

# ON THE ACQUISITION OF MOTION VERBS CROSS-LINGUISTICALLY\*

Anna Papafragou<sup>a</sup> & Stathis Selimis<sup>b</sup>

<sup>a</sup> University of Delaware, <sup>b</sup> University of Athens

<sup>a</sup> [papafragou@psych.udel.edu](mailto:papafragou@psych.udel.edu), <sup>b</sup> [sselimis@yahoo.gr](mailto:sselimis@yahoo.gr)

## Abstract

Languages encode motion in strikingly different ways. Languages such as English communicate the manner of motion through verbs (e.g., *roll*, *pop*), while languages such as Greek often lexicalize the path of motion in verbs (e.g., *ascend*, *pass*). In a set of studies with English- and Greek-speaking adults and 5-year-olds, we ask how such lexical constraints are combined with structural cues in hypothesizing meanings for novel motion verbs. We show that lexicalization biases generate different interpretations of novel motion verbs across ages and languages; furthermore, they generalize to the domain of caused motion. Crucially, these language-specific effects interact with universal mappings between syntactic structure and semantic content, and these interactions are respected by both adults and young children.

## 1. Introduction

One of the most vexing tasks facing the young language learner is acquiring the meaning of verbs. In approaching this problem, the learner has to collect and organize complex observations about event referents across multiple situations (e.g., Gropen et al., 1991; Kersten & Smith, 2002; Mandler, 1996). Such observational evidence needs to be combined with lexical (Berman & Slobin, 1994) and structural (e.g., Brown, 1957; Gleitman, 1990; Naigles, 1990) properties of linguistic stimuli to build hypotheses about verb interpretation.

An important source of information about verb meanings is knowledge of form-meaning mappings that are specific to the child's native language. Since languages differ in terms of segmenting and packaging even the simplest and most 'natural' events, such knowledge can be useful in narrowing interpretations for new words. For instance, languages differ in terms of the elements of motion they typically lexicalize in verbs (e.g., Berman & Slobin, 1994; Naigles et al., 1998; Papafragou et al., 2002; Selimis, 2007; Slobin, 1997; Talmy, 1985,

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\* This research was supported by NSF BCS-0641105 grant to A. Papafragou. S. Selimis' research is co-financed within Op. Education by the European Social Fund and Greek National Resources. We thank A. Karousou, D. Katis, E. Kristallogianni, V. Strafioti, S. Lorch, A. Ritter, K. Woyden, K. Goodwin, C. Friedberg, L. Yarzab, and the parents and children at the Early Learning Center in Newark, Delaware, and daycare centers in Evia, Greece, for their help in conducting the experiments. For fuller analysis of the data reported here, see Papafragou and Selimis (2007a).

1991). English, Polish and other *Manner* languages encode manner information in the main verb (*Mary jumped...*) and path in modifiers (*to the window*). Greek, Spanish and other *Path* languages often encode path in the main verb (Gr *I Maria pige sto parathiro...* ‘*Det Mary went to-Det window*’) and may delegate manner in a modifier (*pidontas* ‘jumping’). These verb lexicalization biases affect the way novel motion verbs are acquired cross-linguistically. In Naigles and Terrazas (1998, Exp. 2), after watching a simple motion event (e.g., a woman skipping towards a tree) and hearing a nonsense verb describing the event, Spanish-speaking adults gave path and English-speaking adults gave manner interpretations of the new verb.

Interestingly, Naigles and Terrazas (1998) found that motion verb interpretations in both language groups were also affected by semantic constraints placed by the syntactic frame that the novel verb appeared in: transitive frames with NP-direct objects (*She’s kradding the tree*) elicited more path interpretations, while intransitive frames with directional modifiers (*She’s kradding towards the tree*) elicited more manner interpretations across both languages. Perhaps most strikingly, lexical preferences interacted with frame information. Specifically, when the semantic implications of a frame agreed with a language’s lexical conflation patterns, speakers were very consistent in following the demands of the frame: English speakers presented with intransitive-with-directional (‘manner’) frames offered predominantly manner choices and Spanish speakers presented with transitive (‘path’) frames offered predominantly path choices. In contrast, when the semantic implications of the frames were inconsistent with a language’s conflation patterns (‘path’ frames for English, ‘manner’ frames for Spanish), speakers were ambivalent and less consistent in their choices.

Our goal in this paper is to consider more closely the nature, scope, and potential usefulness of verb lexicalization biases for verb acquisition, focusing on the domain of motion. One question that is raised by earlier findings is how early these biases emerge. Hohenstein et al. (2004) and Hohenstein (2005) have shown that verb lexicalization preferences are already emerging at the age of 7 in English- and Spanish-speaking children. However, there was no evidence of such language-specific biases in younger children: Hohenstein et al. report that both English- and Spanish-speaking 3-year-olds preferred to extend novel motion verbs on the basis of sameness of manner of motion. The problem does not seem to lie with learners’ ability to form lexical-semantic biases: we know that children below the age of 3 are able to form generalizations about extensions on the basis of a few exemplars in laboratory settings (Smith et al., 2002). It could be, therefore, that the limited repertory of verbs 3-year-olds know simply does not support such lexicalization biases (see Havasi and Snedeker, 2004). At this point, it is an open question whether different methods might reveal the presence of verb lexicalization biases in children below the age of 7, and if so, how tightly coupled these biases are with the internal composition of the verb lexicon.

A separate (but related) question is whether the observed lexicalization patterns generalize beyond the class of (spontaneous) motion verbs to caused motion verbs. Consider, for instance, an event where a girl is kicking a ball into a basket. A novel transitive verb describing the event (*The girl is V-ing the ball*) could describe either the Means ('kicking') or the Result sub-event ('sending'). The Means-Result distinction is a version of the Manner-Path distinction for spontaneous motion. Both distinctions relate to the How vs. the Where To of an event as well as raise similar perspective-taking problems for the learner: given two simultaneously present aspects of an event in the extra-linguistic context, which one would be a better candidate for the meaning of a novel verb? It is therefore reasonable to expect the lexical bias we find with spontaneous motion events to generalize to the much broader class of caused motion events cross-linguistically.<sup>1</sup> Furthermore, it is reasonable to expect that this bias should be implicated in the acquisition of caused motion (or action) vocabulary more broadly (with motion being one sub-type of action; see Talmy, 1991).

Language-specific biases in encoding aspects of caused motion, if they exist, are expected to interact with the semantic implications of transitivity. We know that novel verbs in transitive frames are predominantly interpreted as Result-oriented, rather than Means-oriented. This is because there is a tight connection between transitivity and causativity (Bowerman, 1989; Slobin, 1985), and Result but not Means verbs incorporate a causative component (e.g., *the girl is sending the ball* means that the girl is causing the ball to go somewhere but *the girl is kicking the ball* encodes no causation; Dowty, 1979; Jackendoff, 1990; Levin & Rappaport Hovav, 1995). This bias for Result/causative interpretations of novel transitive verbs has been observed in verb learning studies with English children (e.g., Forbes & Farrar, 1993; Gropen et al., 1991), and is known to exist already at the age of 2 (Bunger & Lidz, 2007). The question is whether this bias might turn out to be even stronger in learners of languages that do not consistently lexicalize Means information in the main verb.

The present studies compare how English- and Greek-speaking 5-year-olds and adults approach spontaneous (Experiment 1) and caused (Experiment 2) motion events in situations when they either have to describe these events, or learn a novel verb that refers to them. Our general goal is to look at how the lexical form and syntactic environment of a newly encountered motion verb are recorded to yield language-specific meaning conjectures. We expect subjects in verb learning contexts to weigh event components such as manner and path or means and result of motion differentially depending on whether their native language tends to encode the corresponding meaning elements in the main verb or not. More specifically, we

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<sup>1</sup> In both English and Greek, manner and means verbs seem to follow similar distributions: in English, such verbs can appear in resultative frames denoting culminated action (e.g., *The ball rolled into...*, *She kicked the ball into...*) but in Greek, such constructions have limited acceptability (e.g., Giannakidou & Merchant, 1999; Snyder, 2005). This fact restricts the frequency of means/manner verbs in Greek, since speakers need to switch to a result/path verb for resultative frames.

expect manner (and means) conjectures in English speakers to be higher compared to Greek speakers. Furthermore, we expect these lexical preferences to interact with the semantic implications of the syntactic frames (intransitive vs. transitive) in which these verbs appear.

## **2. Experiment 1: Intransitive (spontaneous motion) verbs**

### 2.1. Participants

Participants were randomly assigned to either a Verb Learning or a Production task. Participants in the Verb Learning task comprised 10 Greek children between 4;1 and 5;10 years (mean: 5;1), 10 English children between 4;7 and 5;8 (mean: 5;0), 10 English-speaking and 12 Greek-speaking adults. Ten Greek children between 4;5 and 5;10 (mean: 5;3) and 10 English children between 4;5 and 5;7 (mean: 4;9), together with 12 Greek-speaking and 10 English-speaking adults participated in the Production task. Children come from daycares at Newark, Delaware (US) and Northern Evia (Greece). Most adults were undergraduates at the University of Delaware and the University of Athens (Greece).

### 2.2. Method

#### 2.2.1. Materials

Stimuli were 48 short silent animated motion clips organized in 16 triads. Each triad consisted of a sample event and two variants. Sample events depicted entities spontaneously moving along a path in a certain manner (e.g., a ball bouncing to a box). Both path and manner components were salient in these events. Each of the variants presented a specific change to the original event. In the Same-Path variant, only the manner of movement was changed (the ball rolled to the box), while in the Same-Manner variant only the path (the ball bounced past the box). Half of the triads involved animate and the other half inanimate agents.

#### 2.2.2. Procedure

In the Verb Learning task, the stimuli were presented on two identical laptop computers placed next to each other. Each sample played twice, once on the screen on the left and once on the screen on the right. Then participants watched the two variants, one on each screen, and matched the sample to one of the variants. The presentation sequence for each triad was as follows: a) Sample event shown on the left screen (the right screen is black). b) Sample event replayed on the right screen (the left screen is black). c) Both screens are black. d) First variant shown on the left screen (the right screen is black). The last frame of the event freezes on screen. e) Second variant shown on the right screen. The last frame freezes on screen.

Children were introduced to a puppet who enjoyed describing the clips using strange words. They were asked to help the experimenter understand what the puppet meant. While the sample event was playing, the puppet described the scene with a 'mystery' verb (e.g.,

*Look! The ball is gorp-ing!; Gr Kita! I bala tili!*). The sentence was repeated while the sample played a second time. While watching the variants, children were asked, *Do you see the ball gorp-ing now? On which screen?* (Gr *Tora vlep-is oti i bala tili? Se pia othoni?*), and had to pick the scene that could best be described by the same ‘mystery’ word. For adults, the procedure was the same but the experimenter himself offered the ‘mystery’ words.

We included a practice triad in the beginning of each session which did not involve pure motion/displacement events but showed a man manipulating a box. Three Greek-speaking and two English-speaking children who did not pass the practice triad were replaced.

Participants in the Production task described all events. Unlike the main phase of the experiment, sample events were viewed only once. Their responses were tape recorded.<sup>2</sup>

Participants were tested individually in a single session. Screen allocation (left-right) for Same-Path and Same-Manner variants was counterbalanced for each participant, with the constraint that, on consecutive trials, variants playing on the same screen were never of the same type (i.e., Same-Path or Same-Manner). Order of presentation of the triads was counterbalanced within each task.

## 2.3. Results

### 2.3.1 Production task

We focus on the descriptions of sample events, since they offer the best comparison point to the verb conjecture data presented below. Verbs in these descriptions were coded as Manner if they encoded the speed, rate, gait or other internal details of the motion (e.g., *pidol/jump*, *kilo/roll*); Path if they encoded the trajectory of the moving agent (e.g., *fevgo/leave*, *diashizo/cross*); or Other if they did not encode motion at all (e.g., *pezo/play*). A summary of the production data for these events is given in Table 1. As is clear from the Table, there is an asymmetry in the expected direction between English and Greek: English speakers used exclusively manner verbs 77% of the time compared to only 27% in Greek speakers. By contrast, Greek speakers used exclusively path verbs 56% of the time compared to only 16% in English. Furthermore, children used manner verbs less frequently than adults overall (48% vs. 57%), while the opposite holds for path verbs (44% vs. 29%).

Table 1. Verb types in the descriptions of sample events

| Percent of Verb types         | English  |        | Greek    |        |
|-------------------------------|----------|--------|----------|--------|
|                               | Children | Adults | Children | Adults |
| Path V                        | 23.7     | 9      | 65       | 48.9   |
| Manner V                      | 70       | 85     | 26       | 29.1   |
| Path V + Manner V (2 clauses) | 2        | 0      | 5        | 18.7   |

<sup>2</sup> The production data were collected as part of a larger project on event categorization and language (see Papafragou and Selimis, 2007b).

|              |            |            |            |            |
|--------------|------------|------------|------------|------------|
| Other V      | 4.3        | 6          | 4          | 3.3        |
| <b>Total</b> | <b>100</b> | <b>100</b> | <b>100</b> | <b>100</b> |

### 2.3.2 Verb Learning task

In the Verb Learning task, English participants offered manner guesses 60% of the time while Greek participants 34% of the time. More detailed analyses showed that English speakers have reliably higher rates of Manner choices than Greek speakers on all items except for two: in the first item, the change in manner is subtle (a duck is ice-skating vs. roller-blading) but the change in path is more dramatic (the duck is crossing vs. circling the ice rink) - hence the majority of subjects in both languages had a low preference for manner in extending the novel verb; the second item involves an event with an inanimate agent (a leaf moving about) for which manner considerations again were a very low priority for both language groups.

Children's performance was similar to adults' on seven of the items, while on the remainder of the items, children offered either more or fewer Manner conjectures (on three and six items respectively). These differences relate to the path changes in these events. Children gave fewer Path verb interpretations than adults when the change in path involved a reversal in the visual trajectory (e.g., a bottle spinning down to the bottom of the sea vs. up to the surface). Conversely, in items where children were more likely than adults to pick a Path interpretation, the directionality of the trajectory did not change but only the relationship with the reference object did (e.g., a ball went to a box vs. past a box). Furthermore, the majority of items where children's and adults' interpretations converged did not involve trajectory reversals. To explore this idea, we split our items depending on whether the path changes in the triad involved a reversal of trajectory or not. We found that adults' Manner conjectures were not dependent on whether there was a trajectory reversal or not, but for children, trajectory reversals led to more Manner selections than the rest of the items. This asymmetry most likely points to a non-linguistic factor affecting judgments about which motion events are the same (and can be named by the same verb): for adults, a change in either path direction or relationship with a ground object is equally likely to steer away from path choices. For children, however, salient perceptual cues to path identity (such as the directionality of the trajectory) are weighed more heavily than a simple change in the geometric relation between the moving object and the reference object in the scene, and are thus more likely to prompt Manner-based choices.

### 2.3.3. Verbalization effects on verb conjectures?

One concern with the present method is that participants might be simply translating the novel verbs into existing verbs. If so, this method would not reveal much about learning new verbs but simply mirror the existing make-up of the motion lexicon in English and Greek. To

address this possibility, we calculated how codable each sample event was for both children and adults within each language - i.e., how often it was named with the same verb by participants in the Production task. We used a strict criterion of verb identity that excluded responses containing multiple verbs. We then selected for each language four high-codability items (where the sample event was named by the same frequent verb – a manner verb in English and a path verb in Greek – by at least half of the participants) and four low-codability items where responses were mixed (fewer than half of the participants chose the same verb for the sample). We compared the proportion of manner matches for each language group in the high- vs. low-codability trials: if implicit naming with existing labels drives subjects' responses, we should see more manner matches for high- than low-codability items in English and fewer manner matches for high- than low-codability items in Greek. We found no effects of codability. We conclude that, even when there were highly accessible and appropriate existing verbs in their native language that labeled the sample events, participants did not use these verbs to paraphrase the novel verbs.

#### 2.4. Discussion

Our results offer support to the idea that language-specific lexicalization biases shape further lexical learning. When exposed to a new motion verb (in an intransitive frame), adults' and children's conjectures about its meaning are consistent with the way motion is lexicalized in their native language: English speakers generally interpret it as a manner and Greek speakers as a path verb. These results confirm and extend earlier studies on the potency of lexicalization biases in adults speaking Path or Manner languages (Naigles & Terrazas, 1998, Exp. 2), and they lower the age at which these cues have been found to be usable by language learners (cf. Hohenstein et al., 2004).

There is one difference between the present data and previous studies that is worth addressing in some detail. Naigles & Terrazas (1998, Exp.1) have suggested that the presence of an intransitive frame encourages manner interpretations across languages, unlike transitive frames which favor path interpretations. Using a task similar to ours, they found that novel bare motion verbs (e.g., *She's kradding*) were assigned manner meanings by both English- and Spanish-speaking adults. In that study, language-specific lexicalization biases emerged only when novel verbs were embedded into different syntactic frames (transitive: *She's kradding the tree*, or intransitive with a directional modifier: *She's kradding towards the tree*, and their Spanish equivalents). Under these conditions, English speakers were overall more likely to form manner interpretations and Spanish speakers path interpretations (*ibid.*, Exp. 2; see also Introduction).

Why should bare intransitive frames prompt manner verb conjectures in Spanish but path verb conjectures in Greek - two Path languages which allow omission of overt subjects and

sometimes objects (e.g., *I bala pernai* 'The ball is passing')? One possibility is that the frequency with which Greek and Spanish drop direct objects for path verbs may differ. In Naigles et al. (1998, Exp. 1), bare intransitive sentences account for about one fourth of Spanish speakers' responses; furthermore, the vast majority (77%) of such bare intransitives contains a manner verb. In the present Greek data, even though the number of bare verb utterances is very low, the manner bias seems much weaker (in adults' responses, bare path verbs account for about 2% and bare manner verbs 4% of total responses; for children, the corresponding proportions are 6% and 16%). In other Greek corpora, the manner bias for bare intransitives is reversed or disappears altogether: Papafragou et al. (2005) report that bare path verbs in children's productions are three times more frequent than bare manner verbs (17% vs. 5%), while in adults' productions bare verbs are negligible (about 3% of total responses) in either class. Finally, in a recent production study in which Greek-speaking adults described motion events using a single (bare) verb, responses were split between path and manner predicates (Papafragou & Trueswell, in prep.). Some of these differences between studies are undoubtedly due to the specific materials used and/or the argument structure of individual verbs. Be that as it may, it appears that a bare (intransitive) surface structure in the referential context of a motion event is a strong cue for manner interpretations for Spanish but not for Greek speakers (for the last group, a bare intransitive structure may be neutral between a path and a manner construal).

This line of reasoning can explain how Spanish and Greek speakers produce different learning outcomes in what otherwise appear to be identical combinations of lexical and structural pressures (path lexical conflation patterns plus intransitive frames). In Spanish, the strong distributional facts for bare intransitives override the preference for path verb lexicalization and lead to more manner verb conjectures. In Greek, the semantic implications of structures without overt complements are more diffuse and leave more room for the lexical bias to exert its influence, leading to path-oriented interpretations for novel motion verbs.

If this conclusion is along the right lines, it has two broader implications. First, it shows that (bare) intransitive structures in the input do not unambiguously point to manner interpretations cross-linguistically (and, in this respect, they differ from transitive frames with direct object NPs which seem clearly path-biased). Second, it suggests that the acquisition of motion verbs proceeds somewhat differently in languages that share verb conflation tendencies depending on the specific distributional properties of the semantic (path vs. manner) verb classes that constitute the domain of spontaneous motion.

### **3. Experiment 2: Transitive (caused motion) verbs**

We now ask whether the lexicalization biases observed for spontaneous motion generalize to the more complex domain of caused motion. We also explore how these lexical biases interact with syntactic factors such as the semantic implications of transitive (causative) frames.

### 3.1. Participants

Participants, recruited from the same populations as in Experiment 1, were again randomly assigned to either a Verb Learning or a Production task. In the Verb Learning task, participants were 16 English-speaking 5-year-olds (range: 4;5-5;9, mean: 5;2), 20 Greek-speaking 5-year-olds (range: 4;1-5;10, mean: 5;0), as well as 16 English-speaking and 25 Greek-speaking adults. Ten Greek children (range: 4;5-5;10, mean: 5;3) and 10 English children (range: 4;2-5;11, mean: 5;0), together with 10 adults from each language, participated in the Production task.

### 3.2. Method

#### 3.2.1. Materials

Stimuli consisted of 8 triads of short silent animated motion clips. Each triad consisted of a sample event and two variants. Sample events depicted an Agent interacting with a Theme and bringing about a Result through some Means (e.g., a girl pushing a snowball down a hill). Both Result and Means components were salient in the sample events. Each of the variants presented a specific change to the original event. In the Same-Result variant, only the Means of movement was changed (the girl hit the ball with her head and made it go down the hill). In the Same-Means variant, only the Result was changed (the girl pushed the ball but the ball rolled in place). All Agents were animate (human), with the exception of one event where the Agent was a self-moving object (a tugboat) and another event where it was a physical force (a wave). All Themes were inanimate objects. Events always involved direct physical causation.

#### 3.2.2. Procedure

The procedure followed that of Experiment 1 for both tasks. One exception was that now in the Verb Learning task participants were introduced to a novel verb in a transitive frame (e.g., *Look! The girl is snerging the snowball!*; *Gr Kita! To koritsi miri ti hionobala!*). While watching the variants, participants had to pick the one that could best be described by the same ‘mystery’ word (*Do you see the girl snerging the snowball now? On which screen?; Gr Tora vlepis oti to koritsi miri ti hionobala? Se pia othoni?*).

### 3.3. Results

#### 3.3.1. Production task

As in Experiment 1, we report results for descriptions of sample events only. Main verbs for these events were coded as Means if they encoded the activity of the Agent (e.g., *push/sprohno*); Result if they encoded the Result/change of state brought about by the Agent (e.g., *take/perno*); Path if they encoded the trajectory of the Theme (e.g., *go/pao*); or Manner if they encoded the way the Theme moved (e.g., *float/pleo*). We were mostly interested in Means/Result verbs, since these verbs were transitive and their subject NP was the Agent. Manner/Path verbs were mostly intransitive and their subject NP was the Theme.

Table 2 summarizes the linguistic production data. As the data show, there is an asymmetry between English and Greek: English speakers used many more Means verbs than Greek speakers, and the opposite pattern holds for Result verbs. Furthermore, English speakers offered responses containing exclusively Means verbs more often than Greek speakers (63% vs. 35%).

Table 2. Verb types/combinations in the descriptions of sample events

| Number of Verb types             | English   |           | Greek     |           |
|----------------------------------|-----------|-----------|-----------|-----------|
|                                  | Children  | Adults    | Children  | Adults    |
| Result V                         | 4         | 3         | 12        | 15        |
| Path V                           | 17        | 1         | 19        | 6         |
| Means V                          | 41        | 59        | 32        | 25        |
| Manner V                         | 7         | 6         | 2         | 3         |
| Means V + Result V               | 1         | 1         | 3         | 6         |
| Manner V + Result V              | 0         | 0         | 1         | 0         |
| Means V + Path V                 | 3         | 4         | 6         | 16        |
| Manner V + Path V                | 0         | 0         | 2         | 0         |
| Path V + Result V                | 2         | 1         | 2         | 3         |
| Other responses                  | 6         | 5         | 1         | 6         |
| <b>Total number of responses</b> | <b>80</b> | <b>80</b> | <b>80</b> | <b>80</b> |

Conversely, English speakers used exclusively Result verbs only 4% of the time and Greek speakers 16% of the time. There was no difference in the proportion of Path verb-only sentences across languages; the only difference we found was that, overall, children used Path verbs more frequently than adults (22% vs. 4% respectively). (We did not compare the limited tokens of Manner verb-only sentences in the two languages.)

Participants' responses often broke down the sub-events in our stimuli into separate clauses (e.g., *She pushes it, and the snowball rolls down the hill*). We therefore looked at the proportion of those answers in each language that contained a Means, Result or Path verb irrespective of other verbs. These analyses again confirmed the presence of cross-linguistic differences: Means verbs were more frequent in English than in Greek (70% vs. 56%), while Result and Path verbs were more frequent in Greek than in English (26% vs. 7% for Result and 35% vs. 18% for Path verbs respectively). In addition, adults used more Means verbs but

fewer Path verbs compared to children overall (74% vs. 52% for Means verbs; 22% vs. 31% for Path verbs).

### 3.3.2. Verb Learning task

In the Verb Learning task, English speakers offered more Means guesses than Greek speakers (42% vs. 30%). Age did not affect the proportion of Means guesses.

## 3.4. Discussion

The present data offer a clear demonstration of language-specific patterns in both adults' and 5-year-olds' descriptions of caused motion. When selecting a verb to describe an event in which an Agent acts upon a Theme and causes it to undergo a change of location, English speakers are more likely than Greek speakers to use a verb naming the Means component and Greek speakers are more likely to use a verb naming the Result component. Furthermore, this pattern affects conjectures about novel transitive verbs naming the Agent's action in the two languages, with English speakers being more likely to extend a novel caused motion verb on the basis of sameness of physical activity (i.e., Means) compared to Greek speakers.

Despite these cross-linguistic differences, both language groups converge in their overall interpretive preferences for novel verbs of caused motion appearing in transitive frames: they select Result conjectures for the majority of newly encountered such verbs ( $M_{\text{Eng}} = 58\%$ ,  $M_{\text{Gr}} = 70\%$ ). Furthermore, this preference characterizes both children and adults. This finding is consistent with prior results showing a bias for Result-oriented over Means-oriented interpretations of novel transitive verbs in English (e.g., Bunker & Lidz, 2007; Forbes & Farrar, 1993; Gropen et al., 1991; cf. also Bowerman, 1989; Slobin, 1985). In addition, these preferences show that verb learning crucially relies on the presence of strong and principled links between syntactic structure and semantic content which work along similar lines across languages and individual events (see also Gleitman, 1990; Naigles, 1990; Fisher et al., 1991).<sup>3</sup>

Importantly, the English-Greek convergence on Result-based interpretations shows that the semantic implications of transitivity are stronger than lexical biases in determining which event sub-component should be labeled by a novel verb: for instance, when transitive syntax and the lexical statistical tendencies of the language are at odds (as was the case with English speakers), the semantic demands of syntax trump the language-specific lexical biases. Put differently, even though Result verbs are produced infrequently (less than 7% of the time) in English, transitive syntax led English speakers to assume Result interpretations of the target

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<sup>3</sup> In a non-linguistic version of the present study, when instructed to find a clip where 'the same thing is happening', the majority (73%) of adults in each language picked the Same-Result variant (unpublished data; see also Papafragou & Selimis, 2007b).

verbs about 60% of the time.<sup>4</sup> These data are reminiscent of other studies where universal syntactic cues to verb meaning (i.e., the very same link between transitivity and causativity) proved more powerful than strong language-specific lexical-probabilistic cues (i.e., the link between individual morpholexical items and causative interpretations; Lidz et al., 2003). They are also in the same direction as findings that emphasize the potency of syntactic cues over strong contextual cues for the acquisition of verb meanings (Papafragou et al., 2007).

#### **4. General Discussion**

Our studies explored the explanatory potential of language-specific lexicalization biases for a theory of verb learning. We were particularly interested in motion events involving simultaneous and salient competing dimensions (e.g., the manner vs. the path of motion), for which lexical biases might provide a useful source of semantic constraint. We showed that verb lexicalization biases shape motion verb learning cross-linguistically: when English and Greek speakers are given a motion verb in isolation and asked to map it onto either the manner or the path of a motion event, English speakers prefer manner and Greek speakers path guesses, in accord with the verb typologies in the two languages. Our data also offer evidence for effects of lexicalization biases beyond the spontaneous motion domain, with caused motion events being subject to language-specific lexicalization pressures. In both of these empirical domains, effects of the lexicalization bias are already present at 5 years, with language-specific expectations about what novel verbs can refer to being close to adults'. Our findings confirm and extend prior evidence about the presence of such biases in adults and older children (Naigles & Terrazas, 1998; Hohenstein, 2005; Hohenstein et al., 2004).

In addition, our studies show that the syntactic structures in which novel motion verbs appear interact with lexical tendencies. When frames do not go against the preferred lexicalization patterns of the language (Experiment 1), lexical biases emerge. But when there is a clash between the two (Experiment 2), the effects of lexical bias are constrained. Particularly clear evidence for this conclusion comes from the fact that English speakers who rarely use transitive Result verbs spontaneously adopt Result interpretations for novel verbs embedded in transitive frames (Greek speakers, who use Result verbs more regularly, are

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<sup>4</sup> One might argue that the Same-Means vignettes might also be nameable by a causative verb, albeit of a different kind. Recall that, in these vignettes, the Theme does undergo some (minimal) change of state: in the example of the girl pushing the snowball down a hill, the Same-Means variant shows the girl pushing the ball and the ball rolling in place. Perhaps a novel transitive verb could be made to label both the sample and the Same-Means variant, if the verb encoded a specific Means plus a more general causative/Result meaning (something like 'cause to undergo some change by pushing'). The problem with this view is that the combination of a specific Means and a causative meaning to the exclusion of a specific Result is an illicit linguistic representation: there are no verbs cross-linguistically that encode simply a Means + CAUSE combination of features (Harley, 1996; Bunker & Lidz, 2007). We take it, therefore, that Means choices in our Verb Learning task reflect interpretations that maintain the specific Means of the original event but lack a causative component.

even more likely to hypothesize Result meanings in these contexts). Again, children seem to have access to the same set of syntactic cues to verb interpretation as adults, and to weigh them in heavily when applying lexical cues: their verb extension patterns in both languages are identical to those of adults. Our findings add to a body of evidence demonstrating learners' commitment to syntax and its semantic implications, even compared to other cues to verb meaning (e.g., Gleitman, 1990; Fisher et al., 1991; Lidz et al., 2003; Naigles, 1990; Naigles & Terrazas, 1998; Papafragou et al., 2007).

Several questions remain about the nature of language-specific lexical biases and their contribution to verb learning. A first question concerns their scope. One of their limitations is clear: even though they favor certain lexical candidates over others (path vs. manner, result vs. means) within the semantic field of motion, lexicalization biases per se do not tell us how the semantic field of motion is chosen over other possible semantic spaces when a new verb is encountered (the problem is, of course, far from trivial; see Chomsky, 1959; Gleitman, 1990).

Even within the semantic space of motion, lexicalization biases may need to combine with more general principles to guide verb interpretation. For instance, Levin & Rappaport Hovav (1992) have suggested that languages resist naming both manner/means and path/result components into a single verb; even though there are pairs such as *beat-mix* or *wipe-clean*, in which the first verb denotes the manner and the second the result/endpoint of an action, there is no monomorphemic verb that encodes both. Even if this observation reflects a universal tendency rather than an absolute lexical gap, it could be a powerful source of constraints on verb meaning assignments. In trying to obey this general lexicalization principle, children should resist conflating both the manner in which an action is performed and the ensuing result within a single verb, even when manner (or means) of motion and endpoint (or result) are salient in a scene. Furthermore, logically, the choice of which component to encode in a verb should be determined in part by language-specific lexical biases (together with syntactic factors) and should lead to different solutions of this puzzle across languages. We solved this verb conflation puzzle for our participants by presenting them with a choice between segmented manner/means or path/result event components. It would be interesting to explore whether, in a more unconstrained task, learners could use lexicalization biases in choosing a single sub-component of a complex motion event to be the meaning of a newly encountered verb. We are currently testing this possibility with young children.

A second question is how early lexicalization biases emerge, and how input supports the earliest forms of these generalizations across languages. Recall that Spanish and English 3-year-olds are not different in their verb extension preferences, which are mostly manner-based (Hohenstein et al., 2004; cf. Introduction). In English, path verbs are vanishingly rare in the input and relatively infrequent in young children's speech – except for *come* and *go* (see Experiment 1; cf. Papafragou et al., 2002; Papafragou & Selimis, 2007a). In Spanish and

Greek, however, both manner and path verbs appear in the input (Naigles et al., 1998; Papafragou et al., 2002; Selimis 2007). Furthermore, early acquired verbs in Greek lexicalize path (e.g., *kateveno* ‘descend’, *beno* ‘enter’) but also manner (e.g., *pido* ‘jump’, *peto* ‘fly’) (Selimis, 2007). As a result of these asymmetries, the manner verb bias in English might emerge earlier and more clearly than the path verb bias in Spanish or Greek.

A related issue is how flexible these biases are when first developed. There is evidence that, at least in adults, lexicalization generalizations are malleable: after being exposed to brief training on corpora of verbs with different manner/path compositions, English-speaking adults adapted their generalizations of novel motion verb meanings to the statistics of the training corpus, and were able to learn path verbs if such verbs were dominant in the training set (Havasi & Snedeker, 2004). Similarly, there is preliminary evidence that English children aged 5 years can form path lexicalization biases in response to a clear category structure (*ibid.*). These results confirm the conclusion that verb lexicalization biases in the domain of motion emerge as a consequence of experience with previously learned motion verbs, and can change as a function of the input.

Finally, it is an open question how motion verb biases operate across different languages. Recall that our findings revealed subtle differences in the way lexical and structural cues combine in languages (Spanish and Greek) that otherwise share motion lexicalization biases. Recent linguistic evidence suggests that there is considerable variation even within the traditional Path and Manner typological groups (e.g., Beavers et al., 2004). It remains to be seen how morpho-syntactic properties of languages within these broad classes combine with lexical biases and general structural factors to guide learners’ hypotheses about how novel verbs map onto event meanings.

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