The Sense Development of English Prepositions:'at', 'on', and 'in' with Log-Linear Analysis of CHILDES Database

Seungah Hong, Jongsup Jun

Hankuk University of Foreign Studies, Korea

0214

The Asian Conference on Language Learning 2013

Official Conference Proceedings 2013

Abstract

The study aims to see whether the process of metaphoric extension is universal or idiosyncratic by examining the semantic development in English prepositions. The metaphoric extension process in human reasoning is considered what brings polysemy of a word. Thus, the development pattern of senses in a polysemous word may reveal the mechanism of such reasoning. To this end, we looked into the semantic development of the polysemous English prepositions. The native English-speaking children's usage of English prepositions '*at*', '*on*', and '*in*' is examined together since these prepositions are based on spatial, temporal, and abstract senses that function similarly. The acquisition order of the senses will be consistent across the children if the metaphoric mapping process is universal. The longitudinal transcripts of 5 children in the age between 1 and 3, from the CHILDES database, were selected. The data is coded into four variables (*Child*, *Age*, *Preposition*, and *Sense*), and the Log-linear analysis was employed as the method of analysis. As a result, the three-way interaction effect was found in sense development; the model of {CAS},{CPS} is selected. This shows high-involvement of {C}, and it suggests the sense development is highly dependent on each child so the process of metaphoric extension may be rather idiosyncratic than universal.

INTRODUCTION

In many languages, there are words used for describing both spatial and temporal relationships. For example, the postpositional particle {-ey} in Korean is used for expressing a location (Seoul-ey, in Seoul) and time (*Hanshi-ey*, 'at one o'clock'). The same feature is found in English prepositions as well; for instance, the preposition 'on' serves the function representing the spatial and temporal notions such as 'in contact' (*a vase on the desk*) or 'a day' (*picnic on Friday*). This cross-linguistic evidence of space-time parallelism suggests that time and space belong together in a human mind. However, it is not easy to understand intuitively why we handle such different domains collectively.

Cognitive linguists explain it with the theory of metaphoric extension that we understand the world through the experience; the concrete features around us help us to grasp the abstract entities. In this process, we happen to link different domains, and this is represented through a language. Metaphoric Mapping Theory accounts for this relationship with the 'base' and 'target' domains by assuming the asymmetric relationship of these two domains. Since the base domain is composed of concrete features while the target domain is based on abstract features, the former enables the latter to be established. That is, the base domain serves as a schema for the target domain. In the relationship of space and time, the notion of space is the base domain while time is the target domain. Hypothetically, we perceive time through the space in this case, and this leads us to such as the TIME IS SPACE metaphor.

If this metaphor is true, the notion of space should precede to the notion of time in the sense development. That is, in the case of L1 language acquisition, it is predicted that the sense of space is acquired before the sense of time. Interestingly, the acquisition order found from the children's language acquisition data agreed to this prediction that the children acquired spatial sense before the temporal sense (e.g., Clark 1973, Jun & Lee 2009). However, in general, an English preposition represents more than the spatial and temporal relations; the senses of the English prepositions such as 'at', 'on', and 'in' can be classified into spatial, temporal, and abstract categories, and these can be further divided into sub-senses. Then, what is the relationship of senses in a single preposition? As the earlier studies concluded the concept of time arises from the concept of space, can we find other asymmetric relationship among other senses? If so, is the asymmetric relationship of senses absolute in any case or is it applied idiosyncratically?

The study aims to answer these questions by examining the semantic development in English prepositions. We hypothesize that the process of metaphoric extension is revealed through the children's language acquisition that the orders of the sense acquired in a polysemous word reflects the relationships of domains. If a universal pattern is found in the sense acquisition of a polysemous word, it might be possible to conclude that the metaphoric extension process is universal. Further, by looking into the sense development orders, we can trace the relationship of domains. To end this, we investigated the children's use of English prepositions, 'at', 'on', and 'in', which share the character in terms of senses. If the metaphoric mapping process is universal, the acquisition order of these senses may be uniformed across the children. The longitudinal transcripts of 5 children in the age between 1 and 3, from the CHILDES (Child Language Data Exchange System) database, were analyzed. Surprisingly, the

result revealed that the order of sense acquisition is rather idiosyncratic than universal. Thus, we may conclude that the metaphoric extension process depends on the individual reasoning.

SEMANTIC CLASSIFICATION

An English preposition is defined as a functional word that precedes a noun or a noun phrase to indicate a relation to another object in the clause, and it serves as a marker of various references: location, time, manner, goal, and etc. Among many English prepositions, the relational prepositions are used for describing the location of one object in relation to another.

(1) topological configuration
  a. The cat is at the corner.
  b. The cat is on the table.
  c. The cat is in the box.

The prepositions, 'at', 'on', and 'in', are in such a case that they refer to topological relations between the objects. In the Image-Schema, these spatial relations between objects can be explained through the dynamic embodied patterns of 'trajector (primary object)' and 'landmark (reference object)'. In (1a-c), the 'cat' is the trajectory while 'corner', 'table', 'and 'box' are the landmarks for each sentence. The prepositions in (1) reflect the physical configuration between a *trajector* and a *landmark*. Each preposition differs in terms of their topological base that 'at' is the point, 'on' refers the line or surface, and 'in' represents the 3d-surface.

Although the basic semantic elements representing each preposition differ from one another as shown in (1), three prepositions are on common ground in terms of their central meaning, which stands on the spatial dimension. In the view of the cognitive linguists, among all the senses, this concept of spatial dimension in the prepositions is the core source that serves the metaphoric function for other senses (e.g., Kwon 2012). With this view, we can assume that the spatial prepositions in English can be dealt together. The way of classifying the senses of these prepositions is varied; some may simply divide them into either primary or secondary sense. Or the secondary senses can be further categorized into either temporal or abstract (Rice 1996). The studies focusing on the semantic role of prepositional phrases classify the categories more finely such as beneficiary, direction, spatial extent, manner, location, purpose/reason, and temporal (O'hara & Weibe 2003). In the following sections, within the three class level, spatial, temporal, and abstract, we will suggest the classification of senses of English preposition 'at', 'on', and 'in'.

Spatial senses

The spatial sense is a sense which represents the locative information. However, we can classify these spatial senses into three-levels based on the cognitive linguists' view where the 'core' meaning is distinguished from others. As described earlier, the most fundamental sense in the spatial domain is explained through topological configuration. As in (2), the sense of preposition that describes the physical relationship between the figure and the ground can be considered as the primary sense. The prepositions in (3) exhibit the similar function that they obviously stand for the

relation of the figures and the grounds. However, there are difference in between (2) and (3); the grounds in (2) refer the physical space while those of (3) are rather conceptual. Hence, such a sense for geographic location should be distinguished from the prototypical spatial sense.

(2) *geographic location*
a. We docked at Panama.
b. I was born on Honshu, the main island.
c. He had intended to take a holiday in America.

Another sense that should be told apart from the primary topological sense is the sense that stands for the directionality/or goal. Examples in (4) show that the prepositions express the movement of the figure toward the ground. Some may argue that this is not because of the prepositions that they have a characteristic of having argument which has the thematic role of goal (e.g., come, go, look...). However, looking into these verbs with different prepositions, we may notice that they are possibly realized without such an argument (e.g., I go ∅ with Elen). Talmy (2000) suggests English is a satellite-framed language that the path of motion is not embedded in verbs and is represented through the particles. Similarly, the study of Kemmerer and Tranel (2003) exhibits this view with evidence that the process of verbs and the locative prepositions are independent of each other. Thus, it is possible to conclude the prepositions like *in* and *on* can also deliver the sense of directionality.

(3) *direction/goal*
a. he gestured at the shelves.
b. We march on the city hall.
c. The cat goes in the pool.

Temporal senses
The sense that refers time is temporal sense. Perceptually, we can distinguish time in several categories as (5). Even though, they can be all discrete unit, the properties of each temporal unit are varied. For instance, the examples in (5) conceptualized the moment with the quantified unit while the temporal sense in (6) is based on the event, where the experience forms a temporal scene. Constructivists maintain that we form a mental model to understand the world, and the experience is the most powerful tool for constructing such a mental model. Considering this view, we can speculate that the temporal sense with the properties of events may be easier to grasp for children than the static time. To test this hypothesis, we distinguish the time into two categories: *event time* and *static time.*

(4) *static time*
a. She returned at 2 a.m.
b. see you on April.
c. I was born in 1983.

(5) *event time*
a. He had a fight at the high school dance.
b. I will go on vacation.
c. I learned it in class today.

Abstract senses

Tyler & Evance (2003) showed how the semantic networks are extended from a *protoscene* to other abstract domains through the example of 'over'. By adapting this approach, we classified the distinctive abstract senses appear common across 'at', 'on', and 'in'. As the result, 6 senses are found as from (7) to (12); they are target/object, *state/manner, involvement, source, mean* or *idiom*.

(6) *target/object*

a. She would have laughed at the idea.
b. More money should be spent on education.
c. Do you believe in god?

Examples in (7) might be confusing with the sense of goal/direction in spatial category. However, the distinction between these two can be explained with the feature of [+directionality] in the relation of figure and ground, or characteristic of the object of the preposition that it is whether concrete or abstract. In (2), it is implied that the action of the figure is on the direction to the ground: [+directionality]. However, it is not that clear to detect such directionality in (7). In addition to this, the objects of the preposition in (2) refer the place while the ones in (7) are the abstract figures. In (8), the prepositions account for the figure in terms of the ground while the relation of figure and ground in (9) is involvement.

(7) *manner/state*

a. The flower has grown at a sluggish pace.
b. She is on duty.
c. They are in love.

(8) *involvement*

a. She excels at sport.
b. a book on Astronomy...
c. He works in medicine.

The abstract senses as target/object, *state/manner, or involvement* are so far detected across all three prepositions. However, the following senses, *source* or *mean,* are only available for *on* and *in.* In the usage of adult English, it is not possible to find the use of 'at' that describes the relation of 'source' or 'mean'. Since both senses of 'source' and 'mean' are obviously distinct from other abstract senses and available for both *on* and *in*, we count them as the independent semantic entry.

(9) *source*

a. He listened the song on the radio.
b. ...one of the funniest scenes in the film

(10) *mean*

a. He talks on the phone.
b. He speaks in Japanese.

As the last, the prepositions in idioms or idiom-like usage are separately counted, and the examples in (12) show such cases.

(11) *idiom*
a. ...not at all
b. ...turns on the light
c. ...in touch

To sum up, we suggest the semantic classification of English preposition 'at', 'on', and 'in' with 11 categories: topological configuration, location, goal, time, event, target, involvement, mean, state, source, and idiom. With this classification, we look into the development of each sense by analyzing the children's utterance in CHILDES database.

DATA COLLECTION

The material of the study is based on the CHILDES (MacWhinney & Snow 1990). The English database in CHILDES consists of 59 corpora, 50 of American English and 9 of British English. Each corpus has its own characteristics varied by the corpus size, age of target children, number of target children, the participants of the corpus (e.g., children only or with investigators), and etc. However, only few are the sequential data of the same target children; among these longitudinal studies, we choose Providence corpus since it shows the even distribution of age and number of the target children.

<Table 1> detailed information of the target dataset

Age	Mean MLU	STD	Child	No. of corpus	Words	Utterance	MLU
1	1.971	0.405	ale	15	3060	2077	1.473
			lil	24	4974	3289	1.512
			nai	39	25033	10519	2.380
			vio	20	2767	1484	1.865
			wil	14	4029	2854	1.412
2	2.875	0.613	ale	25	17301	8107	2.134
			lil	41	39838	13921	2.862
			nai	42	42504	11446	3.713
			vio	22	15098	5248	2.877
			wil	22	14746	6320	2.333
3	3.211	1.026	ale	11	11423	4211	2.713
			lil	14	20542	6054	3.393
			nai	6	9780	2295	5.261
			vio	9	5003	1592	3.143
			wil	8	12348	4252	2.904

Since the goal of this study is to examine the development of the preposition senses by the age, we narrowed down to the dataset the same child participated through the age between 1 and 3, and thus, the data of 5 children is chosen for the analysis. <Table 1> presents the detailed information of target dataset.

Overall, 312 corpora were selected, and from these, by using the CLAN program, we retrieved the frequency of the each English preposition. The result is summarized in the <Table 2>. After this, we looked into the usage of each preposition on a case by case basis. On this raw data, we coded four explanatory variables: *Child*, *Age*, *Preposition*, and *Sense.*

<Table 2> the frequency of English prepositions in each age

Age	at	in	on	*Grand Total*
1	74	360	167	601
2	346	1382	899	2627
3	174	509	322	1005
Grand Total	594	2251	1388	4233

METHOD OF ANALYSIS

The data is coded by using four categorical variables in <Table 3>. As seen in this table, there are multiple-levels in variables. The goal of this study is to see how the senses in prepositions are developed through the ages. We can consider *Individual difference*, *Age*, *Preposition*, *Sense* as factors bring the difference in the semantic development. That is, we need to consider not only how a single factor affects the acquisition, but also the interaction effect of these factors as together.

<Table 3> Variables for data coding (Abbreviations in curly brackets)

variable	levels	values
CHI {C}	5	ale, lil, nai, vio, wil
Age {A}	3	1, 2, 3 (years)
Preposition {P}	3	at, on, in
Sense {S}	11	topological configuration, location, goal; time, event; target, involvement, mean, state, source, idiom

RESULT BY CROSS-TABULATION

age / sense	at			on			in			*Grand total*
	1	2	3	1	2	3	1	2	3	
t/c	8	12	10	136	677	228	216	944	337	2568
location	26	125	49	2	59	28	119	259	101	768
goal	31	172	98	11	53	13	4	46	11	439
event	4	10	2	0	2	2	4	1	1	26
time	0	11	7	0	6	3	1	18	20	66
target	3	1	0	1	11	7	1	14	8	46
manner	0	0	0	1	7	4	0	21	9	42
involvement	0	0	0	1	4	3	0	13	7	28
source	2	7	2	3	31	15	15	49	12	136
mean	0	1	0	7	18	9	0	9	0	44
idiom	0	7	6	5	31	10	0	8	3	70
Grand Total	75	348	177	168	901	325	361	1384	512	4233

The cross-tabulation of 495 (5 x 3 x 3 x 11 levels) cells can be created to show the sense-classification result. The result of the sense-classification is summarized in the <Table 4> is out of only 99 cells since lack of space forbids inclusion of individual effect {C} in the table. Although it is the cross-tabulation which deals with the three variables (*Preposition*, *Age*, and *Sense*), it is still too complicated to grasp the tendency across the results.

<Table 4> Cross-tabulation of the sense classification

Especially, it is not possible to figure out whether a single factor involves in the sense acquisition or there are interaction effect of multiple factors for leading such result. Thus, we employed the log-linear analysis to examine the effect of each factor and possible interaction effect among the factors.

RESULT BY LOG-LINEAR ANALYSIS

We test a number of hierarchical models with the backward-elimination procedure. The hierarchical models tested, and the results are shown in <Table 6>. The goal of log-linear analysis is to find the model that satisfies the saturated model (#1) with the simplest combination of variables since a variable that involved in a model is counted as a factor, and each combination within a curly bracket shows an interaction effect of factors. For instance, the model #1 includes all four variables within a curly bracket and this means that all variables interact with each other. If the model {AS} fits into the saturated model, that only *Age* and *Sense* are the factors, and these two factors interact so it confirms the certain sense is acquired in a certain age.

<Table 6> Hierarchical models for the sense-classification

No.	Model	L2	df	p
1	{CAPS}	1588.179	444	0
2	{CAP}, {CAS},{CPS},{APS}	99.851	160	1.000
3	{CAS}, {CPS}, {APS}	118.600	176	1.000
4	{CAP}, {CAS}, {CPS}	179.995	200	0.842
5	{CAP}, {CAS}, {APS}	255.479	240	0.235
6	{CAP}, {CPS}, {APS}	202.161	240	0.964
7	{CAS}, {CPS}, {AP}	202.192	216	0.741
8	{CAS}, {APS}, {CP}	279.189	256	0.153
9	{CAP}, {CAS}, {PS}	354.837	280	0.002
10	{CAP}, {CPS}, {AS}	288.587	280	0.349
11	{CAP}, {APS}, {CS}	363.988	320	0.045
12	{CPS}, {APS}, {CA}	241.753	256	0.730
*13	{CAS}, {CPS}	215.866	220	0.566
14	{CAS}, {APS}	355.603	264	0.000
15	{CAP}, {CAS}	1989.424	300	0.000
16	{CAP}, {CPS}	368.198	300	0.004
17	{CAP}, {APS}	549.313	360	0.000
18	{CPS}, {APS}	1078.528	264	0.000
19	{CAS}, {CP}	2050.210	320	0.000
20	{CAS}, {AP}	2086.044	324	0.000
21	{CAS}, {PS}	471.289	308	0.000
22	{CAP}, {CS}	2202.541	400	0.000
23	{CAP}, {AS}	2279.754	420	0.000
24	{CAP}, {PS}	713.581	420	0.000
25	{CPS}, {CA}	428.983	320	0.000
26	{CPS}, {AS}	1194.214	1308	0.000
27	{CPS}, {AP}	1242.795	324	0.000
28	{APS}, {CS}	1333.951	352	0.000
29	{APS}, {CA}	645.933	384	0.000
30	{APS}, {CP}	1423.911	384	0.000

<Table 6> shows the list of models that are tested. As we see, the models below #13 in <Table 6> cannot explain the results while the models above #13 are all good models. Among them, the model #13 is chosen as the best model since it is most parsimonious. The standardized residual of the model is 0, and the *G2/df* is 0.98.

DISCUSSION

The selected model #13 confirmed the three-way association effect in the sense acquisition in English prepositions. The model expects that the senses in the preposition is developed through ages, but the pattern can be different from each child:

{CAS}, and also it predicts that a child has his/her own preferred sense for each preposition, and this can differ from one child to another: {CPS}. In both terms, we cannot find the interaction effect of Preposition and Age directly. Earlier in <Table 2>, we see the difference among the preposition usage in each age; the use of *in* or *on* seems much frequent than use of *at*. However, it was found that the choice of the preposition does not differ from each age; it is rather that a certain sense in a preposition is emphasized through the development, and a child assigns a certain sense to a preposition. Interestingly, the pattern of sense-assigning for each preposition is not universal across the children. That is, the children's view on each preposition sense is highly idiosyncratic, and this could be experience-oriented. The individual preference on each sense may due to the care-takers input which contradicted to the findings of previous study (Jun and Lee 2009). Yet the care-takers' input is not analyzed together in this study, so this should be studied further to confirm whether it brings the individual difference in sense-acquisition or not.

The main goal of the current study is to test if there is a universal pattern in sense development in order to certify the universal reasoning of metaphoric extension. However, we failed to detect the universal pattern in children's sense acquisition. This may suggest that the metaphoric mapping process is idiosyncratic that we do not perceive the world in the same way.

REFERENCE

Clark, H. 1973. Space, time, semantics and the child. In Cognitive development and the acquisition of language. Timothy E. (ed.), pp. 27-63. New York: Academic Press.

Feist, M. & Gentner, D. 2003. Factors involved in the use of in and on. Paper presented at the 25th Annual Meeting of the Cognitive Science Society, Boston.

Jun, J-S & Lee, J. 2009. The Sense Development of the English Preposition ‘on’: log-linear analyses of the CHILDES database. *The Journal of Studies in Language 25.* 631-653.

Kemmerer, D. & Tranel, D. 2003. A double dissociation between the meanings of action verbs and locative prepositions. *Neurocase* 9. 421–435.

Kwon, Y. 2012. A cognitive linguistic study on English spatial prepositions. *Journal of Language Sciences 19*. 1-20.

MacWhinney, B. & Snow, C. 1990. The Child Language Data Exchange System: An Update. *Journal of Child Language* 17. 457-472.

O’Hara, T. & Wiebe, J. 2003. Preposition semantic classification via Penn Treebank and FrameNet. In Proceedings of the Seventh Conference on Computational Natural Language Learning (*CoNLL-2003*), pp. 79–86. Edmonton, Canada.

Rice, S. 1996. Prepositional prototypes. In The Construal of Space in language and Thought. M. Pütz and R. Dirven (eds), pp. 135-165. Berlin: Mouton de Gruyter.

Talmy, L. 2000. Toward a cognitive semantics. Typology and process in concept structuring. Cambridge, MA: The MIT Press.

Tyler, A & Evans, V. 2001. Reconsidering prepositional polysemy networks: the case of over. *Language* 77. 724-765.

iafor