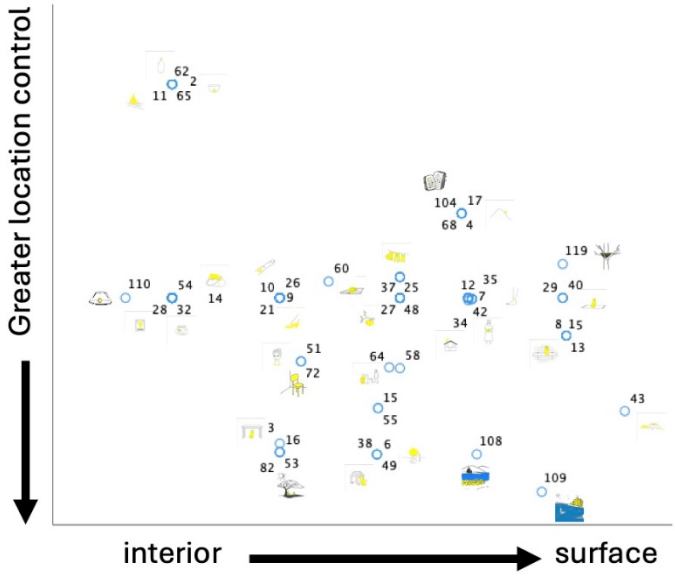

Figure 6. Two-dimensional MDS solution for Moroccan Arabic (adapted from Feist; Bouabida, 2024).

In addition to these qualitative observations, as with the English-Mandarin Chinese comparison, we calculated the correlations between the positions of the pictures along the axes in the spaces for the two languages. In line with the qualitative observations, the horizontal axes were highly correlated, although less so than for the English and Mandarin Chinese comparison, $r = .64$, $p < .0001$, while the vertical axes were again less correlated, $r = -.355$, $p < .0001$.

Although we see broad similarities in the first interpretations of the dimensions, we also see substantial differences. With that in mind, we improved upon our method for interpreting the dimensions in the conceptual spaces in order to gain a more detailed understanding.

In a separate study, Bouabida (in prep; Bouabida; Feist, 2025) showed all 118 pictures to speakers of English and Moroccan Arabic and asked them to rate the relevance of a small set of semantic attributes for each picture: *verticality, higher entity, contact, 3D inclusion, 2D inclusion, bigger entity, Ground control, functional relation, animacy, supportive entity,* and *alienability* (cf., Feist, 2000). We then calculated the correlations between the attribute ratings for the pictures and the placements of the pictures along the axes in the conceptual spaces in order to determine which attributes, if any, varied with picture position along the length of each dimension in the conceptual spaces (Feist; Bouabida, 2024).

Turning first to the English results, we found that the positions of the pictures along the horizontal axis correlated with changes in the relative vertical positions of the Figure and the Ground, three-dimensional inclusion, two-dimensional inclusion, and the extent to which the Ground exerts control over the location of the Figure. Along the vertical axis, the positions of the pictures correlated with eight semantic attributes: the vertical position of the Figure relative to the Ground, contact, the

relative sizes of the two entities, the extent to which the Ground exerts control over the location of the Figure, the function of the Figure, the animacy of the Figure, and the degree of support provided by the Ground against the force of gravity (Table 1).

In Moroccan Arabic, we found that the positions of the pictures along the horizontal axis correlated with changes in contact and three-dimensional inclusion. Along the vertical axis, the positions of the pictures correlated with five semantic attributes: contact, three-dimensional inclusion, the extent to which the Ground exerts control over the location of the Figure, the function of the Ground, and the degree of support provided by the Ground against the force of gravity (Table 1).

Attributes	English x-axis	English y-axis	Moroccan Arabic x-axis	Moroccan Arabic y-axis
Figure higher	τ = 0.28, p < .05	τ = -0.22, p = .05		
Ground higher	τ = -0.28, p < .05			
Contact		τ = -0.59, p < .0001	τ = 0.39, p < .05	τ = 0.32, p < .05
3D inclusion	τ = -0.31, p < .01		τ = -0.35, p < .05	τ = 0.43, p < .005
2D inclusion	τ = -0.43, p < .001			
Figure larger		τ = 0.30, p < .02		
Ground larger		τ = -0.26, p < .05		
Control by Ground	τ = -0.28, p < .02	τ = -0.30, p < .01		τ = 0.39, p < .01
Figure function		τ = -0.37, p < .005		
Ground function	τ = -0.32, p < .01			τ = 0.31, p < .05
Figure animate		τ = 0.29, p < .02		
Ground support		τ = -0.50, p < .0001		τ = 0.47, p < .01

Table 1. Semantic attributes which correlated significantly with axes in the MDS solution spaces.

Taken together, these results reveal overlap in the semantic attributes correlating with dimensions in the English conceptual space and dimensions in the Moroccan Arabic conceptual space. Concretely, locations of pictures in both conceptual spaces correlated with contact, three-dimensional inclusion, the extent to which the Ground exerts control over the location of the Figure, the function of the Ground (although along different dimensions in the two languages), and the degree of support provided by the Ground against the force of gravity. Alongside this overlap, however, we note meaningful differences in the conceptual spaces. Most strikingly, the English dimensions correlated with a wider variety of semantic attributes than did the Moroccan Arabic ones. Furthermore, while the English prepositional system encoded some attributes that were not encoded in the Moroccan Arabic system, the opposite was not the case. Together, these results suggest that the English spatial semantic system may encode a higher degree of complexity than does the Moroccan Arabic one.

Like individual lexical items, the evidence reviewed here suggests that conceptual spaces draw upon a common small set of semantic attributes, indicative of some measure of universality in the semantics of topological spatial conceptual systems. These attributes include, but are not limited to, the attributes identified in the broader cross-linguistic conceptual space uncovered by Feist (2008). However, these attributes appear in different combinations in the underlying structures of the conceptual spaces of different languages, suggesting that languages may build a variety of

conceptual systems from similar building blocks. Furthermore, while the attributes correlating with the axes of the conceptual spaces are broadly similar, the qualitative examination revealed that the axes are anchored with different spatial scenes in both cross-linguistic comparisons, suggesting that there are differences in the details of the conceptual understanding associated with the semantic attributes which define the dimensions of the conceptual spaces. Finally, the English conceptual space evidenced correlations with a greater number of attributes than did the Moroccan Arabic conceptual space, suggesting broader differences in the semantic organization of the domain.

4. DISCUSSION AND CONCLUSIONS

Through an examination of a single, perceptible domain, topological spatial relations, at three different levels of abstractness, the picture that emerges suggests an interplay of the universal and the language-specific in the structuring of meaning. At its most abstract, the conceptual system includes a small set of abstract concepts (e.g., contact, vertical position, support, and inclusion) which participate in the meanings of topological spatial terms across a diverse set of languages, suggesting potential conceptual universals at this high level of abstraction. However, examination of this conceptual space in connection with individual languages reveals three ways in which abstract universals may vary in the ways that they surface in semantic systems: languages may draw upon additional attributes of spatial scenes in the structuring of the systems and in individual lexical meanings, the attributes may combine in a variety of ways in both the systems and individual meanings, and, indeed, the conceptualization of individual attributes may differ in subtle ways across their instantiations in different languages. Taken together, the findings reviewed above reinforce the conclusion that languages overlap in their encoding of broad, potentially universal, abstract concepts such as contact or inclusion, while at the same time evidencing meaningful differences in the details of the individual lexical meanings and, indeed, of the conceptual underpinnings of their spatial semantic systems. This suggests that variation and universality are not incompatible. Rather, universality and variation surface interwoven in complex patterns in the semantic systems of the languages of the world.

The most concrete level at which we examined spatial meaning is the level of individual lexical items, which prior research has demonstrated to vary substantially across languages. The current examination of spatial terms across a diverse set of languages suggests limitations on that variation. First, the meanings of individual terms were found to draw upon a small set of semantic attributes; probing further, we found that the extensional ranges of the terms used across the set of languages were able to be accommodated in a low dimensional conceptual space. These findings suggest that there may be a small universal set of abstract semantic features that underpin the meanings of topological spatial terms. At the same time, the findings demonstrated that these semantic

attributes surface in a variety of combinations across languages, suggesting the combinatorial possibilities as one source of cross-linguistic semantic variation which draws upon, rather than contradicts, an abstract universal core.

At a more abstract level, the conceptual systems underpinning the spatial semantic systems of individual languages mirrored this interplay of the universal and the language specific. Because these language-specific conceptual systems are more abstract than individual lexical items, they are one step removed from the idiosyncracies of individual lexical items and, thus, potentially more likely to align across languages. In order to understand the extent of overlap between these conceptual systems, we considered two focused cross-linguistic comparisons, the first comparing Canadian English with Mandarin Chinese and the second, Canadian English with Moroccan Arabic. Our findings showed that each language's conceptual space is unique, with dimensions defined by overlapping, but not identical, sets of semantic attributes. This suggests a characterization of these conceptual spaces in terms of variable results from similar building blocks, thereby accommodating both cross-linguistic similarities and cross-linguistic variation and echoing the findings from the more fine-grained examination of individual lexical items.

At the most abstract level, a low dimensional conceptual space was found to accommodate spatial terms across twenty-four typologically diverse languages. While the existence of a low-dimensional space highlights potentially universal aspects of topological spatial meaning, the highly abstract nature of the semantic attributes that structure this space brings into focus limitations on the semantic specificity of possible universals in this domain, with these results instead reinforcing the suggestion of a common core of abstract spatial attributes that all languages may draw upon in the construction of spatial meaning types, in line with the findings at the more concrete levels of investigation.

Taken together, these results highlight the variety of levels at which spatial semantic concepts are stored and accessed, as well as the complex interplay of universality and variation evident at each level of representation. At the finest level of analysis the meanings of individual lexical items vary – sometimes substantially - across languages, precluding universal lexical meanings, but not precluding an abstract universal conceptual system which serves as the basis for language-specific meanings. At more abstract levels of analysis, this universal conceptual system, along with limits on its universality, comes into focus.

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ADDITIONAL INFORMATION

CONFLICT OF INTEREST

The author(s) declare no competing interests.

STATEMENT OF DATA AVAILABILITY

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

AI USAGE STATEMENT

The authors declare that no AI tools were used in the creation of this manuscript or in any aspect of the research reported in it.

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