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A QUANTITATIVE CORPUS-BASED APPROACH TO ENGLISH SPATIAL PARTICLES: CONCEPTUAL SYMMETRY AND ITS PEDAGOGICAL IMPLICATIONS

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ABSTRACT

The present study aims to investigate how conceptual symmetry plays a role in the use of spatial particles in English and to further examine its pedagogical implications via a corpus-based evaluation of the course books in senior high schools in Taiwan. More specifically, we adopt a quantitative corpus-based approach to investigate whether bipolar spatial particles (e.g., up/down) on the same spatial dimension (e.g., vertical axis) exhibit a symmetrical extension to similar sets of target domains in real language use. Our data is based on the British National Corpus. We examine the correlation patterns between 13 spatial particles and their co-occurring nouns in English preposition constructions through exploratory statistical methods. The distributional patterns of the spatial particles have clearly revealed different patterning on three dimensions with respect to their degrees of conceptual symmetry. On the other hand, we further analyze the distribution of the spatial particles in three major officially-approved versions of textbooks in senior high schools, namely, Far East, Lungteng and Sanmin. This evaluation features a critical comparison with the authentic corpus-based realization of these spatial particles in the BNC. The similarities and differences between the textbook illustration and the realistic corpus instantiation may shed light on the pedagogical practices for language teachers on the frontline.

Key Words: English prepositions, corpus, space, metaphor

INTRODUCTION

Languages differ in their granularity in dividing up various aspects of the spatial domain. Linguists seem to have agreed that languages tend to be more resistant to adding a new lexical item to the existing set of closed-class words (Tyler & Evans, 2003). Therefore, English preposition constructions often serve as a good candidate for the study of the conceptualization of spatial orientation (Boers, 1996; Clark, 1973; Lindstromberg, 2010; Tyler & Evans, 2001; Vandeloise, 1994).

Among all the controversial topics related to English prepositions, we would like to focus on the notion of geometrical symmetry. Spatial orientation is a projection with respect to the axes of the visual field from a personal to an impersonal perspective (Langacker, 1987). Even though spatial particles[1] such as *up/down*, *in/out*, *before/after*, contrast with one another in a geometrically symmetric way in the absolute Cartesian world, they are not necessarily defined by such oppositional features. Their meanings may be subject to the influence of cultural-specific communities, thus lending themselves "semi-autonomous from and semi-dependent upon the conceptual space labeled by other spatial particles in the language" (Tyler & Evans, 2003, p. 108). In other words, the contrast partners of the spatial particles along the same dimensions may not be straightforwardly oppositional. Speakers may not necessarily experience space in the manner defined by the spatial vocabularies of geometry and geography (Svorou, 1994). Instead, our conceptualization of space may depend upon "a complex network of relationships involving linguistic, cultural and perceptual factors, some of which seem universal and some more culture-specific" (Pollio, Fagan, Graves, & Levasseur, 2005).

The present study aims to investigate how conceptual symmetry plays a role in the use of spatial particles in English and further examine its pedagogical implications via a corpus-based evaluation of the course books in senior high schools in Taiwan. *Conceptual symmetry* refers to the extent to which geometrical symmetry is manifest in our conceptualization of the space. For example, it is yet to be known whether we conceptualize the notion of *up* and *down* on a symmetrical basis as predicted by the geometrical symmetry of verticality in the

[1] In this paper, no theoretical difference is assumed between *preposition* and *spatial particles*. These two terms are used interchangeably.

Cartesian plane. Language use, in this respect, plays a significant role in elucidating the mechanism of spatial conceptualization in a cultural community.

Specifically, we investigate whether bipolar spatial particles (e.g., *up*/*down*) on the same spatial dimension (e.g., vertical axis) exhibit a symmetrical correlation with similar sets of target domains in real language use. On the other hand, we will examine the distribution of the spatial particles in the current senior high school textbooks in comparison with the authentic corpus-based realization of these target spatial particles. As textbooks often account for the majority of the linguistic input for most high school students, an overview of spatial particle distribution in the course book will give teachers a better picture of what kinds of supplements may be needed so as to offer learners a more realistic usage of spatial particles. The similarities and differences between the textbook illustration and the realistic corpus instantiation may shed light on pedagogical practices for high school teachers on the frontline.

After the full-scale deregulation of textbooks for senior high schools in 2001, many publishers began to edit and publish their own versions of course books according to the wordlists regulated by the Ministry of Education. There are three main publishers on the market, whose versions have been officially approved and are now being widely used in most senior high schools, including Far East, Lungteng, and Sanmin. Therefore, we will adopt these three versions as our basis for a corpus-based evaluation. The bibliographical details of the textbooks selected for the present study will be given in Methods.

The remaining parts of the paper are organized as follows. Introduction will first introduce our theoretical framework by highlighting basic tenets in cognitive linguistics and the importance of constructions in understanding our conceptualization of space. The methodology of our corpus-based study on the spatial particles and textbooks evaluation will be provided in Methods. Results will present the results of our statistical analyses on the distribution of the spatial particles in the corpus, and Discussion will discuss our statistical results from a perspective of experientialism, embodiment, and conceptual metaphors. Based on our corpus observation, Textbooks Evaluation will further evaluate the distribution of the spatial particles in the officially-approved senior high-school textbooks. Finally, Conclusions conclude the paper by summarizing our findings.

WORDS, CONSTRUCTIONS, AND CONCEPTUALIZATION

Studies in cognitive linguistics have shown that our reasoning and knowledge are built on bodily-grounded conceptual metaphors (Grady, 1997; Johnson, 1987; Lakoff, 1993; Lakoff & Johnson, 1980), arising from a recurring instantiated correlation between sensorimotor perception and a subjective experience or judgment. This hypothesis of embodiment is further developed in Grady's Theory of Primary Metaphor (Grady, 1997), which underlines a binding of our perception of the world (*source* domain) and our response to the perception of the world (*target* concept).

Take UP IS MORE for instance, a widely-discussed example in the previous literature. It is in our sensorimotor experience that the vertical elevation varies directly with quantity in many situations (e.g., pouring water into a glass, or piling books on the desk). While the vertical elevation is a direct perceptual experience of our visual organs, the rise of the quantity is our cognitive response to the perception of vertical elevation. Such conceptual binding between the sensorimotor experience and the cognitive or emotional response forms the experiential basis of conceptual metaphors. Evidence for conventional conceptual metaphors has come from quite a range of studies, such as polysemy (Tyler & Evans, 2001), inference patterns between source and target domains (Fauconnier, 1998; Lakoff, 1993), novel metaphorical language (Lakoff, 1993), patterns of semantic change (Traugott, 1995), and psycholinguistic experiments (Gibbs, 1990).

Under this cognitive framework, therefore, grammatical patterns have often been studied in terms of colligations, i.e., linear co-occurrence preferences and restrictions held between words and collocates (Hunston & Francis, 1999; Sinclair, 1991), between language and genre (Biber, Johansson, Leech, Conrad, & Finegan, 1999), between words and constructional schemas (Bybee & Scheibman, 1999), or between constructions (Croft, 2001; Goldberg, 1995). More specifically, as constructional schemas often encode a relational meaning, observations on pairs of words in a construction may play a crucial role in the semantic profile of the construction, hence, a step forward toward a better understanding of our conceptualization.

The study of the correlation between a construction and its co-occurring words has been collectively referred to as *collostructional* analysis by Stefanowitsch and Gries (2003). This research methodology

makes theoretical commitments to a holistic and symbolic view of linguistic units and at the same time bases its quantitative methods on sophisticated statistical analyses. Words that are attracted to a particular construction are referred to as *collexemes* of the construction, whose association strength is measured by *collostrength* — defined as the log-transformed *p*-value (to the base of 10) from the Fisher-Yates Exact test on all the raw frequency counts of each word in the specific slot of the construction. Similarly, pairs of collexemes that are statistically attracted to each other within a construction are referred as *covarying collexemes* (Gries & Stefanowitsch, 2004). It is believed that given a partially schematic construction with at least 2 variable slots (e.g. V + *into* + V-ing), observations on the co-occurring patterns of the covarying collexemes (e.g., V and V-ing pairs in the *into*-construction) in these slots may yield useful empirical evidence for the conceptual relation encoded by the construction.

By taking the English preposition construction (*Spatial Particle* + [… *Head-Noun*…]$_{NP}$) as a case study, we would like to see how the covarying collexemes — preposition and the head noun — can shed light on the conceptualization of the spatial orientation in English-speaking communities. More importantly, we are interested in to what extent such covarying patterns may reveal the geometrical symmetry of the spatial particles (e.g., the English prepositions) on major cardinal spatial dimensions. Our working assumption is that the more bipolar spatial particles on the same spatial dimension (e.g., *after* and *before* on the horizontal axis) are correlated with similar groups of covarying collexeme head nouns, the more likely they are metaphorically extended on a symmetrical basis, thus suggesting a higher degree of conceptual symmetry. In short, we are mainly concerned with the question of whether the bipolar spatial terms significantly co-occur with similar groups of nouns as their objects in English preposition construction.

METHODS

The present study adopted a quantitative corpus-based approach of collostructional analysis (Gries & Stefanowitsch, 2004; Stefanowitsch & Gries, 2003). The data was first collected from the British National Corpus World Edition, one of the most representative and balanced English corpora. Specifically, we focused on 13 spatial particles that

have been widely discussed in the previous literature: *after*, *before, in front of, behind, over, above, up, down, under, below, in, out*, and *out of.*

These spatial particles differently referenced three cardinal spatial axes, serving to partition conceptual space on different spatial dimensions. The first dimension is the **vertical** axis, including *over, above, up, down, under,* and *below*. The second dimension is the **horizontal** axis, including *after, before, in front of,* and *behind*. The third dimension includes *in, out,* and *out of*, which collectively give rise to the notion of **boundedness**. In the following, we will refer to this dimension either as the boundedness dimension or the *in-out* dimension. All the English preposition construction instances bearing the target spatial particles were automatically extracted via regular expressions implemented in R scripts written by the author.

Each English preposition construction centers on one spatial particle and one co-occurring noun phrase (NP) following it, as illustrated in (1). The bold-faced expressions in (1) are often referred to as "prepositional phrases" in a traditional L2 classroom. Our next step was to investigate the association between the spatial particles (e.g., the target spatial particles underlined in (1)) and the head nouns of their co-occurring NP[2] (e.g., the semantic center of the noun phrases, i.e., italicized nouns in (1)) in English preposition constructions under the framework of collostructional analysis. Each spatial particle and its co-occurring head noun formed a covarying collexeme pair, such as *in* and *cause* in (1a), *over* and *period* in (1b), *in front of* and *projection* in (1c), *under* and *covenant* in (1d). In order to investigate the conceptual symmetry across three main dimensions, we looked for potential sub-patterns or clustering of the spatial particles on the basis of their covarying collexeme head nouns. In our later discussion, we will use the term NP to refer to the head nouns simply for expository convenience.

[2] Our use of the term "head noun" is meant for the ease of exposition with little theoretical assumption in syntactic theorizing. The lexical categories of the head of the phrase determine the categories of the phrase (Haegeman, 1994). If the head of the phrase is a noun, it is defined as a noun phrase (NP). Given an English preposition construction, each spatial particle takes an NP as its object, where the head of the phrase is a noun. This is mainly the reason why we are looking at the head nouns in the EPC as well as their association with the spatial particles. The head nouns of the English preposition constructions were automatically extracted based on the parts-of-speech tags provided in the BNC (cf. Footnote 3) via regular expressions.

(1) Examples of English preposition constructions from the British National Corpus[3]

a. [A00][4]
<w PNP>It<w VBZ>'s <w DT0>all <w PRP>**in** <w AT0>**a** <w AJ0>**good** <w NN1>***cause*** <c PUN>.

b. [A01]
<w VM0>Can <w PNP>I <w VVI>extend <w DPS>my <w NN1>covenant<c PUN>, <w CJS>if <w PNP>I <w VVB>wish <w TO0>to <w VVI>continue <w VVG>making <w NN2>payments <w PRP>**over** <w AT0>**a** <w AJC>**longer** <w NN1>***period*** <c PUN>?

c. [A01]
<w CRD>Two <w NN2>experts <w VVB>discuss <w NP0>HIV <w PRP>**in front of** <w AJ0>**hugely-magnified** <w NN1>***projection*** <w PRF>of <w NN1>soldier <w NN2>cells <c PUN>. [A01]

d. [A01]
<w DT0>This <w VHZ>has <w AT0>the <w NN1>effect <w PRF>of <w VVG>cancelling <w DPS>your <w AJ0>existing <w NN1>covenant <w CJC>and <w PRP-AVP>in <w NN1-VVB>return <w PNP>you <w VVB>commit <w PNX>yourself <w PRP>to <w VVG>making <w NN2>payments <w PRP>**under** <w AT0>**the** <w AJ0>**new** <w NN1>***covenant*** <c PUN>.

Two exploratory statistical analyses were adopted in order to detect the sub-patterning of these 13 spatial particles, namely, hierarchical clustering and principal component analysis. Procedure of the hierarchical clustering was as follows. First each spatial particle was semantically profiled by its covarying NPs in the English preposition

[3] The annotation embedded in the brackets (<>) is the part-of-speech (POS) tagging provided in the British National Corpus (BNC). The POS tagging of the BNC World Edition follows the CLAW 5 Tagset. A full discussion of the principles and practice underlying the CLAWS word class annotation scheme used in the BNC is provided by the document *Manual to accompany The British National Corpus (Version 2) with Improved Word-class Tagging*, which is distributed with the BNC World Edition in HTML format. For a comprehensive list of the CLAW 5 Tagset, please refer to: http://ucrel.lancs.ac.uk/claws5tags.html.

[4] The three alphanumeric letters in the square bracket refer to the filename of the BNC from which the example sentence is extracted.

construction. Specifically, each spatial particle was quantitatively represented by a vector of co-occurring frequency indicating their association between different types of head nouns in the EPC, as shown in Table 1.

Table 1

Co-occurrence Table of the 13 Spatial Particles with the Covarying Head Nouns in English Preposition Construction (Raw Frequency Counts)

Spatial Particles	**way**	**case**	**country**	**area**	**man**	**wall**	…
above	2	1	2	7	7	7	…
after	13	20	13	7	31	0	…
before	3	1	5	0	13	0	…
behind	1	0	1	0	16	51	…
below	0	0	0	1	3	6	…
down	0	0	1	0	0	59	…
in	13643	9896	6309	6338	552	366	…
in front of	0	1	2	0	12	8	…
out	165	0	0	0	1	0	…
out of	989	11	176	86	20	28	…
over	57	10	504	86	20	46	…
under	4	6	13	4	10	16	…
up	1	0	1	0	0	109	…

As clustering was sensitive to the problem of data sparseness (Kaufman & Rousseeuw, 2005), we made a compromise between the representativeness of the sample and the efficiency of the algorithm. We decided to include as much as 90% of the original dataset by removing covarying collexeme NPs occurring less than 29 times in the English preposition construction. After data filtering, each spatial particle was transformed into vectors based on their association with each covarying collexeme NP. Such association measures indicated how much more often than chance the NP co-occurred with the spatial particle. Following

Gries and Stefanowitsch (2004), we adopted collostrength as our first association measure between spatial particles and NPs. On the other hand, Curran (2004) observed that the *t*-test statistic, first proposed by Manning and Schütze (1999, pp. 162-169), performed the best as a measure of association for weighting context words in the task of profiling semantic similarity. Therefore, we also computed the *t*-test statistic as our measure of association in comparison with the collostrength.

Next we computed the pairwise similarity matrix among the 13 spatial particles. Previous research has shown that correlation-based similarity measures, as compared with a distance-based similarity matrix, are more likely to be detected and to use curvature of vectors in multidimensional space, thus serving as a better index for word similarity in information retrieval (Jurafsky & Martin, 2008, pp. 663-667). Among these, the cosine was the most frequently-used measure in the comparison of semantic similarity (Curran, 2004; Manning & Schütze, 1999, p. 299). Therefore, a pairwise cosine similarity matrix was generated and submitted to hierarchical clustering, using Ward's amalgamation rule. The similarity measures serve as an indicator of the degree to which each spatial particle is correlated with similar sets of NPs. A high similarity measure between two spatial terms on the same spatial dimension may suggest a symmetrical metaphorical extension, thus emerging as major clusters in early stages of the dendrogram.

Our second statistical analysis, Principal Component Analysis (PCA), adopted the same similarity matrix, and it aimed to find out the cardinal spatial dimension used in the English-speaking community. With the help of dimensional reduction of the principal components, it is hoped that a study on the loadings of these 13 spatial particles on major principal components may shed light on the cultural-specific variation in the conceptualization of spatial orientation.

Finally, we took a step further to analyze the distribution of the spatial particles in the textbooks of the senior high schools in Taiwan. Textbooks often serve as the main input for most high-school learners in their English learning. They are considered important materials in curriculum design and in the learning process, thus being a second-to-teacher factor in most EFL classrooms (Davison, 1976), or even playing a more prominent role than teachers (Hutchinson & Torres, 1994). Given the vital and positive part of textbooks in teaching and learning English, we are concerned with the authenticity of the reading materials in the

textbooks. The efficiency of the students' heavy reliance on textbooks is closely related to the representativeness of the reading texts as compared with our daily language use. Therefore, via the analysis of the distribution of the prepositions in the textbooks, we may infer in which ways the teachers could supplement the materials so that students can be exposed to a more realistic usage of the spatial particles. The purpose of the evaluation is two-fold. First, we would like to know to what extent the course book reading materials reflect a realistic account of our authentic linguistic behaviors. Second, a corpus-based review of the teaching materials may help elucidate the gap between classroom texts and authentic discourse, serving as a valuable reference for high-school teachers in their curriculum design of preposition teaching.

Our evaluation was targeted on the textbooks for senior high school students in Taiwan. We first collected three leading officially-approved versions of the senior high school textbooks published by Far East, Lungteng and Sanmin, respectively. The bibliographical information for each version is summarized in Table 2.

Table 2

Bibliographical Information of the Textbooks Selected in the Present Study for Evaluation

Publishers	**Far East (遠東)**	**Lungteng (龍騰)**	**Sanmin (三民)**
Editors	施玉惠 林茂松 黃崇術 Sarah Brooks	周中天	車蓓群
Publishing Year	2009	2013	2013
Number of Books	6	6	6
Number of Lessons[5]	68	68	70

In all three versions of the textbooks selected, each lesson contains materials divided into different sections, such as pre-reading activities,

[5] Normally, each book contains 12 lessons in total to be used for one semester in the senior high school. Yet due to the schedule of the college entrance exams, books for the third-year students (i.e., Books 5 and 6) are usually shorter. For Far East and Lungteng, Books 5 and 6 contain only 10 lessons for each. In Sanmin, Book 5 contains 12 lessons while Book 6 contains 10 lessons.

reading texts, post-reading activities, vocabulary, idioms and phrases, grammar, pronunciation, and other language-skill activities. This study examined only the reading texts in each lesson, as they serve as the main reading materials for the senior high school students in their learning career of English. This amounted to 206 reading texts (68+68+70) in total for our textbook evaluation[6]. The reading texts were provided by the publishers in their digital format and were post-processed in Python through the NLTK package (Bird, 2006) for parts-of-speech tagging by the author. Based on the primitive POS tags, we extracted all the English preposition constructions with the same 13 spatial particles from the reading text in each lesson and then *manually* annotated the head noun for each constructional token. As the size of the textbooks was relatively small compared to the British National Corpus, we opted for the semi-automatic extraction of our target constructions and the head nouns in hope for a better precision. All the head nouns were further lemmatized using the off-the-shelf lemmatizer from the NLTK, i.e., the WordNet Lemmatizer, which removed the affixes based on the dictionary entry.

RESULTS

Descriptive Statistics

About one million instances of the English preposition constructions were extracted from the BNC. After data filtering, 917487 tokens (i.e., 90% of the original set) were included in the later statistical analyses, amounting to 3636 types of covarying collexeme NPs in our final dataset.

This 13 x 3636 contingency table yielded two similar dendrograms, as shown in Figure 1, according to the association measures of collostrength and *t*-test statistic respectively. A closer look at the resulting dendrograms has suggested a high consistency in their grouping of spatial particles.

[6] One of the reviewers suggested an alternative of analyzing the distribution of the spatial particles by versions separately. However, the small size of the samples in only one version of the textbooks may not be legitimate for exploratory statistical analyses. In addition, what we are more concerned with is the general tendency of the distribution. Therefore, we decided to analyze the entire reading texts as a whole irrespective of the difference in versions.

Clustering of Spatial Particles in EPC

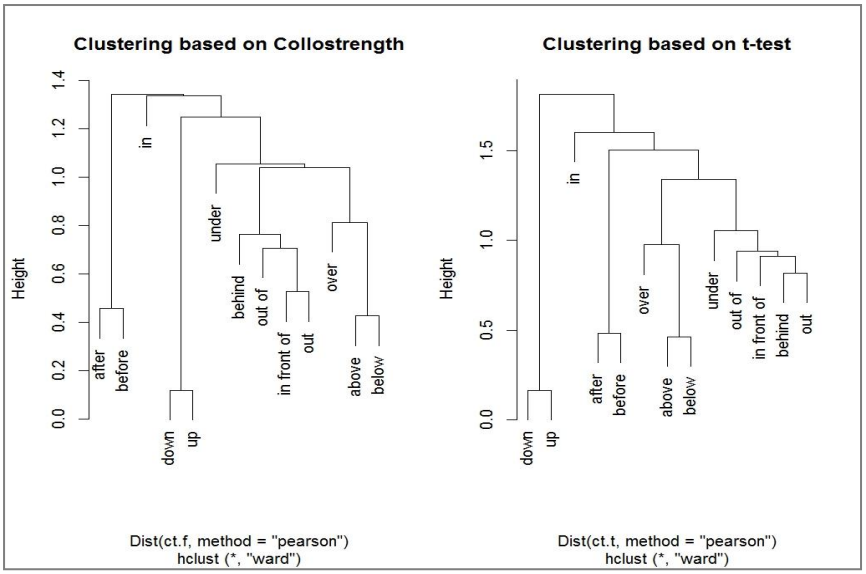

Figure 1. Dendrograms of the hierarchical clusterings based on the association measures of collostrength (left panel) and *t*-test statistics (right panel), respectively.

First of all, both dendrograms have shown that *after*/*before*, *up*/*down*, and *above*/*below* are collapsed into one small cluster in the early stages of the amalgamation (i.e., clusters at the terminal of the tree). This merging suggests that the respective spatial particle of the pair correlates with similar sets of covarying collexeme NPs in English preposition constructions. Let us now take a closer look at the associated head nouns for each spatial particle of these three pairs.

We further examined in detail the top 100 covarying NPs for each spatial particle based on the association measure of the collostrength and extracted the overlapped NPs that appeared as the top 100 covarying NPs of both spatial particles in the same cluster.

Table 3 summarizes the overlapped covarying NPs for the spatial particles of these three terminal clusters.

Table 3

Shared Covarying NPs in English Preposition Construction for the Spatial Particles of the Three Early Amalgamated Pairs/Clusters

Terminal Clusters	**Overlapped covarying NPs in EPC**
after/before	*breakfast, dinner, meeting, death, start, date, lunch, end, tax, war, election, birth, arrival, midnight, completion, marriage, trial, publication, outbreak, onset, break, wedding, time, operation, delivery, introduction, retirement, visit, independence, accident, interval, tea, meal, addition, treatment, surgery, invasion, accession, privatisation, release, announcement, take-off, transplantation, revolution, collapse*
up/down	*road, stairs, hill, steps, path, street, mountain, wall, side, drive, river, track, lane, sides, motorway, walls, corridor, middle, pub, freight, ridge, tunnel, way, world, country, time, area, years, studio, life, areas, form, mind, cases, sense, year, place, house, morning, position, context, terms, turn, room, ways, circumstances, hand, future, bed, period, control, past, practice, direction, field, water, section, car, number, days, town, work*
above/below	*ground, sea, level, average, water, surface, knee, threshold, limit, levels, inflation, horizon, limits, knees, elbow, rate, subsistence, minimum, floor, point, baseline, ceiling, waist, earth, eye, roof, target, line, value, income, ear, height, base, rim, cliffs, cliff, poverty, estimate, rates, price, cost, top, bottom, edge, figure, ocean*

In other words, nouns listed in the second column of Table 3 have been observed to co-occur with both of the spatial particles in the first column. For example, *after* and *before* both have been found to co-occur with nouns like *breakfast, dinner, meeting, death, start,* among others. Typical examples are provided in (2)-(5).

(2) [H8M] I am sitting eating cornflakes in the benign haze you are left

with from making love *before breakfast*.

(3) [FR6] Oh yes, he went off just *after breakfast*, to visit a family in a big house about sixteen miles away.

(4) [G3T] The notice to the creditors must state a time and date, not more than four days *before the meeting*, by when the creditors must lodge their proofs of debt and, if applicable, proxies, in order to entitle them to vote at the first meeting.

(5) [J9P] I'm leaving all my mess here because I'm coming back *after my meeting*.

Up and *down* both have been found to co-occur with nouns like *road, stairs, hill, steps,* and *path,* among others. Typical examples are illustrated in (6)-(9).

(6) [A6W] Part of its sorcery lies in its ability to instil the same exhilaration from a short run *up the road* on a Sunday morning, but most of it comes from that aggressive thrust of power that is always more than enough for any driving situation.

(7) [KCN] And always, before she'd talked, finished talking to him she was off on *down the road*.

(8) [EV1] She was glad to see Alice, began talking in a heavy tired voice about how the old woman had her running *up and down the stairs*, even got her up in the middle of the night.

(9) [FSP] He went *down the stairs*, and she stood at the top of them screaming.

Above and *below* both have been found to co-occur with nouns like *ground, sea, level, average, water,* among others. Typical examples may include:

(10) [CJA] The Capellan was floating *above the ground*, standing on nothing, smiling.

(11) [CCK] There were also tunnels with an electric light-railway to whisk the leadership away in the event of danger even here deep *below the ground*.

(12) [FSA] Since the futures price is currently £100 *above this level*, there is no arbitrage opportunity for Lee, even though the current futures price is 1400 below the no-arbitrage value.

(13) [H9M] The reason why there is no increase in output is that the

typical supplier has correctly realized that the price on his island is rising at the same rate as the average level of prices, and there has therefore been no change in his relative price and so no incentive to raise output *above its natural level*.

(14) [CDD] The next day, following tests, the IIRS said the pollution was well diluted and *below the tolerable level*.

(15) [AJ6] The judge said it had sunk *below a sensible level*."

We are aware that a more detailed analysis is necessary before we can locate the main semantic attributes from the nouns that may contribute to the similarity of the two spatial particles in the terminal clusters. In fact, we are now working on a more finely-tuned analysis of the semantic coherence of the covarying NPs for each spatial particle in another on-going project. That being said, the purpose of the present study is to highlight the conceptual symmetry, i.e., the symmetrical co-occurrence of the two spatial particles with similar groups of head nouns in English preposition constructions. That is, two cardinal spatial dimensions, i.e., the vertical (*up*/*down*, and *above*/*below*) and horizontal axes (*after*/*before*) demonstrate a clear tendency of symmetry in terms of their frequent co-occurring NPs in English preposition construction.

Aside from these terminal clusters on the bottom of the amalgamation, *under*/*behind*/*in front of*/*out of*/*out* form a heterogeneous group, consisting of spatial particles across different spatial dimensions. No symmetrical co-occurrence patterns have been observed with respect to the three spatial dimensions investigated. Examples of each spatial particle in this group provided in (16)-(19) may show the semantic heterogeneity of the NPs among this cluster.

(16) Examples of *under*

a. [CML] Sleep was something he obviously didn't have *under control*.

b. [HRJ] Section 3 shall consist of those delegates from affiliated trade unions, socialist societies, co-operative societies and other organisations present at party conference and each delegation shall be entitled to vote in each ballot *under this section*.

(17) Examples of *behind*

a. [JY2] She pushed herself up on one elbow and, a strong arm

behind her back, he helped her into a sitting position.

b. [CRK] This dynamic could not indeed have developed as it did without the very considerable influence *behind the scenes*, particularly in the preparation of documents between sessions, of leading consultants whose theology was indeed far beyond that of any but a handful of bishops: Congar, Rahner, Philips, Chenu, Courtney Murray among others.

(18) Examples of *in front of*

a. [AEA] I put them on the chairs, here *in front of the fire*, to dry out and the kitchen was like a steam-bath all winter.

b. [AD0] This should prevent certain other locations, like the chair *in front of the television*, becoming a cue to start eating.

(19) Examples of *out of*

a. [EFJ] The oldest boy seized the younger two and dragged them back, *out of sight*.

b. [H86] A small head was poking *out of the topmost window*.

Moreover, both dendrograms suggest that *over* patterns more similar to the pairs of *above/below*, emerge as its most proximal neighbor in the dendrogram. Among the top 100 covarying NPs, the overlapped nouns for both *over* and *above/below* are *top, age, floor, edge, shoulders, limit, surface, bridge, horizon, par, water, rim, sea, budget, deck*. However, typical examples of *over* may be more often related to the temporal domain, as shown in (20).

(20) Examples of *over*

a. [GUY] Common law rights are acquired as a result of custom and practice *over many years*.

b. [FA0] The proportion of service sector jobs within the economy as a whole, however, has risen *over time*.

On the other hand, in both dendrograms, *in* is cast as the most distant spatial particle among these 13 particles, being amalgamated into the cluster in the final stage, with the top 10 covarying NPs being *fact, case, studio, form, areas, sense, ways, turn, past, position*. This may suggest its unique semantic profile in comparison with all the other spatial particles. Its typical examples are provided in (21).

(21) Examples of *in*

a. [HA9] He'd see how quiet she could be; *in fact*, the big ox might just think he was teaching a statue, male-chauvinist pig that he was.

b. [AMS] Then again, no animal eats the whole of a plant; except *in the case*, say, of turnips, where it is possible to eat most of the root as well as the leaves.

Dimensional Reduction of the Spatial Particles

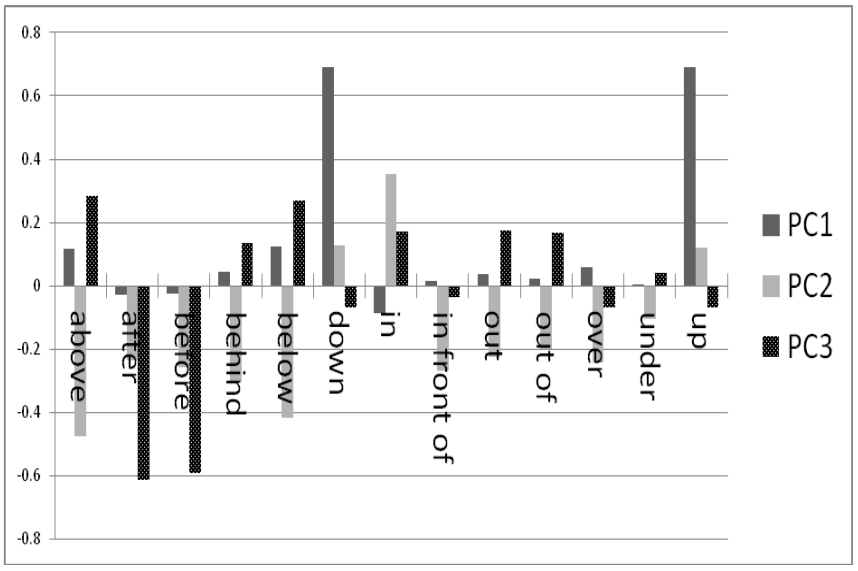

Figure 2. Loadings of each spatial particle on the first three principal components. The x-axis is the 13 spatial particles and the y-axis is the loading of each spatial particle. Every three vertical bars represent the loadings of one spatial particle on the first three principal components, respectively.

As both *t*-test statistics and collostrength yielded similar patterns in hierarchical clustering, our discussion of the PCA will be limited to the one based on the association measure of collostrength.

Figure 2 shows the loadings of each spatial particle along the first three principal components (PC). Every three vertical bars (represented by different colors) represent the loadings of one spatial particle on the

first three principal components, respectively, amounting to 13 groups of barplots. The variation of the first PC (i.e., the solid dark grey bar in Figure 2) is clearly dominated by the spatial particles *up* and *down*, hence, denoting an axis of verticality. The spatial particle *in* dominates the variation of the second PC (i.e., the solid light grey bar), forming a spatial contrast set between *in* vs. non-*in*, namely a boundedness dimension. Interestingly, in the third PC (i.e., the dotted black bar), high loadings of *after* and *before* suggest that this principal component largely accounts for variation along the horizontal dimension. We, therefore, term this PC as the horizontal axis.

In comparison with the results from the hierarchical clustering, we may conclude that the spatial dimension of the vertical axis manifests a more prominent degree of symmetry in the sense that *up*/*down* and *above*/*below* emerge as terminal-level clusters in the early stages of the hierarchical clustering, and that *up*/*down* is found to dominate the variation of the first principal component in PCA. Secondly, the spatial dimension of the horizontal axis shows a moderate degree of symmetry in the sense that *before*/*after* emerges as a terminal-level cluster in the early stages of the amalgamation and also dominates the variation of the third principal component in PCA. The spatial dimension of boundedness manifests the least degree of symmetry in the sense that *in* patterns rather differently from the other spatial particles, as shown in the high loading of the second principal component and no terminal-level clusters are found in this dimension.

DISCUSSION

Table 4 summarizes the results of our statistical exploration on English spatial particles. The first column, *Terminal Clusters*, lists the spatial particles that emerge as the terminal clusters in the dendrogram of the hierarchical clustering. The second column, *Non-terminal Clusters*, shows those spatial particles that do not manifest as groups in the early stages of the amalgamation of the hierarchical clustering. The third column, *PC Relatedness*, lists the spatial particles that show a strong tendency to dominate the variation of first three principal components in our principal component analysis.

Table 4

Summary of the Degree of Symmetry on the Three Cardinal Spatial Dimensions

	Terminal Clusters	**Non-terminal Clusters**	**PC Relatedness**
Vertical axis	*up/down* *above/below*	*over* *under*	PC1 (*up/down*)
Horizontal axis	*after/before*	*in front of* *behind*	PC3 (*after/before*)
Boundedness		*in* *out* *out of*	PC2 (*in*)

While all the spatial dimensions have asymmetrical spatial particles (i.e., particles in non-terminal clusters), it has been observed that two symmetrical particle pairs on the vertical dimension have emerged in English, namely *up/down*, and *above/below* and one symmetrical particle pair on the horizontal dimension, i.e., *after/before*. These three pairs of bipolar spatial particles manifest themselves as early terminal clusters in the dendrograms. However, no symmetry has been observed in the spatial dimension of boundedness. Our PCA also conforms to the clustering results in that two of the terminal clusters—*up/down* and *after/before*—dominate the variation of PC1 and PC3, respectively while *in* stands out uniquely in PC2. We suggest that this different pattering may be attributed to our experiential interaction with each spatial dimension. The symmetry/asymmetry use of the English spatial particles may shed light on our conceptualization of the spatial dimension.

Spatial orientation is a projection of a conceptual *front/back*, *up/down* or *in/out* partitioning of a non-self-entity. While this spatial partitioning may have its basis in geometry, their conceptual partitioning is often believed to be perceived on an asymmetric basis. Cognitive linguists have proposed that the asymmetry may come from the way the entity typically interacts with the environment, such as sitting, standing, or its shape (pointed ends), the way it is used by humans (building entrances), its perceived resemblance to human beings or animals. Of particular importance to the present study is the notion of embodiment.

Following the tenets in cognitive linguistics, we suggest that the attributes which give rise to the different degrees of symmetry in the

conceptualization of spatial dimensions may involve how humans both perceive and interact along the spatial dimension. Accordingly, the concept of spatial conceptualization underscores the importance of embodied experience in the semantics of natural language (Svorou, 1994; Talmy, 2000; Vandeloise, 1994)

Clark (1973) has noted that our bodies are asymmetric in the sense that our legs are at one end and our head at the other. Furthermore, he argued that such physiological asymmetry had non-trivial consequences for our interaction with the environment. Secondly, our environment itself explains clearly the fact that a vertical axis is asymmetric because gravity determines a natural declination.

As a living organism in physical three-dimensional space, we are biologically programed to move along the *front/back* dimension. Even in a self-contained space, a small range of space for moving around is still possible. In our experience, the flexibility of moving forward and backward is symmetrical in the sense that such a dimension makes the most sense biologically. Therefore, we suggest that the symmetrical embodied interaction with the two poles along the *front-back* dimension may have left its footprints in our linguistic recurring practices.

The way we interact with the environment along the vertical dimension is asymmetrical – gravity predetermines the default downward movement of all masses in the universe. However, human advances in technology have made possible an upward movement in our reality (e.g., the invention of aircraft). Therefore, a certain level of symmetry would be expected along this vertical axis. This may explain why two pairs of spatial particles have been observed to manifest symmetrical correlation with similar sets of entities.

In contrast, our interaction with the environment along the dimension of the boundedness appears rather asymmetrical. In order to understand the notion of *in*, we first have to conceptualize our body as a container with a clear boundary. Such disproportionate distribution of the inner and outer space may transform into various degrees of perceived freedom/control. Physical operations within our body are much easier to moderate and control, while the activities and developments in the outer world routinely fall outside of our sovereignty. Therefore, we suggest that this spatial dimension may be the least likely one to manifest a symmetrical extension on its two ends.

From the perspective of existential phenomenology (Merleau-Ponty, 1962), the meaning of the spatial particles could better be understood in

terms of how they are experienced, not by the way they are described in the more objective language of psychological or physical science. Cognitive linguists have taken up this torch of embodiment and further developed the idea that linguistic meanings are grounded in our bodily experiences (Johnson, 1987; Lakoff & Johnson, 1980). One corollary is that such semantic grounding may exhibit a certain level of cultural specificity. Indeed Chen (2010) observed that in the Mandarin-speaking community, only the *front-back* dimension displays clear symmetrical patterning while the vertical and boundedness dimensions show fewer signs of symmetrical metaphorical extension. More in-depth cross-linguistic research is needed for a better answer to the typological differences in the conceptualization of symmetry in bodily orientation.

We, however, suspect that the symmetry/asymmetry patterns of the spatial particles in a specific language may fall on an *implicational* scale or an implicational universal in a typologist sense (Croft, 1990; Greenberg, 1963; Keenan & Comrie, 1977). It is hypothesized that the symmetry of spatial dimensions may form a hierarchy— *front-back* < *up-down* < *in-out* — on which the *front-back* is the most likely to exhibit a symmetrical extension to similar groups of covarying collexemes while the *in-out*, on the other hand, is the least likely. The implicational nature of this hierarchy may predict that if a language shows symmetry on the *up-down* dimension, it will also show symmetry on the *front-back*. The study on Mandarin Chinese in Chen (2010) has found that Mandarin shows symmetry only on the most probable spatial dimension, i.e., *front-back*, on the one end of the implicational scale. On the other hand, the present study has observed that English shows symmetry on both the *up-down* and the *front-back* dimensions, which bears out the prediction of the implicational scale (i.e., symmetry in *up-down* implies symmetry in *front-back*). Several cultural specificities may play a role in such typological variation on the symmetry of bodily orientation, such as the morphological productivity of the spatial particles, or the cultural preference of collectivism or individualism. The assessment of these cultural factors may deserve more additional research, which, however, is out of the scope of the present study.

TEXTBOOKS EVALUATION

Our preliminary investigation on the English preposition constructions in the reading texts of the senior high school textbooks is

provided below.

Table 5 gives a general distribution of all the spatial particles in all the versions of the textbooks. It can be seen that students' reading texts show a strong bias toward one particular spatial particle, namely, *in*, whose frequency is more than 20 times the frequency of the second-frequent particle, *over*. In connection with our earlier observation in the corpora data, such disproportionate distribution of the particles in the textbooks may be argued to reflect few signs of symmetrical patterns for the bipolar pairs of the spatial particles on the same dimension.

Table 5

Distribution of the Spatial Particles in All Textbooks

Prepositions	**Freq.**
in	1712
over	75
after	49
out of	31
under	25
in front of	20
behind	19
before	16
down	14
above	11
out	7
below	4
up	2

Secondly, the head nouns of the English preposition constructions show a strong bias toward particular semantic types in the textbooks.

Table 6 illustrates the frequency of the (lemmatized) head nouns in all the preposition constructions extracted from the textbooks. All the proper nouns and time-related expressions have been collapsed into the same categories (i.e., PROPER and TIME). It can be readily seen that most of the preposition phrases in the textbooks refer to a semantic relation to either specific proper nouns or a time-related reference, suggesting an insufficient exposure of the textbook users to other

semantic domains in terms of prepositional usage. Common examples from the course book are provided in (22)-(26).

(22) [FEB01L12][7] The feeling down south *in Yenshui*, on the other hand, is completely different!
(23) [LTB04L06] Very pleased with Wright's New York museum, the Guggenheim Foundation went on to establish three more museums *in Europe*.
(24) [LTB03L04] While battling *in the Pacific*, MacArthur wrote this prayer.
(25) [LTB03L05] The trend found its way to Taiwan *in the mid-1980s* and has been growing in popularity ever since.
(26) [SMB05L08] According to a report by the Food and Agriculture Organization (FAO) *in February* 2005, 35 other nations have long endured famine-like conditions.

In fact, a closer look at those highly frequent head nouns (e.g., *world*, *life*, *way*, *country*) will lead to the same conclusion that the preposition *in* indeed dominates the attention of the learners in terms of its wide distribution.

Finally, in terms of the conceptual symmetry of the bipolar pairs of spatial particles, no comparable symmetrical patterns have been observed in the readings of the textbooks. In fact, the distribution of the spatial particles in the textbooks is so skewed that no tendency of symmetry can be statistically found. A corollary is that the uses of the spatial particles in the textbooks may not be representative enough in terms of the symmetrical patterning of the bipolar prepositional pairs on the same dimension (i.e., the symmetrical patterns of *after*/*before*, *up*/*down*, and *above*/*below* in the BNC, as discussed in Results.

[7] The index in the bracket refers to the textbook source of the sentence, in terms of its versions (FE for Far East, LT for Lungteng, SM for Sanmin), book number (B01-B06), and lesson number (L01-L12).

Table 6

Distribution of the Head Nouns in the Preposition Constructions of All Textbooks (Only head nouns occurring more than 10 times are included here.)

Head Nouns	**Freq.**
PROPER	311
TIME	68
world	62
life	39
way	32
country	26
area	21
love	19
mind	17
time	17
year	17
history	16
eye	15
room	15
culture	13
it	13
century	12
city	12
school	11
me	10
prison	10
water	10
wood	10

Our observation and evaluation on the distribution of spatial particles in the textbooks may have several pedagogical implications for teaching and learning English. First of all, as the students are exposed to a highly-skewed distribution of the prepositions in the textbooks, teachers may have to provide a more balanced picture of the pragmatic uses for the other prepositions. Two factors may become crucial in designing the supplements for teachers. On the one hand, despite the high frequency of

the preposition *in*, teachers should direct students' attention to the other prepositions on different dimensions (e.g., the vertical and horizontal axes). On the other, given the restricted nature of the semantic types of the head nouns, teachers may have to provide more diverse uses of the prepositions so that students can learn a wider range of the semantic domains where spatial particles can occur. The materials in the current textbooks expend too much effort on the routinized phrases, such as *in the world*, *in life*, *in the way*. Second, the construct of conceptual symmetry may be of great help for teachers in their curriculum design. In Results and Discussions, we have demonstrated clear symmetrical patterns for particular pairs of spatial particles on the vertical and horizontal dimensions in terms of their co-occurring head nouns. We suggest that a central highlight on the symmetrical behaviors may facilitate the learners' acquisition of spatial particles and reduce their memory loading resulting from the arbitrariness of the preposition uses. It should be noted, however, that students' mental readiness for more complex uses of the spatial particles may need to be taken into account. As one of the reviewers has rightly pointed out, our cognitive operation in the acquisition of a foreign language may differ from that of our native language. Our take on this is that teachers may try to highlight the similarities and differences between Mandarin and English in terms of the conceptualization of the spatial particles on the three dimensions. For example, as discussed in Discussions, both Mandarin and English demonstrate a clear symmetrical conceptualization along the dimension of the *front-back*, which may serve as a good starting point for teachers to supplement with more diverse uses in other semantic fields for the spatial particles in this dimension. While providing students' more diverse uses of the prepositions, teachers may start with the examples or semantic domains that also manifest similar patterns in Mandarin and move on to more complex distinct uses in particular to the English spatial particles.

CONCLUSIONS

The present study investigates the conceptualization of our bodily orientation in a quantitative corpus-based approach of collostructional analysis. Results have shown that the spatial dimension of the vertical

axis manifests a clearer symmetry in the sense that *up*/*down* and *above*/*below* emerge as terminal-level clusters in the early stage of the amalgamation, and that *up*/*down* dominates the variation of the first principal component in the dimensional reduction of PCA. Secondly, the spatial dimension of the horizontal axis shows a moderate degree of symmetry in the sense that *before*/*after* emerges as a terminal-level cluster in the early stage of the amalgamation and also dominates the variation of the third principal component. The spatial dimension of boundedness manifests the least symmetry in the sense that *in* patterns rather differently from the other spatial particles and no terminal-level clusters are found in this dimension. It is concluded that the symmetry of metaphorical patterns along each spatial dimension may be attributed to our recurring symmetrical daily interaction and bodily experiences with the surrounding physical environment. While cultural specificity is of great concern for future study, a hypothesis for the implicational scale of conceptual symmetry is proposed.

The distributional patterns of the covarying collexemes in English preposition construction have far-reaching implications not only for the embodiment of spatial conceptualization but also for English teaching and learning. This study has also conducted a critical evaluation on the spatial particles in the current high-school textbooks and highlighted a highly-skewed distribution of the prepositions in the readings of the current textbooks. Several pedagogical implications have been discussed for the curriculum design in teaching and learning English prepositions.

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英語空間介詞之語料庫量化分析：概念對稱性與其教學應用

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本文主要探討「概念對稱性」在英語空間詞語用中之重要性，並以語料庫為本之分析方法，評量現今台灣高中英文課本中空間詞的分佈比例及其語言真實性，提供教師更多教學依據。本文採用英國國家語料庫(BNC)，利用統計方法，分析英語介系詞片語中 13 個空間詞與介詞片語中名詞詞組之間的相關性。我們觀察語料庫中歸屬於同一空間軸(如：垂直軸)之對稱空間詞(如：up/down)是否在真實語用中亦以對稱地方式與其他名詞共現。結果顯示，不同空間軸在實際語用中展現了不同程度的概念對稱性。此外，我們更進一步分析空間詞在目前三個主要版本的高中英文課本(包括遠東，龍騰以及三民版)中的分布狀況，檢視課本課文是否能切實反映語料庫中空間詞實際的語用狀況，進而針對語用真實性檢討教材設計之優劣，提供高中教師具體建議及教學方針。

關鍵詞：英語介系詞、語料庫、空間、隱喻