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Language Typology and Sentence Frame Effects on Motion Verb Interpretation in Grade Schoolers

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Abstract

Most English descriptions of motion events express manner in the main verb and path in a prepositional phrase, as in "She *skips* out of the house". However, the same event *can* be described differently if a different syntactic frame is used: "She *exits* the house". While young children have been found to interpret novel motion verbs according to the syntactic frame information, adults have been found to rely somewhat more on the overall language pattern, or typology (Hohenstein et al., 2004; Naigles & Terrazas, 1998). Grade schoolers have not been examined in this paradigm, and their linguistic abilities suggest that they may show an important part of a developmental trajectory regarding the acquisition of motion verbs.

Sixty-four children grade schoolers and 12 adults viewed live-action events showing spontaneous motion events and heard 8 novel verbs in manner frames ("He's daxing up the stairs"), and 8 in path frames ("He's kradding the garage"). Side-by-side videos then showed the actor performing the same manner but a different path, or performing a different manner along the same path. The accompanying audio asked the participant to find the action matching the verb screen (e.g. "Choose kradding").

Children of all ages chose more manner than path interpretations in both conditions, while adults showed fewer manner interpretations in the path frame condition. As the path frame condition progressed, children chose gradually more path interpretations; moreover, eye movement data show that children looked towards the path screen more during the path frame condition. Support for a u-shaped developmental trajectory and a shift from language-general to language-specific word-learning mechanisms are discussed.

Language typology and sentence frame effects on motion verb interpretation in grade schoolers

How children solve the problem of mapping new words to referents in a scene is well studied and hotly debated in theoretical and experimental literature (e.g. Quine, 1960; Golinkoff, Hirsh-Pasek, Bloom,et al., 2000). The problem can be summed up by thinking of an infant watching her sister skip across the room and hearing her mother say: "Look, she's skipping!" There are many aspects of the scene that the infant can potentially understand as "skipping": going across a room, smiling, moving quickly, even a new nickname for the sister! Researchers have identified many possible sources of information that a child (or adult) may use when interpreting a new word, in an effort to find out how children come to find the correct meanings of words, and how they do so incredibly efficiently: children between the ages of one and two may produce 200 to 600 words, and understand many more (Clark, 2009); by the first grade they may know 10,000 words (Anglin, 1993). Work on the identification and assessment of these sources has led to important findings about the process of language acquisition. For example, it is possible that children learn many of their earliest words based on visual information and concreteness of the object or concept being labeled (Gentner & Boroditsky, 2001). These "word to world mappings" work when something can be easily labeled and indicated, but there are many words that are considerably more difficult to map to a visual referent, among them most verbs (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). This project examines interpretations of motion verbs in the contexts of two types of information that a child might have at his/her disposal: language-specific typological patterns and syntactic frames.

Language-specific typologies

Talmy (1985) has carefully outlined the major ways that languages differ in their expression of motion events. Motion events are said to include a *figure* that *moves* in relation to a *ground* along a *path*. The italicized words are the important components of a motion event, with the figure being an object that is moving with respect to some stationary aspect of the environment, referred to as the ground element. The direction or relationship between the figure and ground comprises the path of the event, and the movement is either implied in the sentence or directly described through a word expressing the manner of motion.

Languages appear to fall into one of three groups when they are analyzed based on characteristic motion event descriptions. Talmy defines "characteristic" in this case as colloquial, frequent, and pervasive (1985, p. 62). It is important to note that these distinctions are not absolute, a point that will be returned to later. One group of languages conflates motion and manner of motion, and expresses these in the main verb of the sentence. Other languages conflate motion and the path of motion, and expresses these in the main verb. Finally, and more rarely, some languages combine the figure (i.e. the object that is moving) with the main verb. The following examples illustrate these three typologies in English:

A. Motion + Manner/Cause

(1) The smoke *squeezed* through the opening.

(2) I *kicked* the ball over the fence.

B. Motion + Path

(3) John *entered* the room.

C. Motion + Figure

(4) It *rained* in through the bedroom window.

(Talmy, 1985)

Languages of type A (hereafter referred to as "manner languages", and exemplified by English) combine the fact of motion with a reference to the way that the motion is occurring, or with the cause of the motion. In (1), *squeeze* is expressing that the subject is in motion, while explaining the way that the smoke is moving. Other examples of these manner verbs (to be used with figures besides smoke, of course) include *run*, *skip*, *jump*, or *tiptoe*. Manner of motion is not required in order to report the occurrence of a motion event. The manner is an optional aspect of the event, as can be seen in type B languages.

These languages (referred to here as "path languages", and exemplified by Spanish and Greek) use the main verb to express the fact of motion along with the direction of that motion. They only optionally refer to the manner in which the motion is occurring by adding another sentence component. The example above describes John's movement with relation to the room (which is the ground in this particular motion event), but it does not say how he is entering the room. The addition of the word "skipping" to the end of the example sentence, for instance, adds a description of the manner of entering. Languages of type C, in which the actor involved in the movement is used as the verb, are mainly indigenous languages of North America. They are not as well documented, and will not be considered further in this discussion. It should be clear that these typologies are not absolute; the fact that the examples 1-4 can be expressed

(grammatically) in English demonstrates that English is capable of using any one of these forms to describe a motion event.

Since Talmy's (1985) original framing of language-specific typologies, researchers have observed another pattern in languages that do not match the three patterns mentioned above. Languages such as Korean and Thai use what is known as "serial verb construction", in which verbs conflating motion and manner *and* motion and path are used in the same clause (e.g. Choi & Bowerman, 1991; Zlatev & Yangklang, 2004). A motion event might be described in Thai as follows:

(5) chán deen khaam thanon khaw paj naj suan

I walk cross road enter go in park

'I walked across the road and into the park'

(Zlatev & Yangklang, 2004, p. 168)

Data from production studies in such languages show a definitively different pattern from any of the types described by Talmy. The equal footing of both verbs in a single clause means that neither one can be considered the "main" verb, and thus the languages do not fit into either "manner" or "path" categories.

Behavioral experiments have demonstrated that this motion verb typology is not just a matter of frequency or verb types available in the lexicon of a given language, but that people are influenced by their language's typology when choosing words to use and when interpreting new words. Berman and Slobin (1994a) elicited narratives from speakers of many ages and many languages, using a wordless picture book (*Frog where are you?*, Mayer, 1969). The picture book shows the story of a boy who loses his pet frog and goes on a journey through the forest to find it; the narratives elicited by the book

necessarily relate motion events, making them a rich source of data for cross-linguistic and developmental studies. Analysis of the motion verbs in narratives elicited from English-speaking participants from age three to adult showed 47 different verb types. Most of these verbs include the manner of motion in their meaning (e.g., *swim*, *crawl*); fewer than 10 of these 47 verbs did not include manner (e.g., *depart*, *go*). Many of the verbs were used with more than one particle (for instance, *fly away* versus *fly out*), and when these were tallied, the narratives from English speakers contained 123 types of motion expressions. In contrast, the narratives elicited from Spanish-speaking participants contained 27 types of motion verbs, focusing mostly on paths of motion (e.g. *acercarse*: 'approach', *meterse*: 'insert-oneself', *traspasar*: 'go-over'), but also including some manner verbs (e.g., *correr*: 'run', and *volar*: 'fly'). In addition to using mostly path verbs, the Spanish speakers' narratives conveyed manner much less frequently; that is, they did not make up for the lack of manner in the verb by using other sentence components to describe manner (Sebastián & Slobin, 1994).

Özçalişkan's (2009) analysis of children acquiring Turkish (another path language) describing the frog story found similarly overwhelming differences between Turkish- and English-speaking children. Even at age three, English-speaking children were using significantly more manner verbs than their Turkish counterparts, and vice versa. Moreover, Turkish children were more likely to leave out manner information all together in the description of motion events, opting to simply express the path of the event.

Another example of the significant difference between manner and path languages comes from Slobin's (1996) analysis of the motion descriptions in 20th-century novels

from well-known English- and Spanish-speaking authors and their professional translations. He found that the authors writing in English were much more likely to use the wide variety of manner verbs available in the language, whereas the authors writing in Spanish tended to use fewer motion verbs overall, and were limited in the complexity of the "journeys" they described. In the translations of the novels, he found that the English to Spanish translations were more likely to omit motion information, especially in the case of the trajectory of motion. Thus, even in cases where the motion descriptions are not limited to a certain storyline (as in the "frog story"), and when they are within highly-polished examples of a given language, the typological difference is evident between languages.

Naigles, Eisenberg, Kako, Highter, and McGraw (1998) set out to determine the influence of language-specific typology in English and Spanish in a more tightly constrained experimental setup. Adults were asked to describe pictures and videos carefully created to elicit motion event descriptions. The English speaking participants produced manner verbs almost every time they were asked to describe a simple motion scene. Spanish speakers were highly variable in their verb choice when it came to describing static pictures, but when describing video clips they used significantly more path verbs than manner verbs. (This highlights the importance of stimuli selection and development, which will be discussed later.) Additionally, English speakers were far more likely to include a prepositional phrase describing the source or goal of the motion (91% of the time) than Spanish speakers (only 56% of the time). This demonstrates that speakers of different languages use different distributions of verb types as well as different syntactic forms to describe motion events. Papafragou and Selimis (2010)

replicated this finding with English and Greek speakers, reporting that English speakers used many more manner verbs, and Greek speakers used more path verbs, when asked to describe simple animated events just involving one actor or figure. Taken together, these studies reveal the influence of typology on the way speakers of a given language choose their words when describing motion events.

Experimental studies by Maguire et al. (2010) and Papafragou and Selimis (2010) have demonstrated that adults also differ based on their language typology when they are asked to interpret new verbs. Maguire et al. showed participants an animated starfish (named Starry) who moved against a black background with relation to a ball that remained still in the middle of the screen. Each participant was shown just one instance of Starry traveling over, under, around, or past the ball (different paths), while doing jumping jacks, twisting, spinning, or bowing (different manner) and heard "Look, Starry's blicking!" Then two videos appeared side-by-side, one showing Starry moving with the same manner of motion but along a different path, and the other with a different manner of motion along the same path, and the participants heard "Where's Starry?" In this paradigm, choosing the video with the same manner suggests that the participant believes the novel verb refers to the way the figure is moving, while selection of the matching path screen suggests that the participant assigned the meaning of the verb to the direction of motion. English- and Spanish-speaking adults performed significantly differently on the task, with the English speakers choosing the manner meaning for the verb more often than chance, and the Spanish speakers performing at chance level.

Papafragou and Selimis (2010) also asked their participants to interpret novel verbs in a similar procedure to that of Maguire et al. (2010), but using animated scenes

with a variety of figures and grounds. They found a significant preference among English speakers for a manner interpretation (they chose manner 60% of the time), and a significant preference among Greek speakers for a path interpretation (they chose manner only 33% of the time). These novel verb studies demonstrate that language typology drives adults' guesses at the meaning of a verb they have never heard before.

Exceptions to language-specific typologies

As mentioned previously, typological distinctions do not define absolute patterns in a language. This is clear from examples of elicited verbs that do not fit the pattern, as well as from the fact that adult speakers do not interpret the verbs based on their language's typology 100% of the time. In fact, *come* and *go* are both path-conflating verbs, and are two of the most frequent verbs used in English and some of the earliest produced by young children (Berman & Slobin, 1994b; Hohenstein, Naigles, & Eisenberg, 2004). Other path verbs in English, such as *descend*, do appear in such sentences as "She is descending the mountain". This sentence is similar, but not identical to the meaning of the more frequent "She is walking down the mountain", as she could be descending at a jog in the first sentence. The presence of a preposition (*down*) in the second sentence makes it clear that these two types of verbs appear in different syntactic frames. When the main verb of a sentence expresses the manner of motion, regardless of language, there is often a content-rich prepositional phrase that encodes the path, and with a path verb, the manner may be omitted entirely. In the *smoke* example (1), the ground element (*the opening*) is the object of the prepositional phrase that describes the path. In (3), the ground element (*the room*) acts as the direct object of the path verb.

Thus, manner verbs are typically intransitive, while path verbs typically appear in transitive syntactic frames (Hohenstein et al., 2004).

Exceptions like these have lead to significant controversy around the typological distinctions described by Talmy (1985). In an examination of exceptions to the Spanish path tendency in particular, Aske (1989) observed that manner verbs could be used in cases where the motion event was ongoing. However, a path verb was necessary where the motion event involved a change of state or the end of a path. Naigles et al. (1998) supported this finding by varying the types of paths shown to Spanish speakers, and finding that path verbs were only *required* where a change of state or end of path occurred. In her analysis of elicited speech samples from Turkish-speaking children, Özçalişkan (2009) found that boundary-crossing events *required* the children to use path verbs, even if other events allowed for occasional manner verbs. These findings suggest that there are aspects of the motion event itself that affect patterns in language.

While Aske (1989) and others are content to revise Talmy's (1985) typological distinctions, Beavers, Levin, and Tham (2010) outline an entirely different way of defining typologies. They argue that the exceptions to Talmy's distinctions are too frequent, and that cross-linguistic differences are better defined by looking at a variety of linguistic factors, not related to the concept of motion. These include lexical factors like available verbs and particles, morphological factors like case markers and compounding, and syntactic factors like verb serialization and subordination. Rather than defining two or three typologies, they claim there are as many ways to express motion as there are combinations of these three types of factors in a given language. The reason there appear to be fewer typologies is that speakers choose the least morphosyntactically complex

expression of motion, which in combination with pragmatic constraints, limits the possibilities. All these characteristics illustrate ways in which languages do *not* fall into the traditionally-defined categories. This does not, however, fully answer questions about how and when children know that they should follow the dominant or subdominant pattern. This study, and ones like it, seek to manipulate the presentation of motion verbs in order to examine children's use of the typological patterns.

To this end, Naigles and Terrazas (1998) used a paradigm similar to the Maguire et al. (2010) study in order to explore the effects of syntax *and* language typology on novel verb interpretation. They presented live-action videos of people acting out simple motion events to adult speakers of Spanish and English, together with sentences that either facilitated a manner interpretation of the verb by using an intransitive frame with a prepositional phrase (a "manner sentence": e.g. "She's *kradding* toward the tree"; "Ella está *mecando* hacia el arbol") or a path interpretation of the verb by using a transitive frame with no prepositional phrase (a "path sentence": e.g. "She's *kradding* the tree"; "Ella está *mecando* el arbol"). The participants were asked to choose the meaning of the verb based on side-by-side videos that showed the actor performing the same manner along a different path, or a different manner along the same path. When English speakers heard a manner sentence, they overwhelmingly chose the same-manner screen, and Spanish speakers hearing a path sentence overwhelmingly chose the same-path screen. That is, when the language typology and syntax provided similar information about what the verb might mean, there was little disagreement from the participants. The participants were less consistent when their language-specific typological pattern and the given syntax were in conflict (e.g., a verb in a transitive frame for an English speaker).

These results suggest that adults are strongly influenced by their language's typology when interpreting novel verbs, while also showing some sensitivity to the syntactic frame being used to describe the event.

Deviations from strict typologically-based language can also be seen in developmental studies. As alluded to earlier, a corpus study demonstrates that young children acquiring both English and Spanish produce *come* and *go* (in Spanish: *venir* and *ir*) very early on (Hohenstein et al., 2004). At 25 and 27 months, respectively, children speaking Spanish and English were producing both manner and path verbs, but their most frequent verbs were *come* and *go*. In fact, all of the path verbs produced by the English speakers were these "light verbs", rather than the less frequent Latinate path verbs like *descend* or *exit*. Light verbs are versatile because of their very general meanings, and can be used with many other sentence components (Snedeker & Gleitman, 2004). Along with *get* and *make*, other light verbs, *come* and *go* comprised many of the verbs found by Berman and Slobin (1994b) in the narratives elicited from young English-speaking children.

Maguire et al. (2010) also demonstrated this departure from language-specific typology by comparing children aged two, three, and five years learning English and Spanish, using a procedure identical to the one described earlier (with Starry the animated starfish performing motion events). Toddlers in both language groups showed a preference for the path interpretation of the novel verb, which goes along with the early frequency of the light path verbs, and with findings that infants find changes in paths to be more perceptually salient (Pruden, Hirsh-Pasek, & Golinkoff, 2008). However, the 3- and 5-year-olds showed a strong preference for interpreting the novel verbs as referring

to manner regardless of language group. Recall that the adults had shown an effect of language typology in their interpretations: hence a shift occurred from a language-general strategy to a language-specific strategy at some point between toddlerhood and adulthood.

In a similar paradigm, Papafragou and Selimis (2010) found probabilistic but not absolute effects of language-specific typology on verb interpretation in five-year-olds. When presented with simple animated motion events paired with novel verbs, Greek and English speakers had a tendency to choose path and manner interpretations, respectively. These were similar to the responses made by adults in those two languages with the same procedure and stimuli. These studies suggest that typology has a strong influence on word learning by around age five and in adulthood; however, the results from Naigles and Terrazas (1998) suggest that syntax does influence adults' interpretations of words and can enable a non-typological guess about a word's meaning. Because the less-frequent English path verbs (such as *ascend, enter,* and *approach*) appear in transitive sentences, and adults are influenced by syntactic information, adults may be taking a clue from syntax in order to correctly construe the meanings of these less-frequent verbs. Could syntax override the typological biases in word interpretation to assist with learning verbs that do not fall into the main pattern of a language? If so, we might see evidence of that in children older than those tested in the reviewed experiments.

Effects of syntax on word learning

The syntactic frame in which a new word appears has already been found to be a powerful source of information for word learners (e.g., Naigles & Swensen, 2006). Gleitman (1990) elegantly reviews several reasons that this aspect of syntax is crucial to

mapping novel words to referents, including evidence from the acquisition of sight-related words by a blind child, the cognitive constraints of the child, and the similarity of situations that call for different verbs (e.g. *chase* and *flee*). These situations lay the theoretical groundwork for examining syntax as a source of information that can limit or narrow the number of possible meanings of a word. For instance, syntax can assign a word to the category of label ("Look at the blick"), description ("That is a blickish one"), or action ("He is blicking"). When this information is used to determine the meaning of a word, the procedure is known as syntactic bootstrapping.

Within the category of verbs, syntactic bootstrapping has been shown to help assign a novel verb to a particular type of action. Naigles (1990) used transitive and intransitive sentences in a word-learning paradigm like the ones described above to show that two-year-olds can differentiate between the syntax referring to causative and non-causative actions. The children who heard the transitive sentence such as "The duck and the bunny are blicking", preferred a simultaneous (i.e. non-causative) action, while the children who heard the intransitive sentence, such as "The duck is blicking the bunny", preferred a causative action. This work extends the earlier description of syntactic information as not only categorizing a word into a semantic role, but suggests that children can distinguish between possible meaning of a verb using only the arrangement of noun phrases surrounding that verb. This and other work (e.g. Yuan & Fisher, 2009) demonstrates that syntax is a rich source of information for children when they are hearing a verb for the first time.

Closer to home, Hohenstein (2005; Hohenstein et al., 2004) explored the syntax-typology relationship using a paradigm like that in Naigles and Terrazas (1998), with

live-action videos showing motion events that were described with either a transitive or intransitive sentence. English and Spanish speakers, ages three and seven, watched the motion events and then were shown screens that had a same-manner and same-path event, and were asked to look at the one showing the meaning of the novel verb. The three-year-olds, regardless of language background, tended to follow the syntactic information, and significantly preferred the path interpretation after hearing the transitive frame sentences, and the manner interpretation after hearing intransitive sentences. In contrast, the Spanish-speaking seven-year-old children showed a path preference in *both* sentence frame conditions, suggesting that they, like the Spanish-speaking adults in Naigles and Terrazas, had acquired their language-specific typology. Meanwhile, the English-speaking seven-year-olds still showed some sensitivity to the syntactic frame.

Taken together, these production and word-learning studies with children begin to reveal a developmental pattern. Children demonstrate early (i.e., ages two to three) frequent use of "light" path verbs across languages, and early use of syntax to construe verb meanings, regardless of the overall language patterns that a child is in the process of acquiring. Then, around ages five to seven, an influence of language typology emerges, and verb use and interpretation seems more strongly driven by whether an individual's language follows the manner-based or path-based pattern of motion description. While this interpretation is generally correct given the language pattern, exceptions are allowed where the syntax suggests a different interpretation (Beaver et al., 2010; Naigles & Terrazas, 1998). With this in mind, we would expect children to acquire path verbs early in the language acquisition process, especially if they hear them in a transitive frame. However, evidence from Berman and Slobin (1994b) and Hohenstein et al. (2004)

suggests that English speakers do not acquire many path verbs (aside from *come* and *go*) until later in childhood (i.e. during the grade school years). This raises the following questions relevant to the current study: How is it that adults come to know the low-frequency English words like *enter* and *ascend*? When does syntax become an important and useful cue to verb interpretation? Might grade schoolers, who have not been included in the previous work, be starting to use syntax to acquire English path verbs?

Word learning in grade schoolers

An analysis of English-speaking children estimated that between grades 1 and 5, they increase their vocabulary from about 10,000 words to nearly 40,000 words (Anglin, 1993). The vocabulary that is acquired during this time includes low-frequency and semantically-specialized words. Grade schoolers also show lexical development in terms of linguistic register, changing between informal and formal vocabulary as the social situation dictates. As part of this increasing use of formal and low frequency vocabulary, English speakers begin using more words that are Latinate in origin, rather than relying solely on the simpler Germanic words of the language (Berman, 2007). It is worth noting here that many English path verbs (e.g. *ascend, exit*) are of Latinate origin.

Acquiring subdominant patterns in one's language, such as path verbs in English, requires children to avoid the use of a previously or more strongly held preference for a certain interpretation. One word learning strategy that may be at work in cases like these is mutual exclusivity. Beginning in infancy, children demonstrate a tendency to assign one label to a given object, and reject other labels for that object (Woodward, 2000). This tendency even holds in simultaneous bilingual children by the age of four; that is, when the two labels being offered are at the same category level, the child will assume

that the new label for a object s/he already knows must be of the other language (Au & Glusman, 1990). This tendency develops into an ability to judge the referent of a word based on the speaker's intent and the communicative context of the situation (Diesendruck, 2007; Woodward, 2000), which shows some level of cognition *about* language, or, metalinguistic awareness. Mutual exclusivity would allow a child who knows the word "running" to see a boy running up a staircase and hear a sentence such as "The boy is ascending the stairs", and realize that since the manner of motion already has a label, *ascending* must be referring to some other aspect of the scene. This reasoning would reflect the overall tendencies of English; while there are instances in which English *can* express manner in a transitive frame (e.g. "He walked the streets all night"), these are mostly special usages and speakers do not demonstrate these usages with any frequency (Naigles et al., 1998; Berman & Slobin, 1994b).

The development of metalinguistic awareness during grade school could also have a role in the acquisition of English path verbs. During these years, children gain an understanding of language that allows them to comprehend and use figurative language and polysemous words, for instance, and allows for different strategies in vocabulary acquisition (Berman, 2007). While implicit word learning surely drives many of the earliest acquisition processes, upon gaining metalinguistic awareness children can use more explicit strategies, and even reason about the possible meanings of words given prior knowledge. Anglin (1993), when testing vocabulary in grade schoolers, found children as young as third grade who used reasoning and knowledge of root words to come to meanings (or approximations) of unusual words. For instance, a first grader responded to an experimenter's request to define *sourer* like this: "Um, let me see.

Something's, like something's sour. And you don't like it. Um, it's too sour….Like if something was too sour, you'd make it sourer if you wanted it sourer….that's all I can think of" (p. 88). Contrast this with a fifth grader, who responds to a question about the definition of *treelet* like this: "Like is it *t-r-e-e*?....OK. Maybe it means like a tree….Is it *–let* or *–lit*?...I'm not sure about this, but it might mean a baby tree" (p. 100). The fifth grader shows considerably more knowledge of word parts and explicit reasoning about what those parts might mean than the first grader, demonstrating metalinguistic awareness.

Karmiloff-Smith (1992) has suggested that increased metalinguistic ability might lead to u-shaped developmental patterns. For instance, three- and four-year-old English-learning children produce and correctly interpret the definite and indefinite articles "the" and "a"; moreover, they make correct inferences about an ambiguous situation that can only be determined by understanding the definite/indefinite article distinction. A study of children acquiring French, however, showed 5-year-olds were not as reliable. The indefinite article and the number "one" are homophones in French, and it appears that around age five children become aware of that, and have more difficulty correctly interpreting commands like "lend me one car" versus "lend me a car" (p. 56). Adults, on the other hand, can use prosody and pragmatics to correctly interpret a speaker's intent.

Karmiloff-Smith's (1992) representational redescription model accounts for this change by saying that children first exhibit "behavioral mastery" of a particular linguistic form. A child may produce correct structures and lexical items thanks to a rote knowledge of when those structures and items should be used. Then as vocabulary increases, that pattern or item might be over-regularized, or a child may recognize that

there are cases where its use is ambiguous, leading to incorrect usages. Finally, the child is able to understand or at least recognize the difference between the regular and irregular cases, and again use the linguistic forms correctly. Thus, similar behavior at early and late stages of development are driven by dissimilar processes. This process of redescription results in "representational flexibility and control, which allows for creativity," (p. 16) which may be exactly what a child requires to correctly interpret different types of verbs (i.e. manner and path verbs) that occur in the same contexts (motion events).If this developmental pattern were to apply to English motion verbs, we would expect to see a dependence on syntax to determine verb meaning, followed by a strict adherence to the manner bias driven by the typology, followed by a correct use of a majority of motion verbs, except where syntax indicates a path verb should be used.

Current study

The current study seeks to explore in detail the influence of syntax and the manner typology in grader schoolers acquiring English. The main question addressed will be: when does the English manner typology demonstrate a dominant influence in children's verb learning? This question is yet unanswered because Hohenstein et al. (2004) showed no effects of typology at age three, and mixed results (depending on language group) at age seven. Maguire et al. (2010) and Papafragou and Selimis (2010) suggested typological influence is at work in younger children (around three to five); however, these studies only asked children to interpret verbs with relatively bare, uninformative syntactic frames (e.g. "Look, she's blicking!"). The apparent typology influence may be a result of the combination of syntax and overall patterns; we cannot judge for certain unless children are given a chance to interpret verbs in syntactic frames

that both match their typology and conflict with it. Thus, this study uses two different informative syntactic frames: one that matches the English typology, and one that conflicts.

Additionally, stimuli development and selection needs to be addressed. Crucially for these experiments, both manner and path of an event need to be clear, salient, and somewhat novel to the participants. Maguire et al. (2010) used a simple computer animation that slid around on the screen while performing a motion such as "jumping jacks" (i.e., upper two "arms" move up and down). Papafragou and Selimis (2010) used animations that depended on the instrument or tool or movement to convey the manner. For instance, a boy skating towards a goal was depicted by an animation of a boy with skates on sliding across the screen, with no movement of the body or legs. In neither type of animation does the intended manner of motion actually *cause* the change in location of the figure. The figure slides along a path, and the manner is represented by movements of the body parts or by the perceived instrument of motion. In the ecologically valid stimuli developed for this experiment, the motion events consist of adults outdoors or in a relatively empty room, moving in ways that make the manner and path very relevant to the event (e.g. exaggeratedly marching behind a large tree). And at the very least, the manners of motion create the change in location along the path, which indeed is what manners of motion are supposed to do. For instance, a person hopping on one leg into a building is clearly using that manner of motion to propel herself along that path, making the aspects of the scene salient and realistic with regards to a word-learning task. The manners and paths are not entirely novel (in fact, there is a physical limit on kinds of paths that one can take in 3-dimensional space), but were designed to be

somewhat unusual in order to avoid a strong influence of mutual exclusivity. (See Method section for more details on the stimuli.)

Furthermore, the age of participants in this study (i.e., grade schoolers) means that explicit word learning procedures may be used (see Anglin, 1993; Berman, 2007). For this reason, children were asked not only for their explicit choice of a verb interpretation, but were also videotaped to examine their eye movements, which is an implicit measure of their decision-making process when faced with the interpretation choice. Finally, studies have varied in the number of items presented to children, from one in Maguire et al. (2010), to four in Hohenstein et al. (2004), to 16 in Papafragou and Selimis (2010). In this study, 15 sentences will be analyzed for each participant, allowing a greater range of manners and paths to be included, and will allow for item analyses.

We hypothesize that children in this study will be influenced by both syntax and typology when asked to interpret novel verbs, but that they may show a u-shaped trajectory in their interpretations across age. While younger children may show a stronger influence of syntax (replicating previous experimental work) because they have not yet acquired the typological pattern, older children may also be more likely to choose path interpretations when presented with transitive frames, not because the typology is not playing a role, but because they are using their metalinguistic awareness and explicit word learning strategies to acquire path verbs.

Method

Participants

Sixty-four children, recruited through word-of-mouth and through a database based on local birth announcements, participated in the current study. Children were all

residents of eastern Connecticut and demographically representative of the population in the area. All of the children were monolingual English speakers, and none of the children's parents reported any learning disabilities or special education services needed in school. Twelve adults, all undergraduate or graduate students at the University of Connecticut, participated in the video part of the study, but were not administered the standardized language measure.

For purposes of analysis, children were divided into three age groups. Table 1 shows the sample size, age, and standardized language scores for each group.

Stimuli

A total of 36 live action movie clips, each six seconds in duration, were created. Each depicted a simple motion event in which a person moved with relation to a reference object, such as a door or a tree. Sixteen were 'teaching' videos (e.g., A girl running down a hill). For each teaching video, two additional clips were filmed, one of which showed the person performing the same manner but traversing a different path (e.g., running up the hill), and the other of which showed the person traversing the original path but in a different manner (e.g., twirling down the hill). The events were designed to depict salient and unusual manners of motion (i.e., not simply walking but rather hopping, galloping, crawling, twirling), as well as salient paths of motion (into, out of, through, behind). The video showing the same manner of motion as the original will be referred to as the manner match, and the one showing the same path of motion as the original will be referred to as the path match. Thus, a total of sixteen triads were created (see Table 2 for the complete set of stimuli). One triad, however, was excluded from all analyses; because of experimenter error, it was of a much shorter duration than the other

triads. This left seven manner frame items and eight path frame items for analysis. Items were placed in the path block based on pilot work in which a different group of adults was asked to describe the events in English. Those events which received any path verb descriptions at all (as would be predicted by Naigles et al. (1998), these were rare) were placed in the path block and ordered to avoid sequences of similar manners, paths, or ground objects.

Each teaching trial was paired with a sentence that described the action in the video using a nonsense word in the place of a verb. Eight of the sentences were intransitive, with prepositional phrases (e.g., "She is gorping in front of the ladder."); these were designed to promote manner-of-motion interpretations of the novel verb. The other eight sentences were transitive (e.g., "She is zorking the hill."); these were designed to promote path-of-motion interpretations of the novel verb. The nonsense verbs were all monosyllabic and followed English phonological conventions. Table 2 displays the list of sentences.

An example of the video stimuli layout is provided in Table 3. As the Table shows, the child heard the manner or path frame sentence twice during each teaching trial. The manner and path matches were then shown side-by-side, once with a non-directive audio (referred to as the 'baseline' trial), and once with the instruction for the child to point to the one matching the meaning of the novel verb (referred to as the 'test' trial). The side of the manner match alternated in a LRRLLRRL pattern. The two blocks of sentences were counterbalanced across participants, but the item order did not vary within blocks and each item was presented only once, in either the manner or the path block. The items, and hence matching screens, were the same for each counterbalance.

Apparatus

The participants watched the video on a Dell Latitude D630 laptop with a 14 inch screen. A Canon Elura 85 camcorder on a small tripod was placed directly behind the laptop and recorded the child's face while s/he was watching the videos.

Standardized measure

Children's overall language abilities were measured using the Clinical Evaluation of Language Fundamentals, 4th Edition (CELF-4) (Semel, Wiig, & Secord, 2003). Only the subtests used for general language abilities were administered, as the test was not being administered for diagnosis. The subtests for all ages were: Concepts and Following Directions (C&FD), Recalling Sentences (RS), and Formulated Sentences (FS). In addition, children between six and eight years of age were given the Word Structure (WS) subtest, and children nine to 11 years of age were given the Word Classes II (WC) subtest.

In the C&FD subtest, the children viewed a row of easily identifiable pictures and were asked to point to pictures in a certain order. For instance, they might be asked to "Point to the big shoe and the little apple" or "Point to the third big car". The RS subtest presented a series of increasingly complicated sentences, which the children were asked to repeat immediately after the experimenter read them. The FS subtest presented a series of picture-word pairs; the child's task was to use the word in a sentence about the picture. The WS subtest (younger children only) presented the children with pairs of pictures, which the experimenter pointed to in turn. The first picture was described in full by the experimenter while the second picture description was to be completed by the child (e.g., "Here the boy is writing a letter, here is the letter that he…" with the correct

answer being "wrote"). The WC subtest (older children only) asked the children to listen to a series of four words and then say which two went together and why. All of the tests were administered up to a certain number of incorrect responses, referred to as the child's ceiling score. Those raw scores were translated into standardized scores based on the child's age (Semel et al., 2003).

Procedure

The procedure took place either at the child's home or in the UConn Child Language Lab, depending on the preferences of the parent. The child and parent were first asked for demographic information. The child participants were told that they would hear descriptions of videos paired with a word they had never heard, and were told: "What if I said a boy was blarking; do you know what blarking is?" in order to introduce the idea of a nonsense word. The example was given without a sentence frame in order to avoid priming or practice effects. They were then instructed to point to the video that "answered the question asked in the video." The participants then viewed the video clips while their faces were filmed. Adult participants were given a simplified version of the instructions, and were not filmed. Half of the participants were assigned to a "manner-first counterbalance" and heard the block of manner sentences first, while the other half were assigned to a "path-first counterbalance" and heard the path block first.

While the participant viewed the videos, the experimenter sat next to him/her and recorded the direction of each point during each test trial on a clipboard; the marked responses were not visible to the participant. Participants were not instructed as to whether their answers were correct; those who asked whether an answer was right were told that there was no right answer and that the experimenter wanted to find out how

different people answer the same questions. After the videos, the CELF-4 was administered to the child participants. The entire procedure for children took about one hour, and for adults about 10 minutes.

Eye movement coding

Mini-DV recordings of the children's faces during the video procedure were digitized and coded using a custom program. Due to equipment failure and experimenter error, videos for only 53 of the original 64 children were available for coding. This left a total of 18 children in the youngest age group, 20 in the middle age group, and 15 in the oldest age group. Each video was viewed frame-by-frame without audio, and the experimenter coded each change in the child's eye position as left, right, center, or away from the screen, as well as marking the beginning and end of the various sections of the procedure (teaching, baseline, test). A custom Matlab program was used to calculate the time spent looking at either side of the screen during the test trials, in milliseconds. Ten percent of the videos were recoded by a research assistant and checked for agreement. The first and second codings had an average correlation of .95, with discrepancies resolved by a review of the recoded video to agree on a final coding.

All children in the sample met a side bias criterion, with overall looking times falling between 30% and 70% to the left side. Six children did not look at either screen during one of the three portions for at least 5 of the 8 items in a given block; therefore, this portion (3.8% of the entire dataset) was treated as missing data for subsequent analyses.

Analyses

The main dependent variable for the pointing task was the proportion of points to the manner match. This was calculated for all participants in each block of sentences by dividing the number of points to the manner screen by the total number of items (seven for the manner block, eight for the path block). For the item order analysis, a 'frame match' measure was calculated by taking the average number of time participants chose a manner interpretation for each manner item, and a path interpretation for each path item.

The main dependent variable for looking time performance was the proportion of time spent looking at the manner match during test trials. This comprised the amount of time spent looking at the manner match divided by the amount of time looking at either the manner or the path match during the entire six second test trial (i.e., excluding time spent looking at the center of the screen or away from the screen). Additional dependent variables were created by dividing the test trial into three portions of two seconds each: proportion of time spent looking to manner was calculated for each portion.

Results

The data were organized to address questions about the influence of age, sentence frame, and language ability on pointing and eye gaze behavior. We looked at the data to determine when the English manner typology has a strong effect on verb interpretation, and whether that effect was the same across items. We also looked at whether the implicit measure offered any clues as to the metalinguistic awareness of the children as they decided on their explicit interpretations of the verbs.

Analyses of pointing data

As Figure 1 shows, all participants pointed to the manner match the majority of the time during *both* the manner and path frame blocks. One-sample *t*-tests showed that the children in each age group chose the manner match more frequently than expected by chance (i.e., 50%) ($t(24) > 4$; $t(21) > 3$; $t(16) > 2$, respectively, ps $< .05$). The adults, in contrast, pointed to the manner match significantly more than expected by chance in the manner frame condition ($t(11) = 20$, $p < .001$), but not in the path frame condition. Paired-sample *t*-tests comparing the proportion of points during each condition yielded a significant difference between the two frame conditions for the adults only ($t(11) = 2.79$, $p < .05$).

A 3-way repeated measures ANOVA [age group (3 levels) by sentence frame (2 levels) by counterbalance (2 levels)] was performed on the proportions of points to the manner match for all of the children. No main effects of age group, sentence frame, or counterbalance were found. However, as Figure 2 reveals, there was a significant interaction between sentence frame and counterbalance ($F(2, 58) = 4.84$, $p < .05$). The children consistently chose manner more often during the first block of sentences, and this pattern was stronger for those in the path-first condition than for those in the manner-first condition.

Figure 3 shows the average frame match for each item; that is, the percentage of children (collapsed across age group and counterbalance) who pointed to the screen that matched the frame of the sentence (i.e. chose manner during the manner block and path during the path block) for each condition. As Figure 3 shows, children pointed slightly more to the manner match as the manner block progressed. Moreover, children appeared

to point *steadily* more to the path match as the path block progressed. Correlations between item number and average frame match show a stronger, significant correlation between item number and frame matches in the path condition ($r = .84$, $p < .001$) than between item number and manner frame matches ($r = .50$, *n.s.*). Additionally, 95% confidence intervals around the correlation coefficients indicate that the path condition correlation is different from zero (CI = .32, .97) while the manner condition correlation is not (CI = -.41, .91). This indicates that item number (i.e. experience with the frame) had a greater influence during the path block than the manner block.

We also explored the influence of language knowledge by examining scores on the standardized language measure, the CELF-4. As Figure 4 shows, bivariate correlations between the proportion of manner choices for each age group and the various subtests of the CELF-4 yielded a significant negative relationship between the oldest children's performance on the Formulated Sentences (FS) test (of expressive language) and their tendency to choose the manner interpretation, regardless of sentence frame. That is, the 10- and 11-year-old children with higher scores on the FS test were more likely to choose the path match when they heard a verb presented in a path frame sentence (Fig 4a: $r = -.537$, $p < .05$) *and* when they heard a manner frame sentence (Fig 4b: $r = -.491$, $p < .05$). One child in particular, assigned to the path-first counterbalance, chose the path match 14 out of the possible 15 times, and scored highest on the FS test.

Analyses of looking time data

The children's eye gaze data are presented in Figure 5 in terms of percentage of time looking at the manner match during both the manner and path frame blocks. During both blocks, the children spent more than 50% of the time looking at the manner match

(manner: $t(52) = 5.07$, $p < .001$; path: $t(52) = 7.12$, $p < .001$). As Figure 5 shows, there was no overall difference between the amount of time children spent looking towards the manner screen during the path and manner blocks. A mixed ANOVA [sentence frame (2 levels) and age group (3 levels)] performed on the average time spent looking at the manner match across items found no significant effects.

Each test trial was six seconds long, and further analysis divided the trial into three portions to examine the looking time measures in two-second increments. As Figure 6 shows, even at this level the children all tended to look at manner more than 50% of the time (ts(52) > 2, ps < .05), however, this tendency seemed to decrease (i.e. manner looks approached 50%) over the course of the trial.

A mixed ANOVA [sentence frame (2 levels), trial portion (3 levels), age group (3 levels)] was performed on the average looking time to the manner match. A main effect of portion was revealed ($F(2, 92) = 10.19$, $p < .001$), with the means demonstrating that children looked less to the manner as the trial proceeded. A significant interaction effect between portion and sentence frame ($F(2, 92) = 4.59$, $p < .05$) suggested that the decrease in looking time to manner across blocks was significantly different for the two sentence frames. There were no significant effects of age, and so the ages are collapsed in Figure 6. Paired-sample *t*-tests demonstrated no significant decrease from portion 1 to portion 2 in looking time to manner for the manner sentences ($t(51) = .84$, *n.s.*), but a significant decrease in looking time to manner for the path sentences ($t(51) = 4.70$, $p < .001$).

Lastly, correlations between looking time and pointing response are presented in Table 4. For all age groups, the children who looked longest at the manner match were

also the ones who also chose the manner match most consistently as their explicit answer (regardless of sentence frame).

Discussion

This study examined the interpretations of novel motion verbs made by English-speaking children across a wide age range, as well as by adults. The children saw 15 triads of motion events and were taught 15 novel verbs; 7 were presented in manner frames and 8 in path frames. Two different measures of interpretation were used: an explicit choice, made by the child actively choosing one video over another, and an implicit process, measured by the direction and duration of children's eye gaze. These measures were used to determine whether children depend more on typological information and patterns (i.e., that English preferentially encodes manner in its motion verbs) or syntactic information (i.e., that transitive frames promote path interpretations while intransitive frames with prepositional phrases promote manner interpretations) to determine the meaning of a novel verb. The participants were shown an event that incorporated a manner and path of motion accompanied by a sentence that was either transitive or intransitive, and were asked to choose between videos that showed similar manners versus paths of motion.

Overall, the results indicated that even the youngest children we tested had acquired the English typological pattern. With both the pointing and eye gaze measures, they showed strong tendencies towards manner interpretations of the novel verbs regardless of sentence frame. These findings corroborate the conclusions drawn by Maguire et al. (2010) and Papafragou and Selimis (2010), but also add to them by demonstrating that syntactic information does not override the typological pattern during

the age range of six to 11 years. Future work could examine the shift from dependence on syntax to a strong influence of typology by studying children at developmental levels between the two- to three-year-olds tested by Hohenstein (2005) and Maguire et al. (2010), and the six-year-olds in the current study.

Despite the overall manner preference, though, subtle effects of syntax were revealed in three ways. First, the adult participants clearly showed an influence of syntax in the path frame block, when they chose a manner interpretation significantly less frequently than in the manner frame block although not significantly less frequently than chance. Thus, these adults performed similarly to the English-speaking adults in Naigles and Terrazas (1998). Second, the children showed an effect of syntax when their pointing responses were compared within a block: more points to the path interpretation were observed later in the path block, as shown by the strong correlation between item number and frame matches. This short-term increase in the sensitivity to syntax across multiple items suggests that the children began paying more attention to the frame as they heard it more and more. Third, children showed an effect of syntax when their eye gazes were compared within a trial: those in the path block looked towards the path interpretation *more* as the trial progressed. In sum, effects of syntax were evident in the explicit responses of the adults, and in both explicit and implicit responses of the children.

The effects of syntax were not as strong as might be expected, based on the work reported by Hohenstein et al. (2004). Why did the children show such strong effects of language typology, and such subtle effects of syntax? We can first rule out overall effects of stimuli, because the adults did show a significant decrease in manner

interpretations during the path sentences. In addition, this discovery calls into question the assertion made by Beavers et al. (2010). If typological patterns are highly inconsistent and motion descriptions are based on the specific linguistic structures in which they occur, it is difficult to imagine that children would be so swayed as to ignore those cues in favor of the overall language pattern. The strong typological effect apparent in these data, then, supports the original classification of English as a "manner language", and may uncover an important part of a developmental trajectory in motion verb acquisition (see Figure 7). If the grade school years comprise the "middle" of the trajectory depicted in Figure 7, language typology might have an overwhelming effect on children's interpretations at that time, as they shift from using syntax to inform their decisions as young children, and then again as adults. The beginning of that shift towards the adult state is hinted at in a hypothesis that receives support from our data: the oldest children are beginning to show signs of the adult dependence on syntax through their use of metalinguistic skill (including an explicit form of mutual exclusivity) and possibly as a result of more educational experience.

Deployment of mutual exclusivity may have been observed in the oldest children's pointing measure, as illustrated by the correlation between path choices and linguistic skill. That is, those children who scored highest on the CELF-4 measure of expressive language were also those who chose more path interpretations. These highly linguistically skilled children (i.e. those one to two standard deviations above the mean on this measure) may know more manner verbs, and moreover *know* that they know them. This could lead to selections of path interpretations, based on the child thinking, for instance, "I know the word for hopping, so *plomming* must mean something else." In

this procedure, the path interpretation is the only other choice available, and so the child assigns the novel verb to the path. Thus, these children may be using metalinguistic knowledge, or their ability to think about language, in order to come to an interpretation. Previous works suggests that this oldest age group (10 to 11 years old) should be able to engage in such processing (Berman, 2007; Anglin, 1993).

Metalinguistic processing has been demonstrated as having a link to education level as well. The oldest children in this study are, of course, those with the most education (most were in fifth or sixth grade). Gleitman and Gleitman (1970) found a similar effect of education level on adults' ability to reason about strange language forms when they asked participants to interpret unusual compound nouns. The authors decided on the best, most grammatically-consistent interpretation of triads of words (such as *black, bird,* and *house*) strung together in every possible combination to form compound nouns. Those who were best at interpreting the compound nouns, according to the researchers' linguistic analyses, were the Ph.D. students and professors, while those who made the most errors were the participants with just a high school education. Thus, education experience, even apart from age, offers some level of ability for reasoning about language when faced with unusual forms.

Further support for the idea that the oldest group of children are engaging in metalinguistic processing comes from anecdotal evidence from the participants themselves. While this processing could give rise to explicit mutual exclusivity or ability to comprehend unusual words, it could also allow for an explicit awareness of the sentence parts (i.e. syntactic information) and how they might relate to word learning. While there were no differences across age groups with respect to using syntactic

information and explicit interpretations, anecdotal evidence reveals metalinguistic processing in some of the oldest child participants. For example, immediately after the watching the video, some children spontaneously (and even excitedly) described how they were thinking about the word-learning procedure. One of them, R., a 10-year-old girl, specifically mentioned the preposition as cueing her into a manner interpretation:

> R: There's a pattern!
>
> Exp: There is?
>
> R: Yeah she was doing the same thing but going a different way…one time…and she was doing a different thing but going the same way….I was doing mostly when she was doing the same motion because, um, it said she's like kibbing *on* the mattress, but she could be kibbing another place too.

Another participant, J., an 11-year-old boy, described a change in his thinking with regards to whether manner or path was the correct interpretation; his description is not as clear as R.'s, but it is obvious that he is considering the relevant aspects of the problem:

> J: It's hard because…I mean…you look at them and you think that…like…like the second to last one like the…the one with the stairs. Like, one of them was going up and one of them was going down, in the first video he was going *up* but he was making the *same* motion going down. So *I* kept on thinking it was the *motions* and then at *that* point I was thinking…maybe it's not the way they're going, maybe it's how they're getting up or down the stairs.

These examples demonstrate that the oldest children were wrestling with the impacts of syntax on their language's typological pattern, even if their choices tended to reflect a manner preference. This could be the beginning of the shift towards using syntax again as an important cue (i.e., the beginning of the upward slope in Fig. 7). As with the example from Karmiloff-Smith (1992) described in the introduction, development may reveal early and late stages in which a certain behavior *appears* similar, even if the underlying processes are different. During the preschool years, children may reach a level of "behavioral mastery", in which they use syntactic frame cues to determine a word's meaning because they have not yet amassed enough examples of motion verbs to use the overall language pattern as a cue. Once enough examples are present in the input, the child's strategy might shift to another level of representation that involves the language's statistical pattern (i.e. the typology) as the main cue for meaning. At an even later stage, the child might recognize that in some cases, a different verb is being used to describe a motion they already have a label for, and realize that the appropriate interpretation is a less-frequent pattern in the language. This change in strategy could reflect another representational redescription that means the child is using metalinguisic knowledge to come to a similar language behavior that was exhibited during the behavioral mastery stage, but one that is more nuanced and flexible.

There is evidence for the input's influence on verb interpretation strategies in a recent study by Hohenstein (2011). She found differences in the types of verbs parents used with their children at different ages during a mother-child play session. Spanish- and English-speaking parents used more "light" verbs with three-year-old children than with seven-year-olds. Parents used more manner verbs over all with their seven-year-old

children, but only seven-year-old Spanish speakers heard many path verbs. This could cue the middle section of the "u" in Figure 7, driving children to use typology as the most influential cue in motion verb interpretation. Then, as adults, syntax is important again when making conjectures about a new motion verb, but *not* because that is the only information available to them. Adults may use mutual exclusivity to realize that a new meaning is needed for a particular word, and then the syntactic frame and metalinguistic awareness might lead them to an understanding of what that meaning should be. The finding displayed in Figure 3 about children's increases in path interpretations during the path block may be a micro-level example of the effect of input that Hohenstein (2011) illustrates. On a very small scale, children were receiving input involving motion verbs in transitive frames, and they gradually began to "realize" that these trials required a different answer than they had been giving at first.

This trajectory may also be thought of as analogous to the perceptual tuning that infants go through when acquiring the sounds of their native language. Werker and Tees (1984), among others, have demonstrated that infants prior to six months of age show sensitivity to a whole range of phonemic distinctions, even those not used in the language they are acquiring. Then, between the ages of six months and 12 months, infants' ability to discriminate phonemes *not* used in the language surrounding them decreases. English-acquiring infants, for instance, are initially sensitive to contrasts that English-speaking adults have trouble distinguishing because they are not present in the language, such as a contrast between /ki/ and /qi/ important to an Indian language but not to English. On the other hand, infants acquiring Japanese lose an initial ability to differentiate between /r/ and /l/, due to its absence in the Japanese language. Moreover, Kuhl, Conboy, Padden,

Nelson, and Pruitt (2005) showed that infants acquiring English *increase* in their sensitivity to the /r – l/ distinction by 12 months of age. Together the work on perceptual tuning describes an initial language-general ability that gives way to a language-specific ability that is finely honed based on language experience.

Analogously, motion verb interpretation may begin with a language-general process (sensitivity to the syntactic frame) and subsequently shift to a language-specific process during childhood. That period is illustrated by the English-speaking grade schoolers in the current study, who show a strong manner bias. The manner bias may result from an increase in the overall number of manner verbs heard around them, similar to the phoneme perception that changes due to sounds heard by the infant. However, sensitivity to the syntactic frame may become more finely tuned towards the end of grade school, possibly with the help of explicit word learning procedures and metalinguistic abilities, until later childhood and adulthood when the syntax again becomes important to verb construal in order to acquire the Latinate, lower-frequency path verbs. Also similar to perceptual tuning, this "syntactic tuning" is not absolute. Indeed it is possible for adults to make distinctions between non-native contrasts when they are very dissimilar from any sounds in their own language (e.g. Best, McRoberts, & Goodell, 2001), and for them to learn non-native phonetic contrasts; adult Japanese speakers can learn a distinction between /r/ and /l/, but only with explicit effort (Bradlow, 2008). Similarly, English-speaking adults can deviate from the manner bias to interpret motion verbs as referring to path when it is suggested by the syntactic frame.

While the current study extends earlier findings about motion verb understanding in children, and breaks new ground by demonstrating subtle syntactic influences in grade

schoolers, it also has some limitations. For example, the children were selected based on being typical language learners, and the CELF-4 was used to verify that. This means that there was fairly low variability in test scores, making it difficult to assess relationships between language ability and verb interpretation. Moreover, in terms of experimental design, future experiments should counterbalance items within sentence frame blocks, as this would strengthen the finding about the item order effect. It is *possible* that the children increased their path interpretations at the end of the path sentence block due to some aspect of those particular stimuli. However, we think this is unlikely due to the stimuli selection methods described earlier. Furthermore, the children only heard the sentences two times, and given the importance placed on the sentence frame in interpreting the results, it may be wise to repeat the sentences more times before asking for an interpretation. Findings regarding syntactic frame would presumably only be made stronger with these improvements in design.

This study breaks new ground by exploring the influence of language typology and syntax on motion verb interpretation in grade schoolers. While syntactic frame has been shown to have a strong influence on very young children, and a somewhat weaker influence on adults, grade schoolers seem to be overwhelmingly influenced by language typology. The data presented here strengthen the case for an interesting developmental trajectory for motion verb learning, and for a language-general to language-specific shift in verb interpretation. Future work can expand this finding to explore other language groups at this age, and to more precisely tap into the mechanisms (such as input frequency and metalinguistic skill) that may be driving the shifts in interpretation.

Table 1

Ages and CELF-4 scores for all participants

Group	N	Mean age and SD (years; months)	Mean standardized CELF-4 score (SD)
Young	25	7;1 (7.6)	105.72 (11.73)
Middle	22	8;11 (9.3)	108.76 (9.91)
Old	17	10;9 (6.9)	113.82 (9.53)
Adult	12	-	-

Table 2

Stimuli description and accompanying audio

Teaching video	Manner match	Path match	Teaching audio	Sentence frame
Tiptoeing in front of a ladder	Tiptoeing behind the ladder	Hopping in front of the ladder	She's gorping in front of the ladder.	Manner
Crawling under a table	Crawling across a table	Crab-walking under a table	She's blicking under the table.	Manner
Waddling off the end of a bridge	Waddling onto a bridge	Leaping off the end of a bridge	She's tigging off the bridge.	Manner
Walking on knees behind a tent	Walking on knees toward a tent	Belly-crawling behind a tent	He's mepping behind the tent.	Manner
Belly-crawling through a tunnel	Belly-crawling out of a tunnel	Crawling through a tunnel	He's tooping through the tunnel.	Manner
Scooting up stairs while sitting	Scooting down stairs	Crawling up stairs	He's daxing up the stairs	Manner
Rolling across a mattress	Rolling off a mattress	Walking on knees across a mattress	She's kibbing across the mattress	Manner
Twirling down a hill	Twirling up a hill	Crawling down a hill	She's zorking the hill.	Path
Bear-walking out	Bear-walking	Walking on knees	He's wugging the	Path

of a tent	away from a tent	out of a tent	tent.	
Galloping out of a house	Galloping into a house	Marching out of a house	He’s tamming the house.	Path
Crab-walking away from a tunnel	Heel-toe walking away from a tunnel	Crab-walking out of a tunnel	She’s mipping the tunnel.	Path
Marching towards a tree	Marching behind a tree	Twirling towards a tree	She’s stimming the tree.	Path
Hopping into a building	Hopping out of a building	Heel-toe walking into a building	She’s plomming the building.	Path
Stepping cross-legged onto and off of a mattress	Stepping cross-legged around a mattress	Getting onto and off of a mattress on all fours	He’s piffing the mattress.	Path
Leaping into a garage	Leaping past the door of a garage	Waddling into a garage	He’s kradding the garage.	Path

Table 3

Sample audio and video layout of a stimulus from a manner sentence frame item. In this example, the manner match is on the left and the path match on the right.

Title	Seconds	Left	Center	Right	Audio
	3				Look, she's gorping under the ladder.
Teaching	6		Girl tiptoeing under a ladder		See, she's gorping under the ladder. (x2)
	3				Look, they're different now.
Baseline	6	Girl tiptoeing in front of a ladder		Girl hopping under a ladder	See how these two are not the same?
	3				Which one is gorping now?

Test	6	Girl tiptoeing in front of a ladder	Girl hopping under a ladder	Choose gorping. Which one is gorping?

Table 4

Correlations between looking time and pointing responses.

Age group		% time looking to manner: manner frame	% time looking to manner: path frame
Young	% manner choices: manner frame	.809**	
	% manner choices: path frame		.696**
Middle	% manner choices: manner frame	.794**	
	% manner choices: path frame		.869**
Old	% manner choices: manner frame	.824**	
	% manner choices: path frame		.730**

Figure 1

Mean and SE percentage of points to manner match

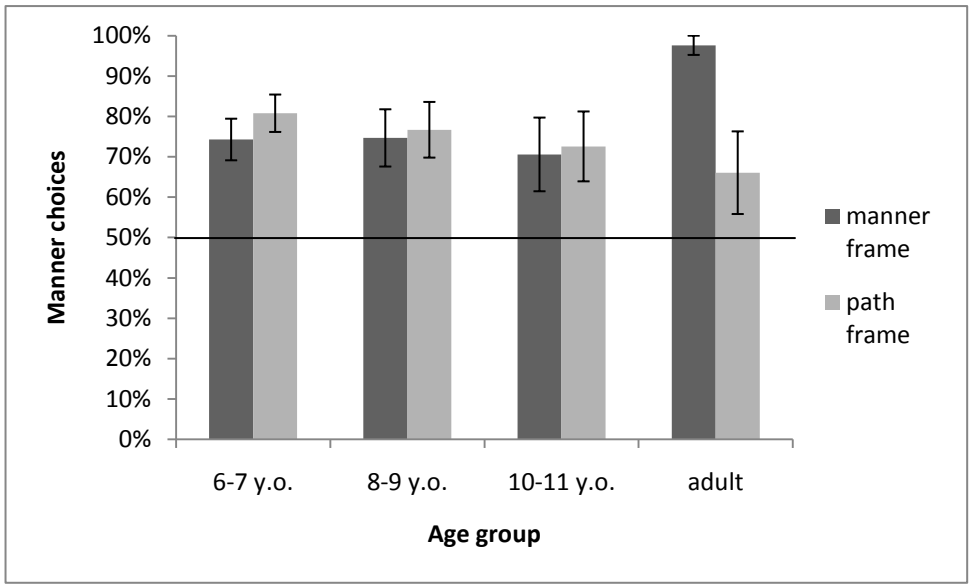


Figure 2

Mean percentage of points to the manner match by counterbalance

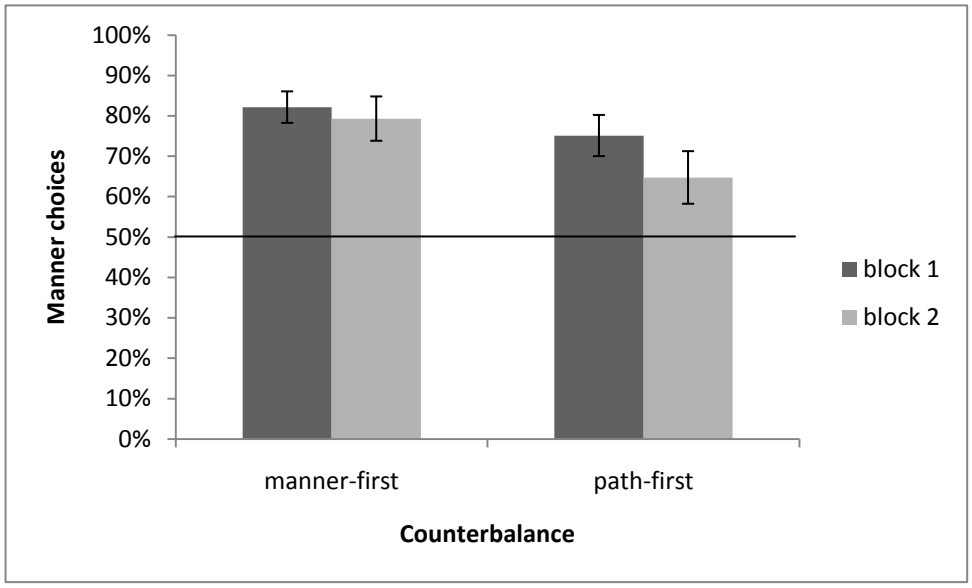


Figure 3

Percent of interpretations that match the frame of the teaching trial

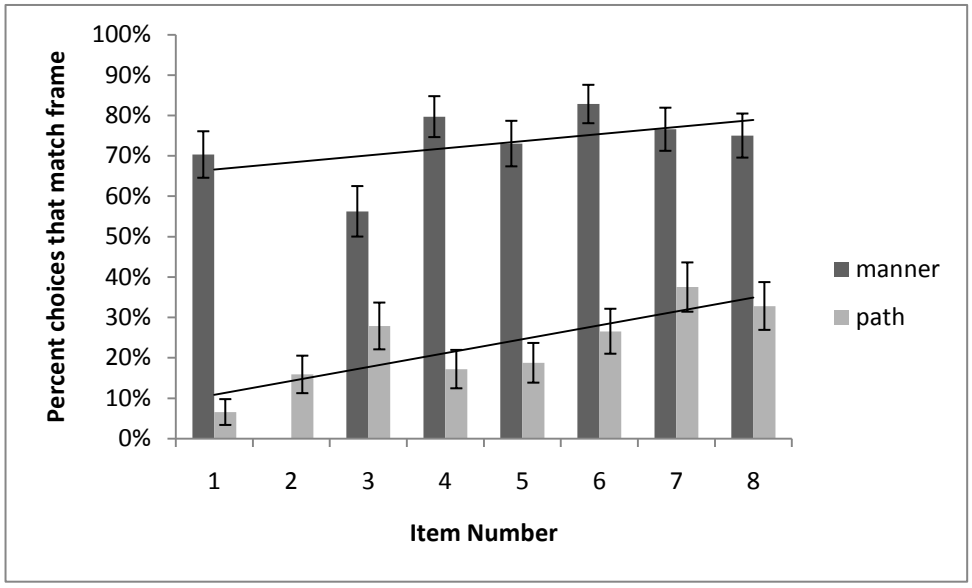


Figure 4a

Formulated sentences score and percent of manner choices during path frame block, oldest age group.

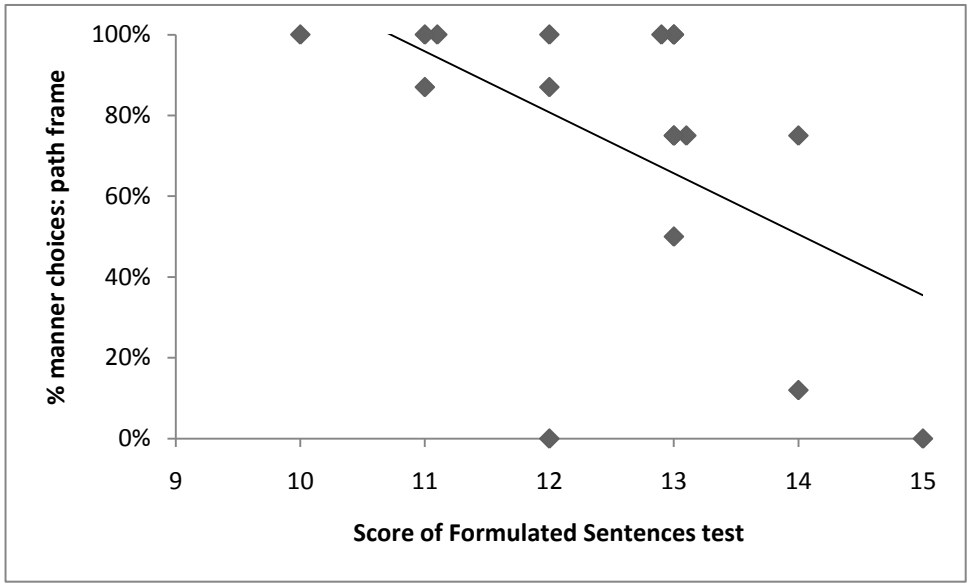


Figure 4b

Formulated sentences score and percent of manner choices during manner frame block, oldest age group.

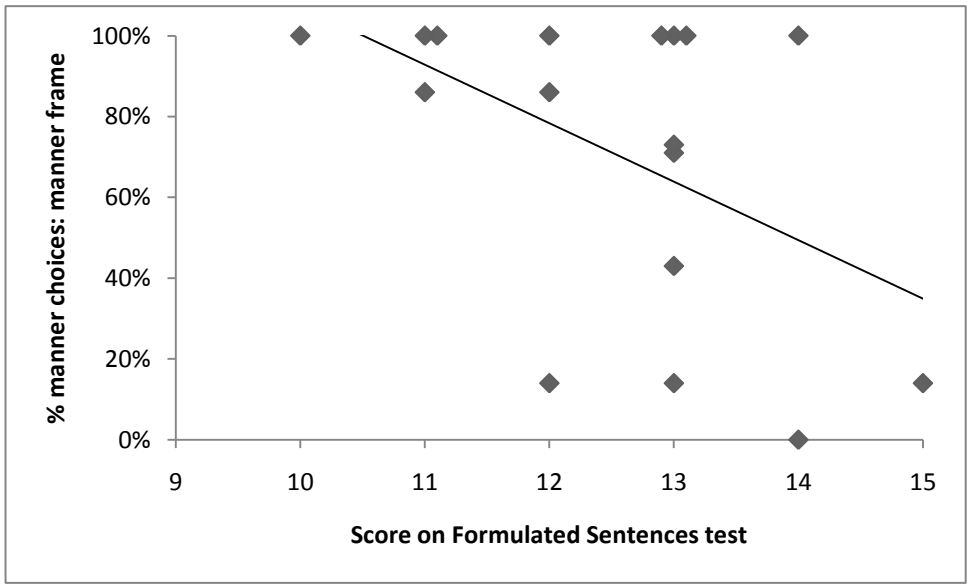


Figure 5

Total looking times to manner for both sentence frames

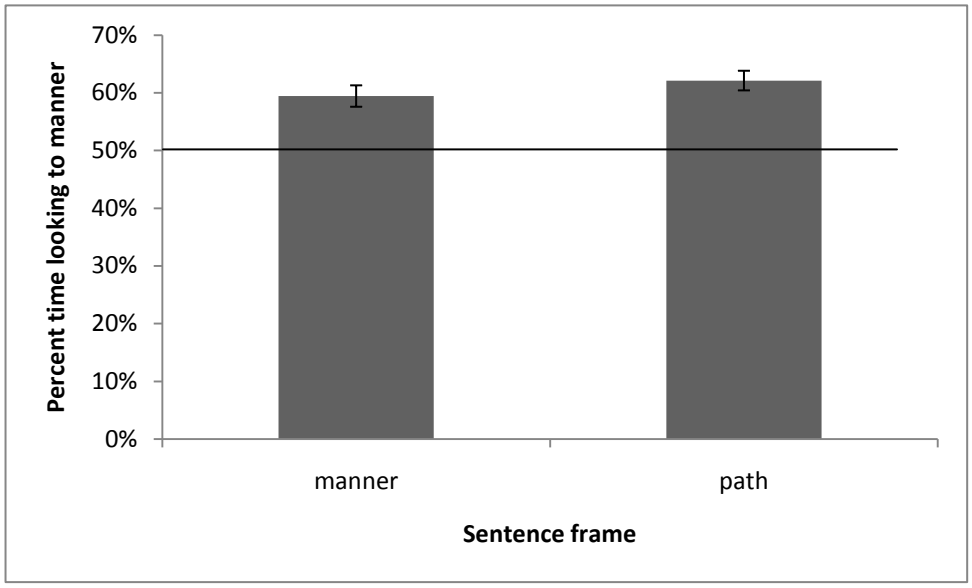


Figure 6

Looking times to manner by trial portion

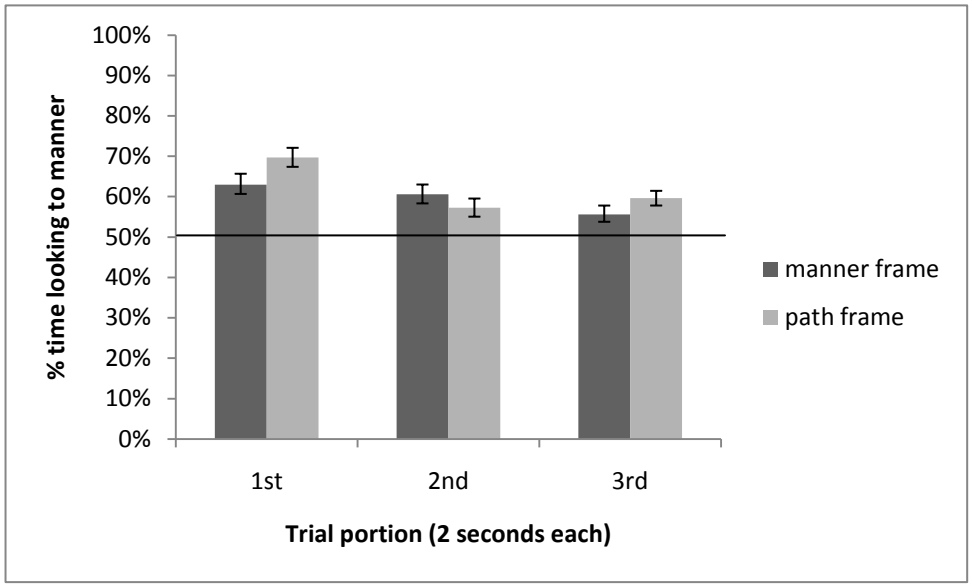
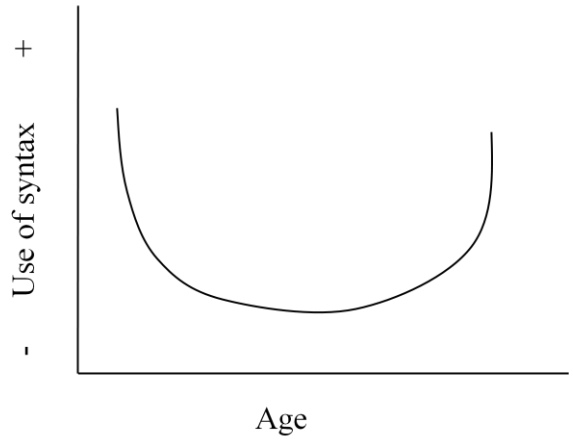


Figure 7

Hypothesized importance of syntactic frame to motion verb interpretation



References

Anglin, J. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society for Research in Child Development, 58*(10, Serial No. 238).

Aske, J. (1989). Path predicates in English and Spanish: A closer look. In K. Hall, M. Meacham, & R. Shapiro (Eds.), *Proceedings of the 15th Annual Meeting of the Berkeley Linguistics Society* (pp. 1-14). Berkeley: Berkeley Linguistics Society.

Au, T. K. & Glusman, M. (1990). The principle of mutual exclusivity in word learning: To honor or not to honor? *Child Development, 61,* 1474-1490.

Beavers, J., Levin, B., & Tham, S. W. (2010). The typology of motion expressions revisited. *Journal of Linguistics, 46,* 331-377.

Berman, R. A. (2007). Developing linguistic knowledge and language use across adolescence. In E. Hoff & M. Shatz (Eds.), *Blackwell handbook of language development* (pp. 347-367). Malden, MA: Blackwell.

Berman, R. A. & Slobin, D. I. (1994a). *Relating events in narrative: A crosslinguistic developmental study*. Hillsdale, NJ: Lawrence Erlbaum.

Berman, R. A. & Slobin, D. I. (1994b). Development of linguistic forms: English. In R. A. Berman & D. I. Slobin (Eds.), *Relating events in narrative: A crosslinguistic developmental study* (pp. 127-188). Hillsdale, NJ: Lawrence Erlbaum.

Best, C. T., McRoberts, G. W., Goodell, E. (2001). Discrimination of non-native consonant contrasts varying in perceptual assimilation to the listener's native phonological system. *Journal of the Acoustical Society of America, 109,* 775-794.

Bradlow, A. R. (2008). Training non-native language sound patterns: Lessons from training Japanese adults on the English /r/-/l/ contrast. In Hansen Edwards, J. G. and

Zampini, M. L. (Eds.), *Phonology and second language acquisition*, (pp. 287-308). Amsterdam: John Benjamins.

Choi, S. & Bowerman, M. (1991). Learning to express motion events in English and Korean: The influence of language-specific lexical patterns. *Cognition, 41*, 83-121.

Clark, E. V. (2009). Lexical meaning. In E. Bavin (Ed.), *The Cambridge handbook of child language* (pp. 283-299). New York: Cambridge University Press.

Diesendruck, G. (2007). Mechanisms of word learning. In E. Hoff & M. Shatz (Eds.), *Blackwell handbook of language development* (pp. 257-276). Malden, MA: Blackwell.

Gentner, D. & Boroditsky, L. (2001). Individuation, relativity, and early learning. In M. Bowerman & S. C. Levinson (Eds.) *Language acquisition and conceptual development* (pp. 215-256). New York: Cambridge University Press.

Gleitman, L. R. (1990). The structural sources of verb meanings. *Language Acquisition, 1*, 3-55.

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J.C. (2005). Hard words. *Language learning and development, 1*, 23-64.

Gleitman, L. R. & Gleitman, H. (1970). *Phrase and paraphrase: Some innovative uses of language*. New York: Norton & Company.

Golinkoff, R. M., Hirsh-Pasek, K., Bloom, L., Smith, L. B., Woodward, A. L., Akhtar, N., Tomasello, M., & Hollich, G. (2000). *Becoming a word learner: A debate on lexical acquisition*. New York: Oxford University Press.

Hohenstein, J. (2005). Language-related motion event similarities in Spanish- and English-speaking children. *Journal of Cognition and Development, 6*, 402-425.

Hohenstein, J. (2011). Parent-child talk about motion: Links to the development of motion event language. *Submitted*.

Hohenstein, J. M., Naigles, L. R., & Eisenberg, A. R. (2004). Keeping verb acquisition in motion: A comparison of English and Spanish. In D. G. Hall & S. R. Waxman (Eds.), *Weaving a lexicon*, (pp. 569-602). Cambridge, MA: MIT Press.

Karmiloff-Smith, A. (1992). *Beyond modularity*. Cambridge, MA: MIT Press.

Kuhl, P. K., Conboy, B. T., Padden, D., Nelson, T., & Pruitt, J. (2005). Early speech perception and later language development: Implications for the 'critical period'. *Language Learning & Development, 1*, 237-264.

Maguire, M., Hirsh-Pasek, K., Golinkoff, R. M., Imai, M., Haryu, E., Vanegas, S., Okada, H., Pulverman, R. & Sanchez-Davis, B. (2010). A developmental shift from similar to language-specific strategies in verb acquisition: A comparison of English, Spanish, and Japanese. *Cognition, 114*, 299-319.

Mayer, M. (1969). *Frog, where are you?* New York: Dial Press.

Naigles, L. R. (1990). Children use syntax to learn verb meanings. *Journal of Child Language, 17*, 357-374.

Naigles, L. R., Eisenberg, A., Kako, E., Highter, M., & McGraw, N. (1998). Speaking of motion: Verb use in English and Spanish. *Language and Cognitive Processes, 13*(5), 521-549.

Naigles, L. R. & Swensen, L. D. (2007). Syntactic supports for word learning. In E. Hoff & M. Shatz (Eds.), *Blackwell handbook of language development* (pp. 212-232). Malden, MA: Blackwell.

Naigles, L. R. & Terrazas, P. (1998). Motion verb generalizations in English and Spanish: The influence of language and syntax. *Psychological Science,* 9, 363-369.

Özçalişkan, S. (2009). Learning to talk about spatial motion in language-specific ways. In J. Guo, E. Lieven, N. Budwig, S. Ervin-Tripp, K. Nakamura, S. Özçalişkan (Eds.), *Crosslinguistic approaches to the psychology of language: Research in the tradition of Dan Isaac Slobin* (pp. 263-276). New York: Psychology Press.

Papafragou, A. & Selimis, S. (2010). Event categorization and language: A cross-linguistic study of motion. *Language learning and development, 6,* 87-115.

Pruden, S. M., Hirsh-Pasek, K., & Golinkoff, R. M. (2008). Current events: How infants parse the world and events for language. In T. F. Shipley & J. M. Zacks (Eds.), *Understanding events: From perception to action,* (pp. 160-192). New York: Oxford University Press.

Quine, W. V. O. (1960). Word and object. Cambridge: MIT Press.

Sebastián, E. & Slobin, D. I. (1994). Development of linguistic forms: Spanish. In R. A. Berman & D. I. Slobin (Eds.), *Relating events in narrative: A crosslinguistic developmental study* (pp. 239-289). Hillsdale, NJ: Lawrence Erlbaum.

Semel, E.M., Wiig, E. H., & Secord, W. (2003). Clinical evaluation of language fundamentals (CELF-4). San Antonio, TX: The Psychological Corporation.

Slobin, D. I. (1996). Two ways to travel: Verbs of motion in English and Spanish. In M. Shibatani & S. A. Thompson (Eds.), *Grammatical Constructions: Their Form and Meaning* (pp. 195-219). Oxford: Clarendon Press.

Snedeker, J. & Gleitman, L. R. (2004). Why it is hard to label our concepts. In D. G. Hall & S. R. Waxman (Eds.), *Weaving a lexicon*, (pp. 257-294). Cambridge, MA: MIT Press.

Talmy, L. (1985). Lexicalization patterns: Semantic structure in lexical forms. In T. Shopen (Ed.), *Grammatical categories and the lexicon. Language typology and syntactic description* (pp. 57-149). Cambridge, MA: Cambridge University Press.

Werker, J. F & Tees, R. C. (1984). Cross-language speech perception: Evidence for perceptual reorganization during the first year of life. *Infant Behavior & Development, 7,* 49-63.

Woodward, A. (2000). Constraining the problem space in early word learning. In R. Golinkoff,, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp.). New York: Oxford University Press.

Yuan, S. & Fisher, C. (2009). "Really? She blicked the baby?": Two-year-olds learn combinatorial facts about verbs by listening. *Psychological Science, 20,* 619-626.

Zlatev, J. & Yangklang, P. (2004). A third way to travel: The place of Thai in motion-event typology. In S. Stromqvist & L. Verhoven (Eds.), *Relating events in narrative: Typological and contextual perspectives, Vol. 2* (pp. 159-190). Mahwah, NJ: Lawrence Erlbaum Associates.