Children's comprehension and production of transitive sentences is sensitive to the causal structure of events

Melissa E. Kline[1], **Jesse Snedeker**[2], **& Laura E. Schulz**[3]
(mekline@mit.edu, snedeker@wjh.harvard.edu, lschulz@mit.edu)

Department of Brain and Cognitive Sciences[1,3]
Massachusetts Institute of Technology
43 Vassar Street, Cambridge, MA 02139

Department of Psychology[2]
Harvard University
33 Kirkland Street,Cambridge, MA 02138

Abstract

Young children learn about causal structure not only from observation, but also from the language they hear. Two novel-verb studies show that preschoolers expect transitive sentences like 'Sarah broke the lamp' to express relationships between cause and effect. Previous work has conflated causation with other semantic features, presenting children with coarse contrasts between scenes varying on multiple dimensions. The current studies used minimal-pair scenes that varied on a single causally-relevant feature, the spatiotemporal contiguity between action and outcome. Preschoolers were more likely to produce transitive descriptions (*She wugged it*) to describe causal versions of events. They also reliably selected causal versions when asked to *find where she wugged [it]*. Transitive syntax thus provides children with a rich source of evidence about the verbs they learn and the events they encounter in the world.

Keywords: Language acquisition; Causality; Argument structure

Introduction

Information about causal relationships is embedded in the structure of the language that young children hear every day. In addition to explicitly causal constructions like 'The hammer made the lamp break', children hear many transitive sentences like 'Sarah broke the lamp.' Although these sentences are argued to express causation in adult grammars (in contrast to intransitive sentences like 'The lamp broke', Levin & Rappaport-Hovav 2005), causal transitive sentences are syntactically identical to noncausal transitives like 'Sarah sees the lamp' and 'Sarah resembles her sister.' Thus, transitive syntax does not provide a deterministic cue to causal structure.

Despite this variation, there are several reasons to believe that adults and children have a bias to interpret transitive sentences causally. First, across languages, verbs of direct external causation are consistently expressed with transitives, whereas the encoding of noncausal verbs is more variable. For instance, in Russian sentences like 'The supervisor *manages* the department' must be expressed in a non-transitive sentence ('The supervisor *manages over* the department'; Levin & Rappaport-Hovav, 2005). Second, when adults are asked to guess the meaning of 'jabberwocky' transitive sentences like 'The glob blebbed the meemor,' they report that such sentences are likely to describe events which have properties of physical causation: motion, contact, exertion of force, and causation (Kako, 1998).

Critically, young children also show signs of this bias: they make and accept transitive overregularizations ('The rabbit disappeared' $\rightarrow$ *'The magician disappeared the rabbit') more readily with verbs that describe a (caused) change of state or motion (Ambridge, Pine, Rowland & Young, 2008; Pinker, 1989). Even children as young as 28 months prefer to associate a new transitive sentence with an event involving causation (e.g., *break*) rather than one that simply involves contact (e.g., *touch*; Naigles, 1996). This suggests that there may be early links between causal semantics and transitive syntax.

In the present studies, we explore whether 3- and 4-year-old children's expectations about novel transitive sentences are specifically sensitive to causality. To do this, we control other event features and vary only a single dimension that is relevant to causal relationships, namely the presence or absence of a spatiotemporal gap between an agent's action and a physical outcome. In nonlinguistic tasks, we know that even young infants are sensitive to spatiotemporal cues in distinguishing causal and noncausal events (Leslie & Keeble, 1987; Muentener & Carey, 2010). These abilities allow children to learn about the world and design effective interventions on causal processes.

However, although children learn a great deal about the world around them through the testimony of others (Harris & Koenig, 2006), relatively little is known about how children map causal relationships into language. This is surprising, given that testimony about causal properties can make a significant difference to children's understanding of causal events. Children shift from perceptually-based to causally-based categorization if causal language is used to describe objects (Nazzi & Gopnik, 2000; Nazzi & Gopnik, 2001), preschoolers explore perceptually identical objects with disparate causal properties more if the objects share a common label (Schulz, Standing, & Bonawitz, 2008), and 2-year olds who have learned that event A predicts event B only intervene on A to try to cause B if the events are described with

causal language (Bonawitz, Ferranti, Saxe, Gopnik, Meltzoff, Woodward, & Schulz, 2010.) Nonetheless, little is known about the relationship between children's perception of observed causal events and the specific linguistic structures used to describe them. In particular, we do not yet know either whether children selectively produce transitive sentences to describe scenes where agent and outcome subevents respect spatiotemporal contiguity. Conversely, we do not know whether children selectively expect transitive verbs to refer to causal events.

Children's ability to produce novel verbs in new sentence frames has often been considered the strongest form of evidence that they understand abstract syntactic representations (Tomasello, 2000). However, few production studies have explored what it is that children know about the *meanings* of these syntactic structures. Instead, they have focused on the presence (or absence) of creative verb use at particular ages. By and large, these studies have not explored the semantic features that children expect with different sentence types, simply providing event types that were sufficiently appropriate for the target generalization. Only two studies (Brooks & Tomasello, 1999; Kline & Demuth, 2008) have looked at how semantic content affects children's syntactic generalization. However, these studies compared children's production of novel sentences for events that differed in many ways (e.g., a puppet dusting a toy boot versus poking it to make it squeak), rather than systematically varying specific event features. These results thus point to semantic *sensitivity* in children's representations, but cannot make strong claims about the semantic *content* of these representations. This represents a significant gap in the literature, because the specific generalizations that children make can provide unique insight into how they license and restrict particular syntactic structures based on the evidence they observe.

The preferential-looking methodology used in the Naigles (1996) study has been a key paradigm used to reveal what young children know about transitive syntax. In these studies, young children hear a novel verb in a particular construction (e.g., *She wugged him*) while looking at two contrasting events. The children's preference for one scene over another is taken as evidence for (a) the presence of an abstract syntactic representation flexible enough to guide expectations about a new verb and (b) a connection between the syntactic construction they hear and the type of scene that they choose. However, these studies have pitted prototypically transitive events (e.g., a girl making a boy bend at the waist) against prototypically intransitive events (e.g., a boy and girl each waving their own arms), giving children a coarse and multidimensional contrast between scenes. This line of work thus cannot make strong claims about the semantic *content* of children's expectations about transitive sentences, because causation has been systematically conflated with other semantic features such as whether the participants have differing roles in the event. The experiments presented here take a different approach, providing minimal-pair contrasts in order to explore a specific semantic property, causation, which may guide young children's expectations about transitive sentences.

Experiment 1 looks at the production of transitive sentences. As Fisher (2002) and others have pointed out, children should not assume that all new verbs can appear in all sentence frames, because in the adult grammar there are semantic restrictions on these constructions. The generalizations they do make can thus reveal the expectations that they have about the semantics of particular constructions. Here we ask whether children attend to causal structure (as indexed by the spatiotemporal configuration of action and outcome subevents) when making transitive generalizations. In this experiment, children saw one of two versions of several novel events, which were described with an intransitive sentence (e.g., *The round thing is wugging.*) In the causal versions of the events, a puppet entered the scene and contacted an object which immediately lit up or played a sound. The noncausal 'gap' events were identical except that the puppet stopped before reaching the object, there was a short pause, and then the effect occurred (apparently spontaneously.) Children were asked: *What's [the puppet] gonna do with that thing?* If children believe a transitive verb can be used to describe the target scene, the prompt invites a transitive response:(*She's gonna wug it!*)

Experiment 2 examines the comprehension of transitive structures, which is especially important for understanding how children learn about events from others. Children were shown two possible referents, a causal and noncausal version of events like those in Experiment 1. Each was initially described with intransitive sentences. Children then heard a transitive prompt (*Find the movie where she wugged the round thing* or *Find the movie where she didn't wug the round thing*) and had to choose one of the two scenes. If preschoolers believe that transitive syntax is preferentially used to refer to causal events, they should choose the appropriate picture for each prompt.

Experiment 1

By comparing the use of transitive descriptions by children who saw either the causal or noncausal version of a particular event, we can learn whether they believe this difference to be relevant for the syntactic privileges of a novel verb. Based on previous studies, we expected 3- and 4-year-old children would be able to use novel verbs creatively when prompted to do so (e.g., *What's she gonna do with that thing?*) This prompt invites a transitive response (*She's gonna wug it*) if children understand the association between causal events and transitive syntax, and believe that they are describing a causal event.

Note that children have a number of other options for responding: they could simply repeat the verb exactly as they had learned it (*It's gonna wug*),they could use another noncausal description of the event (*She's gonna fly down and touch it*) or they could produce serial structure that leaves

the causal relationship ambiguous (*She's gonna fly down and then it's gonna wug.*) With discourse pressure, and other features of the event held constant, we predicted that children would be more likely to generate transitive descriptions to describe spatiotemporally contiguous causal events than to describe closely matched 'gap' events. This pattern of results would be consistent with patterns in adult language and with children's patterns of generalization with known verbs.

Methods

Participants Preschoolers were recruited from a local children's museum (n=24, mean age: 3;11, range 3;0-4;10, 12 girls). The experimental procedure required children to make multiple verbal responses during every trial, a task which was challenging for shy children. Participants were replaced if they failed to produce any sentences with novel verbs in response to test prompts (n=9). Seven additional children were replaced due to failure to speak at all during the experiment, and two for refusal to complete the test session. All children received a sticker and award certificate for their participation at the end of the session.

Materials Four novel apparatuses were constructed to show a variety of novel sound/light emission events. All events were initiated by one of two agents, boy and girl puppets held by the experimenter. Causal and noncausal versions (differing only in the spatiotemporal relationship between action and outcome subevents) were created for four different novel events. This yielded a total of eight possible events. The causal version of each event is described below. The noncausal *meeking*, *wugging*, and *gorping* events were identical to the causal versions except for a roughly 10-15 cm gap and 1 second pause between the puppet's final position and the toy activating. In the noncausal version of the *pilking* event, a wall on the ramp prevented the ball from reaching the target.

Meeking: Puppet reaches both hands out to touch blinking fiber-optic wand.

Wugging: Puppet wiggles down to contact round globe, which lights up and spins.

Gorping: Puppet hops over and lands on a toy which squeaks.

Pilking: Puppet places ball on ramp, which rolls down to hit a donut shape which 'boings.'

Videos of all stimuli are available at http://web.mit.edu/mekline/www/.

Procedure Children were introduced to 'my friend Sarah', a puppet who liked to say silly words. Children were prompted to repeat two novel words (*zorb, gliffit*) to prepare them for the test session. They were then introduced to the second puppet (Joey) in the same manner. Each participant saw one version of each of the four events, with causal and noncausal events alternating. Event version and order of presentation was counterbalanced across children. Children received the same linguistic and event exposure for each trial. Children watched the action (enacted with Sarah as the agent) three times, with the following description:

When this happens, that's called wugging.

Let's watch again, because the round thing is gonna wug.

Whoa, it's wugging!

Now Sarah's gonna have one more turn.

[Prompt 1]: *Can you tell me what she's gonna do with that thing?*

[Prompt 2]:*What's gonna happen?*

If children didn't respond to prompts 1-2, they were reminded of the name of the event and prompted again to describe the event:

[Prompt 3]: *'When this happens it's called wugging. So, can you tell me what she's gonna do with that thing?'*

Finally, the second puppet was introduced and the entire elicitation procedure (*Now Joey's gonna have a turn...*) was repeated.

Results

The primary measure of interest was the rate at which children produced novel transitive sentences during causal versus noncausal event trials. We hypothesized that children would be more likely to make transitive generalizations when they heard a novel verb paired with a causal event than when they saw the corresponding noncausal event. Sentences were coded as transitive as long as they contained at least the verb and a direct object (e.g., *What's Sarah gonna do with that thing? Wug it.*)

Children produced transitive sentences on significantly more causal than noncausal trials (Wilcox signed rank test, $p = 0.0317$; $M_{causal} = 1.2/2, M_{noncausal} = 0.83/2$). Moreover, children produced transitive sentences readily to describe the causal events, but often required all three prompts in response to the noncausal events. Thus the difference between conditions is even more evident when transitive productions generated after the third and final prompt are excluded (Wilcox signed rank test, $p = 0.0034$; $M_{causal} = 0.83/2, M_{noncausal} = 0.29/2$).

The number of trials on which children produced any sentence (of at least two words) with the target verb was also significantly different between conditions (Wilcox signed rank test, $p = 0.039$; $M_{causal} = 1.67/2, M_{noncausal} = 1.38/2$) Given that the prompt (*What's she gonna do with that thing?*) cued the transitive, the fact that sentences were produced on fewer noncausal trials may be due to the increased difficulty of generating an alternative response to the prompt if the child does not believe a transitive sentence is possible in noncausal contexts.

Finally, there was a significant effect of age (3- vs. 4-year-olds, Fisher's exact test, $p = 0.041$): 4 year olds produced more transitive sentences than three year olds on both causal (83% vs 50% producing at least one transitive sentence) and noncausal trials (41% vs 8%).

Discussion

These results show that 3- and 4-year-old children are more likely to generalize a novel verb from the intransitive (*The*

round thing is wugging) to the transitive (*She wugged the round thing*) when they are describing a causal event than when they are describing a matched version of the same event that changes the spatiotemporal contiguity and thus the causal structure of the event. This indicates an adultlike restriction on the types of scenes that can be described with transitive sentences: a lamp can break in many ways, but it is only proper to say that Sarah *broke the lamp* if she caused the effect.

In addition to influencing how children talk about different events, biases about the meanings of syntactic structures can guide language acquisition. If children believe that transitive sentences express causal meaning, then just hearing a verb in that context is significant: the syntactic information can influence how they interpret the meaning of that verb. Experiment 2 asks what expectations children have about events that are referred to with transitive sentences.

Experiment 2

Toddlers as young as 20 months can show preferences about what the verbs might mean based on the syntactic structure of sentences they appear in (see Fisher, 2002, for a review.) However, the relevant studies have provided children with coarse contrasts between events differing on multiple dimensions (e.g., a girl making a boy bend at the waist vs. a boy and girl each waving their own arms). Information about causal relationships has thus been conflated with the many other differences between these scenes.

Experiment 2 presents a first attempt to investigate how children's scene preferences following a transitive sentence are affected when only a single aspect of the event structure, spatiotemporal contiguity, is varied. As with Experiment 1, spatiotemporal contiguity between action and outcome subevents was taken as an index of causality. Previous research has already established that children use spatiotemporal cues to distinguish causal and noncausal events beginning in infancy. What is at issue here is whether this distinction is relevant to how they interpret the meaning of transitive constructions.

As in Experiment 1, the events in this study were minimal pairs: scenes were identical to each other save for the spatiotemporal relationship between the agent's action and the physical outcome. If children expect transitive sentences to refer to causal scenes in particular, then when they hear transitive sentences like 'Sarah wugged the round thing', they should choose causal scenes over noncausal 'gap' variants. However, if children have not yet converged on causality as a preferred interpretation of the transitive (e.g., if they are sensitive only to the coarser scene contrasts that have been tested in previous studies), then children might choose between events randomly.

Finally, to control for the possibility that children might select the causal events simply because they might be more salient than the noncausal events, we also asked children to identify scenes in which the puppet (*didn't wug the round thing*), with questions presented in random order.

Methods

Participants Preschoolers were recruited from a local children's museum (n=24 mean age: 3;11, range 3;0-4;9, 12 girls). Participants were replaced if they were unable to reach criteria on the pretest training (n=3.) Five additional children were replaced due to refusal to participate or parental interference. All children received a sticker and award certificate for their participation at the end of the session.

Materials Videotaped causal and noncausal versions of the four events used in Experiment 1 were created. Slight alterations were made to the *meek* event because a few children in Experiment 1 made comments suggesting they viewed the noncausal event as causal; in the new version the puppet activated the toy by bending over and placing her head on the box (noncausal: on the ground next to the box) rather than reaching with both hands. Two new events were also created (for a total of 6 base events), both involving a caused-motion interaction:

Fooping: Puppet contacts balanced blue wedge, which tips over and swings.

Zigging: Puppet slides over and makes white 'accordion' rectangle pop up.

Noncausal versions were identical but included a roughly 10-15 cm gap and 1 second pause between the puppet's final position and the activating toy. In all videos, the event was played through three times, ending on a still shot showing the result and the final position of the puppet. Videos varied between 4.5 and 8 seconds in total length, with no more than a 1 second length difference between the causal and noncausal version of the same event.

Video stimuli were presented on a 17-inch laptop, using the Psychtoolbox extensions of Matlab (Brainard, 1997). An additional apparatus was used during the introduction, consisting of an open-backed box with a toy helicopter on top that could be covertly activated.

Procedure Each session consisted of an introduction/training, a pretest and the main test [1]. During the introduction, children were (as in Experiment 1) introduced to 'my friend Sarah', a puppet who liked to say silly words. Children were prompted to repeat two novel words (*zorb, gliffit*) to prepare them for the test session. After this the experimenter showed them the helicopter apparatus, demonstrating that 'Sometimes, Sarah puts her hand here [on top of the box] and makes it go...But sometimes, it just happens on its own, because there's a battery inside.' Children were then prompted to activate the toy, and shown again that

[1] Pilot testing with 3- and 4-year-olds revealed that children had difficulty picking out movies 'where Sarah made it happen' without training. This may be because of differences in their experience for how events come about in real life versus television. In order to ensure that children understood the videos used in this study, we included a training/pretest using no novel verbs in which children learned that sometimes Sarah touched and activated objects, and sometimes they activated spontaneously.

it could activate spontaneously. Then the experimenter prepared children for the rest of the session by explaining that in the movies they would see, 'Sometimes, Sarah makes something happen. Like this, when they're touching. And sometimes they don't touch and it just happens on its own, because there's a battery inside.' Note that children never heard causal (or noncausal) events described with transitive sentences such as 'Sarah's touching the box.'

In the pretest, children heard no novel verbs, but simply had to identify both whether a puppet and an apparatus were touching and whether Sarah made the event happen. This allowed us to determine if children understood the videos they were seeing. Children saw both the noncausal and causal versions of one of the sound emission events (version and side presentation counterbalanced.) During these videos, children heard neutral language directing their attention to the video (*Look over here!...Whoa, look at that!*) For each video, children were asked if 'Sarah and that thing [are] touching?...So, did Sarah make that happen or did it just happen on its own?'

After seeing both versions, children made two forced-choice decisions, identifying where Sarah and the object were touching, and where Sarah made the event happen. Positive and negative versions of these questions were counterbalanced. The pretest procedure was then repeated with the second sound-emission event. Children who could not provide correct answers to 3 out of the 4 total forced-choice questions in the pretest were not included in the analysis. Three children were replaced for this reason.

For the main test, children saw one trial for each of four events (*Wugging, Meeking, Fooping,* and *Zigging*). In each trial, children saw the causal version of the event on one side of the screen, and the noncausal version on the other. The trial order, as well as version and side presentation for each trial, was randomized for each child.

With each version, children heard the same description, using the novel verb in intransitive sentences:

Look over here!

The tall thing is meeking, it's meeking.

Whoa! Watch one more time, it's gonna meek...Wow!

Children were reminded that 'In one movie Sarah made it happen, and in one movie she didn't.' They saw each event a final time, and then the final freeze-frames for both movies were presented. Children heard two test prompts (positive- *Can you find the movie where she meeked the round thing?*; negative - *Can you find the movie where she didn't meek the round thing?*); with order randomized across trials. As a manipulation check children were finally asked to identify 'the movie where they're touching.'

Results

The dependent measure of interest was how often children chose the causal or noncausal version of each event in response to the prompt. We predicted that children would choose the causal version of the event when asked to 'find where she wugged the round thing' (a positive transitive prompt.) Note that this kind of sentence should suggest a causal referent *only* if children know that a transitive sentence is likely to refer to this kind of scene. Children saw four trials; their performance was converted to a score between 0 and 4 reflecting the number of trials on which they chose the causal scene. The distribution of these scores was significantly above chance performance (Wilcox signed rank test, $p = 0.00014$; 3.08/4 mean causal choices); no children chose fewer than two causal scenes in response to a positive prompt.

To show that these choices did not result simply from a global preference for the causal movies, children's responses to *negative* prompts (*Can you find the movie where she didn't wug the round thing?*) were also analyzed. For these prompts, children's causal choice scores were significantly *below* chance (Wilcox signed rank test, $p = 0.00020$, 0.88/4 mean causal choices); no children chose more than two causal scenes in response to a negative prompt. There was no significant difference between the performances of 3 and 4 year olds (Mann-Whitney U, Positive prompt: $p = 0.11$; Negative prompt: $p = 0.21$).

A manipulation check confirmed that children were successfully identifying the scenes where the puppet and the object were touching; children identified the correct movie at a rate significantly above chance (Wilcox signed rank test, $p = 0.0014$; 3.04/4 mean correct choices.)

Discussion

3- and 4-year-olds identified the correct versions of matched events in this study: 'Sarah wugged the round thing' led to causal choices, while 'Sarah didn't wug the round thing' led to noncausal choices, even though no transitive sentences were previously modeled during the experiment. Note that children could not simply attend to the words 'Sarah's not' to make this choice, because the puppet made the same motions in both versions of each event. Children were just as successful with the positive prompt, indicating that they did not need to rely on a simple lexical cue to correctly choose a scene.

Unlike previous studies of this kind, all properties of the causal and noncausal videos (other than spatiotemporal contiguity) were matched: the participants, the action performed by the agent, and the physical outcome were identical in both versions. This work shows that children are sensitive to the causal structure of events, and not only to coarser contrasts between event types such as the number of active participants.

General Discussion

Across both a production and a comprehension task, 3- and 4-year-olds were found to be sensitive to causal structure in deciding how to interpret and use novel verbs. In Experiment 1, they were more likely to produce a novel transitive sentence like *Sarah wugged the round thing* when they had seen a causal scene versus a matched noncausal 'gap' event. In Experiment 2, they were more likely to choose the causal scene when asked to 'find the movie where Sarah wugged the round thing', and to choose the noncausal scene when asked to 'find where she didn't wug the round thing.' These results show

that causal relationships, as indicated by spatiotemporal contiguity, are important for children's expectations about transitive sentences. 3- and 4-year-olds understand that a scene showing a causal relationship between action and outcome subevents is more appropriately described with transitive syntax than a very similar one which does not show the same causal relationship. This ability is critical both for constraining children's creative language use and for guiding their understanding of the verbs they learn.

Extensive previous research has established that children understand a great deal about causal relationships by the time they are three years old. However, the present work is novel in showing that beyond *recognizing* causal and noncausal scenes, children are able to *map* these different types of events onto linguistic structures, producing and comprehending transitive syntax in a way that reflects a bias to associate them with causal scenes. From the perspective of children's syntactic development, the present work moves away from demonstrations that syntactic structure can influence children's choice between two scenes varying on multiple dimensions. Instead, these experiments target the semantic *content* of children's representations: a single manipulation that alters the causal structure of an event also alters preschoolers' syntactic expectations about a verb describing that event.

In the present studies, causality was operationalized by spatiotemporal contiguity between action and outcome subevents. Future work will need to address whether children also map transitive sentences to events with other causal cues, such as the presence of an intentional agent or the conditional dependence between the action and the outcome.

This work also provides a strong foundation for studying how younger children learn to associate transitive structures with particular types of events in the world. The forced-choice comprehension study in particular parallels looking-time studies run with children as young as 20 months old. Thus this technique could be used to study how associations between transitive sentences and causal events develop. In addition, ongoing work will address whether young children can use these expectations about transitive syntax to perform syntactic bootstrapping (Gleitman, 1990), using the sentence frame they hear to determine which of two distinct events (with counterbalanced causal and noncausal versions) is the more likely referent for a new verb.

Language is an important channel through which children learn from others. Knowing when and how children expect transitive syntax to describe causal events is critical for understanding both how they learn to use language in an adult-like way, and how they learn about causal relationships from the people around them.

Acknowledgments

We are grateful for funding from the James S. McDonnell Foundation Causal Learning Collaborative, the NSF, and the John Templeton Foundation. Thanks to Claire O'Connell and Lucy Ji for assistance with stimuli construction and data collection, as well as to the Schulz and Gibson labs at MIT and the Snedeker lab at Harvard for discussion and feedback.

References

Ambridge, B., Pine, J. M., Rowland, C. F., & Young, C. R. (2008). The effect of verb semantic class and verb frequency (entrenchment) on children's and adults' graded judgements of argument-structure overgeneralization errors. *Cognition*, *106*(1), 87–129.

Bonawitz, E. B., Ferranti, D., Saxe,R., Gopnik,A., Meltzoff, A., Woodward, J., & Schulz, L. E. (2010). Just do it? Investigating the gap between prediction and action in toddlers' causal inferences. *Cognition*, *115*(1), 104–117.

Brainard, D. (1997). The Psychophysics Toolbox. *Spatial Vision*, *10*, 433–436.

Brooks, P. J., & Tomasello, M. (1999). How children constrain their argument structure constructions. *Language*, *75*(4), 720–738.

Fisher, C. (2002). The role of abstract syntactic knowledge in language acquisition: A reply to Tomasello (2000). *Cognition*, *82*, 259–278.

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

Harris, P. L., & Koenig, M. A. (2006). Trust in testimony: How children learn about science and religion. *Child Development*, *77*(3), 505–524.

Kako, E. T. (1998). *The event semantics of syntactic structures*. Unpublished doctoral dissertation, University of Pennsylvania.

Kline, M., & Demuth, K. (2008). *Syntactic generalization with novel intransitive verbs: Who is pilking?* Boston, MA.

Leslie, A. M., & Keeble, S. (1987). Do six-month-old infants perceive causality? *Cognition*, *25*(3), 265–288.

Levin, B., & Hovav, M. R. (2005). *Argument realization*. Cambridge, UK: Cambridge University Press.

Muentener, P., & Carey, S. (2010). Infants' causal representations of state change events. *Cognitive Psychology*, *61*(2), 63–86.

Naigles, L. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, *17*(02), 357.

Naigles, L. R. (1996). The use of multiple frames in verb learning via syntactic bootstrapping. *Cognition*, *58*, 221–251.

Nazzi, T., & Gopnik, A. (2000). A shift in children's use of perceptual and causal cues to categorization. *Developmental Science*, *3*(4), 389–396.

Nazzi, T., & Gopnik, A. (2001). Linguistic and cognitive abilities in infancy: When does language become a tool for categorization? *Cognition*, *80*(3), B11–20.

Tomasello, M. (2000). Do young children have adult syntactic competence? *Cognition*, *74*, 209–253.