Event-General Conceptual Categories Organize Verb Semantics and Acquisition Cross-linguistically

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Abstract

Languages vary in the ways they package the conceptual components of motion events into verbs. In a series of experiments, we examined the use of event-general conceptual categories of MANNER and RESULT during verb learning. We tested the accessibility of these concepts within and across domains of spontaneous motion and caused motion events, in speakers of typologically different languages (English and Spanish). Our results indicate that learners can adapt new lexicalization biases that may differ from those present in their own native language, and generalize them to novel instances of the same class of verbs. Furthermore, our data also indicate that under certain contexts, learners can transfer these newly learned biases to a different event domain, suggesting that event-general conceptual categories are psychologically available to learners.

Keywords: verb learning; event conceptualization; lexicalization; motion event; lexicon

Introduction

Verb learning is a challenging task. Events that learners observe consist of multiple co-occurring components and relations, but verbs typically do not capture the entirety of an event; rather, they only name a subset of multiple conceptual components of an event. Thus, one of the major challenges in verb learning is understanding how the multiple conceptual components of events are packaged into verbs.

Motion verb lexicalization biases across languages

Languages vary in the ways they package the conceptual components of events into verbs. For instance, there is systematic cross-linguistic variation in the components of a spontaneous motion event that are typically lexicalized in verbs (Beavers, Levin, & Tham, 2010; Jackendoff, 1990; Slobin, 1997, 2004, 2006; Talmy, 1975, 1985, 1991). Manner languages (e.g., English, German, Russian; "satellite-framed" languages in Talmy's typology) prefer to encode the manner of motion information in the main verb and path information in modifiers such as prepositional phrases (e.g., English: *She ran out of the house*). Conversely, path languages (e.g., Spanish, Greek; "verb-framed" languages in Talmy's typology) often package the path information in the main verb and manner outside of the main verb, for instance in an optional gerund (e.g., Spanish: *Ella salió de la casa corriendo 'She exited the house running'*).

This typological distinction affects how speakers of different languages describe motion events (Berthele, 2013, 2017; Bunger, Papafragou, & Trueswell, 2013; Bunger, Skordos, Trueswell, & Papafragou, 2016; Durst-Andersen, Smith, & Thomsen, 2013; Gennari, Sloman, Malt, & Fitch, 2002; Georgakopoulos, Härtl, & Sioupi, 2019; Ji, Hendriks, & Hickmann, 2011; Montero-Melis & Bylund, 2017; Naigles, Eisenberg, Kako, Highter, & McGraw, 1998; Özçalışkan & Slobin, 1999, 2003) and appears early in children's speech (Allen et al., 2007; Özyürek et al., 2008; Papafragou, Massey, & Gleitman, 2002, 2006; Slobin, 1996, 2003, 2004). It also has consequences for the way children and adult speakers interpret novel motion verbs (Maguire et al., 2010; Naigles & Terrazas, 1998; Papafragou & Selimis, 2010; Skordos & Papafragou, 2014). For example, when presented with a novel verb describing a spontaneous motion event (e.g., a woman skipping towards a tree), English speakers prefer to extend the verb to other events with the same manner but not to events with the same path, whereas Spanish speakers prefer to extend the verb to events with the same path, but not the same manner (Hohenstein, 2005; Naigles & Terrazas, 1998). While these lexicalization biases are robust, they can be adjusted based on semantic regularities in the input (Shafto, Havasi, & Snedeker, 2014).

Spontaneous and caused motion verbs

A pertinent question is whether these lexicalization patterns generalize beyond the single class of spontaneous motion events to more complex events, for example caused motion. In a caused motion event, an agent brings about a result in an object by interacting with it in a certain way: for instance, a girl 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 component (the kicking action) or the Result component (the sending-into-the-basket outcome).

One can hypothesize that the Means-Result distinction is related to the Manner-Path distinction for spontaneous motion: both distinctions refer to the How vs. the Where To of an event. This hypothesis is supported by parallels in the encoding (syntax and semantics) of spontaneous and caused motion, which suggest that Manner and Means are members of one category, and Path and Result of another. Specifically, both Manner verbs of spontaneous motion (e.g., *run*, *dance*, and *swim*) and Means verbs (e.g., *kick*, *shove*, and *push*)

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), Proceedings of the 46th Annual Conference of the Cognitive Science Society.

possess the underlying semantic representation in (1) (Levin, 2008):

(1) [x ACT<MANNER>]

In this representation, Manner modifies the action denoted by the verb. For purposes of this paper, we will restrict the term *Manner* to intransitive/spontaneous motion verbs, and reserve *Means* for caused motion verbs.

In the Path-Result dimension, Path verbs of spontaneous motion (e.g., *ascend, descend,* and *enter*) and Result verbs (e.g., *put*, *lower,* and *transfer*) share the change-of-state aspect of the representation in (2) (Path verbs lack the causative component) (see Levin, 2008)[1].

(2) [[x ACT] CAUSE [y BECOME<*RESULT-STATE*>]]

More specifically, a verb such as *enter* denotes a change of state undergone by the subject, such that the resulting state of the subject is in the reference object; a verb such as *ascend* also denotes a change of state that has to do with height. More generally, verbs denoting path traversal (and hence change of location) are semantically related to verbs denoting result (and hence change of state), as location can be considered a type of state.[2]

On this analysis, the event-general semantic primitives of MANNER (including Manner and Means) and RESULT (including Path and Result) are foundational for the structure of the lexicon across languages. Furthermore, they place constraints on lexicalizable meanings across non-stative verbs: because Manner/Means and Path/Result capture complementary aspects of verb meaning, a verb can lexicalize only one, and not both of these aspects (Levin & Rappaport Hovav, 1992; Kiparsky, 1997). Despite the centrality of this analysis for the nature of the lexicon, little direct evidence exists in its support.

Papafragou and Selimis (2010b) provided experimental evidence for semantic similarities between Manner and Means and between Path and Result, in elicited production and verb learning tasks. When adult and five-year-old speakers of English (manner language) and Greek (path language) were asked to describe spontaneous motion events, English speakers preferred to used Manner verbs (e.g., *run*) whereas Greek speakers preferred to used Path verbs (e.g., *enter*); similarly, when asked to describe caused motion events, English speakers typically used Means verbs (e.g., *push*) whereas Greek speakers typically used Result verbs (e.g., *send*). A similar pattern emerged in novel verb learning tasks.

There is a possibility that parallels in lexicalization biases across spontaneous and caused motion arise from a generalization of biases formed for spontaneous motion verbs to caused motion verbs, as suggested by Papafragou and Selimis. However, it is also possible that these cross-domain parallels do not emerge from conceptual mappings between parallel event concepts; rather, lexicalization biases for spontaneous motion and caused motion may have developed independently, or could be reflections of general morphosyntactic properties of the respective languages that are not specific to the encoding of event concepts. In what follows, we present a more direct test of this

The current study

In the current study, we test whether the event-general conceptual categories MANNER and RESULT are available to speakers of typologically different languages, by testing how native speakers of English and Spanish learn new lexicalization biases across verbs in the spontaneous and caused motion domains. Instead of (or, in addition to) examining existing lexicalization patterns in English and Spanish, we test these questions in the context of a novel artificial language that provides differently biased input to learners. In Experiment 1, we test whether and how learners learn novel verb biases in the spontaneous motion domain and transfer them to the caused motion domain. In Experiment 2, we test whether and how this process is affected by the syntactic framing of the caused motion verb. In Experiment 3, we test whether these biases can transfer in the other direction – from caused motion to spontaneous motion. The competing hypotheses being tested in this study can be summarized as follow:

(3) *Restricted Access Hypothesis*:
If learners have restricted access to event-general concepts during verb learning, newly learned biases in one domain (either spontaneous motion or caused motion) should not affect biases in the other domain.

(4) *Accessibility Hypothesis*:
If learners have access to event-general concepts during verb learning, newly learned biases in one domain (either spontaneous motion or caused motion) should affect biases in the other domain.

Findings in support of the *Restricted Access Hypothesis* would suggest that event concepts are event-specific, such that Manner and Path concepts are specific to the domain of spontaneous motion events, but not to caused motion events, and vice versa for Means and Result. Therefore, verb learning biases attested in Papafragou and Selimis (2010b) would just be mere reflections of generalizations about language-specific ways of encoding a particular event domain. If, however, our findings support the *Accessibility Hypothesis*, this would indicate that Manner and Means are indeed part of a more general conceptual category, and Path and Result of another, supporting the psychological reality and availability

[1] This extends to caused change-of-state (e.g., break, clean), which we do not discuss in this paper.

[2] Some researchers take spontaneous Path verbs to be a type of Result verb (Levin & Rappoport Hovav, 1992) or subsume both under "directed change" verbs (Levin & Rappoport Hovav, 1995).

of conceptual categories that structure the lexicon (see also Geojo, 2015).

Experiment 1

In Experiment 1, we tested whether native speakers of English and Spanish can (a) learn new novel verb biases in the spontaneous motion domain and (b) transfer them to the caused motion domain.

Method

Participants We recruited 75 adult native speakers of English and 75 adult native speakers of Spanish on Prolific. (Spanish-speaking participants identified Spanish as their first language, primary language, fluent language, *and* earliest language and resided in various parts of the world including Mexico, Spain, and Chile.) Participants were randomly assigned to one of the three groups: No-Training, Manner-Training, and Path-Training. In all experiments reported in this study, participants were compensated at the $8/hour rate for participating.

Stimuli Stimuli consisted of twelve triads of videoclips that depicted spontaneous motion events, adapted from Papafragou and Selimis (2010a, 2010b) and eight triads of videoclips that depicted caused motion events, adapted from Papafragou and Selimis (2010b). Spontaneous motion events depicted entities spontaneously moving along a path in a certain manner (e.g., a fish bobbing through a barrel). Both manner and path components were salient in these events. In addition to a sample event, two variants each presented a specific change to the sample event. In the Same-Manner variant, the Manner of motion was changed but the Path was kept the same (e.g., a fish dancing through the barrel). In the Same-Path variant, the Path was changed whereas the Manner remained the same (e.g., a fish bobbing under the barrel). Sample caused motion 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 Means and Result components were salient in the sample events. Again, in addition to a sample event, two variants each presented a specific change to the sample event. In the Same-Means variant, the Result was changed whereas the Means remained the same (e.g., the girl pushed the ball but the ball rolled in place). In the Same-Result variant, the Means was changed whereas the Result was kept the same (the girl hit the ball with her head and made it go down the hill). Events always involved direct physical causation.

Procedure *Training groups:* Participants in the Manner-Training and Path-Training groups were told that they would first learn some things from an alien about her alien language (which may seem similar to English (Spanish) in some aspects, but not in all aspects) and that later, they would answer some questions about the alien language. (The alien was shown as a clipart image.)

Table 1 summarizes the structure of the phases and trials, along with examples. During the Training phase, participants were exposed to eight triads of videoclips that depicted spontaneous motion events. At the beginning of each trial, an alien image appeared (in order to indicate that the alien is teaching her language). Next, participants saw the sample event along with a sentence introducing a nonsense verb in written form (e.g., English: "This is nolding."; Spanish: "Esto es dojar."). English verbs were presented with present progressive morphology, and Spanish verbs were presented in infinitive (non-conjugated) form. All verbs were designed so as not to resemble existing verbs in the two languages (English: *nold*, *preak*, *gorp*, *tark*, *glip*, *queed*, *blig*, *lorp*; Spanish: *dojar*, *tolar*, *sarar*, *chobrir*, *coder*, *jater*, *lemir*, *revir*). The sample event and the sentence were presented twice. Then, participants saw the two variants of the sample event (Same-Path and Same-Manner), one by one. Participants in the Manner-Training group were told that the Same-Manner variant was an instance of the verb (e.g., English: "This is nolding."; Spanish: "Esto es dojar.") whereas the Same-Path variant was not (e.g., English: "This is not nolding."; Spanish: "Esto no es dojar."). Conversely, participants in the Path-Training group were told that the Same-Path variant, but not the Same-Manner variant, was an instance of the verb.

At the beginning of the Testing phase, the alien said (again, in written form) "Now you'll watch new videos and make guesses about what I would say!" During the testing phase, participants were tested on four novel spontaneous motion events, and then on eight caused motion events. On each spontaneous motion test trial, participants first saw a sample spontaneous motion event, along with a sentence introducing a nonsense verb (e.g., English: "This is dacking."; Spanish: "Esto es zellar."). Next, they saw each variant of the event (Same-Manner and Same-Path), one by one, and were asked whether each variant was an instance of the verb (e.g., English: "Was that dacking?"; Spanish: "¿Eso fue zellar?"). The caused motion test trials proceeded in the same way, with the sample caused event and a sentence introducing a novel verb (e.g., English: "This is tazzing."; Spanish: "Esto es ticher."), followed by the two variants (Same-Means and Same-Result) to which participants answered whether they accepted them as instances of the novel verb (e.g., "Was that tazzing?"; Spanish: "¿Eso fue ticher?"). The verbs were designed so as not to resemble existing verbs in the two languages (English: *wiss, trib, smip, dack, tazz, zack, pim, teep, glit, shilk, stip*; Spanish: *bezclar, foner, nopar, zellar, ticher, vasir, jecir, nograr, betrar*). The presentation order of the trials was identical for all participants. The presentation order of the Same-Manner (Same-Means) and Same-Path (Same-Result) variants within each trial was counterbalanced within each event class.

No-Training group: In order to identify the existing biases in the participants' native languages, participants in the No-Training group were simply told that they will learn some new words and answer some questions about them. The training phase was omitted for this group. Participants completed twelve (four spontaneous motion, eight caused

motion) testing trials identical to those of the Training groups.

Results

Responses to each event variant (Same-Manner and Same-Path on spontaneous motion trials or Same-Means and Same-Result on caused motion trials) were coded as 0 ("No (That was not V-ing)") or 1 ("Yes (That was V-ing)"). Then, Path/Result bias scores were computed for each trial, by taking the response (0 or 1) on the Same-Path/Result variant and subtracting the response (0 or 1) on the Same-Manner/Means variant. This score would be 1 for a perfect Path/Result bias (accepting the Same-Path/Result variant and rejecting the Same-Manner/Means variant) and -1 for a perfect Manner/Means bias (accepting the Same-Manner/Means variant and rejecting the Same-Path/Result variant). The score would be 0 if both variants were accepted or rejected. Responses were entered into a mixed effects logistic regression with language (for No-Training group) or Training type (for the Training groups) as the fixed effect and participant and item as random effects.

No-Training group For the No-Training group, we focus on whether there existed differences in underlying lexicalization biases within each language group.

Spontaneous motion trials: Within spontaneous motion, Spanish-speaking participants had higher Path-bias scores (M=-0.21, SD=0.42) than English-speaking participants (M=-0.5, SD=0.48) (β=0.29, SE=0.13, df=48.00, t=2.24, p=0.03).

Caused motion trials: On caused motion trials, English-speaking participants had marginally higher Result-bias scores (M=0.49, SD=0.22) than Spanish-speaking participants (M=0.37, SD=0.24) (β=-0.12, SE=0.07, df=48.00, t=-1.81, p=0.07).

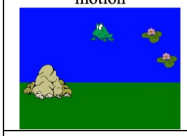
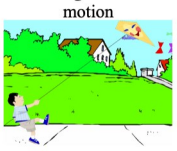
Training groups For the Training groups, we focus on whether and how the lexicalization patterns in the training input (Manner-bias vs. Path-bias) affected participants' response patterns in the Testing phase.

Spontaneous motion trials: Both English and Spanish-speaking participants were affected by patterns in the training input. English-speaking participants in the Path-Training group showed a higher Path-bias (M=0.14, SD=0.51) than participants in the Manner-Training group (M=-0.6, SD=0.41) (β=0.74, SE=0.15, df=38.00, t=4.94, p<.0001). Spanish-speaking participants also showed a higher Path-bias in the Path-Training group (M=0.34, SD=0.51) than in the Manner-Training group (M=-0.76, SD=0.26) (β=1.10, SE=0.13, df=40.00, t=8.61, p<.0001).

Caused motion trials: To investigate whether speakers generalize newly learned lexicalization biases in the spontaneous domain to the caused motion domain, we analyzed caused motion trial data from participants who successfully learned intended biases in the spontaneous motion domain. This was assessed by measuring their "accuracy" on the spontaneous motion trials. For participants in the Manner-Training group, items where they accepted the Same-Manner variant and rejected the Same-Path variant were coded as accurate responses, and vice versa for participants in the Path-Training group. Participants had to score at least 75% accuracy in order to be identified as having successfully learned the intended bias.

English-speaking participants who successfully learned intended biases showed marginally higher Result-bias scores in the Path-Training group (M=0.81, SD=0.54) than in the Manner-Training group (M=0.54, SD=0.66) (β=-0.11, SE=0.06, df=118.86, t=-1.72, p=0.09). Spanish-speaking participants who successfully learned intended biases showed higher Result-bias scores in the Path-Training group (M=0.79, SD=0.53) than in the Manner-Training group

Table 1: Structure of Experiments 1 and 2

Phase	Video type		Scene	Language (English, Spanish)	
Training 	Sample event		Fish flips through barrel	This is gorping. Esto es dojar.	
	Trial	Same **Manner**	Fish **flips** under barrel	**Manner-verb training**	This is gorping. Esto es dojar.
				Path-verb training	This not gorping. Esto no es dojar.
		Same **Path**	Fish bobs **through** barrel	**Manner-verb training**	This is not gorping. Esto no es dojar.
				Path-verb training	This is gorping. Esto es dojar.
Testing – spontaneous motion 	Sample event		Frog jumps to the front of a rock	This is bligging. Esto es sarar.	
	Trial	Same **Manner**	Frog **jumps** to the top of a rock	Was that bligging? (Y/N) ¿Eso fue sarar? (Y/N)	
		Same **Path**	Frog hops **to the front of a rock**	Was that bligging? (Y/N) ¿Eso fue sarar? (Y/N)	
Testing – caused motion 	Sample event		A boy pulls on a kite string; the kite comes down from the sky	Exp. 1	Exp. 2
				This is nolding. Esto es chellar.	The boy is nolding the kite. El chico está chellando la cometa.
	Trial	Same **Means**	A boy **pulls** on a kite string; the kite moves slightly in the air	Was that nolding? (Y/N) ¿Eso fue chellar? (Y/N)	
		Same **Result**	A boy clasps a kite string; the kite **comes down from the sky**	Was that nolding? (Y/N) ¿Eso fue chellar? (Y/N)	

(M=0.54, SD=0.67) (β=-0.12, SE=0.06, df=24.00, t=-2.13, p=0.04).

Discussion

Experiment 1 found that speakers can adjust their underlying lexicalization biases in response to the training input: after participants were trained on a few spontaneous motion verbs that either encoded Manner or Path, they robustly generalized these biases to novel spontaneous motion verbs. Both English- and Spanish-speaking participants did so, regardless of the lexicalization differences between their native language (as indicated by a higher Path-bias in English than in Spanish in the absence of training). These results support the plasticity of lexicalization biases (cf. Shafto et al., 2013) and demonstrate such plasticity cross-linguistically.

Most importantly, Experiment 1 also found that lexicalization biases in the spontaneous motion domain shape biases in the caused motion domain: speakers trained on Manner verbs developed a stronger Means-bias than speakers trained on Path verbs, and speakers trained on Path verbs developed a stronger Result-bias than speakers trained on Path verbs, especially in the Spanish-speaking group (the effect was more subtle for English speakers). These results support the *Accessibility Hypothesis*, suggesting the availability of event-general conceptual categories during verb learning.

Experiment 2

In Experiment 1, we showed that novel lexicalization biases can be learned within the spontaneous motion event domain and also possibly be transferred to a more complex caused motion event domain. In Experiment 1, verbs of both spontaneous and caused motion were presented in the same frame (e.g., "This is V-ing / Esto es V"). However, verbs of caused motion appear more frequently as transitive verbs across languages. In Experiment 2, we replicate Experiment 1 but present caused motion verbs in transitive frames to better capture how the event components are organized into verb meaning.

Method

Participants We recruited 75 new adult native speakers of English and 75 new adult native speakers of Spanish from the same participant pool as Experiment 1. As in Experiment 1, participants were randomly assigned to one of the three groups: No-Training, Manner-Training, and Path-Training.

Stimuli The video stimuli used in the Training and Testing phases were identical to Experiment 1.

Procedure The procedure was identical to Experiment 1, except for one change in the Testing phase: In the caused motion test trials, the verbs appeared in a transitive frame (e.g., English: "The girl is tazzing the snowball."; Spanish: "La chica está tichiendo la bola de nieve."). (See Table 1.)

Results

No-Training group For the No-Training group, we focus on whether there existed differences in underlying lexicalization biases within each language group.

Spontaneous motion trials: As in Experiment 1, Spanish-speaking participants had a higher Path-bias (M=0.11, sd=0.78) than English-speaking participants (M=-0.30, sd=0.74) (β=0.41, SE=0.13, df=72.00, t=3.28, p=0.0016).

Caused motion trials: On caused motion trials, however, we did not find a difference between Path-bias scores in English-speaking (M=0.22, sd=0.73) and Spanish-speaking participants (M=0.31, sd=0.68) (β=0.09, SE=0.12, df=13.27, t=0.79, p=0.45).

Training groups For the Training groups, we focus on whether and how the lexicalization patterns in the training input (Manner-bias vs. Path-bias) affected participants' response patterns in the Testing phase.

Spontaneous motion trials: Both English and Spanish-speaking participants adjusted their lexicalization patterns in response to the training input. English-speaking participants in the Path-Training group showed a higher Path-bias (M=0.46, sd=0.76) than participants in the Manner-Training group (M=-0.67, sd=0.58) (β=1.12, SE=0.13, df=56.00, t=8.60, p<.0001). Spanish-speaking participants also showed a higher Path-bias in the Path-Training group (M=0.17, sd=0.81) than in the Manner-Training group (M=-0.73, sd=0.51) (β=0.90, SE=0.13, df=42.00, t=6.84, p<.0001).

Caused motion trials: As in Experiment 1, we analyzed data from participants who successfully learned the intended biases in the spontaneous motion domain (at least 75% accuracy on spontaneous motion trials). English-speaking participants who successfully learned intended biases in spontaneous motion showed higher Result-bias scores in the Path-Training group (M=0.73, sd=0.55) than in the Manner-Training group (M=0.29, sd=0.76) (β=-0.20, SE=0.06, df=34.00, t=-3.34, p=.002). Spanish-speaking participants who successfully learned intended biases, however, did not statistically differ in their Result-bias scores across the Path-Training (M=0.44, sd=0.74) and the Manner-Training groups (M=0.29, sd=0.73) (β=-0.13, SE=0.08, df=25.00, t=1.58, p=0.128).

Discussion

As in Experiment 1, both speakers of English and Spanish robustly generalized newly learned biases for spontaneous motion verbs to novel instances of spontaneous motion verbs. Moreover, these generalizations later impacted interpretations of novel *caused* motion verbs in the English-speaking group, but not in the Spanish-speaking group. These results offer partial support for the *Accessibility Hypothesis* and suggest a nuanced interaction between lexical and structural factors across speakers of different languages.

Experiment 3

In Experiment 3, we tested whether lexicalization biases transferred in the other direction—from caused motion verbs to spontaneous motion verbs.

Method

Participants We recruited 75 new adult native speakers of English and 75 new adult native speakers of Spanish from the same participant pool as Experiment 1 and 2. As in Experiment 1 and 2, participants were randomly assigned to No-Training, Manner-Training, or Path-Training groups.

Stimuli Stimuli consisted of twelve triads of videoclips that depicted caused motion events and eight triads of videoclips that depicted spontaneous motion events. In addition to the eight triads of caused motion clips used in Experiments 1 and 2, we created four new triads of caused motion clips that paralleled the design properties of the other eight triads. The eight triads of spontaneous motion events were taken from the stimuli used in Experiments 1 and 2.

Procedure Experiment procedure was similar to Experiments 1 and 2, except the ordering of trials. The Training phase consisted of *caused motion* events (8 events), followed by *caused motion* test trials (4 trials) and then *spontaneous event* test trials (8 trials). Caused motion events in both the Training and Test phrases were accompanied by verbs in transitive sentences, as in Experiment 2.

Results

No-Training group For the No-Training group, we focus on whether there existed differences in underlying lexicalization biases within each language group.

Caused motion trials: On caused motion trials, Spanish-speaking participants' Result-bias scores (M=-0.24, SD=0.81) were marginally higher than English-speaking participants' Result-bias scores (M=-0.43, SD=0.71) (β=0.19, SE=0.11, df=48.00, t=1.81, p=.077).

Spontaneous motion trials: Responses on spontaneous motion trials did not reveal a difference in the Path-bias scores of English-speaking (M=0.26, SD=0.72) and Spanish-speaking participants (M=0.18, SD=0.80) (β=0.08, SE=0.11, df=48.00, t=0.67, p=0.51).

Training groups For the Training groups, we focus on whether and how the lexicalization patterns in the training input (Means-bias vs. Result-bias) affected participants' response patterns in the Testing phase.

Caused motion trials: Both English and Spanish-speaking participants adjusted their caused motion lexicalization patterns in response to the training input. English-speaking participants in the Result-Training group showed a higher Result-bias (M=0.34, SD=0.83) than participants in the Means-Training group (M=-0.54, SD=0.68) (β=-0.44, SE=0.06, df=52.00, t=-6.97, p<.0001). Spanish-speaking participants also showed a higher Path-bias in the Path-Training group (M=0.29, SD=0.86) than in the Manner-Training group (M=-0.38, SD=0.71) (β=-0.26, SE=0.09, df=49.52, t=-3.02, p=.004).

Spontaneous motion trials: As in Experiment 1, we analyzed data from participants who successfully generalized the intended biases within the same domain (at least 75% accuracy on caused motion trials). English-speaking participants who successfully learned intended biases in caused motion showed higher Path-bias scores in the Result-Training group (M=0.24, SD=0.90) than in the Means-Training group (M=-0.47, SD=0.71) (β=0.71, SE=0.18, df=25.00, t=4.03, p<.001). Spanish-speaking participants' Path-bias scores, however, did not differ across the Means-training group (M=0.17, SD=0.84) and the Result-training group (M=-0.19, SD=0.89) (β=-0.35, SE=0.20, df=14.69, t=-1.75, p=0.10).

Discussion

Results of Experiment 3 demonstrate that newly learned generalizations about caused motion verbs can shape future learning of new caused motion verbs. Experiment 3 also investigated whether the transfer of lexicalization biases can occur in the opposite direction – from caused motion to spontaneous motion. Newly learned biases in the caused motion verbs affected interpretations of novel spontaneous motion verbs in the English-speaking group, but not in the Spanish-speaking group. Again, these results partially support the *Accessibility Hypothesis*, according to which learners can access event-general conceptual categories during verb learning.

General Discussion

In a series of experiments, we examined the use of event-general conceptual categories of MANNER and RESULT during verb learning. We tested the accessibility of these concepts within and across domains of spontaneous motion and caused motion events, in speakers of typologically different languages (English and Spanish). Our data indicate that learners can adapt new lexicalization biases that may differ from those present in their own native language, and generalize them to novel instances of the same class of verbs, suggesting that the malleability of lexicalization biases (Shafto et al., 2013) is widely shared. Furthermore, our data indicate that under certain contexts, learners can transfer these newly learned biases to a different event domain, suggesting that event-general conceptual categories are psychologically available to learners (*Accessibility Hypothesis*). However, our data also suggests that the transferability of biases also interacts with the morphosyntactic contexts in which the novel verbs appear in. Future work can address how lexical and structural factors interact within a given language given the structural constraints of the language. Overall, our studies show that MANNER and RESULT, which have been proposed to structure the verb lexicon across languages, are not merely features of descriptive typology, but are also accessed as conceptual primitives during language acquisition.

Acknowledgments

This work is supported by the NSF Grant BCS-2041171 awarded to Anna Papafragou.

References

Allen, S., Özyürek, A., Kita, S., Brown, A., Furman, R., Ishizuka, T., & Fujii, M. (2007). Language-specific and universal influences in children's syntactic packaging of manner and path: A comparison of English, Japanese, and Turkish. *Cognition*, *102*(1), 16-48.

Beavers, J., Levin, B., & Tham, S. W. (2010). The typology of motion expressions revisited. *Journal of Linguistics*, *46*(2), 331-377.

Berthele, R. (2013). Disentangling manner and path: Evidence from varieties of German and Romance. In J. Goschler & A. Stefanowitsch (Eds.), *Variation and Change in the Encoding of Motion Events* (pp. 55–75). Amsterdam: John Benjamins.

Berthele, R. (2017). When bilinguals forget their manners: Language dominance and motion event descriptions in French and German. *Vigo International Journal for Applied Linguistics, 14*, 39-70.

Bunger, A., Papafragou, A., & Trueswell, J. C. (2013). Event structure influences language production: Evidence from structural priming in motion event description. *Journal of Memory and Language*, *69*(3), 299-323.

Bunger, A., Skordos, D., Trueswell, J. C., & Papafragou, A. (2016). How children and adults encode causative events cross-linguistically: Implications for language production and attention. *Language, Cognition and Neuroscience*, *31*(8), 1015-1037.

Durst-Andersen P., Smith, V. & Thomsen, O. N (2013). Towards a cognitive-semiotic typology of motion verbs. In C. Paradis, J. Hudson & U. Magnusson (Eds.). The Construal of Spatial Meaning: Windows into Conceptual Space (pp. 118-143). Oxford: Oxford University Press.

Gennari, S., Sloman, S., Malt, B., & Fitch, W. (2002). Motion events in language and cognition. *Cognition*, *83*(1), 49–79.

Geojo, A. C. (2015). *Breaking and Entering: Verb Semantics and Event Structure*. Harvard University Doctoral dissertation.

Georgakopoulos, Th., Härtl, H, & Sioupi, A. (2019). Goal realization: An empirically based comparison between English, German, and Greek. *Languages in Contrast*, *19*, 280-309.

Hohenstein, J. M. (2005). Language-related motion event similarities in English-and Spanish-speaking children. *Journal of Cognition and Development*, *6*(3), 403-425.

Ji, Y., Hendriks, H., & Hickmann, M. (2011). How children express caused motion events in Chinese and English: Universal and language-specific influences. *Lingua*, *121*, 1796-1819.

Maguire, M. J., Hirsh-Pasek, K., Golinkoff, R. M., Imai, M., Haryu, E., Vanegas, S., ... & 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*(3), 299-319.

Montero-Melis, G., & Bylund, E. (2017). Getting the ball rolling: The cross-linguistic conceptualization of caused motion. *Language and Cognition*, *1*, 1–27.

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

Naigles, L. R., & Terrazas, P. (1998). Motion-verb generalizations in English and Spanish: Influences of language and syntax. *Psychological Science*, *9*(5), 363-369.

Özçalışkan, Ş., & Slobin, D. I. (1999). Learning how to search for the frog: Expression of manner of motion in English, Spanish, and Turkish. In A. Greenhill, H. Littlefield, & C. Tano (Eds.), *Proceedings of the 23rd Annual Boston University Conference on Language Development* (pp. 541-552). Sommerville, MA: Cascadilla Press.

Özçalışkan, Ş., & Slobin, D. I. (2003). Codability effects on the expression of manner of motion in Turkish and English. In A. S. Özsoy, M. Nakipoglu-Demiralp, E. Erguvanlı-Taylan, & A. AksuKoç (Eds.), *Studies in Turkish Linguistics* (pp. 259-270). Istanbul: Bogazici University Press.

Özyürek, A., Allen, S., Furman, R., Kita, S., Brown, A., & Ishizuka, T. (2008). Development of cross-linguistic variation in speech and gesture: Motion events in English and Turkish. *Developmental Psychology*, *44*, 1040-1054.

Papafragou, A., Massey, C., & Gleitman, L., (2002). Shake, rattle, 'n' roll: the representation of motion in language and cognition. *Cognition*, *84*(2), 189-219.

Papafragou, A., Massey, C., & Gleitman, L. (2006). When English proposes what Greek presupposes: The cross-linguistic encoding of motion events. *Cognition*, *98*(3), B75-B87.

Papafragou, A., & Selimis, S. (2010). Lexical and structural biases in the acquisition of motion verbs. *Language Learning and Development*, *6*(2), 87-115.

Shafto, C. L., Havasi, C., & Snedeker, J. (2014). On the plasticity of semantic generalizations: Children and adults modify their verb lexicalization biases in response to changing input. *Developmental Psychology*, *50*(3), 794.

Skordos, D., & Papafragou, A. (2014). Lexical, syntactic, and semantic-geometric factors in the acquisition of motion predicates. *Developmental Psychology*, *50*(7), 1985-1998.

Slobin, D. (1996). From "thought and language" to "thinking for speaking". In J. Gumperz & S. Levinson (Eds.), *Rethinking linguistic relativity*. Cambridge: Cambridge University Press.

Slobin, D. I. (2003). Language and thought online: Cognitive consequences of linguistic relativity. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind: Advances in the study of language and thought* (pp. 157-191). Cambridge, MA, US: MIT Press.

Slobin, D. I. (2004). The many ways to search for a frog: Linguistic typology and the expression of motion events. In S. Strömqvist and L. Verhoeven (Eds.), *Relating events*

in narrative: Vol. 2. Typological and contextual perspectives (pp. 219–257). Mahwah, NJ: Lawrence Erlbaum.

Talmy, L. (1975) Semantics and syntax of motion. In J. P. Kimball (Ed.) *Syntax and semantics (vol. 4).* New York: Academic Press.

Talmy, L. (1985). Lexicalization patterns: Semantic structure in lexical forms. In T. Shopen (Ed.), *Language typology and syntactic description, Volume 3: Grammatical categories and the lexicon* (pp. 57-149). Cambridge: Cambridge University Press.

Talmy, L. (1991). Path to realization: A typology of event conflation. *Proceedings of the Seventeenth Annual Meeting of the Berkeley Linguistics Society: General Session and Parasession on The Grammar of Event Structure*, *17*(1), 480-519.