Universality and Language-Specificity in the Acquisition of Path Vocabulary

Megan Johanson and Anna Papafragou
University of Delaware

1. Introduction

It is widely acknowledged that aspects of the acquisition of spatial language may reflect a shared, perhaps universal, conceptual system of space (Bowerman, 1996; Mandler, 1992; Pinker, 1994). To the extent that children learning different languages learn spatial words in a consistent pattern, they may all be relying on a similar conceptual system. Johnston and Slobin (1978) found support for this view in a study that compared children learning English, Italian, Turkish, and Serbo-Croatian. These researchers found that in all of these languages, expressions that meant something close to 'in', 'on', and 'under' were learned before expressions that meant 'beside', 'behind', 'front,' and 'between'. They concluded that children's conceptual biases were responsible for this consistent timetable of spatial language acquisition.

Despite commonalities in the cross-linguistic encoding of space, languages are also characterized by important differences in spatial encoding (Gilbert, Regier, Kay & Ivry, 2008; Levinson, 1997); furthermore, the acquisition of spatial expressions follows language-specific patterns early in language development. One example of a commonly studied difference between languages in the encoding of spatial relations is the degree-of-fit distinction that Korean-speakers generally encode and English-speakers do not (Choi & Bowerman, 1991). Another example of a difference in how spatial information is encoded is the path/manner distinction in the domain of motion (Papafragou, Massey, & Gleitman, 2002): some languages, such as Greek, tend to encode path information in the verb of a sentence and manner information elsewhere (path language) whereas other languages, such as English, encode manner information in the verb and path information in adpositions (manner language). In both of these cases, language-specific encoding patterns seem to be acquired early by children learning their native tongue (Choi & Bowerman, 1991; Papafragou et al., 2002, respectively).

Our objective is to explore the contributions of Universality and Language-Specificity to language acquisition by focusing on the language used to describe

* This research was supported by NSF BCS#0641105 to Anna Papafragou. The author would like to thank the members of the Language and Cognition Lab at UD, the Early Learning Center, and Stathis Selimis for assistance in data collection and coding.

motion events – more concretely, the path followed by a moving entity. Specifically, we are going to look at the well-documented Source-Goal asymmetry, also called the Goal Bias, in encoding motion paths. The Source-Goal asymmetry is a tendency to encode goal path information (e.g., The ball went *into the hole*) more frequently and systematically than source path information in a motion event (e.g., The ball moved *away from the wall*). Linguistic evidence from normally developing children and children with Williams Syndrome (a disorder resulting in a deficit of spatial cognition), as well as linguistic data from adult speakers of different languages supports this asymmetry (Bowerman, deLeon, & Choi, 1995; Lakusta & Landau, 2005; Landau & Zukowski, 2003; Regier & Zheng, 2007). The presence of the asymmetry is also supported by non-linguistic evidence from infants who are not yet speaking, children who are still learning language, and adults (Lakusta, Wagner, O'Hearn, & Landau, 2007; Lakusta, 2006; Papafragou, 2007). In general, this Source-Goal asymmetry can be taken as support for Universality: if preverbal infants are able to encode goal information in events better than source information, the asymmetry must be present in the spatial concepts they possess before they learn to speak. In addition, adult speakers of different languages who encode motion information differently show the same pattern (i.e., they preferentially encode goal objects and paths over source objects and paths), suggesting that they share a universal bias in spatial information encoding.

Although there is a wide range of research on the Source-Goal asymmetry, there are several questions that remain to be answered. For instance, how exactly does the goal bias interact with language-specific biases in spatial encoding? And do children learning different languages show the same preferential encoding of goal information? Here we address these questions about the interplay between Universality and Language-Specificity by comparing spatial language production in adult and child speakers of English and Greek. We chose to study English and Greek because of the previously mentioned difference in encoding of path information: briefly, English encodes path information in adpositions and Greek encodes path information in verbs as well as adpositions. Keeping these syntactic differences in mind, we explore two main questions. First, we ask whether there will be a difference between English and Greek, specifically whether the Source-Goal asymmetry will persist in Greek, and if so, whether children will also exhibit the asymmetry. Second, we want to know if Greek adpositions will reveal less of a goal bias than English adpositions since, in Greek, path information is encoded more consistently in the verbs compared to the adpositions.

2. Method

2.1. Participants

Our participants were 30 English- and 30 Greek-speakers that fell into three different age groups (4-year-olds, 5-year-olds, and Adults). There were 10 participants in each age group for each language. For English speakers, the younger children were between the ages of 3;8 and 4;3 with a mean age of 3;11, and the older children were between the ages of 4;9 and 5;5 with a mean age of 5;0. The child participants were recruited at the Early Learning Center in Newark, DE. The adults were recruited from the undergraduate population of the University of Delaware and received course credit for participation.

For the Greek-speaking participants, the younger children were between 3;9 and 4;3, with a mean age of 4;0, and the older children were between 4;10 and 5;3, with a mean age of 5;0. The Greek speaking adults were primarily University students. All Greek data were collected in Greece and coded by a native speaker.

2.2. Materials

Our materials consisted of 8 different motion configurations, each with a source and a goal version. The participants saw 3 examples of each configuration for a total of 48 events. Each event was presented in Microsoft PowerPoint and consisted of a soccer ball (the moving object, or Figure), and an abstract 3D object varying in color and size (the Ground object). The same scenes were used for the corresponding Source and Goal events, with the only change being in the direction of motion and the color of the Ground object (see Figure 1 for example scenes).

The motion configurations (with the source/goal versions) were the following: Containment (IN/OUT OF), Cover (UNDER/FROM UNDER), Contact (TO/FROM), Support (ONTO/OFF OF), Vertical Proximity (TOWARDS THE SIDE OF/AWAY FROM THE SIDE OF), Horizontal Proximity (TOWARDS THE TOP OF/AWAY FROM THE TOP OF), Occlusion (BEHIND/FROM BEHIND), and Front (IN FRONT OF/FROM IN FRONT OF). The stimuli were in a pseudo-randomized order to ensure that scenes of the same type did not appear within 3 scenes of each other. Once this list was set, we created a reverse version of it, so that half of the participants received the original and half the reverse version. The motion events lasted for three seconds and then remained on the screen until a key press.

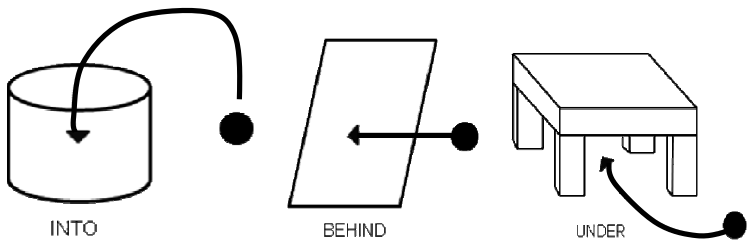

Figure 1. Examples of motion scenes for Containment (INTO), Occlusion (BEHIND) and Cover (UNDER) configurations.

2.3. Procedure

The participants were told that they would see a series of motion events involving a ball and another "toy." After viewing each event, the participants were asked to describe, in their native language, what the ball did in each event. The adult participants performed one practice trial. For the children, the procedure was slightly different. First, the children were told that they were going to play a game where animals play with balls and "toys." They were then shown a screen with all Reference (Ground) objects used in the materials and told to call them all "toys." Second, in order to help the children maintain attention, a slide with a small cartoon animal in one of the bottom corners was presented before each motion event. The children's attention was drawn to the animal by the experimenter saying "Look at the (animal)! Let's see what the (animal)'s ball will do!". The motion clip was then played and remained on the screen; then the experimenter asked the child to describe what the animal's ball did. The children completed at least three practice trials before beginning the experiment. Finally, the set of events was distributed over two sessions, usually a few days apart.

A native speaker coded all sentences in each language and specified whether each contained source or goal information, or both. For example, in English a child might say "The ball popped out of the toy". This sentence contains a manner verb and a path modifier (specifically, a source phrase). In contrast, a Greek participant might say "I bala vgike ekso apo to antikimeno" ('*the ball exited inside from the object*'). This sentence contains a path verb and a path (source) modifier.

3. Results and Discussion
3.1. Path Verbs versus Adpositions

In order to ensure that our sample of English and Greek speakers behaved consistently with previous work, we looked at the proportion of uses of path verbs for English and Greek when these verbs were used to describe the test events (i.e., we looked at source verbs given in source scenes and goal verbs given in goal scenes). This proportion was entered into an ANOVA with Language and Age as factors (see Figure 2). The analysis returned a main effect of Language ($F(1, 120) = 130.89$, $p < .0001$). As we see, Greek speakers used significantly more path verbs than English speakers did ($M_{ENG} = .05$, $M_{GR} = .36$). In addition, there was a significant effect of Age ($F(2, 120) = 12.13$, $p < .0001$) because adults used significantly more path verbs than either the 5-year-old ($F(1, 78) = 6.8$, $p = .012$) or the 4-year-old children ($F(1, 78) = 7.31$, $p = .008$). However, the 5-year-old and the 4-year-old children did not differ from each other in use of path verbs ($F(1, 78) = .0025$, $p = .96$; n.s.). Finally, there was a significant Age by Language interaction ($F(2, 120) = 6.95$, $p = .0014$). Additional ANOVAs revealed that this interaction was due to the fact that there was no Age effect for English speakers ($F(2, 57) = 1.06$, $p = .35$) but there was a significant Age effect for Greek speakers (*F*(2, 57) = 11.29, *p* < .0001). Specifically, for Greek, the adults used significantly more path verbs that both the 5-year-old (*F*(1, 38) = 15.18, *p* = .0004) and 4-year old (*F*(1, 38) = 17.55, *p* = .0002) children. The 4-and 5-year-old children did not differ from each other (*F*(1, 38) = 0, *p* = 1.0).

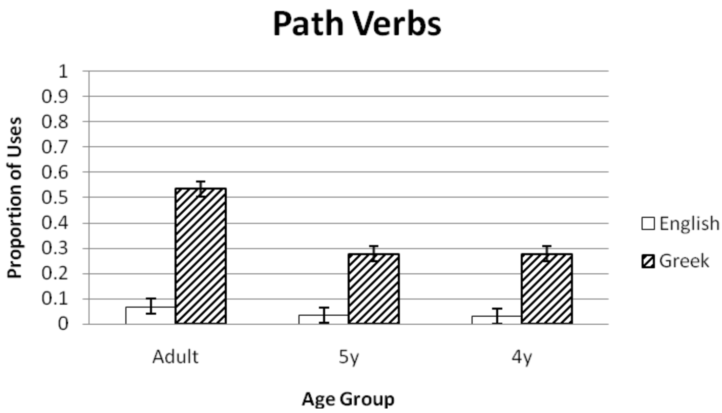

Figure 2. Proportion of path verbs given by English and Greek speakers.

Figure 3 depicts the proportion of use of path adpositions to describe the test events (i.e., source adpositions given in source scenes and goal adpositions given in goal scenes). This proportion was entered into an ANOVA with Language and Age as factors (see Figure 2). The analysis returned the expected Language effect (*F*(1, 120) = 38.08, *p* < .0001). English speakers use path adpositions significantly more than Greek speakers (M_{ENG} = .71, M_{GR} = .44). Again, there was a significant effect of Age (*F*(2, 120) = 25.28, *p* < .0001): adults used significantly more path adpositions than either 5-year-olds (*F*(1, 78) = 27.00, *p* < .0001) or 4-year-olds (*F*(1, 78) = 37.36, *p* < .0001). As with the path verbs, the 5-year-olds and 4-year-olds did not differ from each other (*F*(1, 78) = .43, *p* = .51). For adpositions there was no Age by Language interaction.

These results confirm the previously demonstrated typological differences in how English and Greek speakers encode spatial information. English speakers encode spatial information primarily in adpositions. Greek speakers, on the other hand, encode spatial information in adpositions but also in verbs.

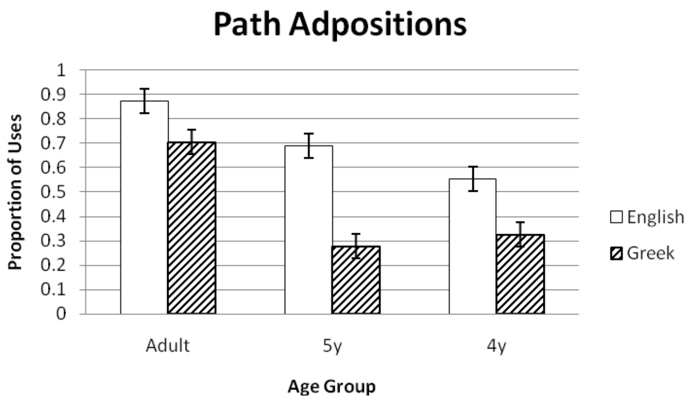

Figure 3. Proportion of path adpositions given by English and Greek speakers.

3.2. Typological Differences and the Goal Bias

Next, we turn to the first question raised at the end of the Introduction, namely whether English and Greek speakers differ in the type of path information they are encoding. Given the syntactic differences between the two languages in the domain of path encoding, one possibility is that Greek speakers may reveal less of a goal bias than English speakers because path information is encoded in verbs, which cannot be dropped from the sentence (unlike English prepositional phrases). Another possibility is that the goal bias might be strong enough to persist across these two typologically different languages. To explore this question, we examined the frequency of source and goal expressions used by English and Greek speakers.

3.2.1. Goals and Sources as Target Information

First, we took a look at the frequency of source and goal information that speakers provided in their descriptions of the target scenes. That is, we looked at the proportion of goal information provided for goal scenes and source information provided for source scenes. We conducted a MANOVA with the proportion of target information at the dependent variable and Language, Age, and Scene Type as factors. The results from this analysis reveal a significant effect of Scene Type ($F(1, 54) = 36.88$, $p < .0001$; $M_{SOURCE} = .65$, $M_{GOAL} = .83$). There was also a significant effect of Age ($F(2, 54) = 22.01$, $p < .0001$): the adults gave significantly more target information than either the 4- ($F(1, 38) = 45.96$, $p < .0001$) or 5-year-old children ($F(1, 38) = 29.08$, $p < .0001$). The 4- and 5-year-old children did not differ from each other in the amount of target information given ($F(1, 38) = 1.66$, $p = .21$). There was also an interaction of

Age with Scene Type ($F(2, 54) = 8.36$, $p = .0007$). The Age by Scene Type interaction was due to the fact that adults did not show a significant difference between Source and Goal scenes ($F(1, 19) = 1.48$, $p = .24$; $M_{SOURCE} = .92$, $M_{GOAL} = .95$; n.s.) - probably because the events were very simple, with only one ground object and one figure object, and adults almost always encoded the target information. However, both the 4-year-old ($F(1, 19) = 33.67$, $p < .0001$; $M_{SOURCE} = .43$, $M_{GOAL} = .75$) and 5-year-old children ($F(1, 19) = 8.68$, $p = .008$; $M_{SOURCE} = .58$, $M_{GOAL} = .77$) showed a preferential bias to encode goal over source information. Finally, there was no effect of Language ($F(1, 54) = .66$, $p = .42$) and no other interactions. Therefore, the goal bias here affects the amount of target information given in both languages to the same extent – i.e. there is a goal bias despite the typological differences between the two languages.

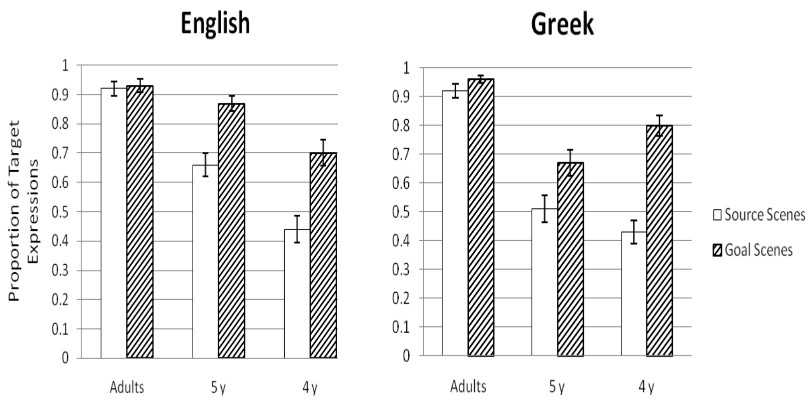

Figure 4. Proportion of target information given by English and Greek speakers.

3.2.2. Goals and Sources as Non-Target Information

We next took a look at non-target information provided in these event descriptions. Non-target information refers to extra information that was occasionally added to the sentence even though it did not describe the test event itself but some other aspect of motion. For present purposes, this included cases where goal information was given for source scenes (either alone or in addition to the target, i.e., source, information), or source information was given for goal scenes. For example, participants might have said “The ball went *from the wall* into the toy” during a goal containment event. Here, “from the wall” is additional non-target information because target information was given in the goal phrase “into the toy.” For the source version of this scene, participants might have said “The ball went from the toy *to the wall*” with “to the wall” being additional, unnecessary goal information. If goal information was encoded more consistently than source information, we might expect more non-target information in source scenes than goal scenes.

Figure 5 represents the proportion of non-target information given by English and Greek speakers. A MANOVA with proportion of non-target information as the dependent variable and Language, Age and Scene Type as factors revealed a significant effect of Scene Type ($F(1, 54) = 51.81$, $p < .0001$; $M_{GOAL} = .11$, $M_{SOURCE} = .36$) and only a marginally significant effect of Language ($F(1, 54) = 3.92$, $p = .053$; $M_{ENG} = .13$, $M_{GR} = .45$).

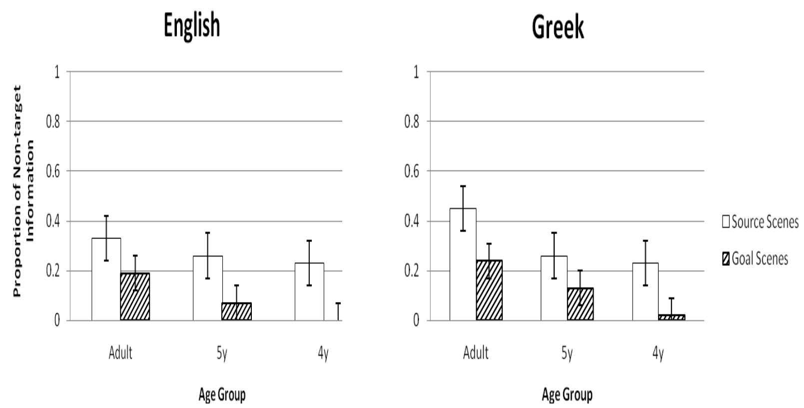

Figure 5. Proportion of non-target information given by participants.

Recall that the first question we raised at the end of the Introduction was whether the goal bias persists cross-linguistically, and whether it persists in children acquiring different languages as well as in adults. The data on the frequency of target and non-target information given for motion events suggest that there is a goal bias in both English and Greek speakers, despite syntactic differences in path encoding. This bias did not emerge for adult speakers (for reasons we believe have to do with our stimuli) but it was evident in the children when talking about target information. Furthermore, we found that the bias persisted across all ages when speakers offered additional, non-target information about the motion events, since goal information was added more consistently to the description of the main event compared to source information.

3.3. Path Verbs versus Adpositions

The second question raised at the end of the Introduction concerns whether the Greek goal bias interacts with the type of spatial expression used (verb or adposition). A first possibility is that the goal bias may be less evident in Greek compared to English adpositions, since Greek path verbs carry most of the path information. A second possibility is that the goal bias might be strong enough to affect both the adpositional and verbal systems in English and Greek. To explore this question, we examined the number of different source/goal expressions used by speakers of each language as well as the semantic specificity of expressions used to label sources and goals.

3.3.1. Number of Goal and Source Expressions Used

First, we wanted to see if there was a difference in the overall number of different source and goal expressions used. Table 1 incorporates all of the expressions given by our participants in English and Greek[1]. In general, there are more distinct goal expressions than source expressions, both for verbs and adpositions and in both English and Greek. This distribution confirms the cross-linguistic potency of the goal bias regardless of the specifics of path encoding. Additionally, there are some differences between the two languages, with Greek speakers using fewer adposition types than English speakers (the difference is particularly striking in the source domain.) This is consistent with the fact that Greek speakers rely heavily on verbs when encoding path information, unlike English speakers, who rely primarily on adpositions.

Table 1. Total number of types of path expressions used by participants.

	Types of Source Adpositions	Types of Goal Adpositions	Types of Source Verbs	Types of Goal Verbs
English	22	36	2	14
Greek	9	24	6	11

3.3.2. Semantic Specificity of Goal and Source Expressions

The second step in exploring the source-goal asymmetry was to look at whether source expressions were used in a wider range of scenes than goal

[1] Although the total number of path verb types used by English speakers seems quite high, the frequency of path verb use is much lower compared to Greek speakers (see Fig.2). The goal verbs used by English speakers were *approach, bang, bump, collide, crash, disappear, end up, enter, hide, hit, land, run into, touch*. These verbs all require that the Figure end up in contact or close proximity with the Ground object. The source verbs used by English speakers were *emerge, exit, leave*. These verbs necessarily require contact or close proximity to the Ground object at the beginning of the motion event.

expressions (i.e., whether they had a larger *spread*). Regier and Zheng (2007) found that, cross-linguistically, adult speakers use source adpositions in a larger number of scenes than goal adpositions. This means that cross-linguistically, source expressions tend to be less detailed and specific and can therefore be applied to a larger number of scenes. Goal expressions, on the other hand, tend to be more specific and can only be used for a very limited number of specific scenes. In addition, some developmental evidence from Bowerman et al. (1995) has suggested that children show this asymmetry in spread as well.

We defined *semantic spread* somewhat differently from the notion of spread used by the above authors as the number of scene *types* an expression was used in. For example, the English goal expression *to* can felicitously be used to describe scenes where the ball moves to the side of the Ground object (VERTICAL PROXIMITY) as well as in front of the ground object (FRONT). In contrast, the English source expression *from* may be used in a wider range of scenes where the ball moves away from the side, the top, the front or the back of the Ground object (HORIZONTAL and VERTICAL PROXIMITY, FRONT, BACK).

An ANOVA using the average number of scene types an adposition was used in as the dependent variable and Adposition Type, Language, and Age as factors returned an effect of Adposition Type ($F(1, 54) = 27.99$, $p < .0001$; $M_{GOAL} = 1.57$, $M_{SOURCE} = 2.31$): source adpositions had a larger average spread than goal expressions. There was also a marginal effect of Age ($F(2, 54) = 2.90$, $p = .06$). No other significant effects were found. Figure 5 presents the average semantic spread of source and goal adpositions given by English and Greek speakers, collapsed across languages. Overall, these results support the source-goal asymmetry and demonstrate similarities in the semantic specificity (or lack thereof) in the adpositional systems used by both English and Greek speakers.

Recall that, in Greek, path information is often encoded in verbs. In a final analysis, we looked at the average semantic spread of Greek source and goal verbs. (English path verbs were used so infrequently that an analysis of this sort would reveal no useful information.) Similar to the results of the adposition analyses, an overall effect of Verb Type was found ($F(1, 27) = 13.33$, $p = .0011$; $M_{GOAL} = 1.97$, $M_{SOURCE} = 3.12$) such that source verbs had a larger spread than goal verbs. However, there was no effect of Age or Age by Verb Type interaction.

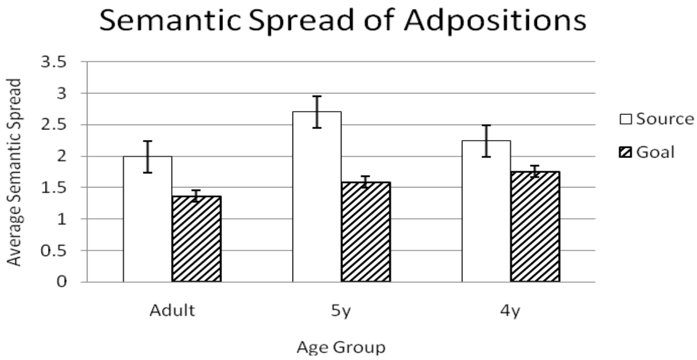

Figure 5. Average semantic spread of path adpositions, collapsing across language.

To summarize, we explored the possibility that the goal bias might differ depending on language-specific aspects of the use of spatial expressions. The data from the frequency count and semantic spread analyses demonstrate that the goal bias is strong enough to persist across both verb and adposition encoding systems for Greek (as well as English). Nevertheless, the vulnerability of source expressions seems to be manifested in slightly different ways in the two languages: the source adposition system is particularly impoverished in Greek (as a result of greater reliance on verbs to encode path information.)

4. Conclusion

In conclusion, we have provided evidence of the persistence of a source-goal asymmetry in the linguistic encoding of spatial information in speakers of both English and Greek. Specifically, this cross-linguistic bias is revealed through the frequency of information – with goal information being given more frequently than source information. This finding is consistent with previous work on the source-goal asymmetry (Landau & Zukowski, 2003; Lakusta & Landau, 2005; Regier & Zheng, 2007). We also found support for the asymmetry in the number of source and goal expressions used, with more goal expressions than source expressions used in general. Also, the semantic specificity of source and goal expressions (both verbs and adpositions) revealed that source expressions in both English and Greek are less specific in meaning than goal expressions. This is a new and exciting finding which adds to previous reports on the breadth of meaning in path expressions (e.g., Regier & Zheng, 2007). These results support the goal bias and show that the bias emerges from potentially universal ways of encoding motion events linguistically.

However, we must note that, in addition to the universal tendency to preferentially encode goal information, we found a language-specific effect: English and Greek speakers differed in the number of path expressions used in this task. That is, while participants used more goal expressions than source expressions overall, Greek speakers used fewer adposition types than English speakers did (and the vulnerability of source adpositions was particularly evident in the Greek data). Thus universality and language-specificity both appear to play a role in the structure and acquisition of path vocabulary.

References

Bowerman, Melissa. (1996). Learning how to structure space for language: A crosslinguistic perspective. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), *Language and Space* (pp. 385-436). Cambridge, MA: MIT Press.

Bowerman, Melissa, de León, Lourdes, & Choi, Soonja. (1995). Verbs, particles, and spatial semantics: Learning to talk about spatial actions in typologically different languages. *Proceedings from the 27th Annual Child Language Research Forum, USA*, 101-110.

Choi, Soonja, & Bowerman, Melissa. (1991). Learning to express motion events in English and Korean: The influence of langauge-specific lexicalization patterns. *Cognition, 41*, 83-121.

Gilbert, Aubrey L., Regier, Terry, Kay, Paul, & Ivry, Richard B. (2006). Whorf hypothesis is supported in the right visual field but not the left. *PNAS, 103(2)*, 489-494.

Johnston, Judith R., & Slobin, Dan I. (1978). The development of locative expressions in English, Italian, Serbo-Croation and Turkish. *Journal of Child Language, 6(3)*, 529-545.

Lakusta, Laura. (2006). Source and Goal Asymmetry in Non-Linguistic Motion Event Representations (Doctoral dissertation, John's Hopkins University, 2005). *Dissertation Abstracts International: Section B: The Sciences and Engineering, 66,* 6944.

Lakusta, Laura & Landau, Barbara. (2005). Starting at the end: The importance of goals in spatial language. *Cognition, 96,* 1-33.

Lakusta, Laura, Wagner, Laura, O'Hearn, Kirsten & Landau, Barbara. (2007). Conceptual foundations of spatial language: Evidence for a goal bias in infants. *Language Learning and Development, 3(3),* 179-197.

Landau, Barbara, & Zukowski, Andrea (2003). Objects, motions, and paths: Spatial language in children with Williams Syndrome. *Developmental Neuropsychology, 23 (1&2),* 105-137.

Levinson, Stephen C. (1997). From outer to inner space: Linguistic categories and non-linguistic thinking. In E. Pederson & J. Nuyts (eds.) *With Language in Mind: the Relationship Between Linguistic and Conceptual Representation*, 13-45. Cambridge: Cambridge University Press.

Mandler, Jean M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review, 99(4)*, 587-604.

Papafragou, Anna. (2007). Spatial asymmetries in language and memory. 32nd Annual Boston University on Language Development, 2-4 November.

Papafragou, Anna, Massey, Christine, & Gleitman, Lila (2002). Shake, rattle, 'n' roll: The representation of motion in language and cognition. *Cognition, 84,* 189-219.

Pinker, Steven. (1994). *The language instinct*. New York: William Morrow.

Regier, Terry & Zheng, Mingyu (2007). Attention to endpoints: A cross-linguistic constraint on spatial meaning. *Cognitive Science, 31,* 705-719.