COGNITIVE SCIENCE
A Multidisciplinary Journal

Cognitive Science (2016) 1–13

ISSN: 0364-0213 print / 1551-6709 online
DOI: 10.1111/cogs.12376

Does Making Something Move Matter? Representations of Goals and Sources in Motion Events With Causal Sources

Laura Lakusta,[a] Paul Muentener,[b] Lauren Petrillo,[a] Noelle Mullanaphy,[a] Lauren Muniz[a]

[a]*Department of Psychology, Montclair State University*
[b]*Department of Psychology, Tufts University*

Received 10 November 2014; received in revised form 18 November 2015; accepted 4 December 2015

Abstract

Previous studies have shown a robust bias to express the goal path over the source path when describing events ("the bird flew into the pitcher," rather than "... out of the bucket into the pitcher"). Motivated by linguistic theory, this study manipulated the causal structure of events (specifically, making the source cause the motion of the figure) and measured the extent to which adults and 3.5- to 4-year-old English-speaking children included the goal and source in their descriptions. We found that both children's and adults' encoding of the source increased for events in which the source caused the motion of the figure compared to nearly identical events in which the source played no such causal role. However, a goal bias persisted overall for both causal and noncausal motion events. These findings suggest that although the goal bias in language is highly robust, properties of the source (such as causal agency) influence its likelihood of being encoded in language, thus shedding light on how properties of an event can influence the mapping of event components into language.

Keywords: Causal motion events; Language development; Goal bias; Goal paths; Source paths; Event representation

1. Introduction

Early in language development, children are sensitive to properties of events—properties that influence how an event's components will be mapped into language. For example, children are sensitive to the intentional structure of an event. They prefer to map agents

Correspondence should be sent to Laura Lakusta, Department of Psychology, Montclair State University, Montclair, NJ 07043. E-mail: lakustal@mail.montclair.edu

(i.e., initiators of action), rather than patients (i.e., objects affected by action), into the syntactic subject position (preferring an interpretation of "giving," "the elephant is giving the ball to the bunny," rather than "taking" when viewing an event that is consistent with both "giving" and "taking") (Fisher, Hall, Rakowitz, & Gleitman, 1994). English-speaking children, as young as 3.5 years of age, are also sensitive to the causal structure of an event when describing events; they prefer to use lexical causative constructions (constructions where both the cause and effect are mapped into a single clause; for example, the elephant moved the dog) to describe direct causal events (e.g., an animal causes another animal to bend over by direct contact), and they prefer to use periphrastic constructions (constructions where the cause and effect are mapped into multiple clauses; for example, the elephant made the dog move) to describe events that involve indirect causation (e.g., an animal causes another animal to bend over by throwing a ball at him) (Pinker, 1989; see Wolff, 2003 who reports a similar phenomenon with adults).[1] They also prefer to map intentional agents, rather than nonintentional agents, into causal linguistic structures (preferring "the girl popped the balloon" only when the girl intentionally, but not accidentally, pops the balloon; Muentener & Lakusta, 2011).

These findings—that the intentional and causal structure of the event influences the mapping of event components into language in children as young as 3.5 years of age—are especially pertinent for theories in language acquisition; they provide information about the possible mechanisms by which children map conceptual representations into linguistic structures (e.g., intentional agents map into subject position; see Fisher & Song, 2006), and they raise questions about the basis of these representations in nonlinguistic and pre-verbal thought (see Wagner & Lakusta, 2009, for a review).

This study explores another case of how children's sensitivity to the causal structure of an event might influence the way an event's components are mapped into language. The event components under investigation are goal and source paths. Following Jackendoff's analysis (1983) of the semantic structures of events, source paths (or FROM-Paths) are paths in which a figure (object under motion) moves from an object that is its spatial starting point (e.g., the car moves from the box), whereas goal paths (or TO-Paths) are paths in which the figure moves to an object that is its spatial endpoint (e.g., the car moves to a bowl). Source and goal paths can take on roles in addition to those of spatial starting points and endpoints; for example, they can be agents and patients—roles that characterize the intentional and causal structure of an event (the "action tier" in terms of Jackendoff, 1990). In the event *Nicholas threw the ball to Jessica*, Nicholas is not only the spatial starting point of the ball's motion (the source), but he is also the causal and intentional agent. Note that although source and goal paths are proposed to be linguistically universal (Jackendoff, 1983), there are differences in how languages map these paths into syntax; for example, in English, goal and source paths are typically mapped into prepositional phrases (PPs) (e.g., the car moves from the box to the bowl), whereas in Japanese, they are encoded as case particles attached to the verb (e.g., "ni" and "kara" for goal and source respectively; see Levinson and Wilkins, 2006, for a detailed discussion of source and goal markings across many languages).

The starting point for this study is the broad and robust asymmetry, observed across several languages, where goal paths take a more prominent role than source paths (see Lakusta & Landau, 2012, for review). For example, Lakusta and Landau (2005) found that when 3.5-year-old English-speaking children and adults were shown manner of motion events (e.g., bird flying out of a pot and into a bowl), they were more likely to map the goal path than the source path into a PP and say, "the bird flew <u>into the bowl</u>" (for a replication with Japanese-speaking children, see Lakusta, Yoshida, Smith, & Landau, 2006). A goal bias has also been found to characterize the descriptions of events that differ from manner of motion events in their semantic and syntactic constraints for encoding source and goal paths (e.g., attachment/detachment, transfer of possession, and change of state; Lakusta & Landau, 2005).

Although several studies have reported a goal bias in language, fewer studies have explored explanations for its existence. One proposal is that a goal bias in language may be explained as a simple attentional bias for endpoints over starting points, which is then reflected in language (Regier, 1996). If perceivers of an event attend more to endpoints, then, in language, they may be more likely to mention goals in their descriptions. However, studies have shown that such a nonlinguistic attentional bias cannot fully explain a goal bias in language. Lakusta and Landau (2012) have shown that there are events for which people *remember* the endpoint and starting point equally well, but yet still include only the goal path in their description.

Alternatively, a linguistic goal bias may also arise due to constraints *internal* to linguistic representations. For example, it has been proposed that in syntax, goal paths are syntactic arguments, while source paths act more like adjuncts. In semantics, goal paths constitute core events, while source paths modify the event (Filip, 2003; Markovskaya, 2006; Nam, 2004). Further, some formal theories of word meaning propose that lexical items (e.g., nouns) possess a qualia or explanatory structure that includes a telic and an agentive component (Moravcsik, 1981, 1990; Prasada, 2000; Pustejovsky, 1995). The endpoint of an event (run, fly, move, TO X) may play a critical role in this structure. Pragmatic constraints may also play a role; goal paths may presuppose some starting state (source), although the reverse is not necessarily true (van Riemsdijk, 2007).

If a goal bias in language can be explained by linguistic constraints, then factors shown to be critical to linguistic structure might modulate speakers' use of goal and source paths. Lakusta and Landau (2012) took such an approach by systematically manipulating the *intentional* structure of an event—a property that has been suggested to influence the mapping between semantic and syntactic structure (Dowty, 1991; Jackendoff, 1983). English-speaking 4-year-olds and adults viewed and described "what happened" in motion events where an *inanimate* figure moved from a source to a goal, such as a paper blowing from a container into a candle. Children and adults mapped the goal path into the PP more than the source path; thus, a goal bias persisted for language even when the figure was inanimate and thus likely to be construed as nonintentional. However, when an animate figure moved from the source to the goal while *looking back* at the source, such as a person hopping from a table to a ladder while looking back at the table, adults did *not* show a significant goal bias; rather, encoding of the source increased, and they tended to map both the goal and the source into the PP. Children continued to show a goal bias, perhaps because the "look back" manipulation was not a strong enough cue of the actor's intentions for some children. These findings suggest that, for adults at least, the intentions of the figure do indeed influence the mapping of goal and source paths into language. When the source (spatial starting point of the action) may have been construed as the actor's intentional goal (the actor wanted to get away from the source), it was also mapped into language.

The aim of the current study is to extend this finding by investigating how another property of event structure—the *causal* structure—influences the encoding of goal and source paths in language. In this study, we present participants with motion events that include starting points that either cause the figure object's motion (causal sources) or act only as noncausal, spatial starting points of the figure's motion (noncausal sources).[2] We ask participants to describe these events and code their descriptions for inclusion of sources and goals. Similar to intentional features discussed above, linguists have also argued that the causal features of an event are central to the way language is structured (e.g., Dowty, 1991; Jackendoff, 1983; Levin & Rappaport-Hovav, 1995). Consider the event of a "cannon shooting a bean bag into a bowl." An object that causes motion, such as "the cannon," may be construed as a causal agent (Dowty, 1991), and plays two linguistic roles in an event—it is the spatial starting point on the thematic tier as well as a causal agent on the action tier (Jackendoff, 1990). Given that agents are highly prominent in language and are likely to be mapped into the syntactic subject position (Aissen, 2001; Dowty, 1991; Kako, 2006), a causal starting point should take on a more prominent role in an event representation than a noncausal starting point of a figure's motion (e.g., the ball went from the tube into a bowl). Therefore, we predict that spatial starting points that are also causal agents will be mentioned more in linguistic descriptions than spatial starting points that are noncausal.

Despite our prediction for increased inclusion of sources for the causal motion events, we also predict that speakers will still display an overall bias to include goals in their descriptions. As reviewed previously, endpoints in noncausal motion events are often encoded in event descriptions (Lakusta & Landau, 2005, 2012; Papafragou, 2010). Moreover, for the causal events used in the current study, such as a "cannon shooting a bean bag into a bowl," in addition to the endpoint being the spatial endpoint of the figure's motion, it might also be construed as part of the effect (e.g., the bean bag lands in the bowl because the cannon shot it), and thus mentioned often in the linguistic descriptions for the causal events.

2. Method

2.1. Participants

Thirty children between the ages of 3;6 and 4;0 (N = 12 females; M = 3;9), all from the Northern New Jersey area, participated in the current study. All children were fluent English speakers; one child was bilingual (Spanish was the second language).

Additionally, 16 undergraduate native English-speaking adults from the Montclair State University Psychology Department's subject pool participated in order to measure adult performance; students were given course credit for their participation.

2.2. Materials

Participants were seated in front of a laptop computer and presented with 24 videotaped events portraying a figure object moving from a source to a goal. In half of the events (n = 12; henceforth "causal events"), the source caused the motion of the figure; for the other half of the events (henceforth, "noncausal" events) the figure object appeared to move on its own from the source to the goal. The figure object in the event was a ball (silver or blue) or a toy vehicle (car or truck). The goal object was a green bowl or a red block, and the source object was a tube, blue block, or red box. For the causal events, the source objects had a causal mechanism that launched the figure from the source to the goal (e.g., the tube had a spring that propelled the ball, the blue box had a flap that opened on top and a spring flipped the ball, and the red box had a side that moved out and pushed the toy vehicle across the stage). For the noncausal events, a black string that was indistinguishable from the black background of the experimental set-up (and hence not detectable by the viewer) was used to move the object from the source to the goal. The causal and noncausal events were presented in blocks and within each block the events were randomized to create two orders.

2.3. Procedure

The study consisted of three phases: object identification and practice (for children only) and test. In the object identification phase, the children viewed the pictures of the objects they were going to view in the test phase. As they viewed each picture, children were asked to name each object in the picture. This was done in order to familiarize children with the objects that they would view in the test events. Following the object identification phase, children viewed two practice events (a woman waving and of a woman clapping). After each video ended, the child was prompted to describe "what happened" and was encouraged to provide a complete description of the event (e.g., if the child responded "clapped," the experimenter asked, "who clapped?").

Following the practice phase, participants viewed the 24 test events. Following the method used by Lakusta and Landau (2005, 2012) and others (e.g., Fausey, Long, Inamori, & Boroditsky, 2010) after each video ended, the screen went blank and the participant was asked to describe "what happened" in the event. The participants' answers were recorded using a tape recorder and were later transcribed for analysis.

2.4. Data coding

In motion events (e.g., the bean bag went from the box into the bowl) sources and goals are typically mapped into PPs in English. However, agents are typically mapped into syntactic subject positions, in English (Dowty, 1991; Kako, 2006). Given that half of the sources in this study caused motion, and thus had a property typical of agents (Dowty, 1991), for the analyses below, we coded any mention of the source/goal in the participants' description as the source/goal being included. The data were coded by two independent coders and a third coder reviewed all the coding. A fourth coder was called upon to resolve any discrepancies in the coding.

3. Results

Four children did not complete both blocks (causal and noncausal) due to the child opting not to continue the experiment ($N = 2$ for causal block, $N = 1$ for noncausal block) and technical difficulty ($N = 1$ for causal block). Further, data from three children were excluded ($N = 1$ in the causal event block, and $N = 2$ in the noncausal event block) because the children used only one-word utterances (e.g., "ball"). Thus, data for 26 children in the causal event block (12 who viewed the causal events first) and 27 children in the noncausal block (16 who viewed the noncausal events first) were further analyzed for inclusion of goal and source.

The two predictions were that (a) the causal manipulation would influence a goal bias, such that participants would include the source more in their descriptions of causal events than noncausal events and (b) a goal bias would persist for both the causal and noncausal events. As shown in Figs. 1 and 2, the patterns of goal and source encoding for both children and adults support these predictions. Child and adult data were entered into two separated mixed-effect logistic regression models to predict path encoding, which was coded as binary (for each trial, 1 = source/goal included, 0 = no source/goal included). Models were fit using the lme4 package for R (Bates & Maechler, 2009). Event type (noncausal, causal) and path type (source, goal), along with their interaction, were treated as fixed-effect predictors; the models also included random intercepts for subject and item. Path type, event type, and their interaction were all significant predictors of path encoding. Goal paths were encoded significantly more than source paths for both adults ($\beta = 5.17$, Wald $Z = 11.47$, $p < .001$) and children ($\beta = 3.85$, Wald $Z = 14.91$, $p < .001$), suggesting a goal bias for both causal and noncausal events.[3] Paths were also encoded at greater rates for causal events compared to noncausal events for adults ($\beta = 1.16$, Wald $Z = 4.11$, $p < .001$) and children ($\beta = 1.30$, Wald $Z = 5.43$, $p < .001$). However, there was also a significant path type × event type interaction for both adults ($\beta = -1.57$, Wald $Z = -2.91$, $p < .01$) and children ($\beta = -1.53$, Wald $Z = -4.77$, $p < .001$): The effect of path type changed from noncausal to causal events. Specifically, the relative goal bias was lessened for causal, compared to noncausal, events (see Figs. 1 and 2), suggesting that the causal manipulation influenced a goal bias.

Two sets of secondary planned mixed-effect regression models were conducted to test the effect of event type separately on source encoding and goal encoding. These models revealed that the encoding of the source increased from the noncausal to the causal events

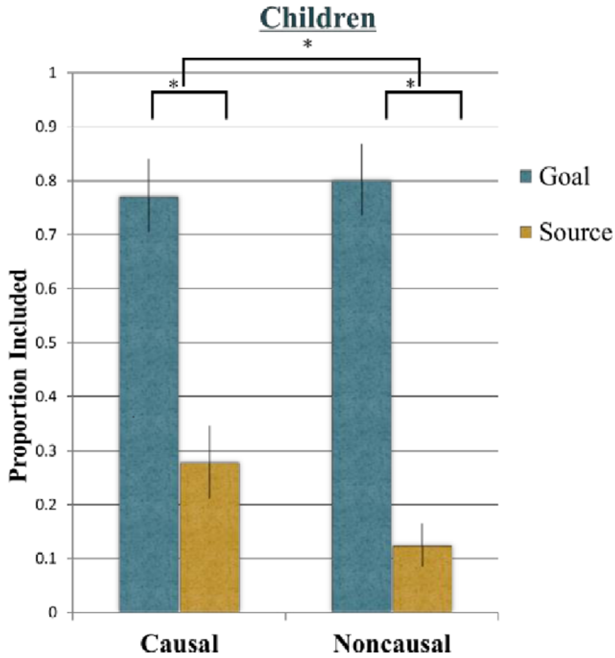

Fig. 1. Proportion (and ± 1 *SE*) of goal and source included across the causal and noncausal events for the child participants. **p* < .05.

for adults (β = 1.40, Wald $Z = 4.50$, $p < .001$) and for children (β = 1.72, Wald $Z = 5.78$, $p < .001$); no such increase occurred for goal paths in either age group.

In order to further explore *how* the causal manipulation influenced the mapping of sources into syntactic structure, the next analysis examined how the sources were syntactically encoded in children and adults' descriptions. As shown in Table 1, children predominantly encoded the source in the subject position for both the causal and noncausal events (e.g., "The cannon shoot the ball"; but see Table 1, footnote g). For adults, the source was encoded in a variety of syntactic positions for the causal events; however, for the noncausal events, the source was predominantly encoded in the prepositional phrase.

4. General discussion

The current findings show that manipulating the causal structure of the event influences a goal bias in language. Specifically, when the source caused the motion of the figure, children and adults included the source more in their descriptions of the events compared to when the source was noncausal; the encoding of goal remained the same. However, both adults and children continued to display a goal bias for both causal and noncausal events.

Before we consider the implications of our findings for explanations of a goal bias, we address an alternative interpretation of our data that the source object may have simply

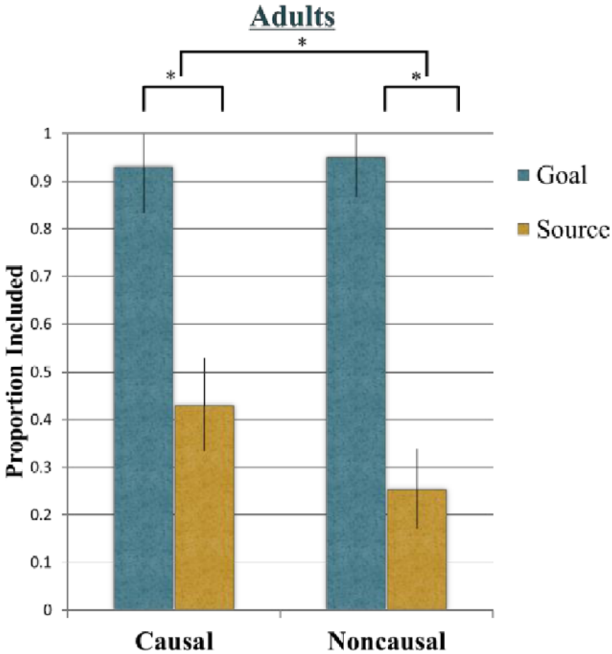

Fig. 2. Proportion (and ± 1 *SE*) of goal and source included across the causal and noncausal events for the adult participants. **p* < .05.

been more perceptually salient in the causal condition than the noncausal condition. We think this is highly unlikely because both adults and children encoded the causal source in the syntactic subject position with high frequency (see Table 1)—a position into which agents are often mapped in English (Dowty, 1991; Fisher et al., 1994). If sources were only perceived as salient, but not as causal, then adults and children should have encoded the sources in the PP—the syntactic position where (noncausal) source paths in motion events are typically mapped into in English (Jackendoff, 1983; Lakusta & Landau, 2005, 2012). Rather, we hypothesize that in the current study, when the source object caused motion of the figure, children and adults often interpreted the source, not only as the spatial starting point of the motion, but also as *the agent*, and thus were more likely to map the source into a linguistic structure.

Second, another question raised by the current study is whether the sources may have been perceived as intentional, rather than, or in addition to, being causal. In fact, research on the development of causal reasoning suggests that representations of causality and intentionality are closely linked. Muentener (2009) found that 8.5-month-old infants attribute novel state change events to intentional agents acting in goal-directed manners, but not to nonintentional agents. In this study, infants were shown occluded outcomes that were potentially caused by intentional or unintentional actions. Muentener tested whether infants attributed the outcome to potential agents by measuring their sensitivity to the contact relations between the agent and the outcome. Infants looked longer both when the

Table 1
Frequency of source encoding in children and adults for the causal and noncausal events[a]

	Children		Adults	
	Causal Events (%)	Noncausal Events (%)	Causal Events (%)	Noncausal Events (%)
Source in subject position[b]	94.0	77.8[g]	31.7	4.0
Source in by- phrase of passive structure[c]	0.0	0.0	3.7	2.0
Source in locative PP[d]	3.6	13.9	22.0	76.0
Source in locative PP in passive structure[e]	0.0	0.0	37.0	11.0
Source mentioned[f]	2.4	8.3	6.1	7.0

Notes. [a]For the causal events, seven children and two adults omitted the source on all trials, and for the noncausal events, 12 children and 2 adults omitted the source on all trials. Thus, the data in this table are representative of a subsample of the participants: causal events (N = 19 children, N = 14 adults) and noncausal events (N = 15 children and 14 adults).
[b]Source coded as subject; for example, The cannon moved the ball.
[c]Source in by-phrase as passive structure; for example, The ball was moved by the cannon.
[d]Source in locative PP; for example, The ball moved out of the cannon).
[e]Source in locative PP in passive structure; for example, The ball was moved out of the cannon).
[f]Source mentioned somewhere other than in the PP, subject, or subject of a by-phrase; for example, It was on the box and it moved).
[g]It should be noted that further inspection of the data revealed that seven children encoded the source as the subject in some of their descriptions for the noncausal events, and five of these children viewed the causal events before the noncausal events. Thus, for these children, viewing the source as causal in the prior block may have influenced their descriptions of the source in the noncausal events. Given this high proportion of children encoding the source as a subject for the noncausal events, we also examined the data only for the first block that children were tested on (causal or noncausal events). Results revealed that children who viewed the causal events first (n = 12) encoded the source in subject position 95% of the time and as a locative PP only 5% of the time. On the contrary, children who viewed the noncausal events first (n = 16) encoded the source in the subject position 43% of the time, as a locative PP 36% of the time, and mentioned somewhere other than in the PP, subject, or subject of a by-phrase 21% of the time.

agent contacted the object and the outcome did not occur and when the agent did not contact the object and the outcome did occur only when the potential agent was an intentional agent. When the potential agent was nonintentional, infants did not display a similar sensitivity to contact causality. Muentener and Lakusta (2011) have also found that this link persists in children's descriptions of causal events: 3.5 to 4-year-old children use more causal language to describe intentional compared to nonintentional causal events. Thus, children may have also been more likely to view the causal events in the current study as more intentional than the noncausal events. Future studies can test this by exploring whether children perceive mechanical causal objects (e.g., tubes with springs) as intentional in other situations.

The current findings shed light on possible theoretical explanations for a goal bias in language. Consider the following examples in which a goal bias has been observed for cases (A)–(C), but not observed for (D) and (E):

Goal bias in language observed:

(A) John moves from X to Y (Lakusta & Landau, 2005, 2012; Papafragou et al., 2010)
(B) The bean bag is moved to Y by the cannon (current study)
(C) The tissue moves from X to Y (Lakusta & Landau, 2012)

Goal bias in language *not* observed:

(D) The boy throws the ball to Y (Wilson, Unal, Trueswell & Papafragou, 2014; see also Lakusta & Landau, 2005)
(E) The girl moves from X to Y while looking back at X (Lakusta & Landau, 2012).

Theories positing that there is a qualia structure to word meaning that includes a teleological and agentive component (Moravcsik, 1981, 1990; Prasada, 2000; Pustejovsky, 1991, 1995) may help explain a linguistic goal bias in cases (A), (B), and (C) and the lack of one in (D) and (E). Consider the qualia structure for the nouns participating in these events (i.e., John, the cannon, the beanbag, the tissue). In (A), John is likely represented as an agent with a goal of reaching endpoint Y (telic component of the qualia structure); in (B), the cannon's function may be for shooting objects toward an endpoint (telic component of the qualia structure). Thus, in both cases, the endpoint has an integral role in the event and leads to frequent encoding of the goal in language. As the current study shows, however, adding an explicit causal mechanism to the source increases encoding of the source (i.e., the source is encoded more in scenarios such as B than A). Although in (A) John is a natural kind and does not require explanation for the creation of his motion (the agentive component of qualia structure), in (B) the beanbag is an artifact that does not typically move on its own, and thus the cannon provides a causal explanation. In (C) the tissue is also an artifact that requires an external source to explain its motion, but the absence of a visible source may allow the speaker to omit this reference and focus on the goal of the motion. Therefore, although in all three sentences "move" is the target verb, the qualia structure of the participants in the events calls about different senses of the verb. For (A), the source of motion is internal and focused toward the endpoint; for (B) and (C), the source of motion is likely external and requires explanation. When that explanation is available, as in the causal condition of the current study (scenario B), speakers are more likely to encode that component.

Consider now the qualia structure for the nouns in (D) and (E)—cases where a goal bias has not been observed, and the source is more prominent. In (D), the boy is now the spatial starting point *as well as* the intentional and causal agent, and brings about the action of throwing. In (E), the girl is likely represented as an agent with a goal of *getting away from* the starting point, thus the starting point may be the intentional goal (telic component of qualia structure) and may have also been construed as causing the figure to initiate her movement away from the source. Future research could test further scenarios, such as events of changes of state where there seems to be no relevant goal (other than the change in state being achieved), but where the source object is highly relevant for the existence of the event in the first place, such as events of volcanoes erupting and ice cubes melting. Would the source—the starting state that is solely responsible for causing an event to occur—be mapped into the surface syntax more than a spatial endpoint (e.g., the ice cube melted to the floor)? Given our discussion above that a goal bias in language can be explained largely by factors relating to the conceptual role of the nouns in an event, and not only by spatial properties of the event (e.g., source encoded first and the goal last), we predict that the source would be highly prominent and thus encoded in language for these types of change in state events.

Before concluding, it is worth noting that the explanation for a linguistic goal bias presented above also leads to the prediction that a goal bias in language may be highly generalizable across different languages; it may extend to languages that mark sources and goals differently syntactically and lexicalize paths differently than English (e.g., Gennari, Sloman, Malt, & Fitch, 2002). Further, a goal bias may even show up as errors in the way young children describe events; for example, children may interpret the meanings of some verbs incorrectly as goal oriented. Although a thorough review of the literature is beyond the scope of this paper, recent findings support this hypothesis. Srinivasan and Barner (2013) report that children misinterpret locatum verbs, such as “weed” in “weeding the garden,” as goal-oriented, whereas really it is source-oriented.

In conclusion, the present study tested, does making the source causal modulate the encoding of the source in language (English)? And, even if it does, does a goal bias persist for these types of causal events? Our results suggest that the answer is “yes” to both of these questions. Sources that cause motion of the figure object were encoded more often than noncausal sources in language. However, a goal bias remained nonetheless, highlighting the robustness of the goal bias in language, and shedding light on explanations for its existence.

Acknowledgments

We gratefully thank the children and parents who participated and made this study possible. Thanks to Amrita Bindra and Maria Brucato for help with manuscript preparation, Kristen Johannes for assistance with statistical analyses, and two anonymous reviewers for stimulating our thinking about explanations for a goal bias and suggesting alternate scenarios for which a goal bias could be tested (see “General discussion”). This research was supported by start-up funds from Montclair State University and NSF grant #1145762 awarded to Laura Lakusta.

Notes

1. Note that there are also cross-linguistic differences in how speakers of different languages encode agents, particularly agents of accidental actions. For example, English speakers encode agents more in their descriptions of accidental events than Japanese speakers (Fausey, Long, Inamori, & Boroditsky, 2010) and Spanish speakers (Fausey & Boroditsky, 2011). Thus, although children’s sensitivity to the intentional and

causal structure of events may assist them with mapping conceptual representations into language, given these cross-linguistic differences observed, they also then need to learn how their particular language expresses agents for different events.

2. We refer to events where the source does not cause motion of the figure, as noncausal, since the source does not cause the motion of the figure per se. However, it is quite possible that events with noncausal sources (e.g., a ball rolls from X to Y, a man hops from X to Y) have an underlying causal structure; for example, a ball only can roll if an external force acts on it, and a man can hop by causing his own motion). Research has shown that toddlers (Muentener, Bonawitz, Horowitz, & Schulz, 2012; Muentener & Schulz, 2014) and even infants (Saxe, Tenenbaum, & Carey, 2005) infer causal structure for otherwise unexplained events. Similarly, in the current study, children may also infer causal structure for the noncausal events. In the "General discussion" we address how the causal/intentional structure may explain a goal bias in language for a variety of events.
3. A set of post hoc models tested the effect of path type (i.e., the goal bias) separately for causal and noncausal events. These models confirmed that a goal bias persisted in adults' and children's encoding of both causal (adults: $\beta = 3.71$, Wald $Z = 9.30$, $p < .001$; children: $\beta = 2.13$, Wald $Z = 10.30$, $p < .001$); and noncausal events (adults: $\beta = 5.78$, Wald $Z = 9.44$, $p < .001$; children: $\beta = 4.82$, Wald $Z = 13.29$, $p < .001$).

References

Aissen, J. (2001). Markedness and subject choice in optimality theory. In G. Legendre, J. Grimshaw, & S. Vikner (Eds.), *Optimality-theoretic syntax*. Cambridge, MA: MIT Press.

Bates, D., & Maechler, M. (2009). lme4: Linear mixed effects models using S4 classes (Vol. R package version 0.999375-31).

Dowty, D. (1991). Thematic proto-roles and argument selection. *Language*, *67*(3), 547–619.

Fausey, C. M., & Boroditsky, L. (2011). Who dunnit? Cross-linguistic differences in eye-witness memory. *Psychonomic Bulletin & Review*, *18*, 150–157.

Fausey, C., Long, B., Inamori, A., & Boroditsky, L. (2010). Constructing agency: The role of language. *Frontiers in Psychology*, *1*, 162.

Filip, H. (2003). Prefixes and the delimitation of events. *Journal of Slavic Linguistics*, *11*(1), 55–101.

Fisher, C., Hall, D. G., Rakowitz, S., & Gleitman, L. (1994). When it is better to receive than to give: Syntactic and conceptual constraints on vocabulary growth. In L. Gleitman & B. Landau (Eds.), *Acquisition of the Lexicon* (pp. 333–375). Cambridge, MA: MIT Press.

Fisher, C., & Song, H. (2006). *Who's the subject? Sentence structures as analogs of verb meaning*. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), *Action meets word: How children learn the meanings of verbs* (pp. 392–425). New York: Oxford University Press.

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

Jackendoff, R. (1983). *Semantics and cognition*. Cambridge, MA: MIT Press.

Jackendoff, R. (1990). *Semantic structures*. Cambridge, MA: MIT Press.

Kako, E. (2006). Thematic role properties of subjects and objects. *Cognition*, *101*, 1–42.

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

Lakusta, L., & Landau, L. (2012). Language and memory for motion events: Origins of the asymmetry between goal and source paths. *Cognitive Science*, *36*(3), 517–544.

Lakusta, L., Yoshida, H., Landau, B., & Smith, L. (2006). Cross-linguistic evidence for a goal/source asymmetry: The case of Japanese. Poster presented at the International Conference on Infant Studies, June, Kyoto, Japan.

Levinson, S.C., & Wilkins, D. (eds.) (2006). *Grammars of space: towards a semantic typology*. Cambridge: Cambridge University Press.

Levin, B., & Rappaport-Hovav, M. (1995). Unaccusativity: At the syntax-lexical semantics interface. Cambridge, MA: MIT Press.

Markovskaya, E. (2006). Goal-source asymmetry and Russian spatial prefixes. In P. Svenonius (Ed.), *Working Papers in Linguistics, 33.2, Special Issue on Adpositions* (pp. 200–219). Tromsø C: Nordlyd.

Moravcsik, J. M. (1981). How do words get their meanings? *Journal of Philosophy*, *78*(1), 5–24.

Muentener, P. (2009). The origin and development of causal reasoning. Unpublished doctoral dissertation.

Muentener, P., & Lakusta, L. (2011). The language of causal events: Exploring the link between representations of intentional action and causal events. *Cognition*, *119*, 341–355.

Muentener, P., Bonawitz, E. B., Horowitz, A., & Schulz, L. (2012). Mind the gap: When toddlers do and do not expect contact causality. *PLoS ONE*, *7*(4), e34061.

Muentener, P., & Schulz, L. (2014). Toddlers infer unobserved causes for spontaneous events. *Frontiers in Psychology*, *5*, 1496. doi:10.3389/fpsyg.2014.01496

Nam, S. (2004). Goal and source: Asymmetry in their syntax and semantics. Paper presented at the Workshop on Event Structure, March, Leipzig, Germany.

Papafragou, A. (2010). Source-goal asymmetries in motion representation: Implications for language production and comprehension. *Cognitive Science*, *34*, 1064–1092.

Pinker, S. (1989). *Learnability and cognition: The acquisition of argument structure*. Cambridge, MA: MIT Press.

Pustejovsky, J. (1991). The generative lexicon. *Computational Linguistics*, *17*(4), 409–441.

Pustejovsky, J. (1995). *The generative lexicon*. Cambridge, MA: MIT Press.

Prasada, S. (2000). Acquiring generic knowledge. *Trends in Cognitive Science*, *4*(2), 66–72.

Regier, T. (1996). *The human semantic potential: Spatial language and constrained connectionism*. Cambridge, MA: MIT Press.

van Riemsdijk, H. C. (2007). The case of source and goal: What determine case in German spatial PPs. Paper presented at Harvard Linguistics Theory Group, April 2007, Cambridge, MA.

Saxe, R., Tenenbaum, J., & Carey, S. (2005). Secret agents: Inferences about hidden causes by 10- and 12-month-old infants. *Psychological Science*, *16*, 995–1001.

Srinivasan, M., & Barner, D. (2013). The Amelia Bedelia effect: World knowledge and the goal bias in language acquisition. *Cognition*, *128*, 431–450.

Wagner, L., & Lakusta, L. (2009). Using language to navigate the infant mind. *Perspectives on Psychological Science*, *4*(2), 177–184.

Wilson, F., Unal, E., Trueswell, J. C., & Papafragou, A. (2014). Homologies between language and event cognition: Evidence from event role prominence. Paper presented at the Boston University Conference of Language Development, November, Boston, MA.

Wolff, P. (2003). Direct causation in the linguistic coding and individuation of causal events. *Cognition*, *88* (1), 1–48.